Self-Development in Mechanical and Manufacturing Engineering

Questions and Answers

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Synopsis

The mechanical and manufacturing field requires an understanding of core areas including mechanics, dynamics, thermodynamics, material science, structural analysis and electrical technology. It is the branch of engineering that involves the design, production, and operation of machinery.

The present text book contains a wide spectrum of questions and answers which focuses on most areas of mechanical and manufacturing engineering. This book covers important topics in mechanical and manufacturing engineering. These topics are chosen from a collection of most authoritative and best reference books on mechanical and manufacturing engineering.

The questions cover the following areas of mechanical and manufacturing engineering:

- Fluid mechanics.
- Engineering design.
- Refrigeration and air conditioning.
- Heat transfer.
- Machining operations.
- Metal casting.
- Engineering materials.
- Forming operations.
- Joining operations.

One should spend one hour daily for two months to learn and assimilate mechanical and manufacturing engineering comprehensively. This way of systematic learning will prepare anyone easily towards mechanical and manufacturing engineering interviews, online tests, examinations and certifications.

Marketing Plan

I have no marketing plan for my book. I hope that you would take the advantage of marketing it.

Social Media

The only social medium I accustomed to use is Facebook.

Writing Plans

There are five books which have been published in Lap Lambert Publishing Institution. These books specialize in mechanical engineering, mathematics and civil engineering. For next 2 – 3 years, I am planning to publish more than ten books on composite materials technology and theoretical analysis.

Question One

What are Mechanical Properties of Material which every Mechanical Engineer Should Know?

Mechanical properties of material:

There are mainly two types of materials. First one is metal and other one is nonmetals. Metals are classified into two types: Ferrous metals and Non-ferrous metals. Ferrous metals mainly consist iron with comparatively small addition of other materials. It includes iron and its alloy such as cast iron, steel, HSS etc. Ferrous metals are widely used in mechanical industries for its various advantages.

Nonferrous metals contain little or no iron. It includes aluminum, magnesium, copper, zinc etc.

Most Mechanical Properties are associated with metals these are-

#1. Strength:

The ability of material to withstand load without failure is known as strength. If a material can bear more load, it means it has more strength. Strength of any material mainly depends on type of loading and deformation before fracture. According to loading types, strength can be classified into three types.

1. Tensile strength:
2. Compressive strength:
3. Shear strength:

According to the deformation before fracture, strength can be classified into three types.

1. Elastic strength:
2. Yield strength:
3. Ultimate strength:

#2. Homogeneity:

If a material has same properties throughout its geometry, known as homogeneous material and the property is known as homogeneity. It is an ideal situation but practically no material is homogeneous.

#3. Isotropy:

A material which has same elastic properties along its all loading direction known as isotropic material.

#4. Anisotropy:

A material which exhibits different elastic properties in different loading direction known as an-isotropic material.

#5. Elasticity:

If a material regains its original dimension after removal of load, it is known as elastic material and the property by virtue of which it regains its original shape is known as elasticity.

Every material possesses some elasticity. It is measure as the ratio of stress to strain under elastic limit.

#6. Plasticity:

The ability of material to undergo some degree of permanent deformation without failure after removal of load is known as plasticity. This property is used for shaping material by **metal working**. It is mainly depending on temperature and elastic strength of material.

#7. Ductility:

Ductility is a property by virtue of which metal can be drawn into wires. It can also define as a property which permits permanent deformation before fracture under tensile loading. The amount of permanent deformation (measure in percentage elongation) decides either the material is ductile or not.

Percentage elongation = (Final Gauge Length – Original Gauge Length) *100/ Original Gauge Length

If the percentage elongation is greater than 5% in a gauge length 50 mm, the material is ductile and if it less than 5% it is not.

#8. Brittleness:

Brittleness is a property by virtue of which, a material will fail under loading without significant change in dimension. Glass and **cast iron** are well known brittle materials.

#9. Stiffness:

The ability of material to resist elastic deformation or deflection during loading, known as stiffness. A material which offers small change in dimension during loading is stiffer. For example, steel is stiffer than aluminum.

#10. Hardness:

The property of a material to resist penetration is known as hardness. It is an ability to resist scratching, abrasion or cutting. It is also define as an ability to resist fracture under point loading.

#11. Toughness:

Toughness is defined as an ability to withstand with plastic or elastic deformation without failure. It is defined as the amount of energy absorbed before actual fracture.

#12. Malleability:

A property by virtue of which a metal can flatten into thin sheets, known as malleability. It is also defined as a property which permits plastic deformation under compression loading.

#13. Machinability:

A property by virtue of which a material can be cut easily.

#14. Damping:

The ability of metal to dissipate the energy of vibration or cyclic stress is called damping. Cast iron has good damping property, that's why most of machines body made by cast iron.

#15. Creep:

The slow and progressive change in dimension of a material under influence of its safe working stress for long time is known as creep. Creep is mainly depending on time and temperature. The maximum amount of stress under which a material withstand during infinite time is known as creep strength.

#16. Resilience:

The amount of energy absorb under elastic limit during loading is called resilience. The maximum amount of the energy absorb under elastic limit is called proof resilience.

#17. Fatigue Strength:

The failure of a work piece under cyclic load or repeated load below its ultimate limit is known as fatigue. The maximum amount of cyclic load which a work piece can bear for infinite number of cycle is called fatigue strength. Fatigue strength is also depending on work piece shape, geometry, surface finish etc.

#18. Embrittlement:

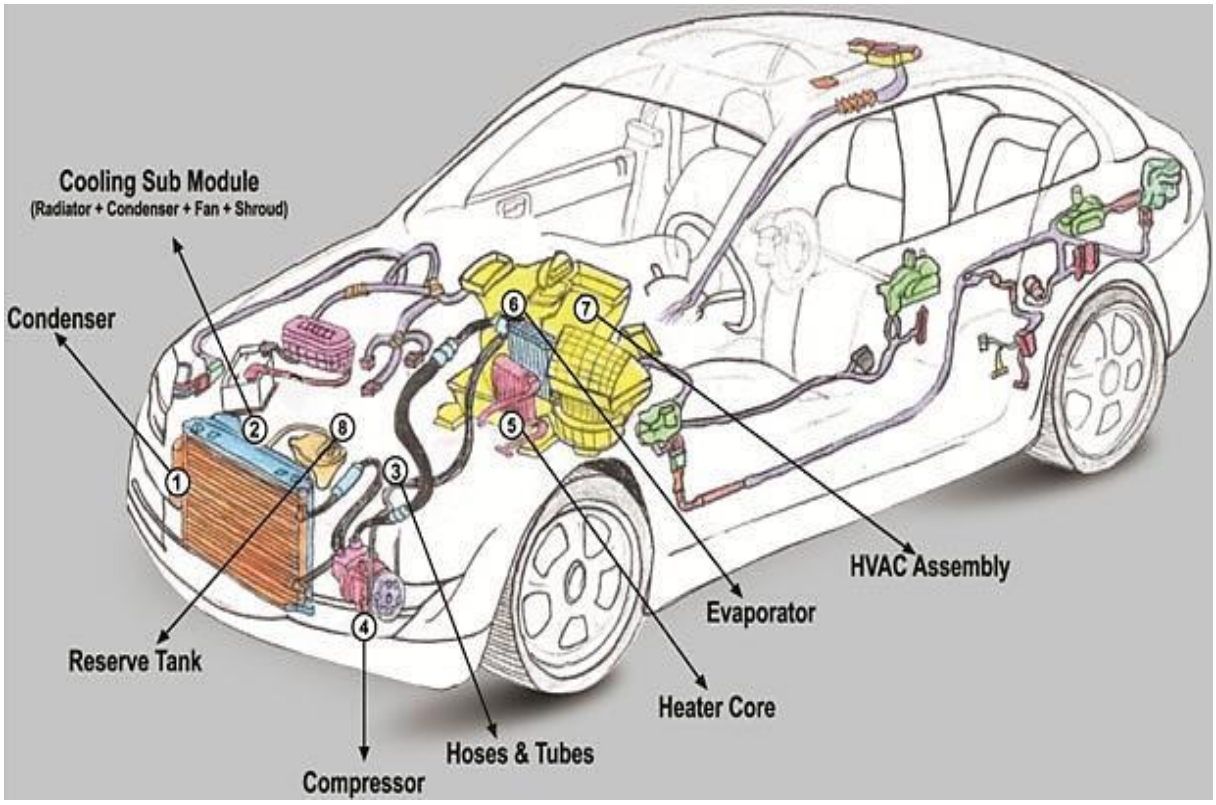
The loss of ductility of a metal caused by physical or chemical changes, which make it brittle, is called embrittlement.

Question Two

Define Automotive air conditioning and it's working principles?

Nowadays, the cars and trucks we buy all come with the feature of air conditioning. The automotive air conditioning system works on the ideology of the reverse Brayton or the Rankine cycle. This system effectively controls the temperature and the humidity of the atmospheric air and circulates it in the vehicle cabin.

The automotive air conditioning system contains refrigeration, air circulation and distribution and the controlling system. Here, the refrigeration helps in cooling of the air with the help of the parts like compressor, condenser etc. The air circulating system effectively distributes the cold air through a blower or the air duct. The control system senses the temperature and allows managing the refrigerating system.



Essential parts of automotive air conditioning system

An automotive air conditioning system works with the incorporation of parts like

- Condenser
- Compressor
- Evaporator
- Receiver-dehydrator

- Connecting lines including,
- Orifice tube
- Expansion valve
- Absolute valve
- Suction throttle valve
- Evaporation pressure regulator valve
- Thermal sensors
- High pressure cut off switch
- Cycling compressor switch
- Refrigerants (Nowadays, Freon 12 is replaced by the alternative refrigerant R134a)

Watch the video on next page to understand the working of the automotive air conditioning system-

The working of the automotive air conditioning system is the same as the normal air conditioners. The compressor suppresses the refrigerant vapours at very high pressure coming from the evaporator. The car engine drives the compressor with the belt drive. Hence, the magnetic clutch is responsible for engaging and disengaging the compressor.

There is a notable increase in the refrigerant pressure and temperature in the compressor, as a result turns it into vapours. The compressor discharges the high-pressure vapours to the condenser. It much as works like a heat-exchanger and is in front the vehicle. In conclusion, the refrigerant releases the heat and converts it to the liquid form. Because of ram air and the electric driven fan, the temperature of the refrigerant cools down.

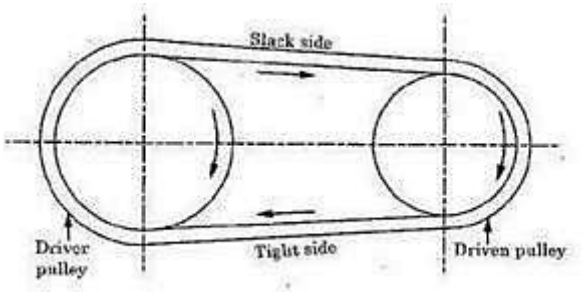
The refrigerant at very high pressure moves from the dehydrator and extracts moisture. After extracting moisture, it passes through the expansion valves and expands the refrigerant at low pressure. In result, the expansion process cools down the evaporator. The sensing device also known as the temperature sensing tubes, signals the diaphragm at the expansion valve and it varies the orifice sizing. This entirely depends on the temperature of the evaporator outlet, as a result, helps in automatic temperature control. Most noteworthy, the evaporator is of the similar construction as the condenser.

Question Three

What is Belt Drive and its Types?

Belt Drives are a type of frictional drives used for transmitting powers. They are quite popular owing to their high durability and reliability. For most of the power transmission requirements, belt drives are also economical and financially viable. They are comparatively easy to install and maintain and generally are durable and viable in the long run.

Belt drives are used to transmit power between two shafts which do not have a common axis. The amount of power transmitted between the shafts is dependent upon the amount of friction between the two. Factors that determine the power transmission are the velocity of the belt, belt tension between the pulleys and the angle of contact between the pulleys.



For getting the optimal performance and the desired results from the belt drive the selection of the right belt according to the application becomes crucial. Selection of the right kind of belt for a given application will depend upon the type of drive used, operating RPM, Horsepower generation, Diameter of pulleys and center distance, take up design, space available for the setup, shock load conditions, issues with static dissipation, the service life of the belt etc.

Types of Belt Drives:

There are two broad classifications as far as types of belt drives are concerned, they are determined by the amount of power transmission required and arrangement of belts.

Belt Drives according to the power transmitted:

Light Drives:

Used in agriculture machines and small machines. The belt speed generally remains in the range of 10 m/sec. Perfect for applications where small power transfer is required.

Medium Drives:

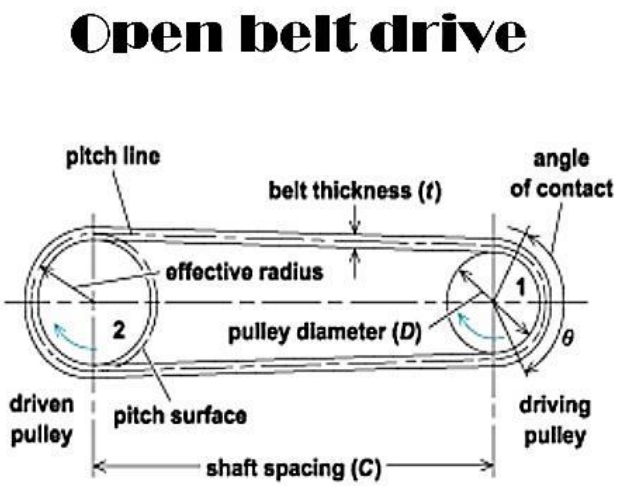
Used in industrial and semi-industrial applications the power delivery in this set up is of medium range. Highly utilized in machining and similar applications the belt speed in this type of setup ranges from 10 m/sec to 22m/sec.

Large Drives:

As the name suggests these are big belt drives used for heavy power delivery. It finds wide application in processes where high transmission power is required. The belt speed in this format of the belt drive is in excess of 22 m/sec. It finds application in running of compressors and similar large machinery.

Belt Drives according to the arrangement of belt:

Open Belt Drive:



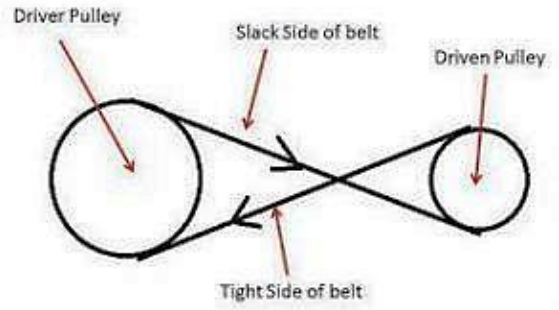
Open belt drive

In this type of belt drive, the assembly of shafts is parallel and rotates in the same direction. The size of the shaft varies and has a large shaft connected to a small shaft. The power is transmitted from the larger shaft to the smaller shaft, the lower side is known as the tighter side.

Cross belt drive:

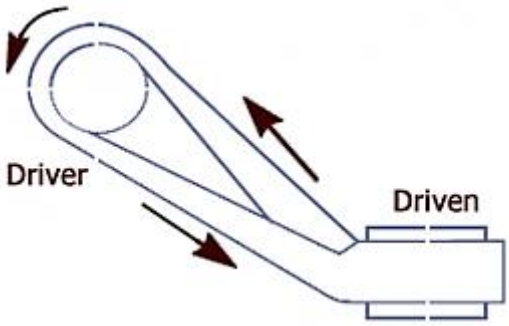
In this type of belt drive, the shafts are parallel to each other just like in open belt drive but the belts are in cross configuration and moving opposite to in each other in direction. In this configuration, the same layout of one shaft is bigger than the other is applied. Crossed belt drive has more tension

on the side which is acting as the driver i.e. the direction in which the belt is being moved. The side being pulled in known as the tight side and the other one is known as the slack side.



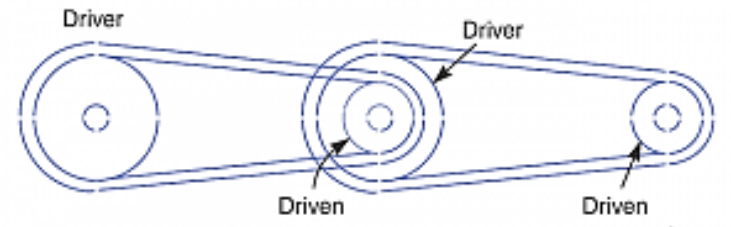
Cross Belt Drive

Quarter Turn Belt Drive:



This type of belt drive is also known as right angle belt drive. In these configurations, the shafts are at the right angle and move in one direction. This provides for a unique problem and that is the belt running down the pulley, to overcome this problem the width of the shaft is quarter times more than the width of the belt. Hence the name quarter turns belt drive.

Compound Belt Drive:



As the name suggests, compound belt drive is a complex arrangement of shafts and pulleys where power is transmitted from more than one shaft utilizing a number of pulleys. It is generally used in a complex application environment.

Question Four

Explain Bernoulli's Equation & Applications

Bernoulli's Equation & Applications of Bernoulli's Equation?

Bernoulli's Equation is one of the most versatile equation ever.

This is an important principle involving the movement of a fluid through a pressure difference. Suppose a fluid is moving in a horizontal direction and encounters a pressure difference. This pressure difference will result in a net force, which by Newton's 2nd law will cause an acceleration of the fluid. The fundamental relation,

work done = change in kinetic energy

in this situation can be written as-

- (change in pressure) x area x distance = change in kinetic energy,

which furthermore can be expressed as

change in pressure + change in (kinetic energy / volume) = 0.

In other words,

Pressure + (kinetic energy / volume) = constant

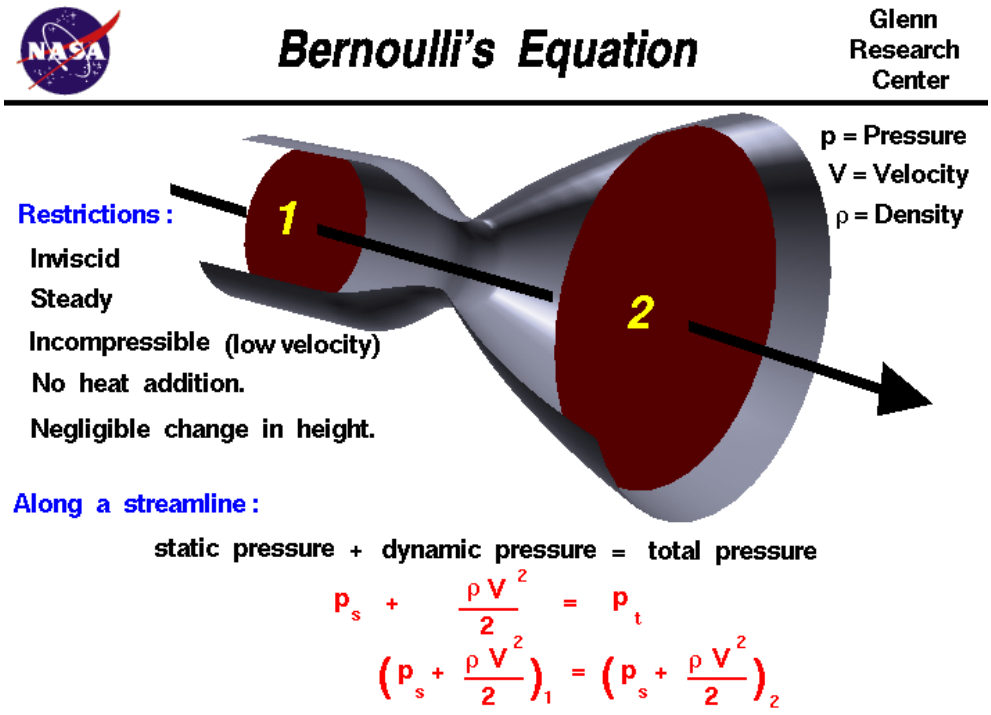
This principle is generally known as the **conservation of energy principle** and states that the **total energy** of an isolated system remains constant — it is said to be conserved over time. This is equivalent to the **First Law of Thermodynamics**, which is used to develop the general energy equation in thermodynamics. This principle can be used in the analysis of **flowing fluids** and this principle is expressed mathematically by the following equation:

$$\rho \frac{Dh}{Dt} = \frac{Dp}{Dt} + \nabla \cdot (k \nabla T) + \Phi$$

where h is enthalpy, k is the thermal conductivity of the fluid, T is temperature, and Φ is the viscous dissipation function.

Bernoulli's Equation-

Bernoulli's Equation & Applications of Bernoulli's Equation



The Bernoulli's equation can be considered to be a statement of the **conservation of energy principle** appropriate for flowing fluids. It is one of the most important/useful equations in **fluid mechanics**. It puts into a relation **pressure and velocity** in an **inviscid incompressible flow**. **Bernoulli's equation** has some restrictions in its applicability, they summarized in following points:

- steady flow system,
- density is constant (which also means the fluid is incompressible),
- no work is done on or by the fluid,
- no heat is transferred to or from the fluid,
- no change occurs in the internal energy,
- the equation relates the states at two points along a single streamline (not conditions on two different streamlines)

Under these conditions, the general energy equation is simplified to:

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

This equation is the most famous equation in **fluid dynamics**. The Bernoulli's equation describes the qualitative behavior flowing fluid that is usually labelled with the term **Bernoulli's effect**. This effect causes the **lowering of fluid pressure** in regions where the flow velocity is increased. This lowering of pressure in a constriction of a flow path may seem counterintuitive, but seems less so when you consider pressure to be energy density. In the high-velocity flow through the constriction,

kinetic energy must increase at the expense of pressure energy. The dimensions of terms in the equation are kinetic energy per unit volume.

Applications of Bernoulli's Equation:

Bernoulli's equation is used any time we want to relate pressures and velocities in situations where the flow conditions are close enough to what is assumed in deriving Bernoulli's equation. You need to be in a flow that is not changing with time and in a regime for which the fluid behaves pretty much like an incompressible fluid without viscosity.

If the flow is dominated by viscous stresses (low Reynolds numbers), then Bernoulli's equation cannot be used. We can still use it for parts of the flow where viscosity isn't so strong, but inside the boundary layer, for example, we cannot use it.

If the flow is highly unsteady, then it cannot be used. In some cases, we might be able to use it, but we have to be careful about how we do it.

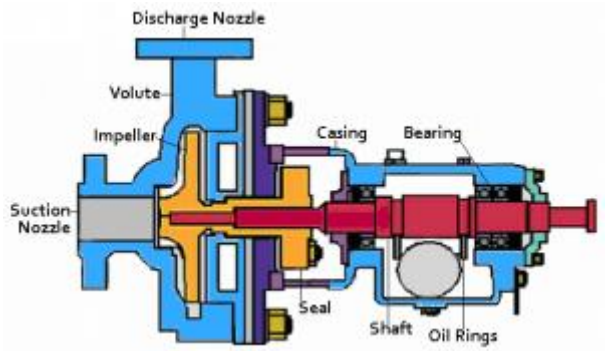
The incompressible version can only be used if the effects of compressibility are small. That typically means lower than about Mach 0.3. But even at somewhat higher Mach numbers, you can still use it to get a rough idea about the flow. Just remember that your results are distorted, so don't assume they have a lot of accuracies.

We use Bernoulli's equation for a lot of different fluid flow situations.

Question Five

Explain Centrifugal Pump: Principle, Parts, Working, Types, Advantages, Disadvantages with its Application?

Centrifugal pump is a type of turbomachinery which is dynamically axisymmetric and work absorbing in nature. In more simpler terms it's a pump which is used to lift liquids from a lower area to a higher area. Its most widely used in industries where sensitive fluids as in chemical industries are required to be moved.



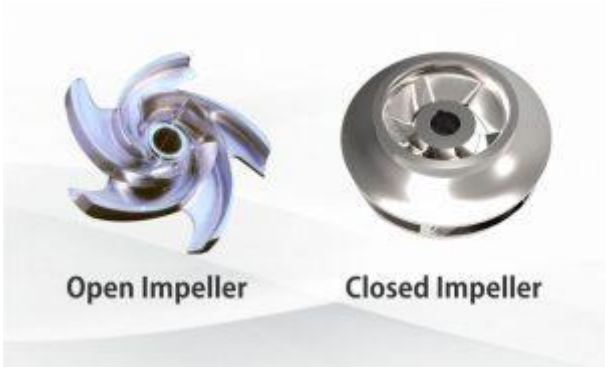
The basic principle of centrifugal pumps is the conversion of rotational kinetic energy to hydrodynamic energy of fluid movement. The fluid enters through the pump impeller near the rotating axis and gets accelerated reaching the desired destination.

Parts of a centrifugal pump:

Rotating Parts:

Impeller:

It is the heart and soul of a centrifugal pump it has following subtypes.



Open Impeller:

This impeller does not have a crown and base plate, it finds wide application where physical impurities in the liquid to be pumped has to be kept at bay.

Closed Impeller:

It is completely covered with no scope of any foreign body entering. Widely used for pumping water.

Semi-Open Impeller:

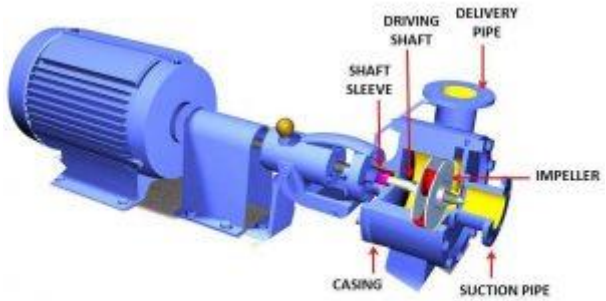
Lacks a crown plate and is suited for fluids which might have charged debris in them.

Shaft:

This is the component which is responsible for the rotation of the impeller. It also transmits torque to the impeller and keeps it in sync with other components of the centrifugal pump.

Shaft Sleeve:

It's a covering for the shaft assembly and protects the unit from corrosion. Its open from one end.



CENTRIFUGAL PUMP

Casings:

Casings used in a centrifugal pump are of two types: the volute casings and vortex casings. Volute casings are funnel-shaped and are designed to reduce the overall pressure of the fluid on the shaft of a centrifugal pump. It acts as a safety measure and keeps the fluid velocity in check, on the other hand, vortex casings have vanes which convert the kinetic energy into pressure.

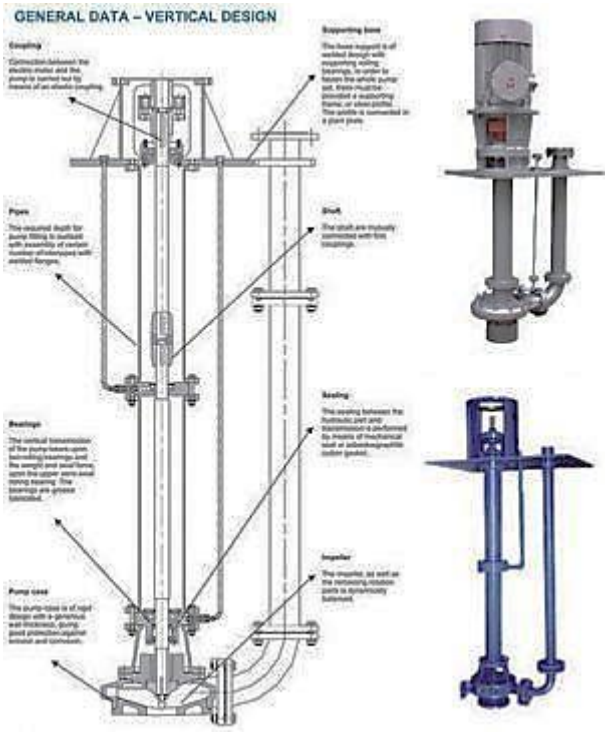
Suction Pipe:

It’s a pipe which connects the source of the fluid or the liquid to be pumped to the centrifugal pump. Generally, the lower end of the pipe which gets dipped in the fluid has a strainer which acts as the first line of defense for debris and other non-desired material from entering the pump. Also, a valve is present which only allows the upward movement of the fluid.

Types of centrifugal pumps-

Vertical Centrifugal Pumps:

They are also known as cantilever pumps, they are unique in design as it allows for the volute to hang in the sump while keeping the bearings outside the sump.

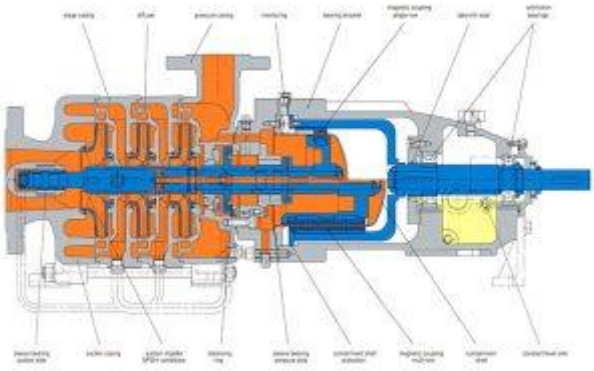


Froth Pumps:

It is a kind of open impeller centrifugal pump and is widely used in minerals industry or the industries where keeping the impurities at bay becomes crucial. In mining for minerals, a lot of froth is generated, this froth over the course of time generates air which blocks the conventional pumping setup, froth pumps act as a remedy to this problem.

Multistage centrifugal pumps:

It's the most complex type of centrifugal pump and has a unique configuration. In this type of pump, the impellers can be mounted on a single shaft or on multiple shafts depending upon the use. This pump also has many stages of fluid movement. In every stage, the fluid is moved to center before getting discharged. In case of higher pressures, the impellers are connected in series and for the higher output, they are connected in parallel.



Advantages of centrifugal pump:

- No leakage issues.
- Can be used for pumping sensitive fluids like petrol and diesel.
- No loss of power due to friction.
- Economical to operate

Disadvantages:

- At times clogging of pipes may occur
- Any external vibration can damage the pump
- Low flow may cause overheating
- Risk of cavitation is high

Question Six

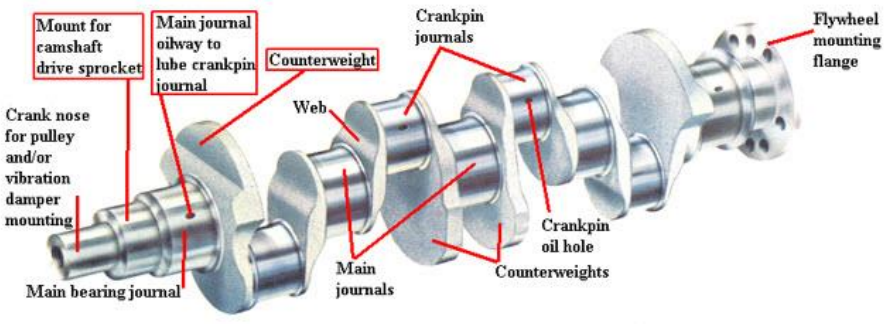
Definition of crankshaft and its basic functions

The crankshaft is an essential part of the engine responsible for converting reciprocating to rotational motions. In a simple language, it is a shaft with a series of crank and crank pins, which are attached to the connecting rod of the engine. Nowadays the large engines have multi-cylinders and the crankshaft is necessary to drive the pistons.

You cannot find such mechanism in single cylinder engines as they have an only single piston in it. These parts are made with the forging processes and need careful designing to reduce the effect of vibrations. Let's learn about this product and its functions.

Functions of the Crankshaft in an Engine

This mechanism is very necessary to provide a smoother drive to the large engines which have multi-cylinders. They are responsible for transforming the linear motion of the piston into the rotational motion. This specific part of the engine is made with the process of forging the alloy of iron ore called steel.



While visually inspecting the crankshaft, you can find the rod bearings are nearly offset or eccentric. Here the offset of the shaft transforms the reciprocating motion (up and down) of the piston in the rotating motion of the crankshaft.

Most often the shaft is drilled with minute holes which feed the engine with the oil necessary for smooth operations. Sometimes, this mechanical part consists of counterweights which help in balancing the system and the weight of the connecting rod. It also ensures to balance the force while rotation of the moving parts.

Every engine is designed specifically and so is the crankshaft. Its design varies with the size and number of cylinders in the engine. Featuring an example, in a four-stroke engine, the crankshaft will have four crank throws. These throws connect the four pistons and are efficiently connected to the flywheel of the engine.

While driving the engine or during the combustion cycle the crank throw works as a lever arm, which pushes and pulls the piston. This considerably creates a successive rotational motion in the engine.

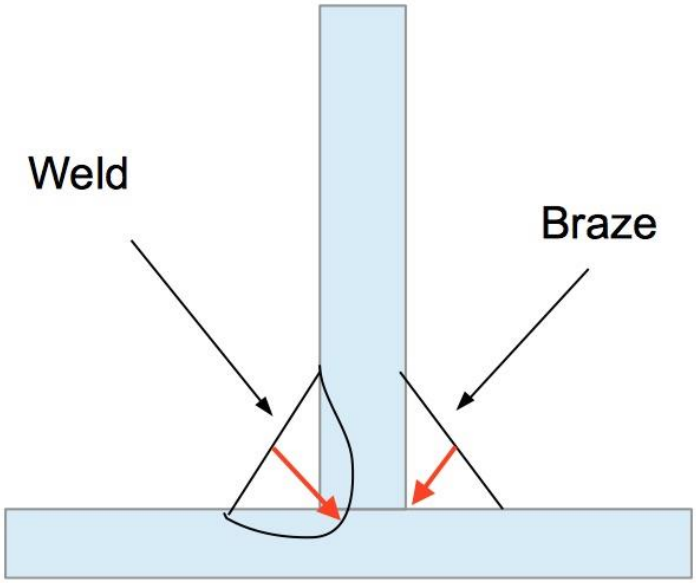
The crankshaft helps the piston to complete its rotation and the throw will return the piston at the top of the cylinder. This product needs very sleek designing while production with respect to its weights and balancing. Such engineering is necessary to reduce the vibrations in the engine. Such, vibrations can be very harmful to the vehicle and can even lead to major accidents.

Question Seven

What is the Difference between brazing and welding

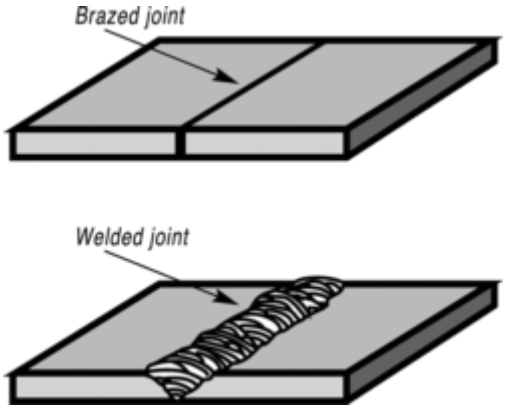
Difference between brazing and welding

Several processes are used to join the different metal parts. Among all of those processes, brazing and **welding** are used to fill or join or fix in the gaps in metals. These two processes serve the same purpose. However, their modus operandi is different. Both the processes differ in terms of their temperature, base metals and melting point temperature of the filler.



Talking about the **welding**, it is the most common process that is used to join the two metal pieces and the thermoplastics. In this process, the base metal is melted along with the filler electrode to form a weld pool of molten metal. This weld pool gets solidified and makes a strong joint. Sometimes pressure can be also applied along with the heat for the **welding**. **Welding** also needs a shield that protects the filler metal from getting contaminated or getting oxidized. There is also a solid-state welding process – friction welding. It uses the heat generated from friction to weld the metal.

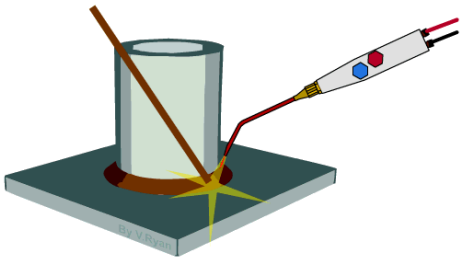
Welding can be performed by using various energy sources like gas flames, laser, electron beam, ultrasound, and friction. This process can be performed under different environmental conditions including underwater, outer space and open air. It is a dangerous process and needs precautions to avoid any electric shock, vision damage or poisonous gas inhalation.



In brazing, only the filler metal is melted to make a joint between the two metals. The wetting is formed between the metals to be joined together and it gets solidified, resulting in a stronger joint. The filler metal goes between the close-fitting parts by capillary action. Brazing is similar to the soldering process. Through these statements, we can say that in **welding** both base metal and filler metal are melted whereas in brazing process only filler metal is melted to make a joint.

In the **brazing** process, it is necessary for both the parts to be joined together don't have oxide layer over their surface. In case, the oxide layer is present, then it should be cleaned using mechanical or chemical cleaning process. Moreover, in this process, the base metal is not heated to their melting point, but filler metal is heated to its melting point. The processes involve different temperature range as compared to one another.

BRAZE WELDING / BRONZE WELDING



In **welding**, a high temperature is required to melt both base metal and filler metal, but in **brazing**, the temperature is low as compared to the **welding** process. The **brazing** gives a considerable strength to the metal.

Another aspect that differs **brazing** from other metal joining process is its temperature. In **brazing**, the temperature should be in such a range that it is higher than the melting point of its filler metal.

Question Eight

Difference between Casting & Forging

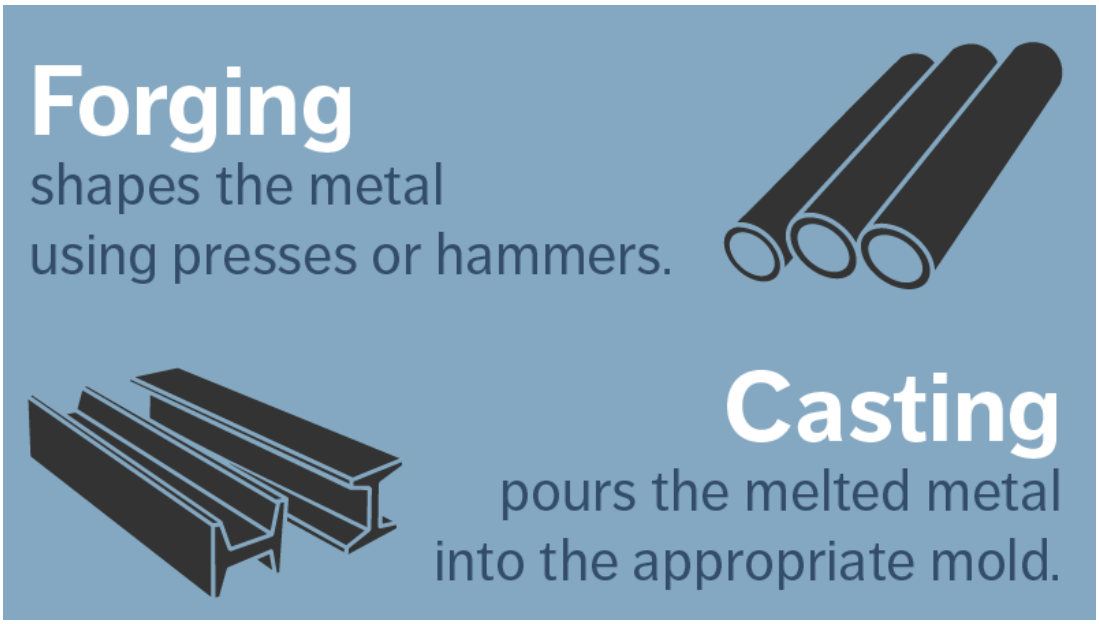
This question, "**Forging vs. Casting: Which is better?**" is one that I have been asked many times. To properly explore the answer, let's first consider the process of each.

Casting:

In this process, the metal is heated until molten. The molten metal is then poured into a vessel or mould to get the desired shape.

Forging:

In this process, the metal is heated and then bent or beat into the desired shape using external physical force.



Why use Casting?

We use casting for wear parts that are too large, complex and can't be easily forged. For forging large pieces of a metal huge amount of sheer force is required so casting is a better alternative. There are no such size limits for metals in casting. It is way more beneficial because –

-No such difficulty in casting complex parts.

-No size limitations

-Lesser workforce

-Comparatively easier than forging

Why use Forging?

Forged steel is stronger and more reliable than castings. Forged parts have higher tensile strength than cast parts. Forged parts also have higher fatigue strength. Forging is used because-

-Will handle impact better than cast one

-The nature of forging excludes the occurrence of porosity, shrinkage, cavities and cold pour issues.

-The tight grain structure of forgings making it mechanically strong. There is less need for expensive alloys to attain high strength components.

-The tight grain structure offers great wear resistance without the need to make products “super hard” We have found that on a blank HRC 38-42 forged grinder insert wear/wash is about the same as a high alloy HRC 46-50 cast grinder insert. The difference being an HRC 46-50 casting does not have the ductility to handle high impact grinding.

Question Nine

Difference Between Fan and Blower

A fan and a blower although having the same working principle and somewhat same functionality have some very stark differences in them. In this article, we will make a sincere attempt at making a clear distinction between the two and at the same time review some of its fundamentals.

Fans and blowers are technically both mechanical devices working for displacing air in the given area. However, a fan is used to distribute the air at larger and vague areas and a blower is used to concentrate the air flow to a particular area.

The major difference that has to be understood while differentiating both is that a Fan is an electrical device whereas a Blower is a mechanical device to which a fan is attached. A blower cannot function without a fan attachment. The fan in case of the blower is the source of air which it redirects to a particular point or location.

Fans and blowers have wide utility, they are used almost everywhere, a car has both fan and blowers in it. A fan might be found in the AC condenser area of a car and a blower would be found acting as a source of cool air inside the car in form of AC duct. Fans displace a large amount of air over the large surface at a low pressure whereas a blower displaces a moderate amount of air towards a particular direction with a moderate amount of pressure.

In case of the fan, the ratio of pressure is below 1.1, whereas in case of a blower the ratio of pressure is between 1.1 and 1.2.

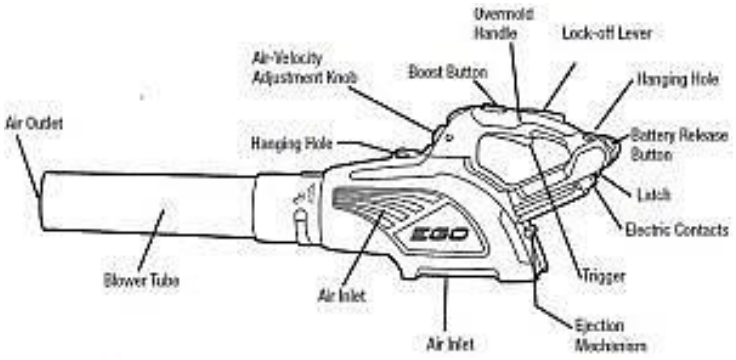
The axial flow, centrifugal and cross flow are the three most common types of fans whereas blowers are only of two types, the centrifugal blower, and the positive displacement blower.

The fan consists of motor blades whereas a blower consists of a housing casing with a fan.

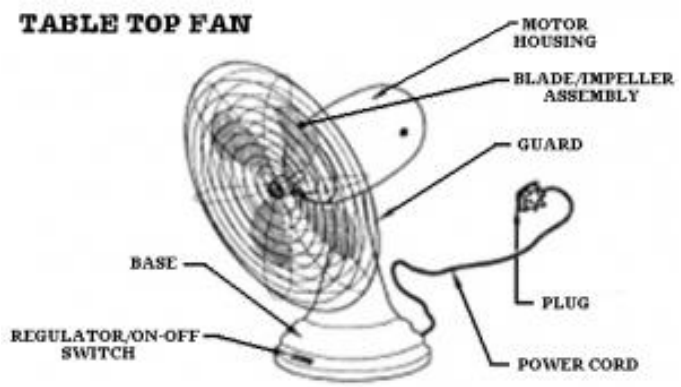
Axial Fan

Centrifugal Blower

There are more differences between a fan and a blower, for example, a blower generally has a very specific usability spectrum. Blowers have a good acceptability in fields of applications where a concentrated beam and consistent air flow is desired. Like in a furnace or certain type of blowtorch applications the blower would be the preferred source of air. Blowers are also good companions for kitchen ovens and grills where continuous air supply is required for proper combustion of fuel.



On the other hand, fans are widely used for cooling purposes, fans generally work under a consistent temperature range and are not subject to any environmental extremes. They are heavy duty equipment and have a sturdy long lasting built quality.



Fans are easy to maintain and repair and can be cleaned easily just because of their simple operational needs whereas a blower might need some serious maintenance efforts as depending upon the application it may or may not be subjected to harsh working conditions and extreme debris and effluents.

A blower used in the industrial application will surely be exposed to high temperature, humidity and ash and similar kind of industrial waste which can impact its service life and durability.

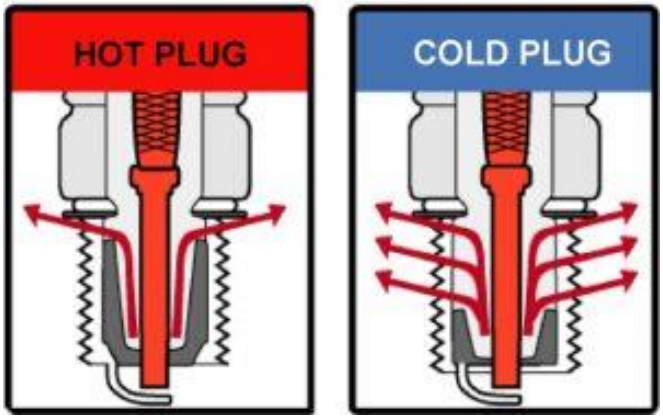
A fan would essentially be powered by electricity in current scenarios whereas a blower also has a human labor-centric option where a handle is used to drive the fan unit of the blower. There is also a clear difference between the cost of these two units. A blower most of the times will be expensive than its counterpart within same scale and usability.

Question Ten

Difference Between Hot Spark Plug and Cold Spark Plug Explained

When a plug becomes very hot in an engine, then it's a hot plug. The plug that doesn't reach a high temperature is a cold plug. The metal shell of each plug will function at almost the same temperature as the metal of the head itself because the plugs are screwed into the head and there is a good path for heat flow between shell and head.

Heat collected by the insulator tends to accumulate there because the insulator material is not a good conductor of heat. The track for heat flow is away from the insulator nose. Heat has to flow upwardly along the nose until it reaches the place where the insulator is in mechanical contact with the shell.



Spark plugs are manufactured with different heat ratings, from very cold to very hot, so a desirable plug can be found for your engine, depending on what you need, based on your riding or driving conditions. Plugs with the same diameter and reach will have different lengths of the insulator nose section and different type numbers to indicate which runs hot and which runs colder.

These plugs are mechanically interchangeable but will run at different operating temperatures in the same engine. Part of the tuning problem is to find a plug that survives in an engine.

What happens when the plug is too hot?

A mixture that's too lean will do it because the gasoline drawn into the firing chamber has a cooling effect. If there is not enough gasoline, there is not enough cooling. When a spark plug gets too hot, the insulator may boil and bubble On examination, it will be plain that it has been too hot. Also, the metal electrodes may melt away and disappear. If any of these bad things happen, that's good.

The worst-case scenario of a too-hot plug that fails to destroy itself is when it destroys the engine instead; this is called pre-ignition. If the tip of the plug becomes hot enough to ignite the fresh mixture being drawn into the cylinder, then the incoming mixture will start to burn without waiting for the spark to happen.

Ignition due to any hot spot in the cylinder begins before the proper time for ignition, so it is called pre-ignition. Anything in the combustion chamber which gets hot enough can cause pre-ignition, but typically the end of the spark plug is the cause. When the mixture is firing sooner than it should, that's like advancing the spark too much, and no matter what causes it, early ignition makes engines heat up, causing pre-ignition. Eventually, something melts, which comes under the heading of a bad thing.

What happens when a plug is too cold?

If the nose of the plug is not hot enough, it will gradually accumulate deposits, known as fouling. During normal engine operation, residue from the combustion process hits the insulator nose. This may include carbon, unburned fuel and oil, and chemical additives present in both fuel and oil. If the insulator nose and electrodes are hot enough, the combustion deposits will be continuously burned off by the heat of the plug. The ideal situation is to have the deposits burned off as fast as they accumulate, so the insulator nose stays fairly clean and free of deposits.

If the deposits accumulate on the plug because it is not reaching a high enough temperature to burn them off, the gradual accumulation will eventually short out, or foul, the plug. The fouling is electrically conductive and forms a path along the insulator, which connects the center electrode to the metal shell of the plug.

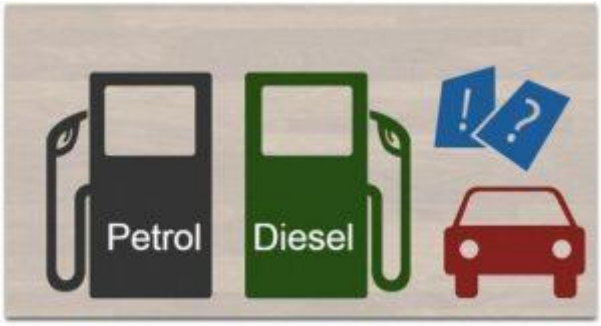
Question Eleven

What is the Difference Between Petrol and Diesel?

Difference Between Petrol and Diesel

Another curious question, in this article, we will talk about the difference between the two most commonly used fuel **Petrol or Gasoline** and **Diesel**.

Petrol and Diesel are used as fuel in IC and CI engines. It is obtained by fractional distillation of crude oil. When crude oil is heated first, LPG gas vaporizes then petrol is obtained. Petrol is a hydrocarbon which contains 4-12 carbon-carbon atoms per molecule. The common molecules found are alkanes, cycloalkanes, aromatic chains, and asphaltenes. These alkanes also are known as paraffin have the chemical formula C_nH_{2n+2}.



The alkane from pentane to octane (C5H12-C8H18) is refined to petrol while the alkane from nonene to hexadecane (C9H20-C16H34) is refined as diesel or kerosene. Diesel fuel is used in compression ignition engines while petrol (or also called gasoline) is used in spark-ignition engines.

Difference between the two:

PROPERTY	**PETROL**	**DIESEL**
Chemical name	Mostly cyclic compounds like aromatics and naphthalene	Straight chain of hydrocarbons
Chemical formula	Ranges from C5H12-C8H18	Ranges from C9H20-C16H34
Energy content	Less compared to diesel as it is lighter. Energy content is 33.7MJ/Kg	Up to 16% more energy content than petrol as it is denser. Energy content is 36.7MJ/Kg
CO_2 emission	Less proportion of carbon atoms so less CO_2 emission	More proportion of carbon atoms so more CO_2 emission
Engines	Spark-ignition engine	Compression ignition engine
Viscosity	Less viscous	More as compared to petrol
Volatility	Greater because of the additives	Less volatile
Boiling temperature	350^{o}C-2000^{o}C	1800oC-3600^{o}C

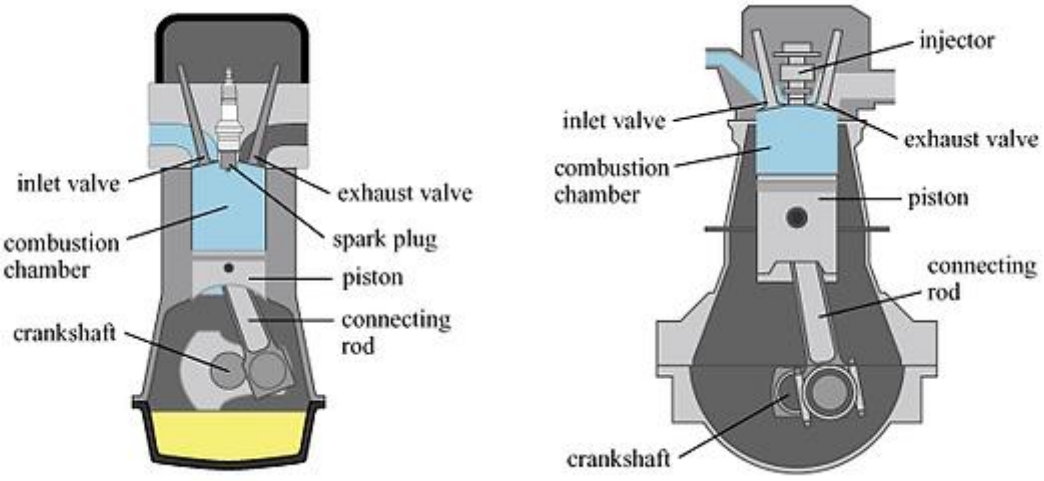
Power	34.6MJ/liter Higher RPM for petrol engines	38.6MJ/liter More torque in case of diesel engines
Calorific value	Net calorific value=44.4MJ/kg	Net calorific value=43.4MJ/kg
Flammability	Has high vapor pressure. Hence more flammable	Has less vapor pressure so less flammable
Ignition type	Self-ignition temperature is 2460^{o}C For combustion of this fuel, the spark plug is required	Self-ignition temperature is 2100^{o}C Self-ignited because of temperature rise due to high-pressure compression.
Flashpoint (the minimum temperature at which fuel is available for ignition in the evaporated state)	430^{o}C	Ranges from 520^{o}C-950^{o}C
Fire point (temperature at which fuel tends to burn itself and stays for five seconds)	Near about 440^{o}C	530^{o}C-960^{o}C
Indexing	By octane number, it is the ability to resist auto-ignition.	By cetane number, combustion speed depends on this number
Fuel price	Price is more	Price is less

Question Twelve

What is the Difference Between SI engine and CI engine?

Difference Between SI engine and CI engine

What are these SI & CI engines? The difference is actually the mode by which the fuel is ignited. SI here stands for spark ignition engine and CI here stands for Compression Ignition engine. Today we will try to differentiate between the two.



The basic difference between the two is same as that between a petrol engine and a diesel engine. This line is just for you guys to get a small hint of what we are talking about. So here we go.

Operational Cycle: Now SI or spark ignition engines which are also known as petrol engines ignite their fuels on basis of Otto cycle or constant heat volume addition cycle. Here the ignition is carried out with the help of a spark plug. What the spark plug does is, it introduces a spark into the combustion chamber where the fuel and air mixture are present. Whereas in case of a CI engine also known as compression ignition engine (diesel engine) works on the principle of diesel cycle or constant pressure heat addition cycle. Here the ignition of fuel occurs due high pressure and temperature in the combustion chamber. Hence no spark plugs are required in this case.

Type of Fuel: As mentioned earlier SI or spark ignition engines use petrol for working whereas CI or compression ignition engine use diesel as working fuel.

Method of fuel injection: In spark ignition engines the mixture of fuel and air is introduced at the time of suction. For this, it has a carburetor for mixing fuel and air. Whereas in the diesel engine or compression ignition engine the fuel is directly injected into the chamber at a high pressure. Hence CI engine has a fuel pump and fuel injector.

Compression Ratio:

In spark ignition engine or SI engines the compression ratio varies from 6 to 10. Here the compression ratio upper limit is set by the anti-knock properties of the fuel in use. i.e. the octane

rating for the fuel. Whereas in diesel engines or compression ignition engine the compression ratio varies from 16 to 20. Here the upper limit of compression ratio is determined by the weight of the engine.

Speed: Spark ignition engines or petrol engines are high-speed engines. This is because of their low weight and homogeneous combustion. On the other hand, compression ignition engine is low-speed engines owing to their heavy weight and heterogeneous combustion process.

Thermal efficiency: Since spark ignition engines have lower compression ratios the maximum value of thermal efficiency is lower than a compression ignition engine.

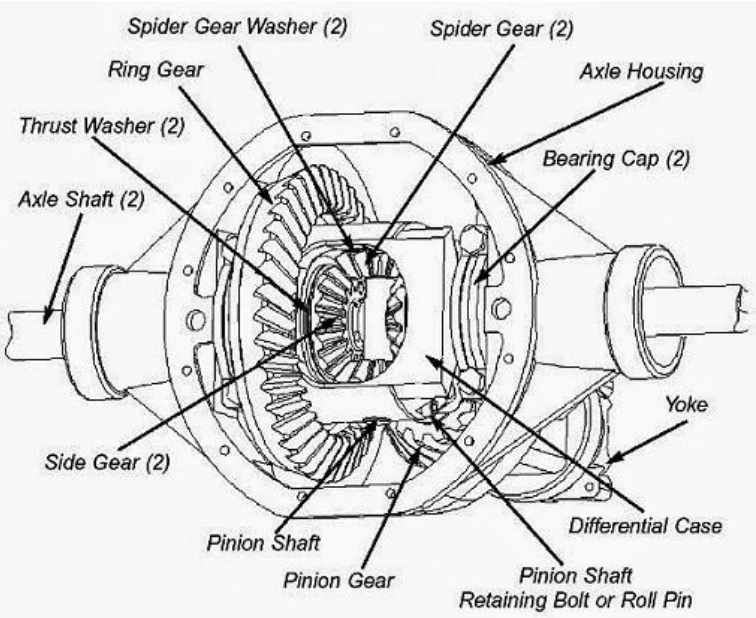
Weight: Spark ignition engines are lighter than compression ignition engine. The reason for this is simple. In compression ignition engine very, high operating pressures are present. Hence, they have to have thicker and stronger construction when compared to spark ignition engines.

Time of knocking: In spark ignition system, knocking takes place at the end of the combustion process. Whereas in case of compression ignition system knocking takes place in starting phase of combustion. Now, what is knocking anyways? Knocking happens when there is an autoignition of fuel in the chamber. This happens when there are carbon deposits in the engine. What happens is that carbon absorbs heat and does not release it. This results in fuel getting ignited before the desired time. Knocking can be harmful to the engines. Hence so much emphasis is laid on regular maintenance of the engine.

Question Thirteen

Differential Gear & It's Working

The differential gear is an integral part of all four wheelers. This technology was invented years ago and is termed as one of the most indigenous technologies human brains could ever create. Differential gears are an arrangement of spur gears in an automobile of more than two wheels so that it allows the two wheels on the so-called same axle to revolve at different speeds. Say while turning the outer wheel, i.e. away from the center of the turning needs to revolve more (simple relation of arc = radius * angle).



The main function of the differential gear is to allow the drive wheels to turn at different RPMs while both receiving power from the engine. The differential has three jobs:

To aim the engine power at the wheels

To act as the final gear reduction in the vehicle, slowing the rotational speed of the transmission one final time before it hits the wheels.

To transmit the power to the wheels while allowing them to rotate at different speeds (This is the one that earned the differential its name.)

Why use Differential Gears-

The differential is used in vehicles because during the turning of a car the tires have different speeds due to the different radius of curvature. During straight motion, both tires move with same speed so at that time there is no need of differential, but when the car turns tires must adjust their speeds according to the radius of curvature. If the differential is not used in a vehicle then there is a chance of slip in the tire.

The slippage mainly occurs because the inner wheels & outer wheels rotate at a different speed, the inner wheel will rotate slower than the outer wheels. The differential gear allows two gears on the same axis travels at different angular velocity. There are different number of teeth on each gear and a third gear is meshed horizontally with the two gears facing each other. Differential gear consists bevel gear planet gear those are connected to output shafts.

Question Fourteen

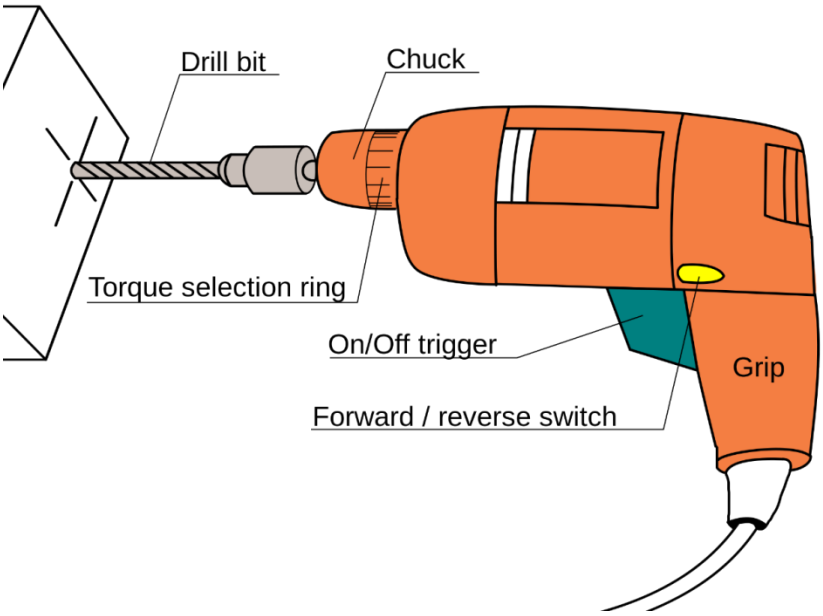
Drilling Machine – Types & Working

A drilling machine is a tool which we use to cut something. Drilling machines consist of a cutting tool attachment, called the drill bit. This part is the core of a drilling machine, and its tip pierces the material and drills through it. There is a base which supports this drill bit and rotates it. So, the *fundamental process* of drilling is **rotating the drill bit while pressing it against a material**. This results in cutting or piercing of the material.

A drilling machine can also be used to make large holes in comparatively softer materials. Using special drill bits, one can make holes in glass.

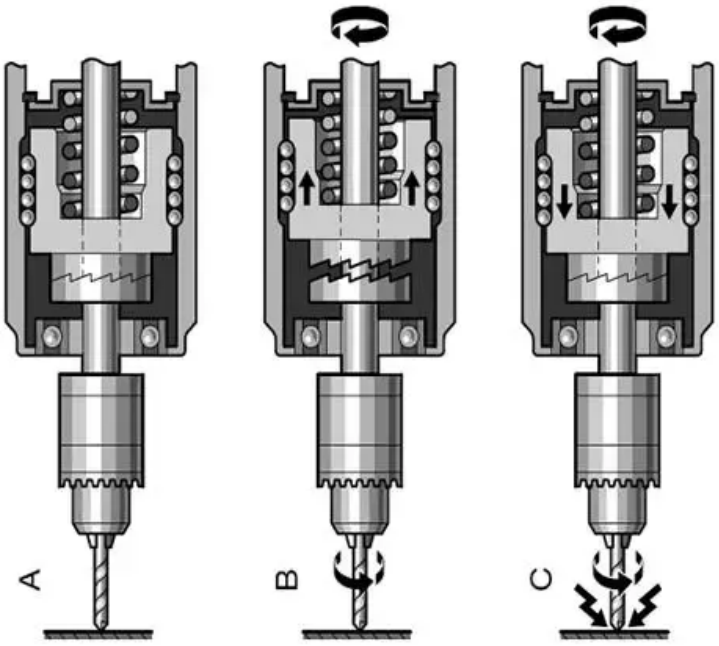
Drilling machine is classified depending upon its mechanism and its applications

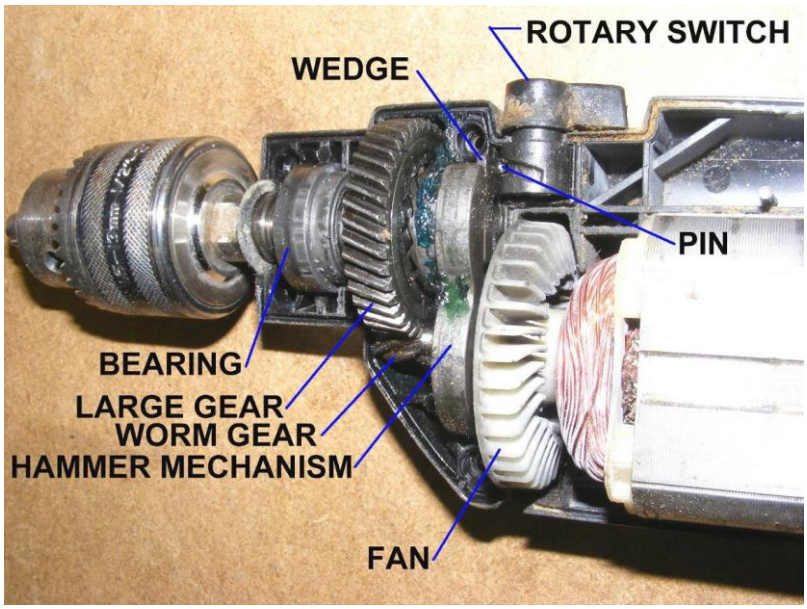
1.Drill/Rotary Drill: This is a general hand-held electric drill machine, having a normal drill chuck. It is used for drilling in wood, metal and plastics. also used for screw driving.



2. Impact Drill/Percussion Drill:

This is similar to normal drill machine as mentioned above, but it has an additional gear mechanism as shown below





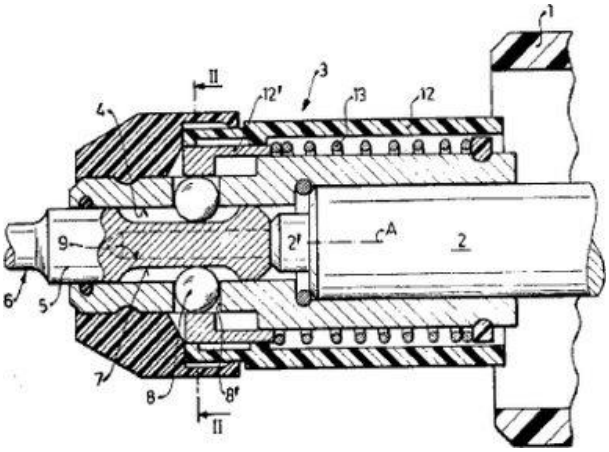
When you turn the rotary switch to impact drill mode it will engage a pulsating gear to the drill spindle and make the drill bit to move forward and backward towards the wall, which works like a chisel while it rotates to break the stone and hardened cement.

Impact drills are used for multiple applications like drilling on brick/masonry wall, concrete (without reinforcement) when you put the machine on impact mode. you can use it as a normal drill for drilling on wood, metals, plastics and screw driving when you put it in normal drill mode.

3.Rotary Hammer/Hammer drill/SDS hammer/Combi hammer etc.:

These drill machines are entirely different from the above and it has pneumatic hammering mechanism with a piston and cylinder to produce higher hammering force.

These drills have a Special Direct System (SDS) instead of a normal drill chuck, which enable key less fixing of drill bit in the machine (just push it in will get locked)

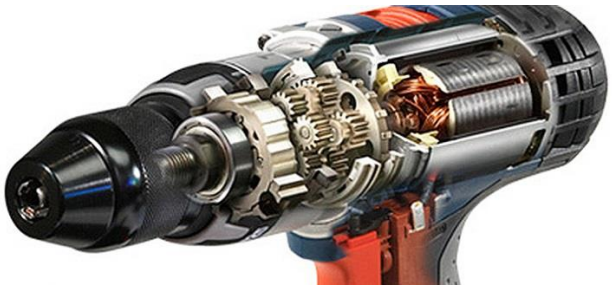


Rotary hammers are mainly used by construction professionals and contractors for drilling and breaking of Masonry/Concrete/RCC/High-strength Concrete surfaces. These drill machines come in 2 or 3 modes, in 2 modes drill you can use Rotary drilling and Hammer drilling functions, and in 3 mode drill, you have a hammer only mode and an additional function called chiseling/chipping can be used for breaking and demolition of concrete/masonry surfaces.

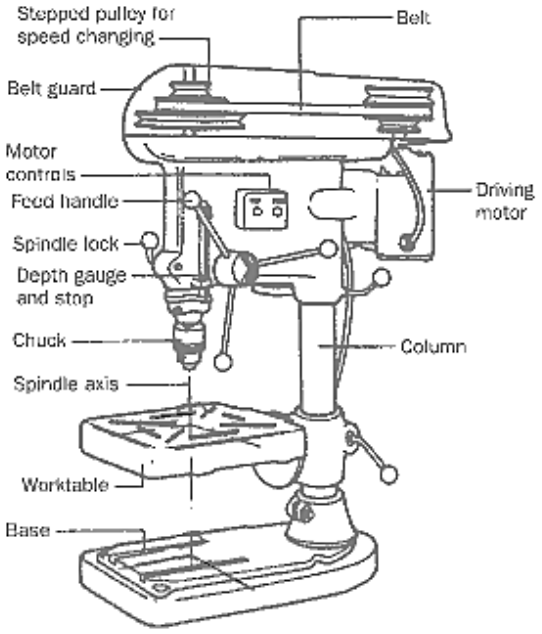
4.Drill Driver: These are similar to rotary drills, but having an additional torque control clutch mechanism for controlling the tightness of screws/bolts.

Drill drivers are mostly used for screwing on wood and metal surfaces and it can do normal drilling work.

Drill drivers mostly available in Battery powered(cordless) version for convenience.



5. Bench drills: These are conventional drill machines mounted on a bench or floor. it has a belt drive and standard chuck. Used for heavy duty drilling on metals and wood.



Question Fifteen

What is the Difference between First Angle and Third Angle Orthographic Projection

First Angle and Third Angle Projection

First of all, we know that the first angle projection system and third angle projection system both are the methods used for orthographic projection drawing.

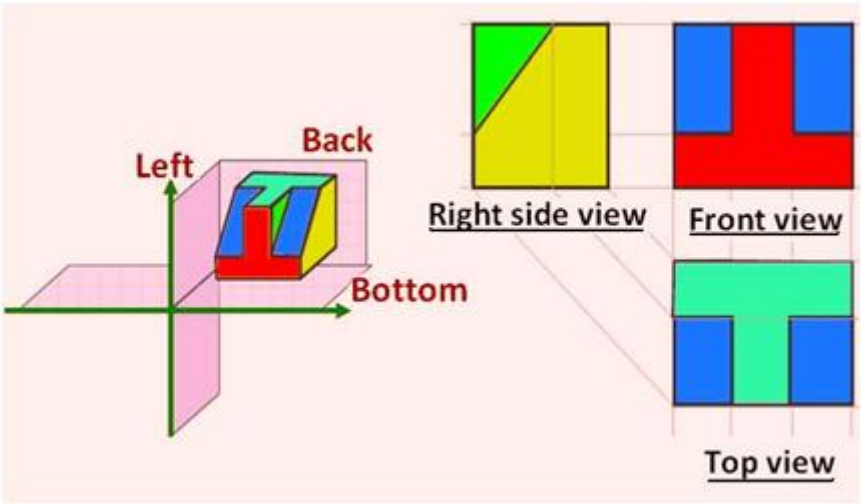
In the first angle projection system, the object placed in the first quadrant and in third angle projection system the object placed in the third quadrant.

If one regards the artesian coordinates as being made of quadrants, then 1st angle and 3rd angle are two different quadrants in which an object is places and different planes on to which the drawing is projected.

In 1st angle, the object is between the observer and the plane of projection. In 3rd angle, the plane is between the observer and the object.

First Angle Projection:

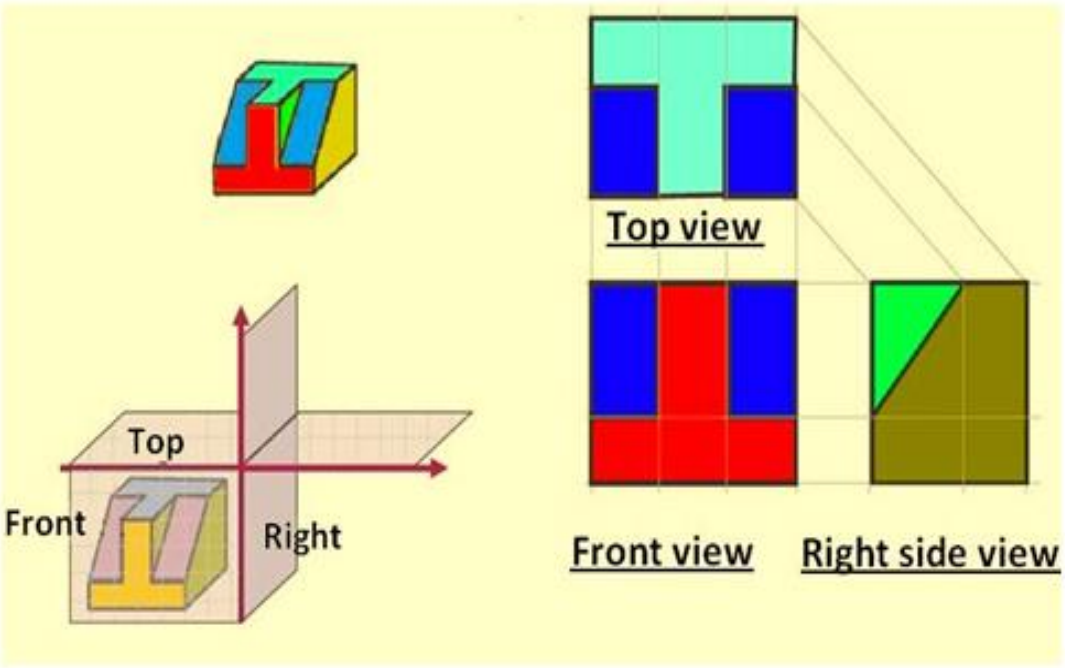
In this, the object is assumed to be positioned in the first quadrant and is shown in figure. The object is assumed to be positioned in between the projection planes and the observer. The views are obtained by projecting the images on the respective planes.



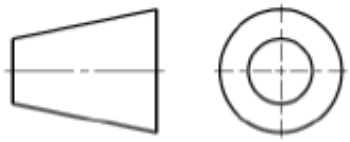
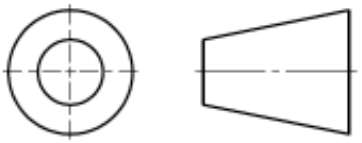
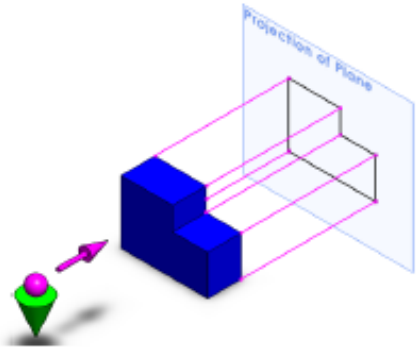
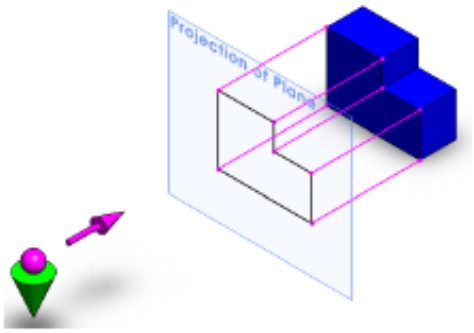
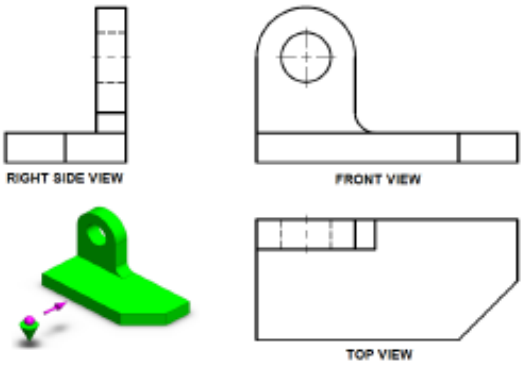
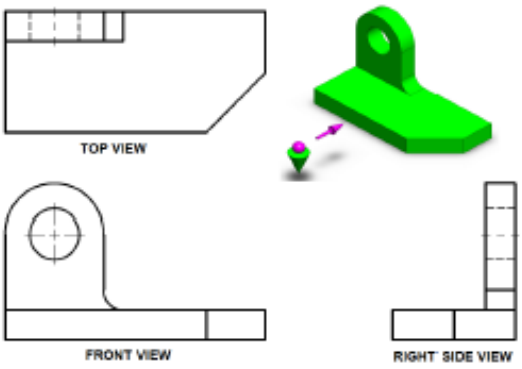
Note that the right-hand side view is projected on the plane placed at the left of the object. After projecting on to the respective planes, the bottom plane and left plane is unfolded on to the front view plane. i.e. the left plane is unfolded towards the left side to obtain the Right-hand side view on the left side of the Front view and aligned with the Front view. The bottom plane is unfolded towards the bottom to obtain the Top view below the Front view and aligned with the Front View.

Third Angle Projection:

Here the object is assumed to be in the third quadrant. i.e. the object behind vertical plane and below the horizontal plane. In this projection technique, Placing the object in the third quadrant puts the projection planes between the viewer and the object and is shown in figure.



The Difference:

First Angle Projection	Third Angle Projection
The object is imagined to be in first quadrant.	The object is imagined to be in third quadrant.
The object is lies between the observer and plane of projection.	The plane of projection lies between the observer and object.
The plane of projection is assumed to be non transparent.	The plane of projection is assumed to be transparent.
When view are drawn in their relative position Top view comes below Front view, Right side view drawn to the left side of elevation.	When view are drawn in their relative position Top view comes above Front view, Right side view drawn to the right side of elevation.
 SYMBOL	 SYMBOL
	
 RIGHT SIDE VIEW FRONT VIEW TOP VIEW	 TOP VIEW FRONT VIEW RIGHT SIDE VIEW
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Question Sixteen

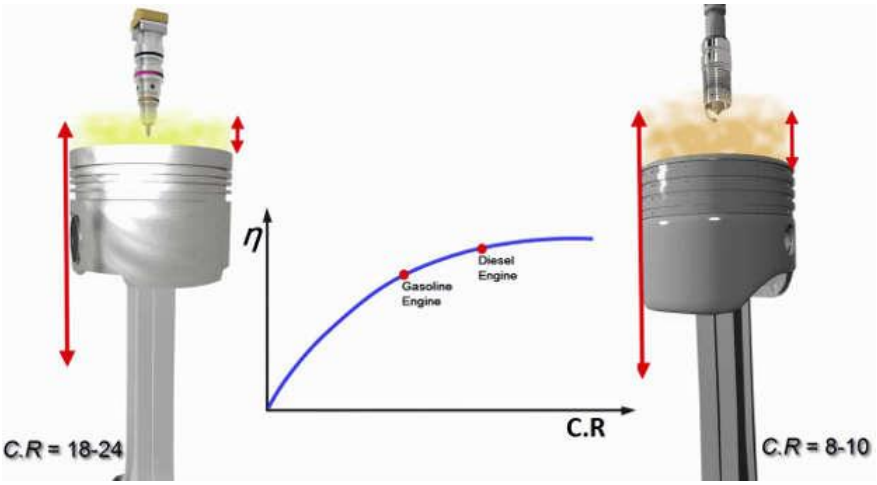
Five Reasons Why Diesel Makes More Torque Than Gasoline

The Diesel Engine is known for more power and better efficiency. Now the reasons why the diesel engine produces more torque are listed below.

Compression Ratio:

In both the engines when the piston moves towards the T.D.C, The Piston of the Diesel Engine compresses the air further more than its T.D.C. This is because in the diesel engine for instant combustion of the fuel heat of the air is required. Thus, it raises the temperature above its self-ignition temperature for self-combustion. While in a Gasoline engine we do not require the air to be compressed more as a spark plug is used to ignite the fuel-air mixture and combustion to take place.

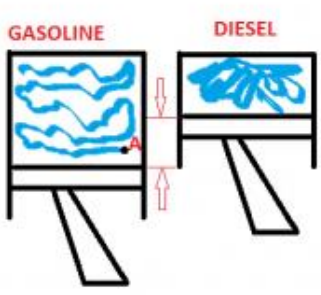
The following graph will show the efficiency of the Diesel Engine is more with respect to compression ratio:



Compression Ratio and Efficiency Graph

Faster Combustion:

As we know in a gasoline engine the spark plug ignites and the flame travels till it burns all the air-fuel inside the cylinder whereas, in a diesel engine, complete combustion occurs as soon as the fuel is injected in thus combustion occurs much sooner.



Cylinder Piston for Gasoline and Diesel

That is, in a diesel engine the fuel spends more time in pushing down the piston whereas in gasoline engine translates into useful work. In the gasoline engine if the combustion still occurs (suppose at a point A) that will move the piston down for short duration only. But if it would have occurred at the top it would have moved the piston for the entire length. So, the compression ignition property of the diesel engine gives more torque.

Bore Stroke Length:

The diesel engine actually has longer stroke length. For a gasoline engine, the bore diameter is more but the piston does not travel much up and down while in a diesel engine the bore diameter is not much wide but the piston moves quite more up and down. Now torque is the force multiplied by the distance. So, in a diesel engine, the force is more and the distance of the stroke is more.

Diesel Engines are Turbocharged:

Diesel engines use heavy-duty pistons, iron blocks, connecting rods, crankshaft all of which add together to make a heavy engine that can handle the increased torque that is produced by the diesel engine. Also, the air-fuel ratio for diesel is 18:1 to 70:1. They burn lean and thus have more air to compress and produce more work. Pumping loss is also not there during the intake making the engine more efficient.

Calorific Value:

The diesel fuel has slightly lower calorific value than petrol. So, more heat is stored in the petrol for the same volume of given diesel. But diesel is much denser than petrol and can store 15% more energy. So, each time diesel is combusted it produces more energy to pressure the piston and more torque to the crankshaft.

We Hope that now you know Why a diesel engine produces more Torque than a Gasoline.

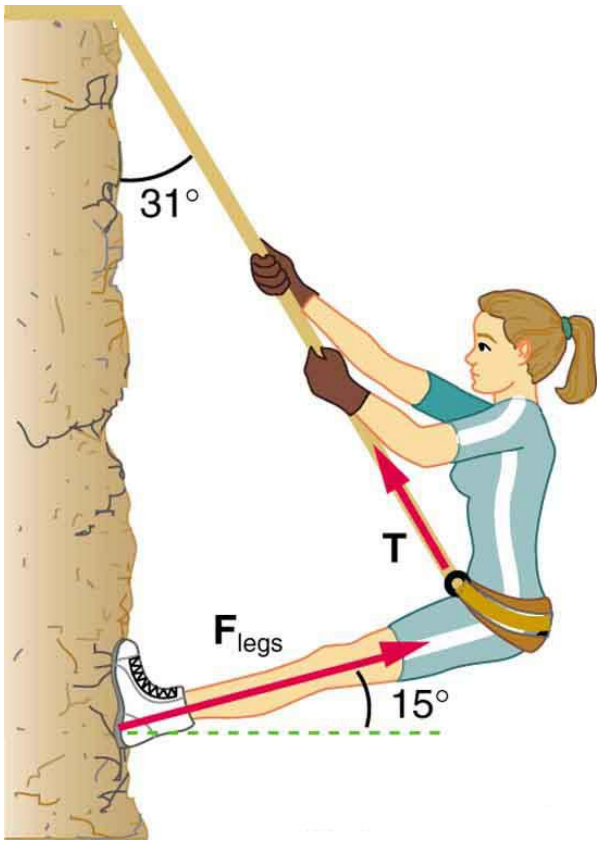
Hope you Liked what we have offered.

Question Seventeen

Friction Force & Its Types

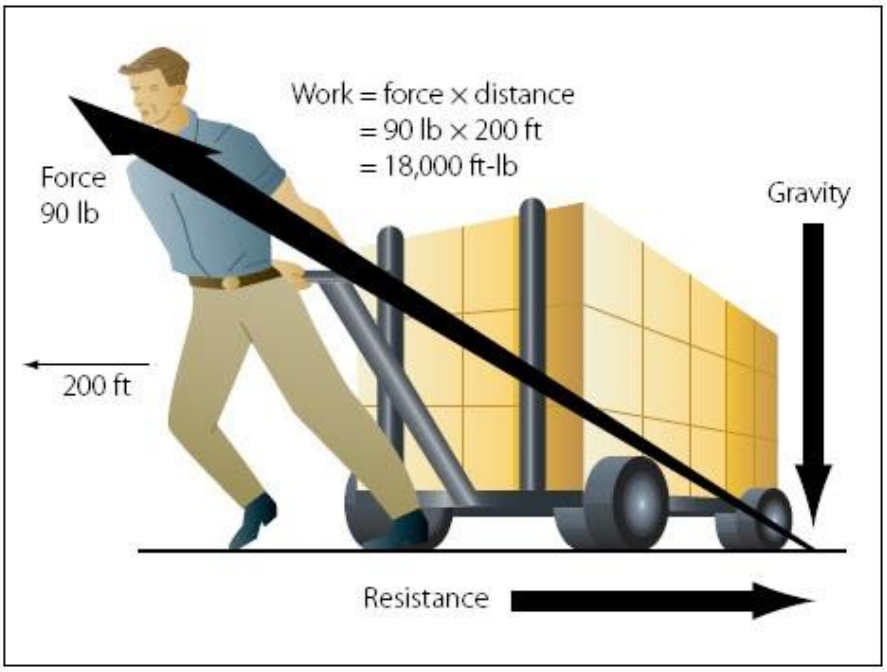
Friction is a force between two solid surfaces which are in contact with each other and which opposes the relative motion between the two. The friction arises because of two reasons. One is, that the surfaces are not smooth on a microscopic level and that leads to rubbing of the two, producing a force opposing to the motion. Second is the interaction between molecules of the two surfaces.

If the interaction is attractive, the motion between the two surfaces is opposed. The frictional force can never be eliminated but can be reduced by making the surfaces smoother or by inserting some smooth material (like power or liquid) between two surfaces. The force is considered to be independent of the relative velocity between two surfaces but this is an approximation.



What is described above is sliding friction. There is another concept of rolling friction where when two bodies are moving relative to each other, the surface in contact is stationary. This happens when a wheel is rolling on a plane. Here the part of the wheel which is in contact with the plane is not moving and therefore there is no sliding of the two surfaces. But there is still some frictional force because when the wheel rolls, the part of wheel which is in contact with the plane has to be separated and that requires some force and this force opposes the motion. Rolling friction is much

smaller than sliding friction. Finally, when a solid is moving in fluid (liquid or gas), there is a force opposing the motion of the solid. This force is not called friction but viscosity.



Types of Friction Force:

Static Friction:

Static means stationary, so an object will stay in-place until it experiences a great enough force to overcome the static friction force (which is the coefficient of static friction multiplied by the normal force). The coefficient of static friction depends on the surface the object is resting upon, and the normal force is the electromagnetic force that keeps all of us from falling into the hot, melting core of the Earth!

Sliding Friction:

The friction force acting between two relatively sliding and is measured as the force required to ***just*** move the body over the other. As per the name suggests, this friction arises when the object slides over the surface. This friction is weak in strength from static friction. You can easily slide the heavy objects from one position to another. Do you know that without sliding friction you won't be able to write on paper? The tip of the pencil slides over the surface and allows you to write perfectly. Another notable example is the braking system in the bikes. It is the sliding friction between the brake pads and the bike rim which slows down your bike.

Fluid Friction:

Viscosity is also known as fluid friction. Viscosity is defined as the resistance offered by liquids to motion. It arises from the internal resistance between layers of moving fluid. A viscous liquid is one which moves slowly example honey, glycerin, tar and others. The viscosity of a liquid determines the terminal velocity of objects moving through them. The effect of viscosity is taking into

consideration in the design of ships, submarine, aircraft and other vehicles to reduce energy wasting to a minimum when these bodies pass through fluids.

Rolling Friction:

It is the force resisting the motion of a rolling ball or wheel (a curved surface). This type of friction is typically a combination of several friction forces at the point of contact between the wheel and the ground or other surfaces. It is the weakest type of friction (compared to static and sliding friction). This is the reason that wheels and ball bearings facilitate motion.

Question Eighteen

How a hydraulic jack works?

A hydraulic jack is a small device which can lift heavy loads with very little effort by the jack operator. It works on the lever principle. If we place a lever under a heavy object we can lift it by racing the free end of the lever.

The distance the object is lifted can be a few inches but the free end of the lever has to travel much more distance than that and that is a ratio of multiplication of the force if we move a lever times the distance it will lift the object.

We can lift pounds with an effort equivalent to pounds thus we will have to move the lever inches for every inch of lifting. One drawback is that the free end of the lever is limited as to the distance it can travel so the object cannot be lifted very far from the ground. The way to solve that problem is by using a mechanism which allows swinging of the free end of the lever without the object going down again if we can swing the lever several times we can lift the object for a practical distance.

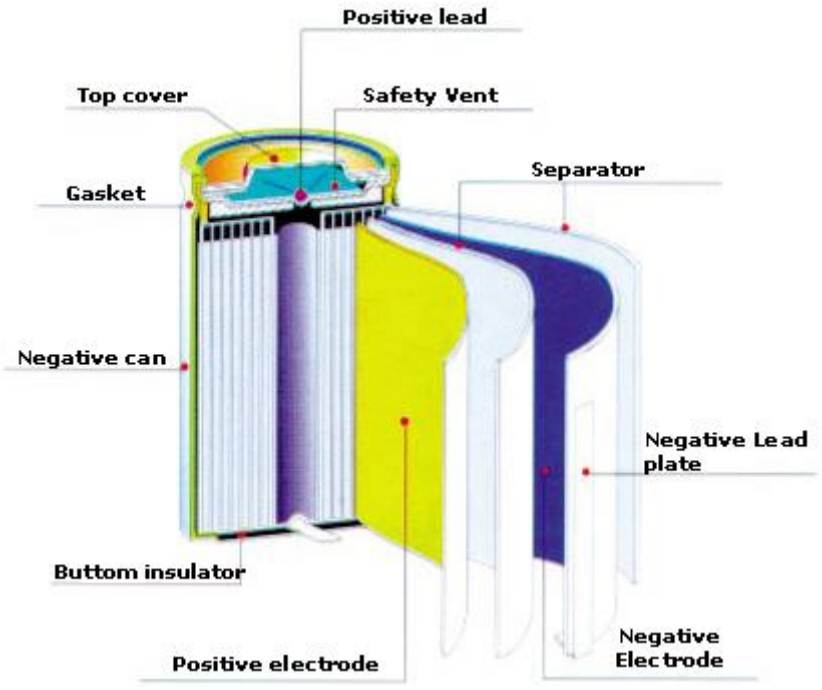
Question Nineteen

How are lithium batteries made?

Lithium batteries or simply LIB have revolutionized the electronic world with its discovery and advancement. Their increasing popularity can be seen among home-based electronic devices, electronic vehicles and even at military and aerospace applications. A lithium battery is a successful replacement to the large and heavy lead-acid batteries which were harmful to the environment. The concept behind the Lithium batteries is quite simple but still, it took decades of research to develop its technology. Today, featuring from cylindrical cells to the big batteries all are formulated with Lithium ions.

Manufacturing Process of Lithium batteries

The anode and cathode in the Lithium batteries are of the same form and act as a current collector and conducts the current in and out of the cell. The material of anode is Carbon based and the cathode is a Lithium metal oxide. They are delivered as a black powder and are stored with great care.

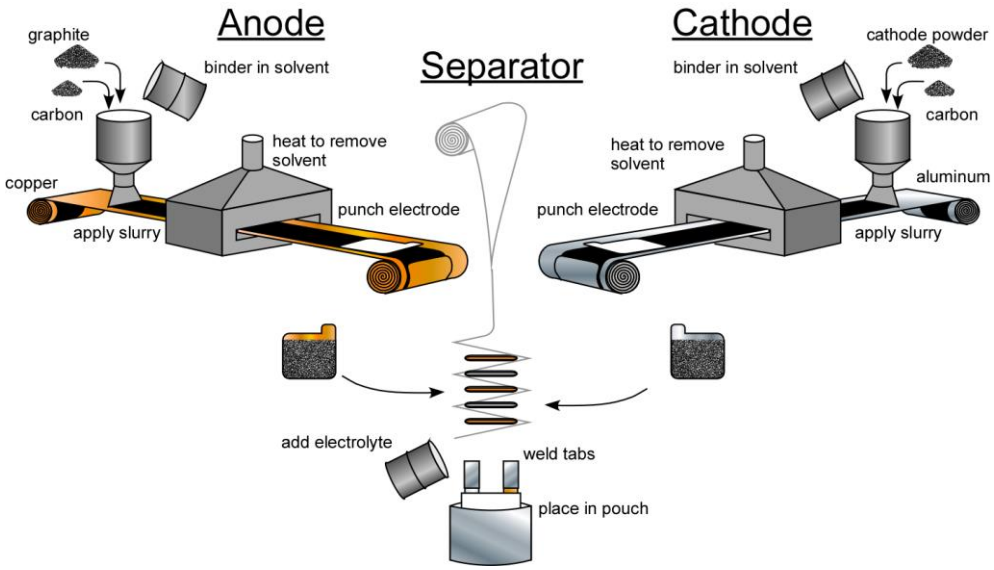


Now the metal electrode foils are delivered in large reels nearly 500mm wide. Here copper is used for anode and aluminium for the cathode and these reels are carefully mounted on the coating machine. Here the foil is unreeled and fed to the machine through precision rollers. The thickness of the coating layers must be set to allow the energy storage per unit area of the anode and cathode electrodes to be matched.

From the coater, the coated foil is fed directly into a long drying oven in order to bake the electrode material onto the foil and is further re-reeled. The foils are cut into desired lengths without burrs which can lead to internal short circuits.

The Cell Assembly

In the leading manufacturing companies of lithium batteries, automated equipment is used for cell assembly, but manual assembly methods are used by smaller units. In the first stage, the separator is sandwiched between the anode and cathode. There are two basic structures depending on the cell casing to be used. Stacked structure for the prismatic cells and spiral structure for the cylindrical cells



Prismatic cells

These are basically high capacity lithium batteries and in its design, a stacked electrode structure is used where anode and cathode foils are cut into individual plates, stacked alternately and kept apart from the separator.

Cylindrical cells

In this structure, the anode and cathode foils are formed in long strips, wound upon a cylindrical mandrel, with a separator that parts them and forms a jelly roll.

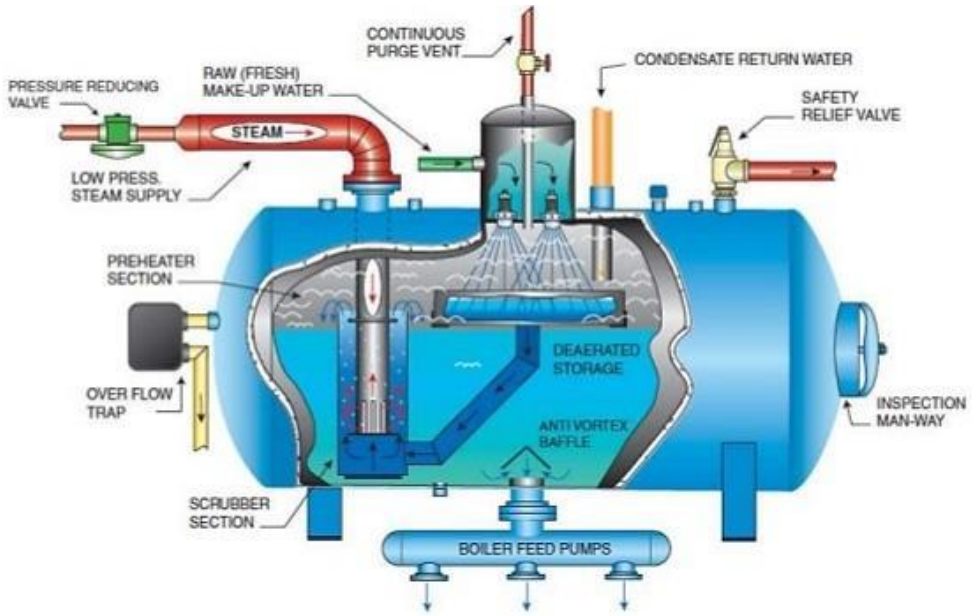
Question Twenty

How Boiler Works?

A boiler can be defined as a closed vessel in which steam is produced from water by combustion of fuel. A boiler is used in many industries such as in steam power generation, in sugar industries, in textile industries for sizing and bleaching etc. and in many other chemical industries. Earlier it was mainly used in generating power in the steam engine.

A boiler is simply an enclosed vessel which boils water and ultimately turns it into steam which is used for heating of rooms and heavy fuel oils on the ships.

The boilers are fitted with different safeties as the steam pressure is up to 8 bars in most cases. There are normally two kinds of boilers on ships, Auxiliary and Exhaust, some ships have composite boilers.



STEAM BOILER

Boiler are of two types:

1. STB (Smoke tube Boiler) or donkey boiler
2. WTB (Water tube Boiler) or High-pressure boiler

On board a vessel, STB or WTB may be used as per the requirement.

Stages of Combustion:

Since a boiler operates through fuel combustion, heat transfer and energy release, the stages of combustion are typically described as follows:

1. Standby: boiler is ready to meet demand.
2. Call for Heat: system pressure or temperature has fallen below a pre-determined set point.
3. Safety Check: A series of self-tests are performed to ensure the boiler is safe to operate (water level, gas pressure, electrical status, etc.).

4. Pre-purge: a forced draft fan or blower is used to force air through the furnace or combustion chambers to remove any potential unburned fuel that might be present.
5. Pilot Ignition: fuel and air are mixed and forced through a small pilot flame tube where a spark is generated to ignite the fuel.
6. Pilot Flame Trial: a flame sensor is used to make sure a strong, sustainable flame has been developed.
7. Main Ignition: Fuel and air are mixed and forced through a burner nozzle and are ignited by the pilot flame. Main combustion continues at various rates – low to high fire – until the system set point pressure or temperature is met.
8. Post Purge – the forced draft fan or blower is run to remove any potential unburned fuel from the furnace or combustion chamber.
9. Boiler goes into standby mode until temperature or pressure falls below the set point.

WORKING PRINCIPLE OF BOILER:

The basic **working principle of boiler** is very simple and easy to understand. The boiler is essentially a closed vessel inside which water is stored. Fuel (generally coal) is bunt in a furnace and hot gasses are produced. These hot gasses come in contact with water vessel where the heat of these hot gases transfer to the water and consequently steam is produced in the boiler. Then this steam is piped to the turbine of thermal power plant. There are many different types of boiler utilized for different purposes like running a production unit, sanitizing some area, sterilizing equipment, to warm up the surroundings etc.

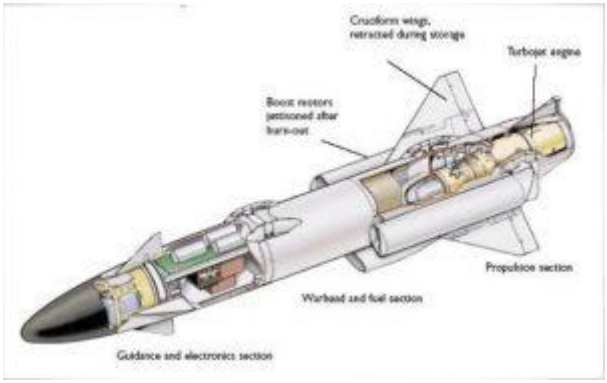
Question Twenty One

How do missiles work?

Targeting, Guidance & Propulsion

All of us has seen war footages and Hollywood war movies where a missile bound air strike saves the day. We have also heard of rockets something which seems to be just like a missile but actually isn't. Although beyond the scope of this write-up but still we will make a small mention of rockets.

By definition, A missile is a self-propelled vehicle which uses a guiding system to guide it to its location. The basic difference between a missile and rocket is its guidance system. A rocket has no guidance and relies on pre-fed coordinates to hit its target. Missiles were first developed by German Nazis and were simple devices guided by radio waves. The missile technology has come a far way since then.



Missile Diagram

Missiles are generally categorized on the basis of its launch platform. Missiles can be air to surface, surface to surface and air to air depending on the nature of the application and need. Some missiles can even be launched from underneath a sea where a submarine acts as the launch platform.

Guidance and Targeting in missiles:

Modern missiles are a complex piece of machinery, they make use of sophisticated computer algorithms and external guidance technology to reach their targets. Guidance and targeting for modern missile systems go hand in hand as both are essentially required in order to make the hit a success. Missiles are really expensive pieces of equipment hence the guidance and targeting systems on them has to be flawless and perfect.

A missile might use simple fixed GPS coordinates as sent back by a ground team near the target and responsible for marking the target and then the same is fed into the missiles computers which in turn decides the flight path of the missile.

The missiles might even use a real-time GPS guided guidance and targeting system to hit their target. These systems would use a mix of GPS, Radar, IR, lasers & radio waves for real-

time flight assistance and target acquisition. Such systems widely find their use in cruise missiles and ICBM or intercontinental ballistic missile systems.

Their mode of functions relies on one basic GPS location of the target, then this location is fed on the launch platform and missile guidance system.

To make the targeting more precise, a ground team near the target or an aircraft flying above the target will lace and mark the target with a laser which is visible to the missile systems and acts as confirmation of the target to be hit. This is the basic system for hitting the ground targets which might be stationary like a building. For moving targets, the missiles rely either on heat signature of the vehicle in question which can be tracked by the IR sensors on the missile or by having a real-time radar lock on the moving target.

Ground Laser System

When firing a missile for air to air assault the missiles would most probably rely on IR heat tracking and lock. In this case, the heat generated by the aircraft thrusters are used to lock on. This happens when both the air crafts in combat are in proximity to each other. In case the distance between the firing platform and the target is more than a mix of radar guidance and IR lock might be used to hit the target.

In-flight course corrections and change of directions, as well as maneuverability of missiles, are done by a process called thrust vectoring. In thrust vectoring the propulsion jets change the direction of thrust for changing the course of the missile. Apart from changing the vector primary

thruster, the missile has some additional thrust equipment designed especially for course corrections.

Propulsion systems:

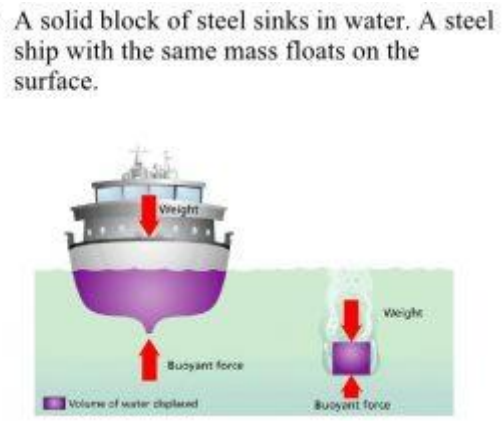
The missiles owing to the nature of their utility have to gain great speeds in the least time possible, this calls for having a propulsion system which is both heavy duty and powerful. Missiles run on dry fuel and wet fuels in general but might have a mix of both depending upon the desired range and application.

Missiles may have a single stage engine for short range applications and multi-stage for a long-range purpose. A mix of rocket engine for initial speed and acceleration and a jet engine for maintenance of flight may also be used in some types of missiles. Thrust vectoring may be present in more sophisticated missile systems.

Question Twenty Two

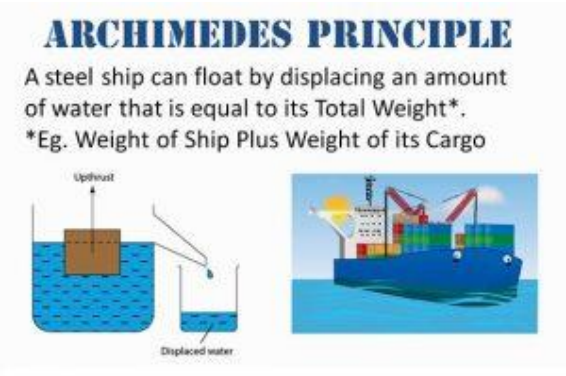
How do Ships Float?

Now, this is the question which everyone must have pondered over as a kid. Why something so heavy does not sink but floats, and not only floats but also carries so much cargo at times. Well, today we will understand why ships float. Now, everything in this world is ruled by classical physics and so does this phenomenon



Before we jump on to the science and math of why ships float we have to pay some due respect to the guy because of which we have the answer to this curious question. That guy is **Archimedes**, Archimedes was a scientist and much more. He was a genius and some people even regarded him as being mentally retarded.

The legend has it that he was given a task by the king to adjudge whether his crown was made up of pure gold or not. Now Archimedes was having a bath in his bathtub and also pondering over the task at hand. Nobody knows what happened but somehow the movement of water in his bathtub led him to formulate the Archimedes principle.

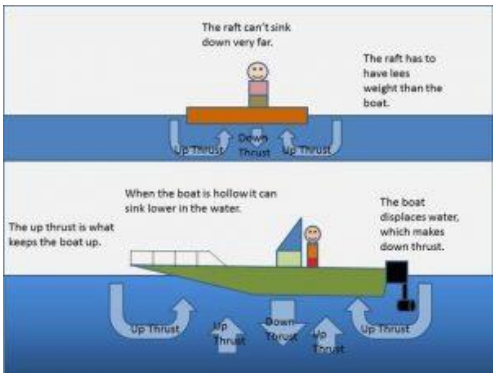


Archimedes Principle

Archimedes principle states that “The upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces”

So how does it fit into this equation or our question that “why ships float?”, see its quite evident that when the weight of the body is less than the weight of the fluid it displaces, then that object will float and not sink. The game is off the volume vis weight.

For example: let us take an object which has a volume of say 10 cubic meters and weighs 20 metric tons. Put it straight in the water and see what will happen. Naturally, it will sink as the amount of water displaced will be far more than the volume of the object.



Now, let’s increase the volume of the object to say 20 cubic meters keeping the weight same, again let’s throw it in water, what will happen now is that the object will neither sink nor float. Reason is that the amount of water displaced here is equal to the volume of the object. Now let’s assume we increase the volume of the object to say 30 cubic meters keeping the weight same, now we have an object that is floating in the water due to the obvious reasons.

Same happens in case of a ship, the design of the ship is made in such a way that the amount of water it displaces is always more than its weight. Hence the ships float on water. Modern ships have buoyancy control mechanism which makes adjustments according to the laden weight of the ship. So, this was the answer to your curious question folks.

Question Twenty-Three

How do trains turn without differential?

This is a question that would baffle many. It surely baffled us and we thought the flanges on the wheels keep the trains on the track, but that's not the case at all. Then what could it be? Let's try to address that exactly.

If you notice the shape of the wheel of a train, you will notice that they are conical in shape. The side with greater diameter is on the inside. The shorter diameter lies towards outside. When the train approaches a curve, and has to turn then the wheels slide away in the correct direction. This keeps the train on the track and allows for proper negotiation of the curve.

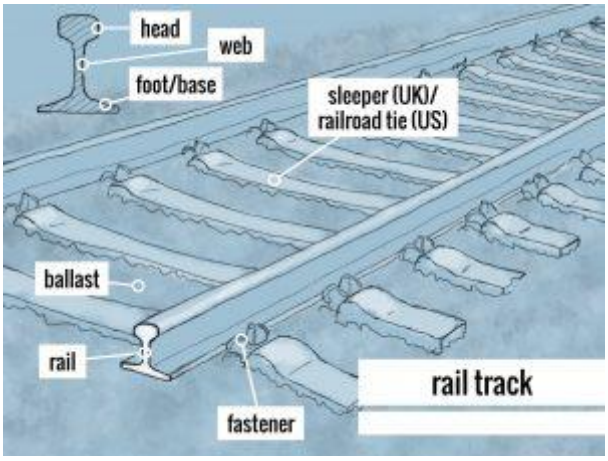
The following takes place once a train is in motion:

In studying this theory, we are considering that the train is moving in the left direction. Now if the train is making a left turn. Then the wheels due to centrifugal force will move towards the right. Obviously, this will result in an increase in diameter of the right wheel and decrease in diameter of the left wheel.

This will allow the right wheel to travel more distance due to the larger diameter when compared to the left wheel. Hence solving the problem. The simple design provides a genius solution every time. The beauty of the whole system is that the wheel shift happens automatically. No external system is required for the same.

Additional Information on Rail Wheel:

Now we know how trains turn without a differential. Let us also garner some information on the locomotive wheel.



Railway Track

A locomotive wheel consists of two parts:

- Wheel.
- Tire.

The Tire is the outer surface which remains in contact with the track. A Tire is fitted on the wheel to reduce maintenance costs. Replacing a worn-out wheel is very expensive. Hence a replaceable steel layer called tire is used. The tire is forged on the wheel and wears over the use.

The most common cause of wheel or tire damage in trains is heavy breaking. The entire brakeforce is directed towards wheels. This puts a heavy burden on them and damages them. If the damage is severe then wheel has to be replaced. Train tires are about 3 inches in thickness making them durable. The replacement also calls for replenishing the worn inches. Hence making maintenance reasonable.

Question Twenty Four

How Much Current Can the Human Body Withstand?

Human body is a good conductor of electricity. When it comes to an electric shock, we all have at least one bad experience with it in our lifetime. We have heard about many incidents where a person gets electrocuted at a workplace or gets an electric shock through their household appliances.

But why is it that some people don't get affected by an electric shock whereas others end up with being fatal? The answer is the amount of electric current that passes through their bodies.

We often see a 'danger' or 'no trespassing' symbol around generators and electric boards. These symbols warn us not to touch that equipment as they constantly work at high voltages. But do voltages really affect us or there is some other culprit?

Most of us aren't aware of the fact that voltage doesn't really affect us. It is the current that is forced through our body that affects us. That's why birds sitting on electric wires aren't electrocuted. When there is a potential difference created in a conductor, then current flows from the higher potential end to the lower potential end. This is the reason why birds don't get electrocuted as they are at the same potential on both ends of the body as the wire. Hanging on the wire at high potential and touching the ground which is at a zero potential, creates potential difference and it renders the flow of current from higher potential to lower potential. Thus, forcing huge current to flow through us.

So, in short, humans can withstand any amount of voltage until and unless they are not creating a potential difference in their body. Now, how much current can a human body withstand?

You can get a shock from a current of 10 mA or .01 A, but it won't be fatal. At 100 mA, muscular contraction starts but as the human heart has a low resistance, even a current of smaller magnitude like 10 mA can be deadly.

However, current never reaches the heart because our skin has more resistance than the heart and hence it absorbs the current completely. When the current magnitude is more than 1000 mA, the muscular contractions augment to a level which doesn't allow us to let go of the wire. This results in muscle paralysis and heart get ventricular fibrillation which is an uncoordinated intermittent twitching of heart ventricles that produce ineffective heartbeats. This may result in death if not aided in time.

Moreover, with a current of a magnitude of 2000 mA, there can be burn and unconsciousness. This shock makes muscular contraction so severe that heart plunges into clamps. This amount of current can lead to internal burn and clamps may result in a cardiac arrest which can cause death.

So, aren’t we unaffected by the current?

The amount of current flowing through our body depends on the extent to which our body is permeable or resistant to current. Well, resistance to the current depends on our skin condition. If the skin is wet it is estimated to be 1000 ohms and for dry skin, it is 500000 ohms. This finite resistance of our body makes us non-impervious to current.

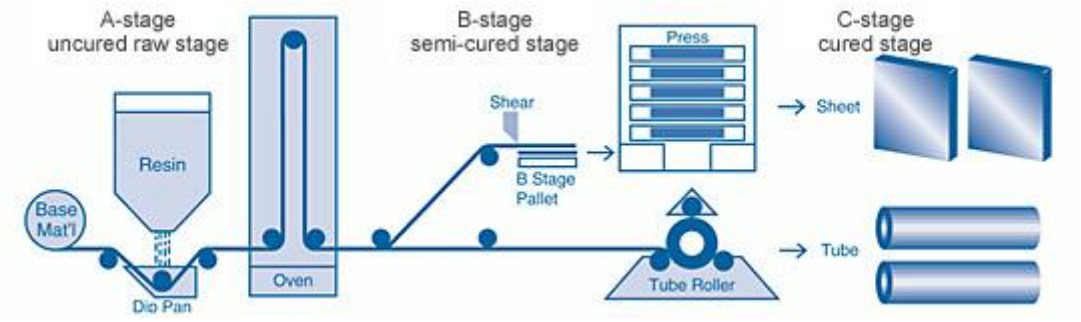
Question Twenty Five

How Plastic Is Formed and Molded

Plastic is a polymer, chains of simple organic chemicals (monomers), linked together in long chains. The monomers are synthesized in refineries, from oil. The linking of the monomers in the polymer chain is done inside polymerization reactors until the desirable average molecular weight is achieved for the polymer. Then dyes and other additives are added to the molten polymer and the material is extruded into filament, granules or flakes and cooled.

Plastics are sold in these forms as raw materials to the various manufacturers. Recycled plastic can be molten and re-extruded or directly crushed into granules or torn into flakes.

Plastic products are made out of raw plastic using a host of moulding techniques which always involve mixing and melting of the raw material inside a screw extruder.



Most plastic molecules are just hydrogen and carbon atoms, or mostly hydrogen and carbon with some oxygen, sulfur, nitrogen or chlorine atoms as well. They take advantage of the ability of carbon atoms to bond their electrons together in long flexible chains in order to create long flexible molecules.

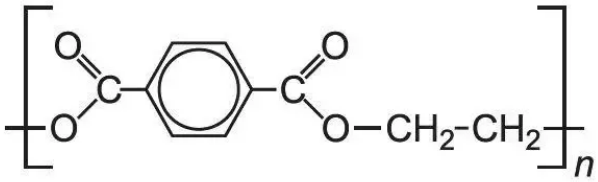
When we combine monomers, we generate polymers or plastics. The plastic production process begins by heating the hydrocarbons in a "cracking process." The resulting resins may be molded or formed to produce several different kinds of plastic products with application in many major markets.

Processes Used in Plastic Making:

Organic substances, in chemistry, refer to substances containing carbon. Carbon has a very useful electronic configuration which allows it to bond easily with 4 atoms at once.

The basic organic molecules, alkanes, alkenes and alkynes, contain only carbon and hydrogen. However, many other 'functional groups', can be added to the carbon chain to change the properties of the substance. For example, oxygen, nitrogen, sulphur or chlorine. However, the vast majority of plastics do not contain the latter two.

If you aren't familiar with the structure of organic compounds, here is an example:



The above substance is polyester. The brackets and subscript 'n' around this diagram representing the fact that this is a single unit of polyester, which is repeated in a chain to create the full fabric. As you can see, there is only carbon, hydrogen and oxygen in polyester (the three elements most common in the human body). The overall structure is reasonably complex, with two standard methyl links, two ester groups, and an aromatic ring (benzene).

So, where do the elements and substances, that make up plastics like polyester, come from?

The answer is, of course, from fossil fuels. Crude oil, petroleum, coal, and natural gas are entirely composed of these organic substances, and plastics are made by utilizing various chemical processes, with chemicals from fossil fuels.

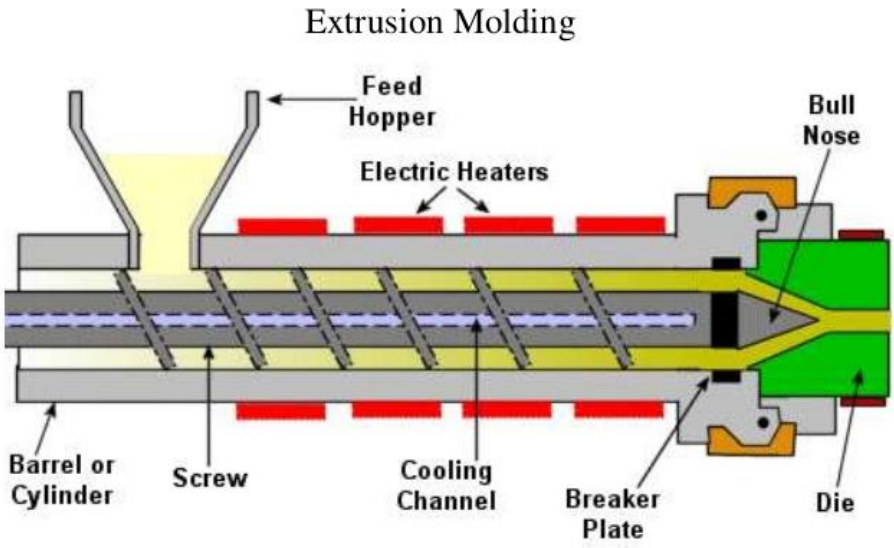
Fossil fuels, in turn, are made of dead and compressed organic matter (this time referring to things that were previously alive, like trees).

So, if you were to go way back into the history of the atoms in that pair of polyester underwear you're wearing, they might have been part of a dinosaur, or a huge tree.

Now Enough About Plastic Making Process, let us talk about how plastic is molded into various shapes.

Plastic Molding Processes:

The main process used to form plastics. A heated plastic compound is forced continuously through a forming die made in the desired shape (like squeezing toothpaste from a tube, it produces a long, usually narrow, continuous product).

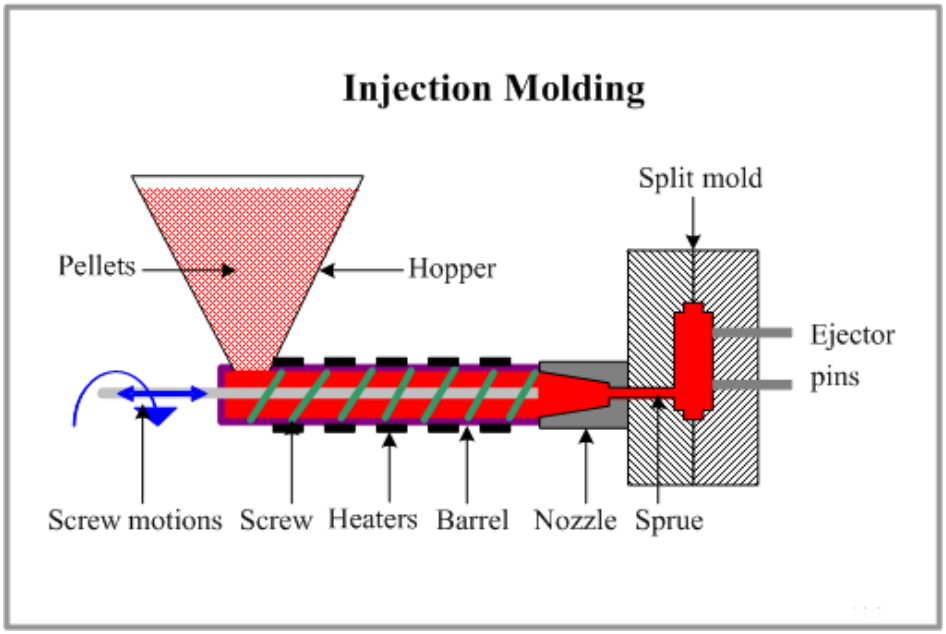


The formed plastic cools under blown air or in a water bath and hardens on a moving belt. Rods, tubes, pipes, Slinkys, and sheet and thin film (such as food wraps) are extruded then coiled or cut to desired lengths.

Plastic fibers also are made by an extrusion process. Liquid resin is squeezed through thousands of tiny holes called spinnerets to produce the fine threads from which plastic fabrics are woven.

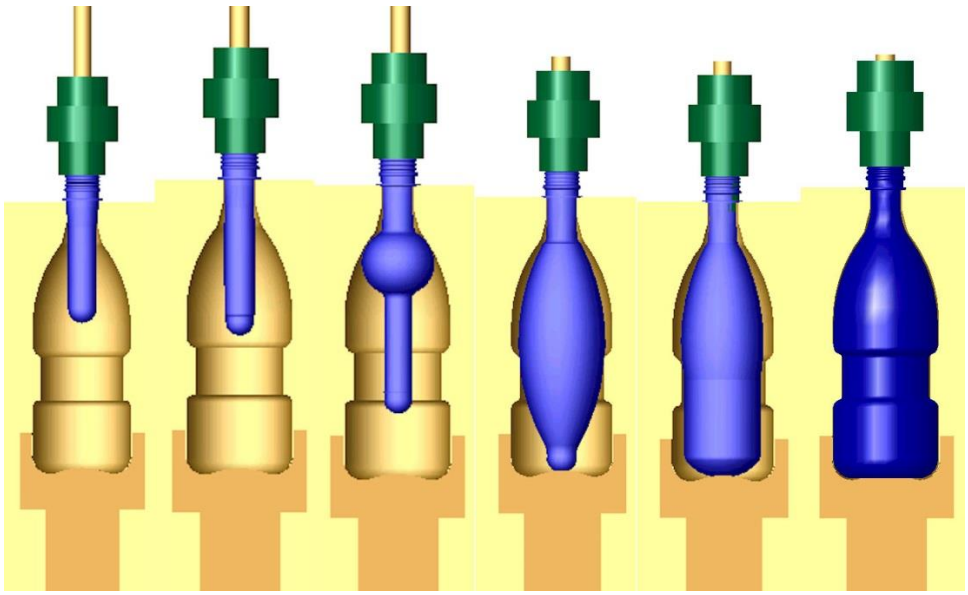
Injection Molding:

It is the second most widely used process to form plastics. The plastic compound, heated to a semifluid state, is squirted into a mold under great pressure and hardens quickly. The mold then opens and the part is released. This process can be repeated as many times as necessary and is particularly suited to mass production methods. Injection molding is used for a wide variety of plastic products, from small cups and toys to large objects weighing 30 pounds or more.



Blow Molding:

Pressure is used to form hollow objects, such as the soda pop bottle or two-gallon milk bottle, in a direct or indirect method. In the direct blow-molding method, a partially shaped, heated plastic form is inserted into a mold. Air is blown into the form, forcing it to expand to the shape of the mold. In the indirect method, a plastic sheet or special shape is heated then clamped between a die and a cover. Air is forced between the plastic and the cover and presses the material into the shape of the die.

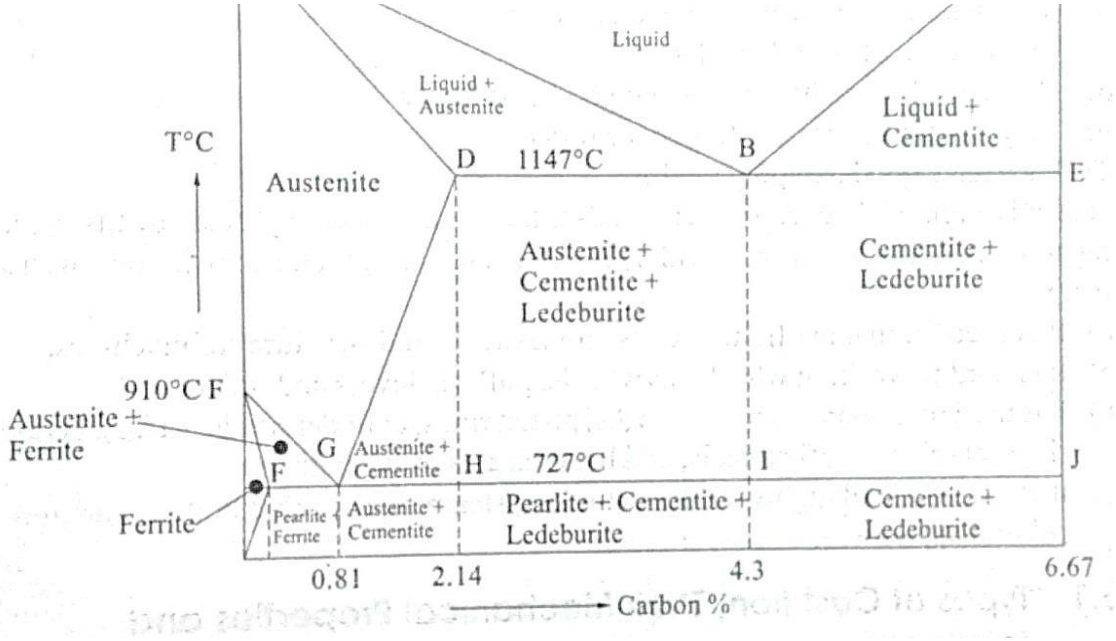


Question Twenty Six

Iron – Carbon Phase Diagram

In their simplest form, steels are alloys of Iron (Fe) and Carbon (C). The study of the constitution and structure of iron and steel start with the iron carbon phase diagram. It is also the basic understanding of the heat treatment of steels.

Iron Carbon phase diagram



On this diagram, the carbon percentage is shown on the x-axis and temperature on the y-axis. This figure shows the Iron Carbon Equilibrium Diagram. In this diagram, the lines indicate the boundaries where the alloy changes its phase. The different phases or mixture of phases occur in different areas enclosed by these curves. Pure iron exists in two allotropic forms, ∝-iron, γ-iron, both in the solid state. The ∝-iron exists between 910°C, and also above 1392°C, and its crystal lattice body-centered cubic. The ∝-iron which exists above 1392°C is also called δ-iron. The γ-iron exists in the range 910°C to 1392°c, and its crystal is face-centered cubic. The melting point of iron is 1539°C.

In Fe-C system is in the solid state, the different phases which are present are Ferrite (Solid solution), Austenite, Cementite (Chemical compound iron Carbide), and free carbon in the allotropic form of graphite.

Steel is an alloy of carbon and iron and other alloying elements (e.g. Mn, Si) with carbon content up to 2% intended for wrought products or semi-products. Cast iron is an alloy of carbon and iron and other alloying elements (e.g. Mn, Si) with carbon content over 2% intended for castings. Now, we consider only a part of Fe-Fe3C diagram referring to steel. Perlite is a structure (i.e. consists of two phases) consists of alternate layers of ferrite and cementite in the proportion 87:13 by weight. Perlite is formed from austenite at the eutectoid temperature (A1) 727°C upon slow cooling. There are three groups of steels according to carbon content: – hypereutectoid steels containing less than 0.76% C – eutectoid steel with carbon content about 0.76% – hypereutectoid steels contain more than 0.76% C (up to 2% C).

The austenite-ferrite transformation:

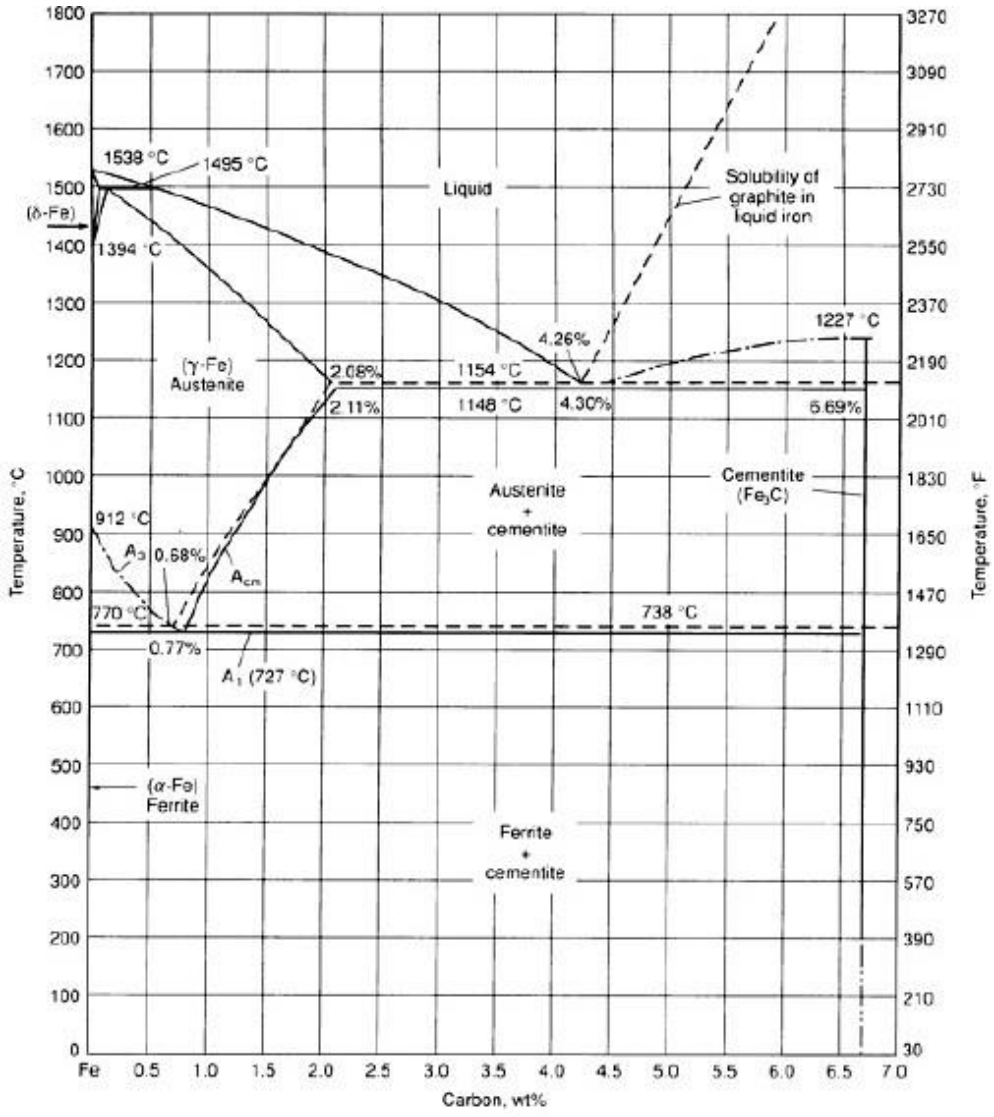
Under equilibrium conditions, pro-eutectoid ferrite will form in iron-carbon alloys containing up to 0.8 percent carbon. The reaction occurs at 910 Deg. C in pure iron, but takes place between 910 Deg. C and 723 Deg. C in iron-carbon alloys.

However, by quenching from the austenitic state to temperatures below the eutectoid temperature Ae1, ferrite can be formed down to temperatures as low as 600 Deg. C. There are pronounced morphological changes as the transformation temperature is lowered, which it should be emphasized apply in general to hypo-and hyper-eutectoid phases, although in each case there will be variations due to the precise crystallography of the phases involved. For example, the same principles apply to the formation of cementite from austenite, but it is not difficult to distinguish ferrite from cementite morphologically.

The austenite-cementite transformation

The Dube classification applies equally well to the various morphologies of cementite formed at progressively lower transformation temperatures. The initial development of grain boundary allotriomorphs is very similar to that of ferrite, and the growth of side plates or Widman Staten cementite follows the same pattern. The cementite plates are more rigorously crystallographic in form, despite the fact that the orientation relationship with austenite is a more complex one. As in the case of ferrite, most of the side plates originate from grain boundary allotriomorphs, but in the cementite reaction more side plates nucleate at twin boundaries in austenite.

Iron Carbon phase diagram



The austenite-pearlite reaction:

Pearlite is the most familiar microstructural feature in the whole science of metallography. It was discovered by Sorby over a century ago, who correctly assumed it to be a lamellar mixture of iron and iron carbide.

Pearlite is a very common constituent of a wide variety of steels, where it provides a substantial contribution to strength. Lamellar eutectoid structures of this type are widespread in metallurgy, and frequently pearlite is used as a generic term to describe them.

These structures have much in common with the cellular precipitation reactions. Both types of reaction occur by nucleation and growth, and are, therefore, diffusion controlled. Pearlite nuclei occur on austenite grain boundaries, but it is clear that they can also be associated with both pro-eutectoid ferrite and cementite. In commercial steels, pearlite nodules can nucleate on inclusions.

It may be seen that the normal Iron-carbon equilibrium diagram represents the metastable equilibrium between iron and iron carbide. Cementite is metastable as the true equilibrium is between iron and graphite. Although graphite occurs extensively in cast irons (2 to 4 wt percent

carbon), it is usually difficult to obtain this equilibrium phase in steel (0.03 to1.5 wt percent carbon). Therefore, the metastable equilibrium between iron and iron carbide is normally considered, since it is relevant to the behavior of a variety of steels in practice.

On comparing austenite (? -iron) with ferrite (? -iron) it is noticed that solubility of carbon is more in austenite with a maximum value of just over 2 wt percent at 1147 Deg. C. This high solubility of carbon in austenite is extremely important in heat treatment when solution treatment in the austenite followed by rapid quenching to room temperature allows the formation of a supersaturated solid solution of carbon in iron.

The ferrite phase is restricted with a maximum carbon solubility of 0.02 wt percent at 723 Deg. C. Since the carbon range available in common steels is from 0.05 to 1.5 wt percent, ferrite is normally associated with cementite in one or other form. Similarly, the? -phase is very restricted and is in the temperature range between 1390 and 1534 Deg. C and disappears completely when the carbon content reaches 0.5 wt percent.

Question Twenty Seven

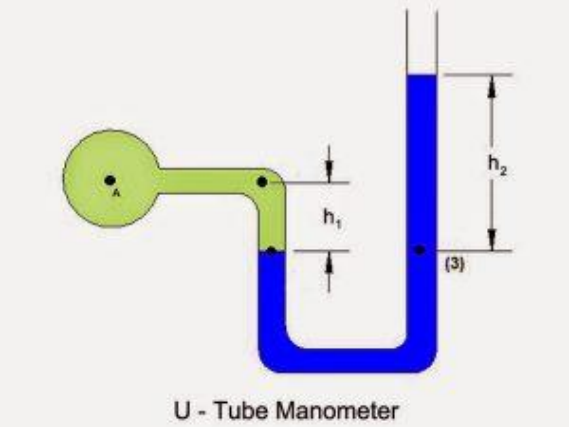
Manometer & Its Types

A Manometer by definition is a device used for measuring the pressure of a fluid by balancing it against a pre-determined column of fluid. The most common type of manometer which almost all of us might have seen is sphygmomanometer. It is the device which doctors use to measure your blood pressure.

A manometer is can be used at any applicative process where the pressure of a fluid needs to be measured.

The five basic types of manometers are:

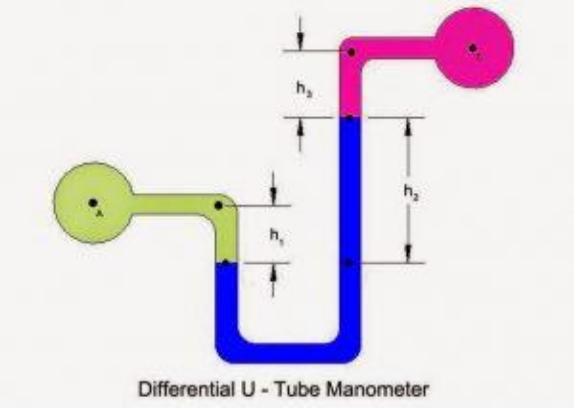
1. U-Tube Manometer:



U - Tube Manometer

This type of manometer is U shaped, with one end open to atmosphere. It is used for measuring suction. It has the capability of measuring both positive and negative suction pressures. It utilizes the principle of specific gravities for measuring the suction pressure. This type of manometer generally has a liquid whose specific gravity is greater than that of the fluid whose suction pressure is to be measured.

2. Differential U-Tube Manometer:



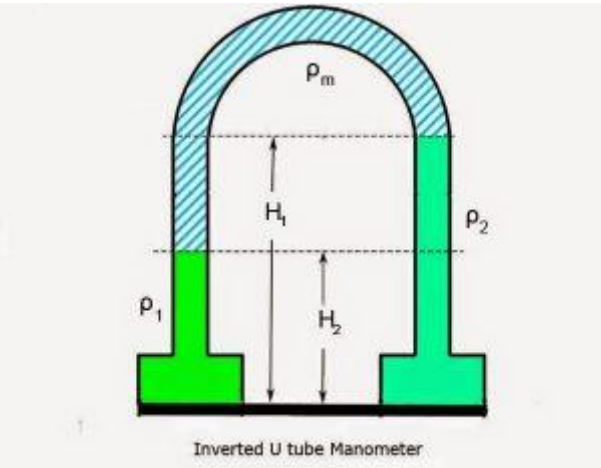
Differential U - Tube Manometer

This type of manometer is slightly different from the normal U Tube manometer. Here the open end is also closed, what that means is both the ends of this type of manometer are closed. It really becomes a tool of importance where the pressure is to be measured directly. This manometer type has fluid or liquid filled at different pressures on both ends.

The equation for this is as follows:

3. Inverted U – Tube manometer:

This type of manometer as the name suggests has an inverted U-shaped tube. It is used to measure differences in low pressure between two points, where the high level of accuracy is desired. It is filled with liquid on the ends. The space between liquids is filled with air. This air can be expelled or admitted into the apparatus using a tap. This is done to adjust the pressure difference to obtain an accurate reading.



Inverted U tube Manometer

The equation for the same (source: http://www.msubbu.in/ln/fm/Unit-I/InvertedUtubeMano.htm)

Equating the pressure at the level XX'(pressure at the same level in a continuous body of static fluid is equal),

On the left-hand side:

$P_x = P_1 – rg(h+a)$

On the right-hand side:

$P_x' = P_2 – (rga + r_m gh)$

Since $P_x = P_x'$,

$P_1 – rg(h+a) = P_2 – (rga + r_m gh)$

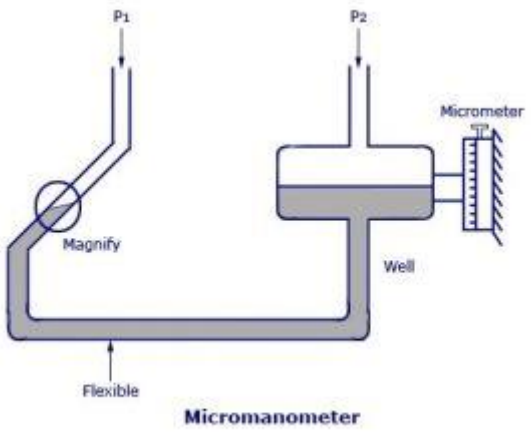
$P_1 – P_2 = (r – r_m)gh$

If the manometric fluid is chosen in such a way that $r_m << r$ then,

$P_1 – P_2 = rgh.$

4. Micro Manometer:

Micromanometer is a great tool used in fluid statics. It is a modified form of a simple manometer. It has one limb which is larger in cross-section. It is a device which is used to measure very minute pressure differences with high accuracy.



Micromanometer

The equation of hydrostatic equilibrium at PQ can be written as

$$p_1 + \rho_w g(h + \Delta z) + \rho_G g\left(z - \Delta z + \frac{y}{2}\right) = p_2 + \rho_w g(h - \Delta z) + \rho_G g\left(z + \Delta z - \frac{y}{2}\right) + \rho_m g y$$

where ρ_w, ρ_G and ρ_m are the densities of working fluid, gauge liquid, and manometric liquid respectively.

From continuity of gauge liquid,

$$A\Delta z = a\frac{y}{2}$$

$$p_1 - p_2 = gy\left[\rho_m - \rho_G\left(1 - \frac{a}{A}\right) - \rho_w \frac{a}{A}\right]$$

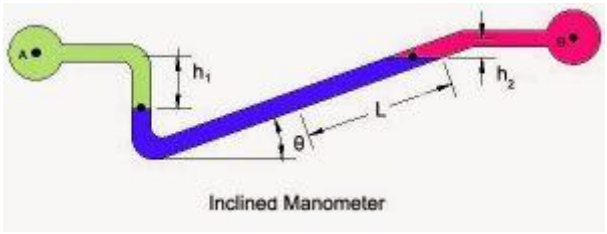
If a is very small compared to A

$$p_1 - p_2 \approx (\rho_m - \rho_G) gy$$

With a suitable choice for the manometric and gauge liquids so that their densities are close a $(\rho_m \approx \rho_G)$ reasonable value of y may be achieved for a small pressure difference.

5. Inclined Manometer:

This a high precision and high accuracy type of manometer. It is used to measure the minuscule amount of pressures with high accuracy. Its configuration is inclined and this makes it more accurate than other types of manometers. It is used where manometric properties of liquids are very close.



Inclined Manometer

If the manometer, instead of being vertical, is set at an angle θ to the horizontal, then a pressure difference corresponding to a vertical difference of levels x gives a movement of the meniscus s = x/sinq along the slope.

If θ is small, a considerable magnification of the movement of the meniscus may be achieved. Angles less than 5^0 are not usually satisfactory because it becomes difficult to determine the exact position of the meniscus. One limb is usually made very much greater in cross-section than the other. When a pressure difference is applied across the manometer, the movement of the liquid surface in the wider limb is practically negligible compared to that occurring in the narrower limb. If the level of the surface in the wider limb is assumed constant, the displacement of the meniscus in the narrower limb needs only to be measured, and therefore only this limb is required to be transparent.

Question Twenty Eight

Stress and Strain Explained with Types

Stress is nothing but the force applied to the cross-sectional area and strain is nothing but change in dimensions of given material by original dimensions, after the load is applied. Think of a long bar, with one end fixed to a wall, and you're pulling on the other end. **Stress** is how hard you're pulling. **The strain** is how far the bar has stretched.

Let us understand stress-strain in brief-

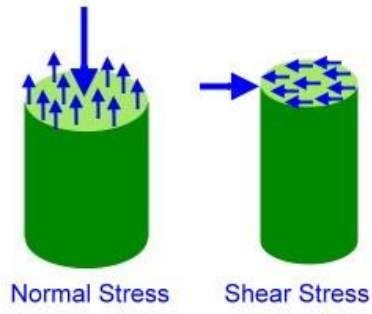
Stress

When anybody is subjected to external loading, then elements from the body will try to oppose that force, that internal resistance offered by elements from the body is known as stress.

When force is applied to any deformable body which behaves as a continuum i.e. its mass is continuously distributed through the body, internal forces manifest inside the body. Quantitatively, stress is the average internal force acting upon a unit area of a surface within the body. Its SI unit is Pascal (N/m^2).

In the context of three-dimensional bodies, there are two types of stresses, shear stress and normal stress. The former occurs as a reaction to body forces and the latter as a reaction to surface forces. Body forces act on the entire volume of the body e.g. gravitational force and surface forces act across a particular internal or external surface element of the body.

Normal stress and Shear stress



Often in real life, most mechanical bodies experience both types of stresses simultaneously.

Strain

It is the ratio of change in dimension of the body due to external loading to original dimension of the body before loading.

When force is applied to a body similar to the one described above, its configuration (set of positions of all particles of the body) tends to change. This is called deformation. It often involves a change in shape, but the definition of deformation includes rigid body motions which do not involve shape change. The term strain refers to the *relative* deformation of a body. In two

dimensions, it would refer to the relative change in length, which is (new length/old length). It is dimensionless.

Types of Stresses-

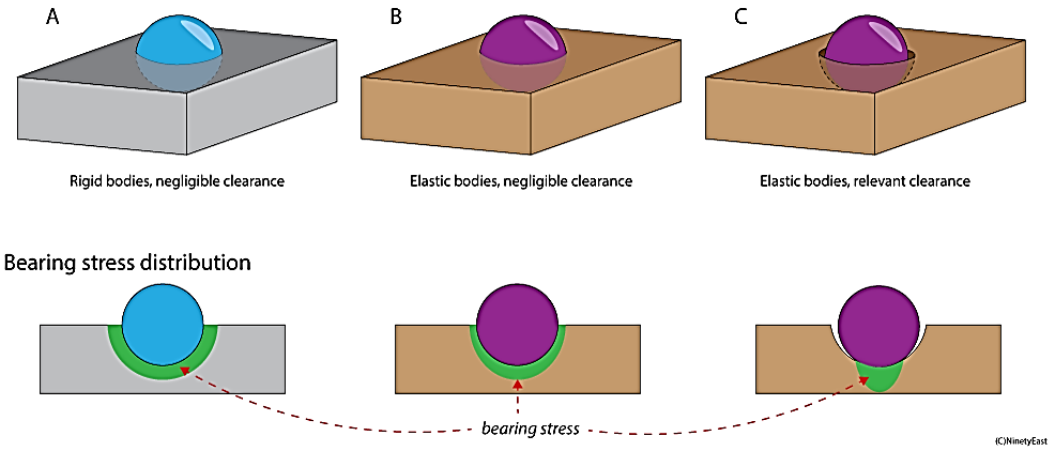
1) Normal Stress:

Stress produced by loads acting normal to the cross-sectional area of the body.

A. Axial Stress:

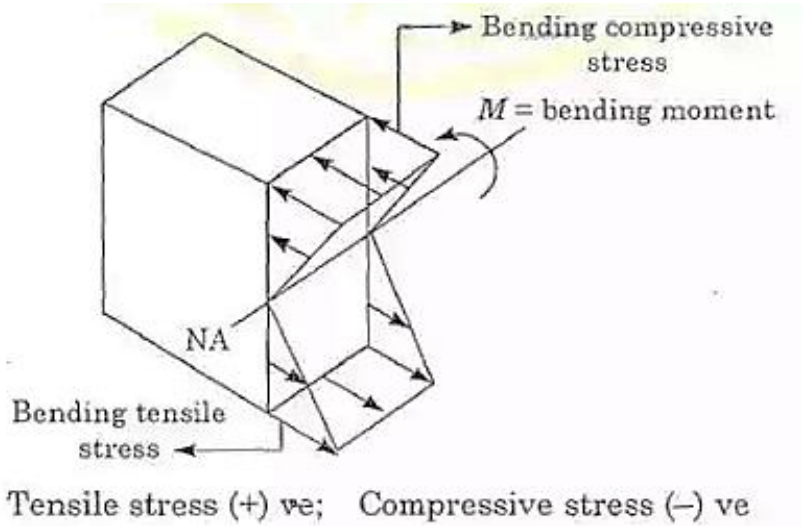
When Direction of the load is along the axis of the member i.e. normal to the cross-section of the member where it is applied it is known as Axial Stress.

B. Bearing Stress:



Compressive Stress arising when one body is supported by another body is known as bearing stress.

C. Bending Stress:



Stresses that produces a net Bending Moment parallel to the cross-section of the body.

2) Shearing Stress:

Stress produced when the loads are applied along the surface plane of the body.

Following are the 2 types of Shearing Stress.

A. Direct Shear Stress:

Shear Stress caused by the direct action of the forces in trying to cut through the material.

B. Indirect Shear Stress:

Arises due to application of a tensile or compressive force on an oblique surface or torsion.

a) Tensile or Compressive force:

Produced when a force is applied at an oblique surface. And, it's magnitude equals the component of the applied force along the surface.

b) Torsion:

Zero at center and maximum at extreme points. Produced when a body is subjected to torsional moments.

Types of Strain

1. Longitudinal strain: change in length to original length l.
2. Volumetric strain(dilatant): change in volume to the original volume.
3. Lateral strain: change in diameter or lateral dimension to the original diameter.
4. Superficial strain: change in area to the original area.

Question Twenty Nine

Type of chips

During the machining process of the workpiece to give it a desired shape, metal chips are produced. The chips formed may be of continuous, discontinuous and continuous with built up edge type. The types of chips formed in machining process depends upon so many factors, we will discuss it later. Basically, there are three types of chips produced in the metal machining and these are continuous, discontinuous and continuous with built up edge.

1. Continuous chips
2. Discontinuous chips &
3. Continuous chips with built up edge (or BUE chips)

Let's discuss about them one by one

1. Continuous Chips

If the metal chips formed during machining is without segments i.e. without breakage, then it is called as continuous types of chips.

Continuous chips are formed when the ductile material is machined with high cutting speed and minimum friction between the chip and tool face.

The conditions which are responsible for the formation of continuous types of chips are

(i) Ductile material like mild steel is used.

(ii) Bigger rake angle of the tool.

(iii) High cutting speed.

(iv) Minimum friction between the chip and tool interface.

(v) Small depth of cut.

Advantages

The formation of continuous chips during machining process has the following advantages

• Better surface finish to the ductile material.

• Less heat generation due to minimum friction between the tool face and chip.

• Low power consumption.

• Long tool life due to less wear and tear.

2. Discontinuous Chips

If the chips formed during machining process is not continuous i.e. formed with breakage is called discontinuous chips.

Discontinuous types of chips are formed when hard and brittle metals like brass, bronze and cast iron is machined.

Conditions which are responsible for the formation of discontinuous chips are:

(i) Low feed rate.

(ii) Small rake angle of the tool.

(iii) High cutting speed.

(iv) High friction forces at the chip tool interface.

(v) Too much depth of cut.

Advantages

The formation of discontinuous types of chips in brittle materials provides good surface finish, increases the tool life and reduces the consumption of power.

Disadvantages

When discontinuous chips are formed in the ductile materials, the workpiece result in poor surface finish and excessive wear and tear of the tool takes place.

3. Continuous Chips with Built Up Edge

Continuous chips with built up edge is formed by machining ductile material with high friction at the chip-tool interface.

It is similar to the continuous types of chips but it is of less smoothness due to the built-up edge.

How Built Up Edge is Formed?

When the chip is flows in upward direction and high friction is exist in between the interface of the chip and tool. Due to the high friction between the chip and tool a very intense heat is generated at the nose of the tool. The compressed metal adjacent to the tool nose gets welded to it. This compressed metal welded to the nose is called built up edge. When the chip flows through this built up edge, it gets broken and carried away by the chip and called as built up edge chips, the rest of the built-up edge is adhering to the surface of the workpiece and makes it rough.

Due to formation of the built-up edge the rake angle of the tool gets changed and so is the cutting force.

The factors which are responsible for promoting the formation of the BUE chips are:

(i) Excessive feed rate.

(ii) Small rake angle of the tool.

(iii) Low cutting speed.

(iv) Lack of coolant and this increase the friction between the chip tool interfaces.

Advantages

The making of the BUE has one advantage i.e. it protects the tool from getting damaged from high friction and temperature generated during machining process and hence the tool life increases.

Disadvantages

The formation of these types of chips results in rough surface finish, change in the rake angle and cutting forces.

Comparison between Continuous, Discontinues and Continuous Chips with Built up Edge in Tabular Form are:

S.no	Factors	Continuous Chips	Discontinuous Chips	Continuous chips with Built Up Edge (BUE)
1.	**Material types**	Ductile	Brittle, ductile but hard	Ductile
2.	**Rake angle**	Large	Small	Small
3.	**Cutting speed**	High	Medium or high	Low or medium
4.	**Friction between chip tool interface**	Minimum	Maximum	Maximum
5.	**Depth of cut**	Small	High	Medium

Question Thirty

Types of Fluid Flow

Laminar, Turbulent & Transitional Flow

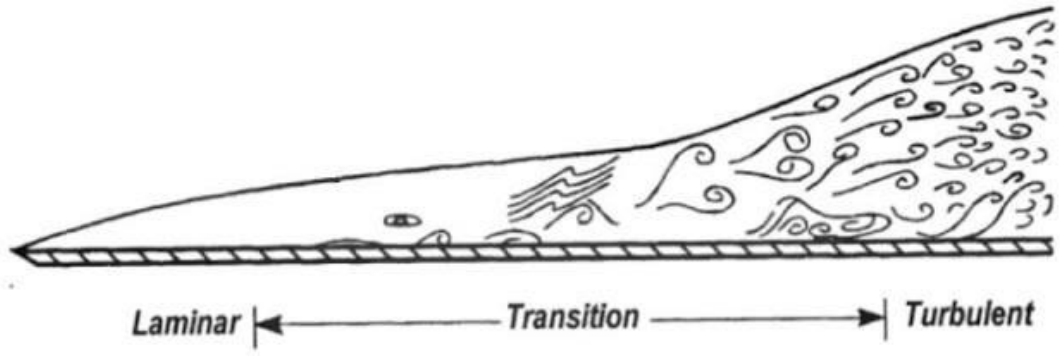
The matter is classified as Solids, Liquids and Gases. Out of these liquids and gases are termed as fluid. Thus, fluid is a substance that has the ability to flow in any direction. The shear force acting on any fluid due to the continuous relative motion between the fluid particles tends the particles to move. And when the fluid particles are not able to resist the shear force the fluid particles tend to move over each other. Thus, a fluid flow takes place.

Fluid, as I said above, can be gas or liquid and the main difference between these two fluids is that liquid takes the shape of the container it is stored in but gas occupies the complete space.

Types of Fluid Flow:

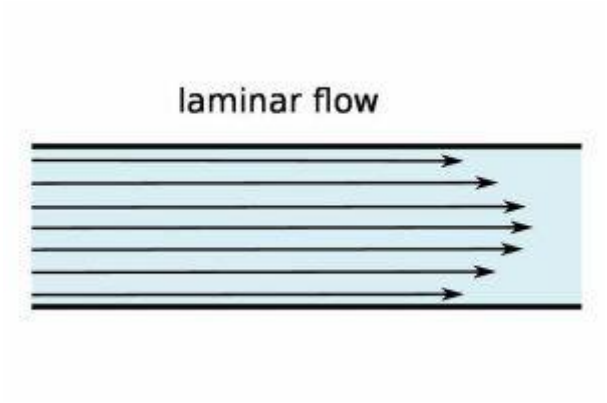
Considering the layers of fluid in a pipe, fluid flow is categorized into 3 types:

- Laminar flow
- Turbulent flow
- Transitional flow



Laminar Flow:

Laminar flow is otherwise called as Streamline flow. Particles of fluid are considered to travel in a smooth continuous path called streamlines. They can be curved or straight depending on the pass way they are moving. In a laminar or streamline flow the fluid layers slide relative to each other. Any two layers doesn't mix. For example, if any colored fluid is introduced into the laminar flow, the colored fluid remains in with the stream, so the fluid is steady. The laminar flow is represented with a set of straight or curved lines called streamlines or flow lines.



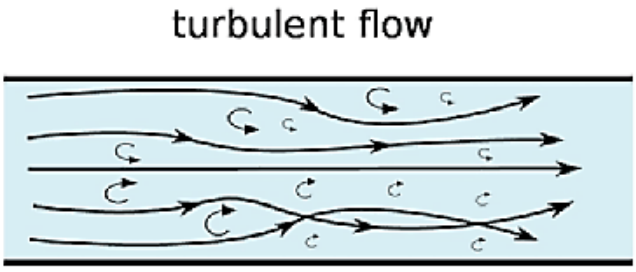
For a laminar flow, all the particles will follow a streamline and no two will intersect each other. The instantaneous velocity of the particle is in the direction of the tangent to the streamline.

As the streamlines get closer, the velocity of the fluid flow will increase, and when the streamlines flow somewhat far away from each other, the velocity stays low.

Turbulent Flow:

Turbulent flow is just the opposite of laminar flow. Vigorous mixing occurs as a result of which the flow pattern continually changes with respect to time. In turbulent flow, the fluid layers move very fast thereby mixing the fluid layers. The velocity of the fluid keeps on changing continuously.

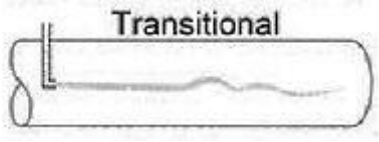
A laminar flow changes to turbulent flow when the flow rate suddenly increases making the steady flow unstable.



Whenever there is any abrupt change in the boundary of the pipe, turbulent flow occurs. The volume flow rate dramatically decreases when the flow becomes turbulent.

Transitional Flow:

Transitional flow is the combination of both laminar and turbulent flow. Considering a pipe with laminar flow, transitional flow is said as occurred when any disturbance is created and the fluid flow at the centre of the pipe is turbulent and at the edge of the pipe, it is laminar. This is basically the transformation of laminar flow to turbulent flow.



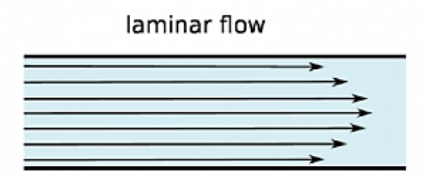
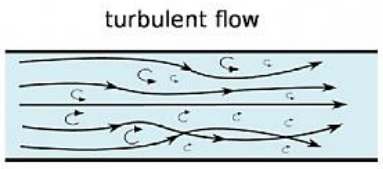
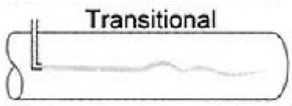
FACTORS DETERMINING THE LAMINAR OR TURBULENT FLOW:

Reynolds number: The fluid flow depends upon this dimensionless quantity. This number is used to know whether the fluid flow is laminar or turbulent. It is the ratio of force of inertia to the viscous force.

Inertial force is due to the momentum of fluid and is given as (ƒv) viscous force is the frictional force due the relative motion between the various layers of the fluid.

- Laminar flow occurs at low Reynolds number; because the flow is steady, hence viscous force is less. For a laminar flow, the Reynolds number is **less than 2100**.
- Turbulent flow occurs at high Reynolds number, as the flow is unsteady and velocity is high resulting in more inertial force. For a turbulent flow, the Reynolds number is **greater than 4000**.
- In the transition flow the Reynolds number ranges from **2100 to 4000.**

SUMMARY TABLE

LAMINAR FLOW	TURBULENT FLOW	TRANSITIONAL FLOW
Particles travel in parallel layers	Particles do not travel in parallel layers	Particles move in mixed flow, laminar and turbulent
		
Layers do not mix with each other	Layers mix in random manner	It is the stage of changing of laminar flow to turbulent flow
Moves along the direction of flow.	Only average motion of flow is parallel to pipe axis	Flow transits from laminar to turbulent at the center of pipe

Question Thirty One

What Are Bearings? Their Properties & Types

Bearings are modern machinery and equipment is an important component. Its main function is to support the mechanical rotating body, reducing its coefficient of friction during movement, and to ensure the accuracy of its rotation.

According to the different nature of friction of moving parts, bearings Rolling and plain bearings can be divided into two categories. Wherein Rolling has been standardized, serialized, but compared with the sliding bearing its radial dimension, vibration and noise are large, the price is higher.

Rolling generally consists of an outer ring, inner ring, rolling elements and cage four parts, strictly speaking, by the outer ring, the inner ring, rolling elements, cage, seals, lubricants six pieces of composition. Mainly includes outer, inner ring, rolling elements can be given meaning-bearing. According to the shape of the rolling elements, bearing into ball bearings and roller bearings two categories.

A bearing is a mechanical element which is used to support another moving element.

It is used to give free rotational motion to the shaft. It reduces the friction and heat.

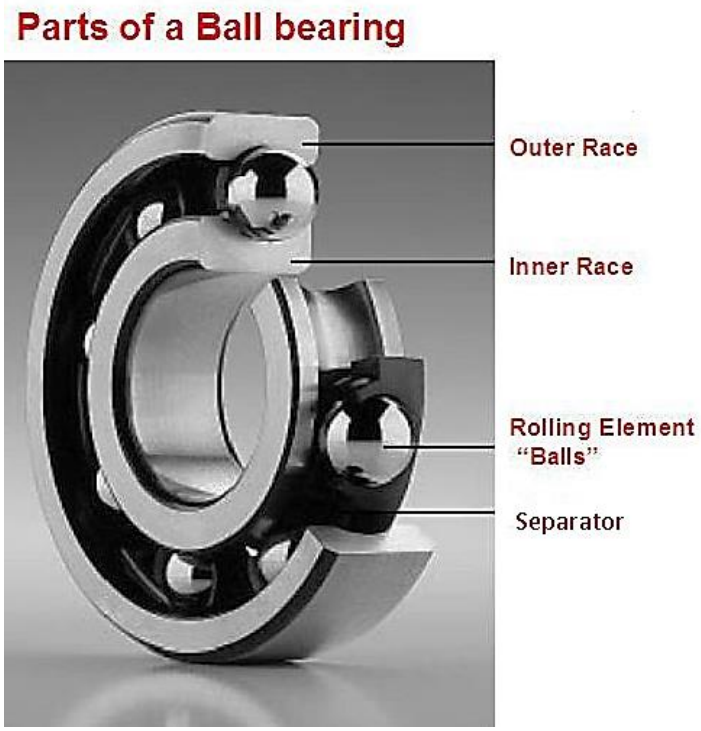
Bearings should have following properties-

2. High fatigue strength
3. High thermal conductivity
4. Low thermal expansion

There are numerous different kinds of bearings that are designed to handle the radial load, thrust load, or some combination of the two. Because different applications require bearings that are designed to handle a specific kind of load and different amounts of weight, the differences between types of bearings concern load type and ability to handle the weight.

Types Of Bearings-

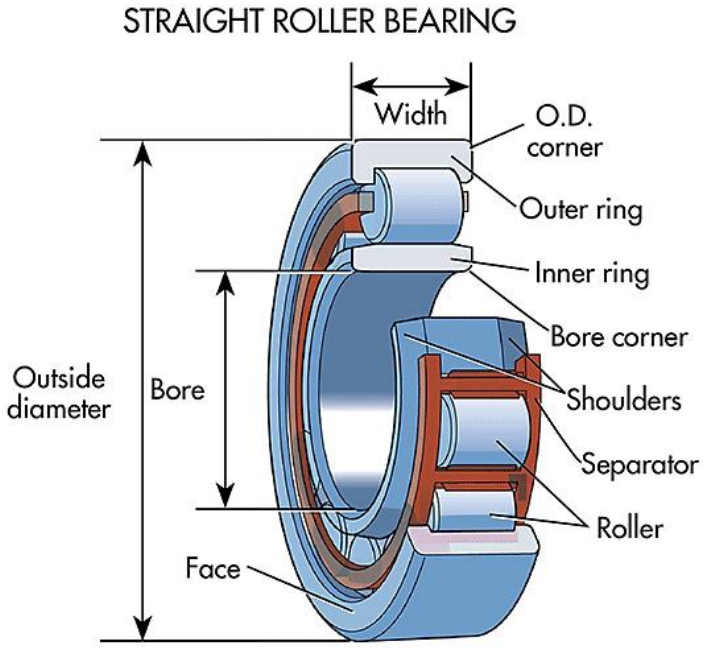
- **Ball Bearings**



Ball Bearings are extremely common because they can handle both radial and thrust loads, but can only handle a small amount of weight. They are found in a wide array of applications, such as roller blades and even hard drives, but are prone to deforming if they are overloaded.

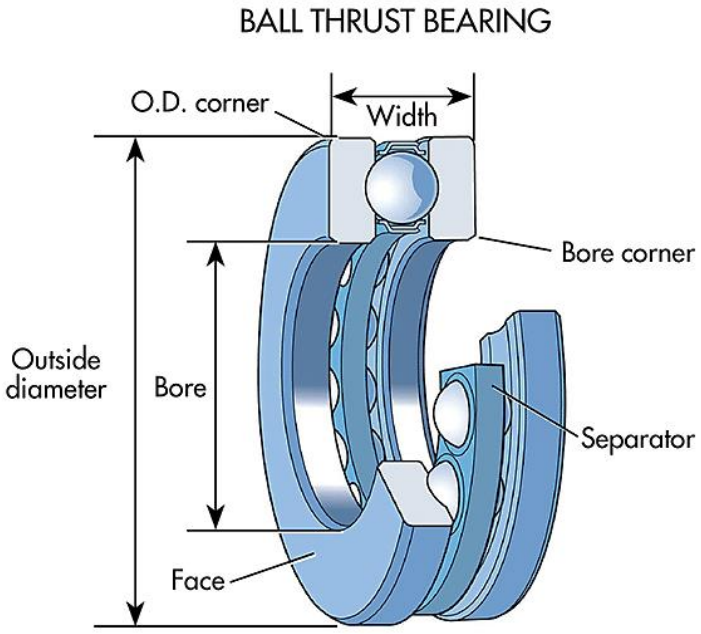
Learn in detail about ball bearings and their purpose here- **What are ball bearings and what is their purpose?**

- **Roller Bearings**



Roller bearings are designed to carry heavy loads—the primary roller is a cylinder, which means the load is distributed over a larger area, enabling the bearing to handle larger amounts of weight. This structure, however, means the bearing can handle primarily radial loads but is not suited to thrust loads. For applications where space is an issue, a needle bearing can be used. Needle bearings work with small diameter cylinders, so they are easier to fit in smaller applications.

- **Ball Thrust Bearings**



These kinds of bearings are designed to handle almost exclusively thrust loads in low-speed low-weight applications. Bar stools, for example, make use of ball thrust bearings to support the seat.

- **Roller Thrust Bearings**

Roller thrust bearings, much like ball thrust bearings, handle thrust loads. The difference, however, lies in the amount of weight the bearing can handle: roller thrust bearings can support significantly larger amounts of thrust load, and are therefore found in car transmissions, where they are used to support helical gears. Gear support, in general, is a common application for roller thrust bearings.

- **Tapered Roller Bearings**

This style of bearing is designed to handle large radial and thrust loads—as a result of their load versatility, they are found in car hubs due to the extreme amount of both radial and thrust loads that car wheels are expected to carry.

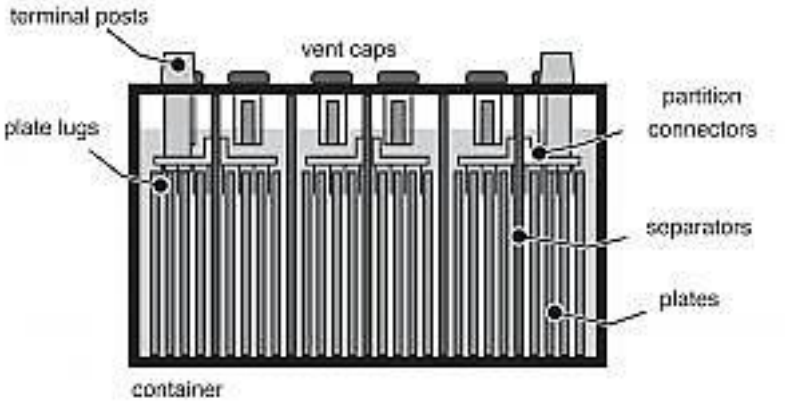
- **Specialized Bearings**

There are, of course, several kinds of bearings that are manufactured for specific applications, such as magnetic bearings and giant roller bearings. Magnetic Bearings are found in high-speed devices because it has no moving parts—this stability enables it to support devices that move unconscionably fast. Giant roller bearings are used to move extremely large and heavy loads, such as buildings and large structural components.

Question Thirty Two

What is a battery? What Are the Various Types of Batteries

A battery is an electronic device which consists of one or more electrochemical cells. It is used to provide power to various electrical devices such as flashlights, smartphones, electric cars etc. But, there are various types of batteries which are used for various purposes in the electric world.



Battery Insides

The various types of batteries are:

- Household Battery
- Industrial batteries
- Vehicle batteries.

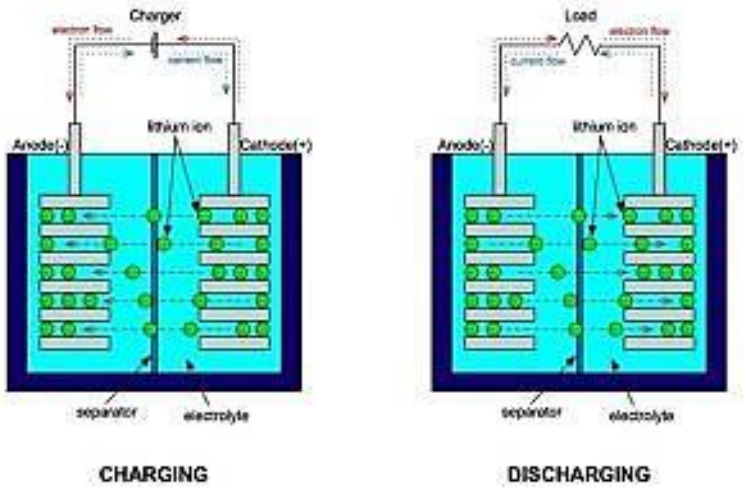
1. Household Batteries:

These are most common batteries which we use in our everyday life.

Household batteries can be subdivided into 2 categories:

- Rechargeable
- Non-Rechargeable.

Rechargeable Batteries:



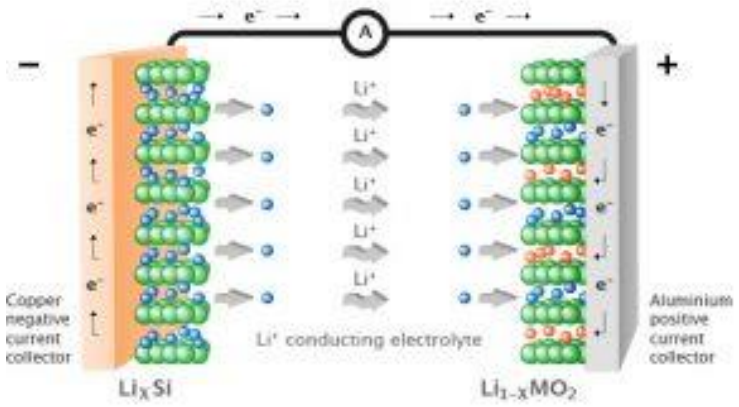
These are the batteries which can be charged using external sources. We can use them for multiple purposes by charging them until the battery is in the condition to get replaced.

Examples of rechargeable batteries are:

i). Lead Acid Gel battery:

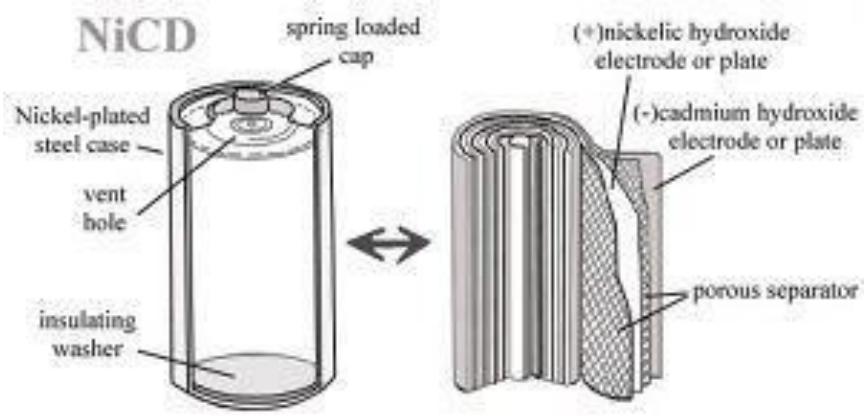
It is a rechargeable dry-cell battery, usually comes in rectangular hard plastic cases. It is used in Wheel Chairs, golf carts, military aircraft, RV's, and boats.

ii). Lithium-ion battery(Li-ion):



It is a small dry-cell sealed rechargeable battery, generally comes in hard plastic cases or in a small cylinder format or in the shape of buttons, which we usually call button cells. These batteries are used in Cellphones, laptops, video cameras or in a hybrid automobile.

iii). Nickel-Cadmium battery:



These are also small, dry-cell, rechargeable batteries. These batteries come in a poly-wrapped cell packed in a hard plastic case. These batteries are used in handheld electronics, R/C hobby vehicles, and mechanical equipment.

iv). Nickel Metal Hydride:

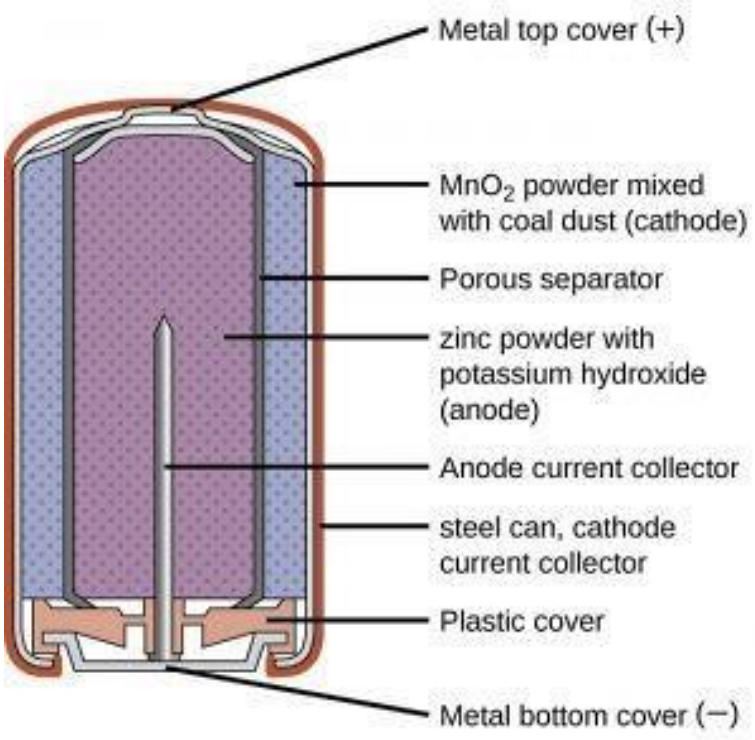
Nickel metal hydride batteries are small, dry-cell, rechargeable batteries. It comes in AAA, AA, C, D, 9volt and 12volt formats. These are used in power tools, PDAs, and cameras.

Non-Rechargeable Batteries:

These are batteries which cannot be charged using external sources. These batteries are also known as single-use batteries because once they ‘re fully discharged they cannot be recycled.

Some Examples of Non-rechargeable batteries are:

i). Alkaline and Carbon Zinc Battery:



It is a small, dry-cell, non-rechargeable battery. Zinc-carbon batteries are labeled for general purpose or for heavy duty. It comes in AAA, AA, C, D, 9volt format. It is used in cameras, toys, and watches.

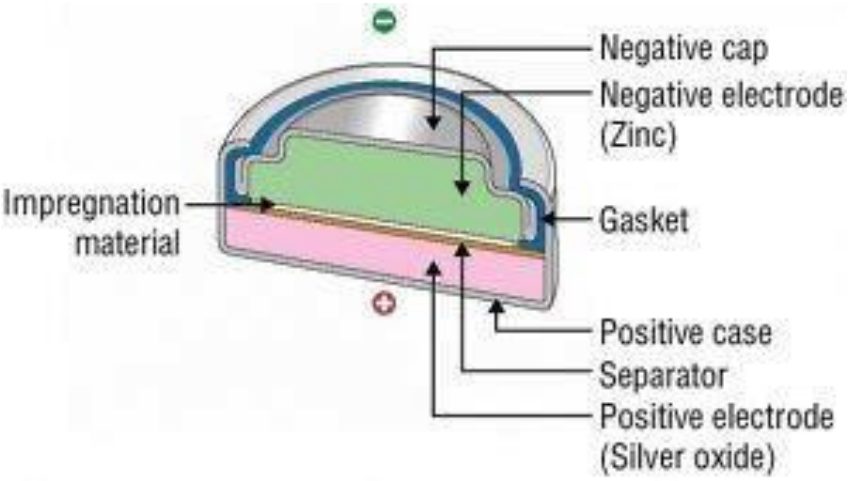
ii). Lithium(Primary):

Lithium batteries are small, dry-cell, non-rechargeable batteries which come in AAA, AA, button cell and 9 V formats. These are used in tire-pressure sensors, alarms, pacemakers and in remote car locks.

iii). Mercury:

It is also a small, dry-cell, non-rechargeable battery, which comes in AA, 9V format. These batteries are used in medical devices and in military gadgets.

iv). Silver Oxide battery:



These batteries can be small or large, depending on how power is to be supplied. These are dry-cell, non-rechargeable batteries, comes in button cells, high voltage formats. These batteries are used in hearing aids, torpedoes and aircraft.

v). Zinc Air battery:

These are small, dry-cell, sealed non-rechargeable batteries. It comes in button cells or in 9volt format. These batteries are used in electrical vehicles (mechanically recharged).

2. Industrial batteries:

This kind of batteries are used to supply power in heavy duty applications like machinery, railroad and backup power for data centers, utilities and telecommunications.

The various types of industrial batteries are as follows:

i). Absolute battery:

These are the large kind of batteries, made up of lead acid and cadmium. It is ‘vented VRLA (Valve regulated, lead-acid battery). It is used in the telecommunications system, railroad switchgear and signals, and in solar arrays.

ii). Large Flooded Cell:

As the name suggests, these are the large batteries, typically a lead acid, vented battery. It comes in rectangular or in hard case formats. These batteries are used in Stationary power and in utility systems.

iii). Nickel Iron:

These batteries vary in size from Medium to Large. These are flooded cell, vented batteries and are rechargeable. These batteries are very long-lasting batteries. They come in rectangular or in metal cases. These batteries are used in railroad signals, mining operations.

iv). Wet Nickel Cadmium(NiCd):

These batteries vary from small to large in size. These are flooded cell, rechargeable batteries. It is of 2 types, pocket plate, and sinner plate. It comes in hard cases or multi-cell in metal or in wooden cases formats. These batteries are used in marine and aviation applications.

3. Vehicle batteries:

These batteries are less spillable and more user-friendly. These batteries are used to supply power to light motor vehicles, boats, and other motorized vehicles.

The various types of Vehicle batteries are:

i). Hybrid Automotive:

These are large, dry-cell, rechargeable batteries. NiMH and Li-ion batteries are the most commonly used hybrid automotive batteries. They are used in hybrid and electric automobile.

ii). Lead Acid battery:

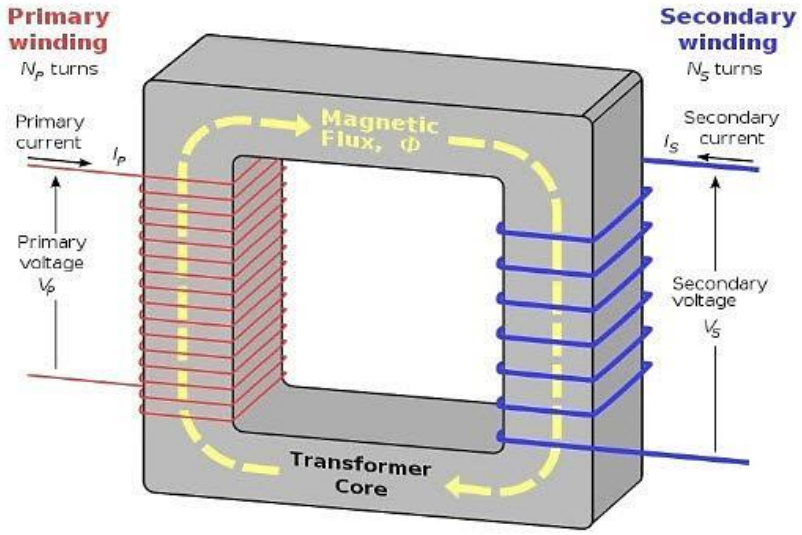
These are the vented, flooded cell, rechargeable batteries, which comes in a hard case format. These batteries are used in boats, motorcycles and in outdoor power equipment.

Question Thirty Three

What Is a Transformer? It's Types and Working

The transformer is an electromagnetic device, which is used to either step up or step down the voltage levels by keeping power, frequency and flux as constant.

These are devices used in electrical circuits to change the voltage of electricity flowing in the circuit. **Transformers** can be used either to increase the voltage (called "stepping up") or decrease the voltage ("step down"). By the definition you will get the clear idea that transformers are the need of electrical industry, **we use it in our home, apartment, building, electrical appliances etc**. wherever we want the power supply in huge amount.



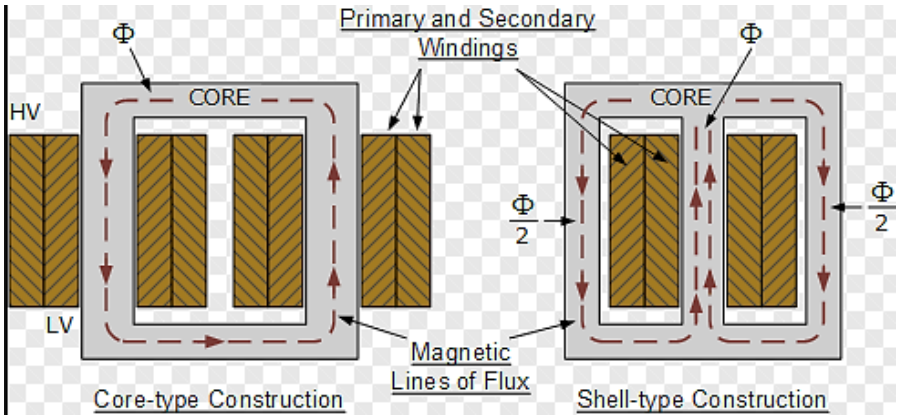
Classification / Types:

Transformers can be classified on a different basis, like types of construction, types of cooling etc.

(A) On the basis of construction, transformers can be classified into two types as;

(i) Core type transformer

(ii) Shell type transformer



(I) Core Type:

In core type transformer, windings are cylindrical former wound, mounted on the core limbs as shown in the figure above. The cylindrical coils have different layers and each layer is insulated from each other. Materials like paper, cloth or mica can be used for insulation. Low voltage windings are placed nearer to the core, as they are easier to insulate.

(Ii) Shell Type Transformer:

The coils are former wound and mounted in layers stacked with insulation between them. A shell type transformer may have a simple rectangular form (as shown in above fig), or it may have a distributed form.

(B) On the basis of their purpose

1. Step up transformer: Voltage increases (with a subsequent decrease in current) at secondary.
2. Step down transformer: Voltage decreases (with subsequent increase in current) at secondary.

(C) On the basis of type of supply

1. Single phase transformer
2. Three phase transformers

(D) On the basis of their use

1. Power transformer: Used in transmission network, high rating
2. Distribution transformer: Used in distribution network, comparatively lower rating than that of power transformers.
3. Instrument transformer: Used in relay and protection purpose in different instruments in industries
    - Current transformer (CT)
    - Potential transformer (PT)

(E) On the basis of cooling employed

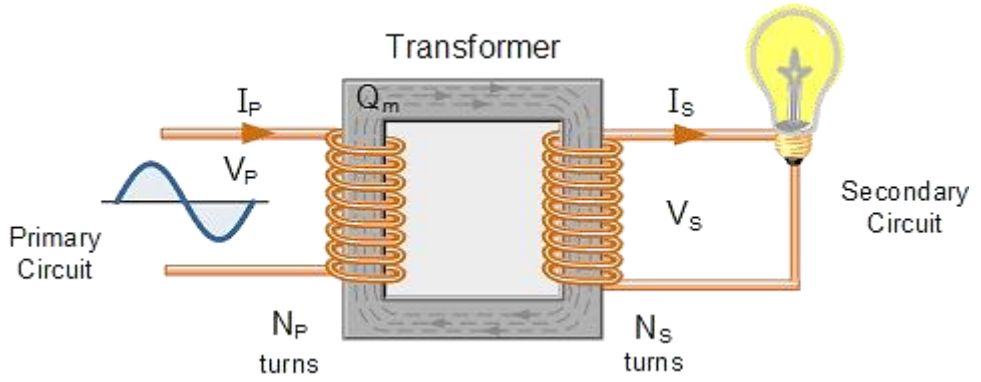
1. Oil-filled self-cooled type
2. Oil-filled water-cooled type
3. Air blast type (air cooled)

Working of Transformer –

The basic idea is to connect the first circuit to a primary winding, typically of many turns of wire in some sort of coil shape which creates a concentrated zone of the high magnetic field on the inside of the coil. Then you want to place a secondary winding (or several) so that as many as possible of the magnetic field lines from the primary go through the secondary as well. This can be done by winding the primary and secondary into the same space, but often a more convenient method is to use a Magnetic core of material with a high magnetic Permeability and low Magnetomotive force.

Magnetic field lines like to run in high permeability materials, so you can put the primary and secondary a convenient distance apart and use the core as a conduit to pipe the field lines between them.

Then it's just Faraday's law twice over. If you apply a fixed voltage to the primary, a steadily increasing current will build up (except for the magnetic effects, a coil is a short circuit), creating an increasing magnetic field, and integrated across the area of the coil, a magnetic flux. According to Faraday's law, there's a back voltage generated equal to the rate of change of magnetic flux times the number of turns in the primary. The rate of increase of current will adjust itself until this back voltage is in equilibrium with the applied voltage.



Then, the same increasing magnetic flux is acting on the secondary, so a voltage is induced there as well, except there you multiply by the number of turns in the secondary. If the number of turns in the secondary is different, you have the voltage transforming action for which the transformer is named. More turns in the secondary give a step-up transformer which increases voltage; fewer turns gives a step-down transformer.

Of course, with a fixed input voltage, the poor transformer can't keep up for more than a very brief time because the current can't actually keep increasing indefinitely. Sooner rather than later the heating effect of all the current will cause a burnout. So, in practice, you only ever use transformers with AC input, where the input voltage reverses regularly and the current never has a chance to build up too much.

Primary winding gets input voltage and produces flux in the iron core, then this settled flux get linked with the secondary winding. Because of ac supply flux will change its direction and magnitude ……so secondary coil will get inducement voltage.

Induced voltage=-N(dphi/dt)

Where N is a number of turns in secondary windings and dphi/dt is the rate of change of flux."-"ve sign describes Lenz's law.

As rate of change of flux is same for both,

E1/N1=E2/N2

E1/E2=N1/N2……**

The transformer changes the voltage levels without affecting power.

Power remains same for both sides.

P1=P2

E1I1=E2I2

E1/E2=I2/I1

N1/N2=I2/I1(from…).**

As it is a static device, losses are too small.

Efficiency: 96%to98%

Question Thirty Four

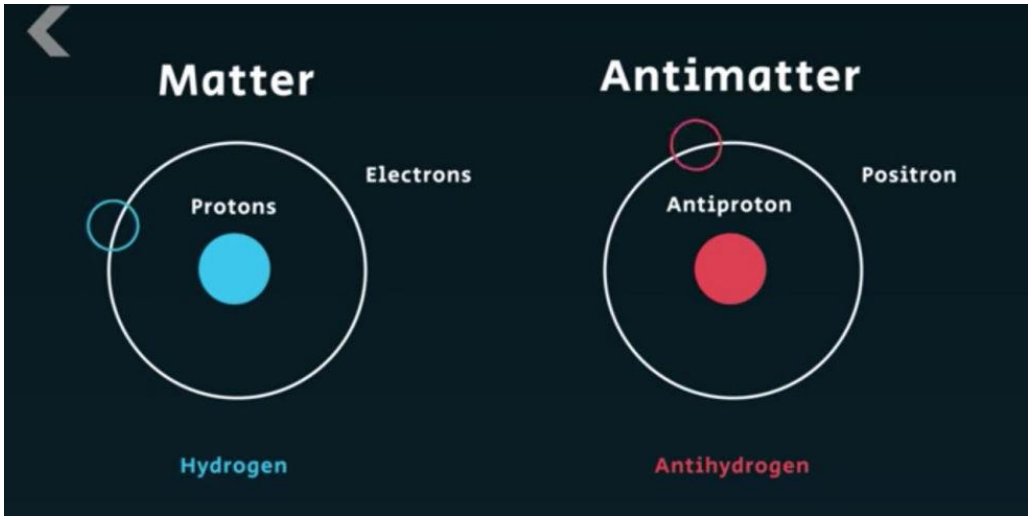
What is an anti-matter?

As the name suggests, an anti-matter is the opposite of matter. It consists of sub-atomic particles that show properties entirely opposite of those of matter. Anti-matter and matter were created together after the Big Bang. However, it is very rare to find them in the current universe. For a better understanding of the antimatter, let's first understand the matter.

The matter is made from several atoms that are small units of elements like oxygen, hydrogen or helium. Each element comprises a different number of atoms: One for hydrogen, two for helium and so on. It is difficult to understand the working of a whole atom, as it has many exotic particles that possess the spin and flavor that scientists have just begun to understand. For simple understanding, we can look at the particles like proton, neutron, and electron inside an atom.

So, what exactly is anti-matter:

Inside an atom, there is a nucleus in the center which contains a proton (which is positively charged) and neutron (which doesn't have any charge). Around this nucleus, electrons (Negatively charged particles) move in different orbits. The electrons can jump on the higher orbits, depending on their energy.



As per NASA, in case of antimatter, the charges of the particles are reversed relative to the matter. A Positron (which is an anti-electron) has a positive charge and behaves like an electron. Moreover, an antiproton has a negative charge and behaves like a proton. "These antiparticles have been produced and studied at huge particle accelerators like Large Hadron Collider operated by CERN", said NASA.

In simple words anti-matter can be defined as – ***matter consisting of elementary particles which are the antiparticles of those making up normal matter.*** Also, antiparticles are not anti-gravity.

However, it has not been confirmed experimentally, the existing theories predict that antimatter acts in the same way to gravity as normal does.

How was antimatter created?

Antimatter particles were created in the ultra-high-speed collision, which was Big Bang. After the Big Bang, only energy existed and as the Universe started cooling down, both matter and the antimatter were generated in equal amount. However, the reason for the existence of matter and the rare existence of antimatter in today's Universe is still to be figured out by a scientist. The only theory that suggests the existence of matter over antimatter is that after mutual annihilation the matter was left to form stars and other galaxies.

The existence of the antimatter was first predicted in 1928 by Paul Dirac. He had put together quantum mechanics and Einstein's theory of relativity equations and discovered the equation that worked for the electrons of negative or positive charges.

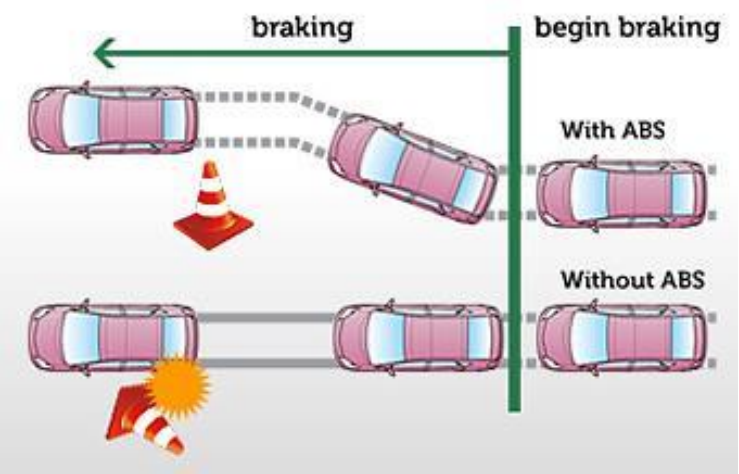
As Werner Karl Heisenberg said, "I think that the discovery of antimatter was perhaps the biggest jump of all the big jumps in physics of our century," the engineers had speculated the power of antimatter by considering the fact that when antimatter collides with matter particles, they annihilate each other and produce energy. This energy is sufficient to power a spacecraft that can be an efficient way to explore the Universe.

Question Thirty Five

What Is Anti-Lock Braking System? Its Components & Working

Anti-lock Braking system was designed to help the driver maintain some steering ability and avoid skidding while braking. The impending need of safety features for automobiles owing to increasing number of accidents is expected to boost the ABS market. Anti-lock braking system holds great potential to ensure the safety of automobiles at an event of braking in the wet & rough surface.

The Below picture describes the advantage of the use of Anti-lock Braking System



Anti-lock Braking System helps the rider to brake confidently in any situation. In normal Bikes whenever you apply pressure hard on the brake lever in a panic, the total amount of pressure is transferred to the brake caliper which leads to Wheel locking which may result in Skid.

Whereas in the motorcycles Equipped with the ABS, the wheel locking is sensed by the ECU. Soon after it detects the situation of wheel locking it will send a command to Solenoid valves which release the pressure on the brake line by letting the wheel to rotate temporarily.

This action continues several times and due to this process, you can feel a pulsating feeling near the brake lever.

Components of Anti-Lock Braking System –

ABS have four major components….

1)Speed Sensor

- This sensor monitors the speed of each wheel and determines the necessary **acceleration and deceleration of the wheels**. It consists of an **exciter (a ring with V-shaped teeth) and a wire coil/magnet assembly, which generates the pulses of electricity as the teeth of the exciter pass in front of it.**

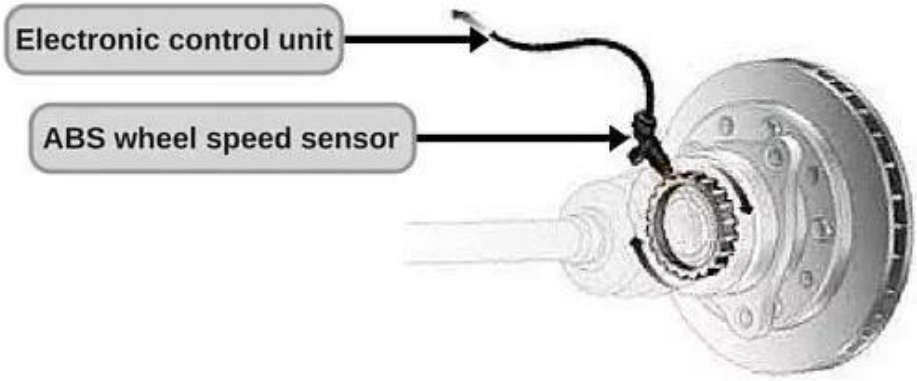
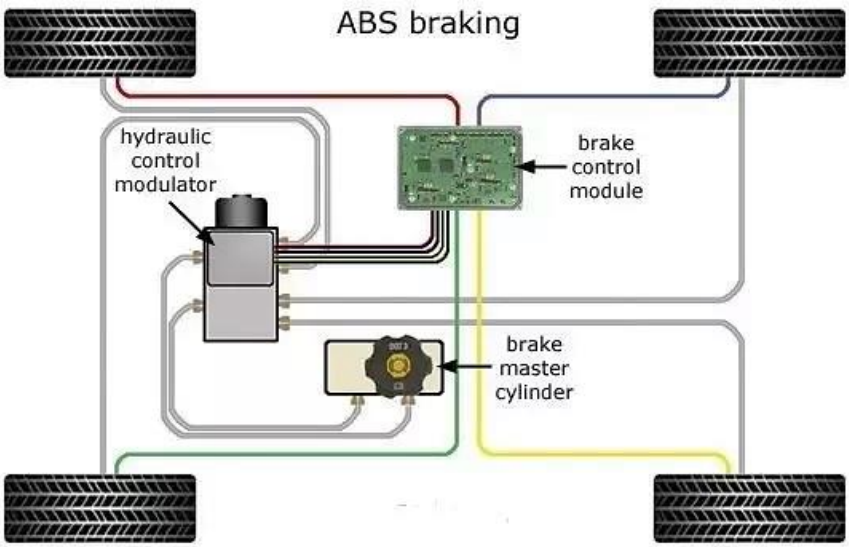


Fig: - **The speed sensor**

2) Valves

- The **valves regulate the air pressure to the brakes** during the ABS action.
- There is a **valve in the brake line of each brake that is controlled by the ABS.**
- In the **first position,** the **brake valve is open and it allows the pressure from the master cylinder to be transferred to the brakes.**
- In the **second position**, the **brake valve remains closed and pressure from the master cylinder to the brakes is constrained.**
- In the **third position**, the **valve releases some of the pressure on the brakes.**
- The **third step is repeated until the car comes to a halt.**
- The resistance **that you feel when braking suddenly at high speeds is actually the brake valves controlling the pressure that is being transferred to the brakes from the master cylinder.**



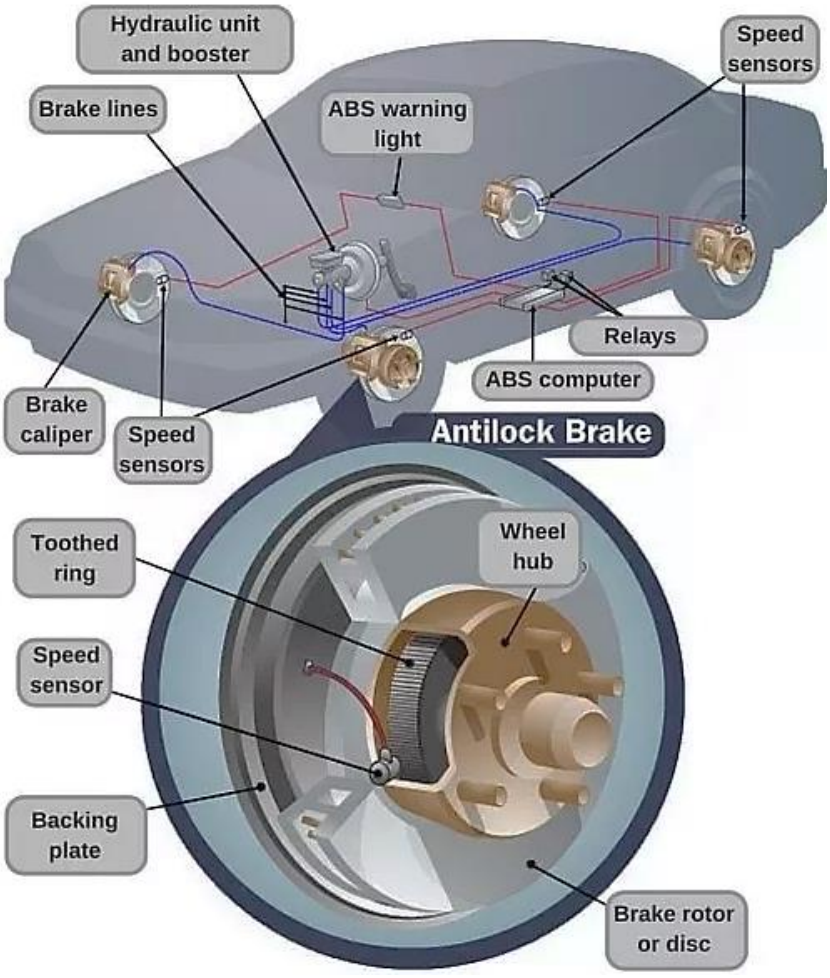
3) Electronic Control Unit (ECU)

- The ECU is an **electronic control unit** that **receives, amplifies and filters the sensor signals** for calculating the wheel **rotational speed and acceleration.**

- The ECU receives a **signal from the sensors in the circuit and controls the brake pressure, according to the data that is analyzed by the unit.**
- **4) Hydraulic Control Unit**
- The **Hydraulic Control Unit** receives signals from the **ECU** to apply or release the brakes under the anti-lock conditions.
- The Hydraulic Control Unit **controls the brakes by increasing the hydraulic pressure** or **bypassing the pedal force to reduce the braking power.**

Working of Anti-Lock Braking System-

Working Components of Anti-Lock Braking system-



While braking, if a wheel-locking situation is detected or anticipated, the **ECU alerts the HCU by sending a** current and commands it to release the **brake pressure,** allowing the wheel velocity to increase and the **wheel slip to decrease.**

When the **wheel velocity increases**, the **ECU reapplies the brake pressure and restricts the wheel slip to a certain degree**

(**Note**: When the braking action is initiated, a slippage between the tire and the road surface in contact will occur, which makes the speed of the vehicle different from that of the tire).

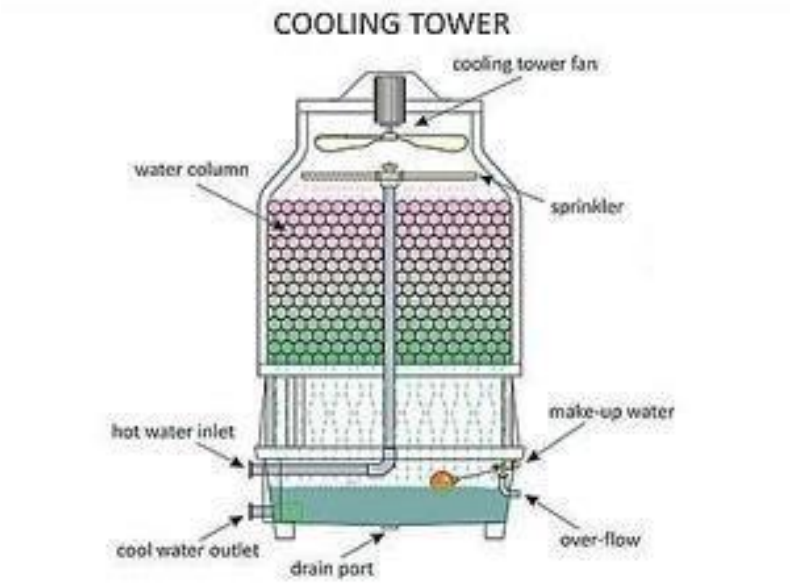
The Hydraulic Control Unit controls the **brake pressure in each wheel cylinde**r based on the inputs from the system sensor. As a result, this controls the **wheel speed.** This process is repeated for the next braking operation.

Question Thirty Six

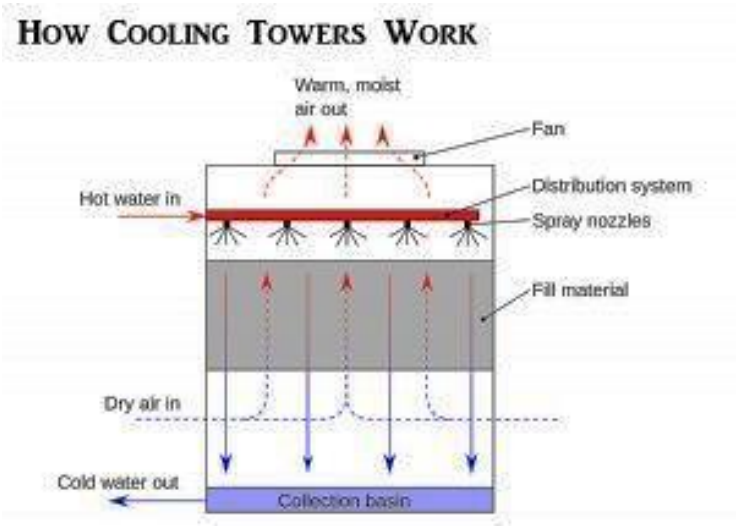
What is Cooling Tower? What are main Types of Cooling Tower?

A cooling tower as the name suggests is a device which releases excess heat from a system into the atmosphere. Cooling tower technology finds its utility in large-scale economical cooling solutions. Its also is the number one choice where work efficient long-term cooling solution is desired.

Cooling tower utilizes cooling a stream of water which is at the higher temperature to a lower temperature in order to gain the required or desired cooling effect. Commonly cooling towers reach their objectives by either cooling the working fluid to near wet bulb temperature using evaporation or in case of closed circuit cooling towers the mechanism cools the working fluid to dry bulb temperature using air solely as the cooling medium.



Size of the cooling tower can vary from a small rooftop unit to huge hyperboloid units as used in nuclear power stations. However, in the real and practical sense, we seldom see such huge sized cooling towers and mostly small-sized cooling towers are common in use for discharging heat generated by air conditioning systems.



Cooling towers find wide applicability in petrochemical applications, HVAC, chemical plants and thermal power stations.

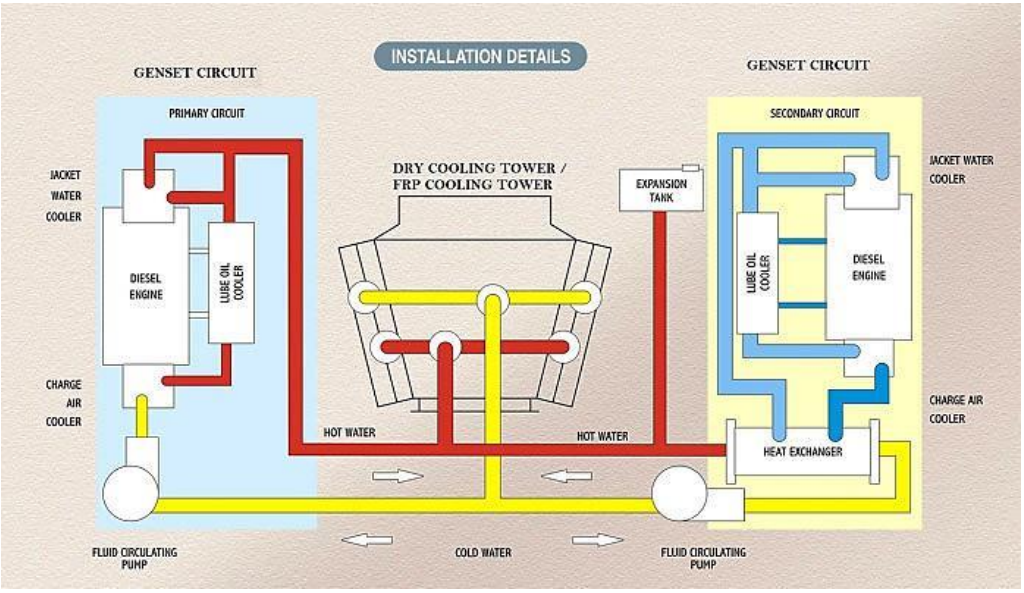
Types of Cooling Towers:

Broadly the cooling towers are classified according to the type of air induction utilized and are classified as a natural draft and induced draft cooling towers.

Types of Cooling Towers on The Basis of Heat Transfer methods used:

Dry Cooling Towers:

In this type of cooling tower, the working fluid is channeled through tubes which collects the ambient heat and then this heat is exchanged with atmosphere using air as a medium. No liquid or water is hence used for cooling in this type of setup



Wet Cooling towers:

It is also known as open circuit cooling towers. The working principle of wet cooling towers is

evaporative cooling and in this case the working fluid or the fluid used for heat exchange and the fluid that is actually evaporating is the same i.e. water.

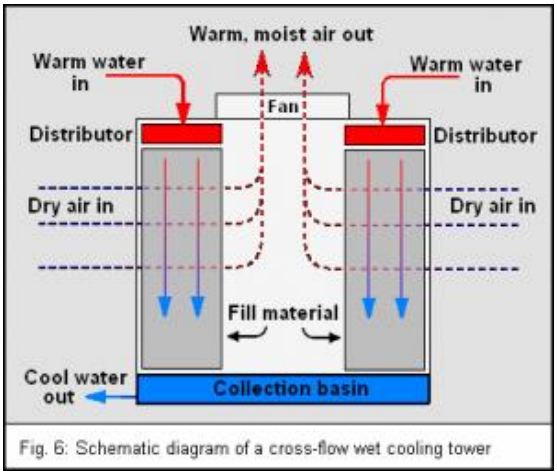


Fig. 6: Schematic diagram of a cross-flow wet cooling tower

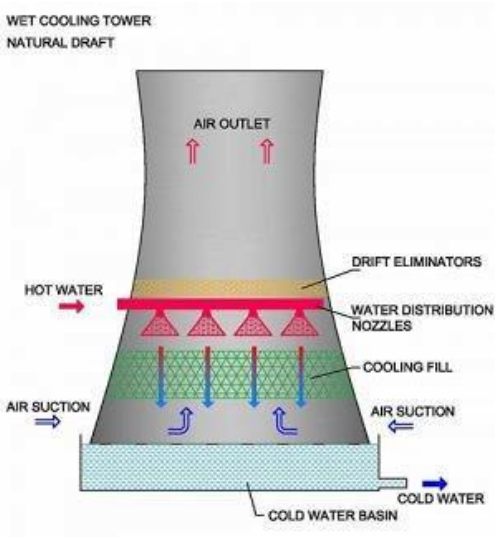
Fluid Coolers:

Also known as closed circuit cooling towers, these devices are actually hybrid in nature and combine the best of both dry and wet cooling systems. Here the working fluid or the heat exchange fluid is encased in a tubing system and never comes in contact with the open atmosphere. The tubing or the heated tubing is then subjected to a stream of water which in turns exchanges the heat.

Types of cooling tower on basis of methods of air flow generation :

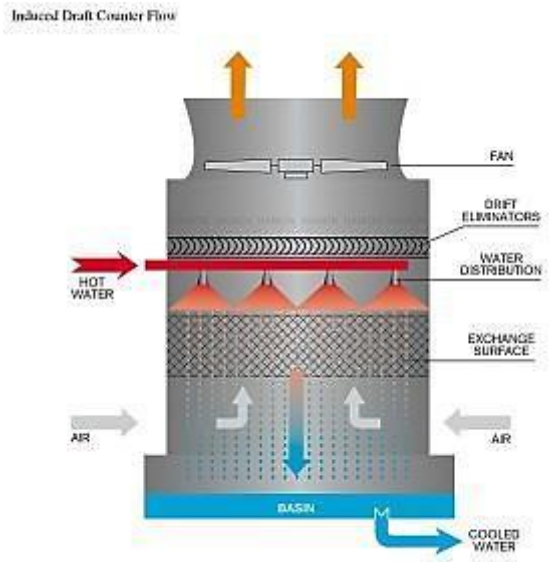
Natural draft cooling tower:

A large tall tower which is also wide-mouthed is used for this type of cooling. It utilizes the principle of buoyancy to achieve the desired effect. The warm and moisture-laden air inside the tower will naturally rise towards the dry and cooler air outside the tower and this differential acts as a medium of heat exchange. This type of cooling tower is suitable for the huge area and heavy usage.



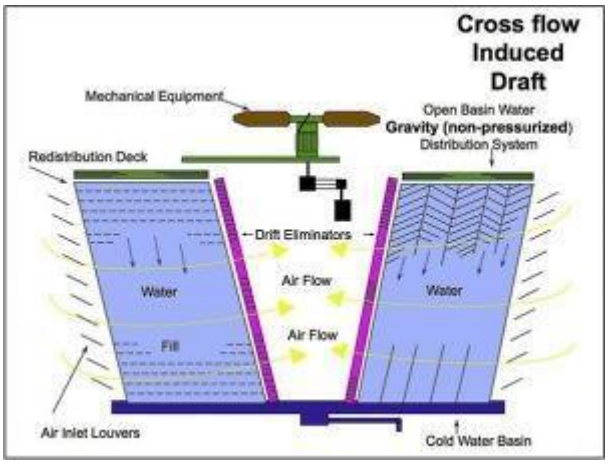
Mechanical Draft Cooling tower:

This method uses power-driven fans to circulate air or suck out air through the cooling tower. They are further classified into induced draft towers and Forced draft towers.



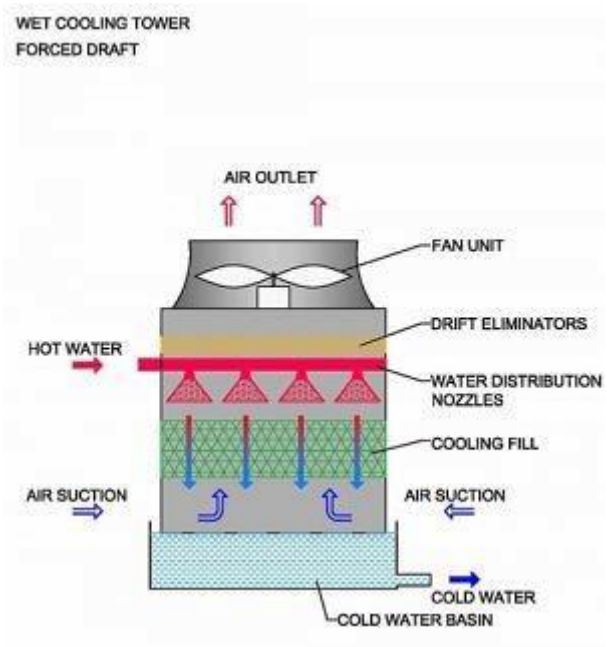
Induced Draft Towers:

This type of tower has a powerful fan unit at the top. When turned on this powerful exhaust fan pulls the hot moist air out of the system and into the atmosphere. The exit velocity of air, in this case, is quite high when compared to the entry velocity hence eliminating the risk of recirculation.



Forced Draft Towers:

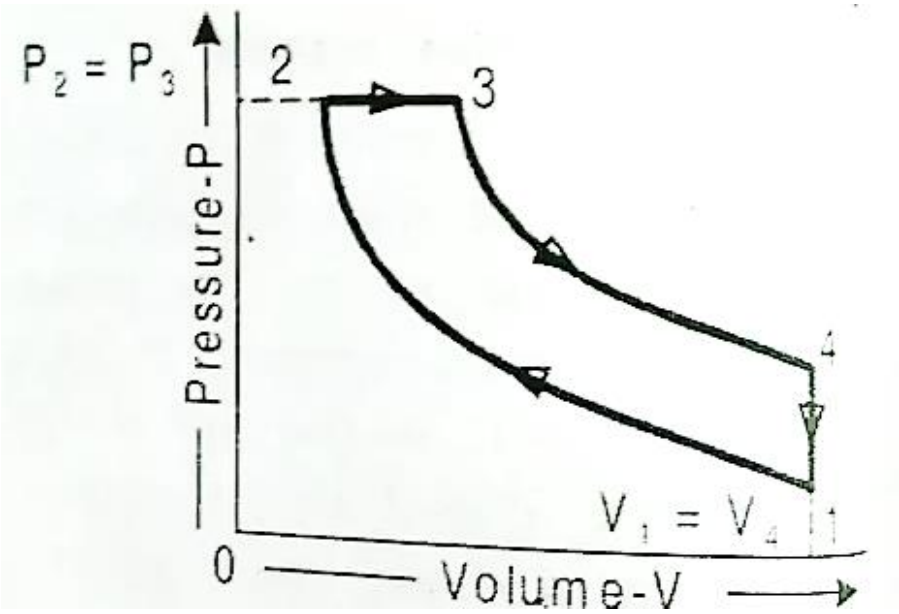
This is just the opposite of induced draft system, in this set up the fan blows in the air at high velocities in to the tower rather than forcing it out. Here the entry velocity of the air is quiet high in comparison to the exit velocity. This type of cooling tower not only cools but also raises the pressure of the system. Ideal for applications where cooling and pressuring are both desired.


WET COOLING TOWER
FORCED DRAFT
AIR OUTLET
FAN UNIT
DRIFT ELIMINATORS
HOT WATER
WATER DISTRIBUTION NOZZLES
COOLING FILL
AIR SUCTION
AIR SUCTION
COLD WATER
COLD WATER BASIN

Question Thirty Seven

What Is Diesel Cycle? What Are the Four Processes of Diesel Cycle?

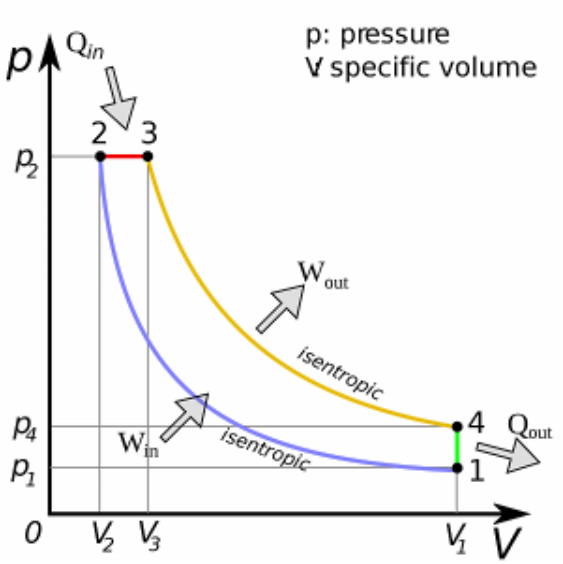
Diesel cycle is also called as constant pressure cycle. The diesel engine operates on this cycle. This cycle also contains four processes, out of which two processes are adiabatic, the third one is constant pressure process and forth process is constant volume process. Diesel cycle is an air-standard cycle (a combustion process), which is used to design mostly compression ignition engines. **Generally, these engines are heavier than petrol engines.**



Processes In Diesel Cycle-

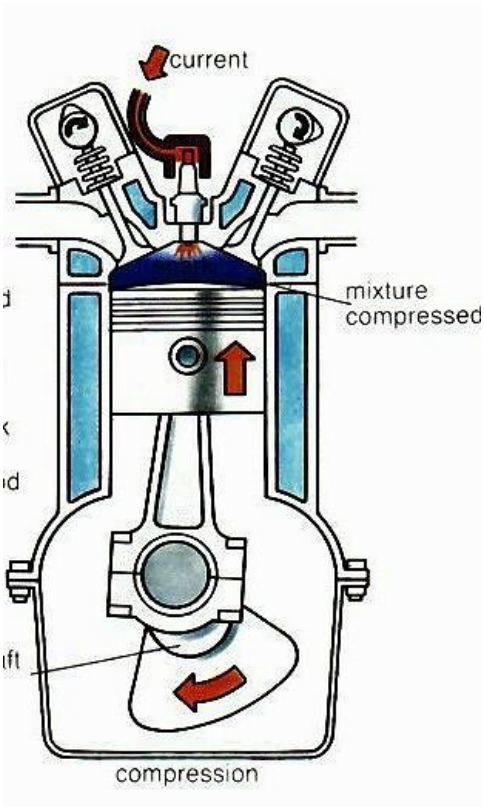
1. 1–2= Adiabatic compression
2. 2–3= Heat addition at constant pressure
3. 3–4= Adiabatic expansion
4. 4–1= Heat rejected at constant volume

Following is the pressure vs volume graph for a diesel cycle.



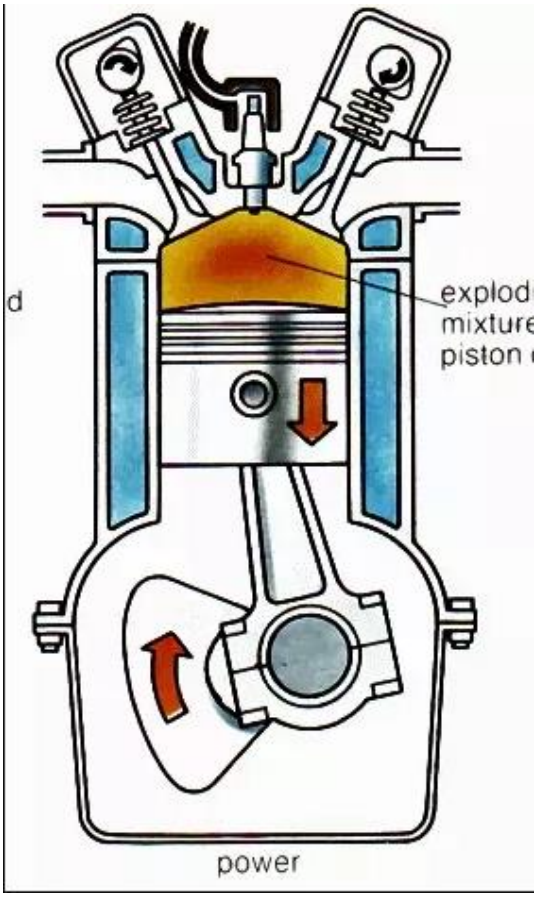
Isentropic Compression (Process 1–2)

- This process is called isentropic as there is no heat transferred (adiabatic) to or from the system and it is a reversible process.
- The gas inside the cylinder is compressed isentropically from a volume V1 to V2.
- The ratio of V1 and V2 is referred to as the compression ratio.
- Work is done by the piston on gases (negative work Win), which means external work has to be done to compress the gases.
- This process is characterized by the compression stroke of the 4-stroke cycle.



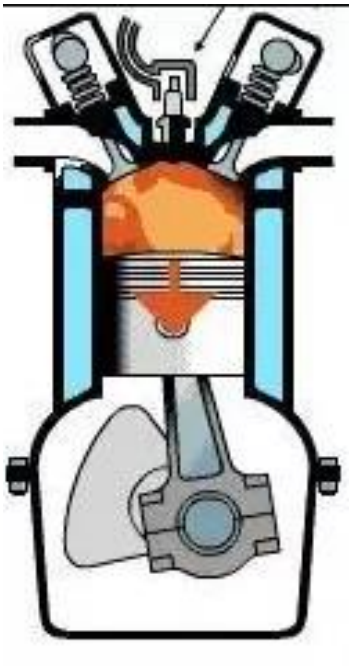
Isobaric Heat Addition (Process 2–3)-

- Isobaric means that the process carried out at constant pressure.
- With the pressure being constant, heat is added externally until volume V3 is reached.
- The ratio of V3 and V2 is referred to as the cut-off ratio.
- Heat is added to the system (positive heat Qin), by combusting the air-fuel mixture.
- This process is characterized by the initial part of the power stroke of the 4-stroke cycle, until volume has expanded to V3.



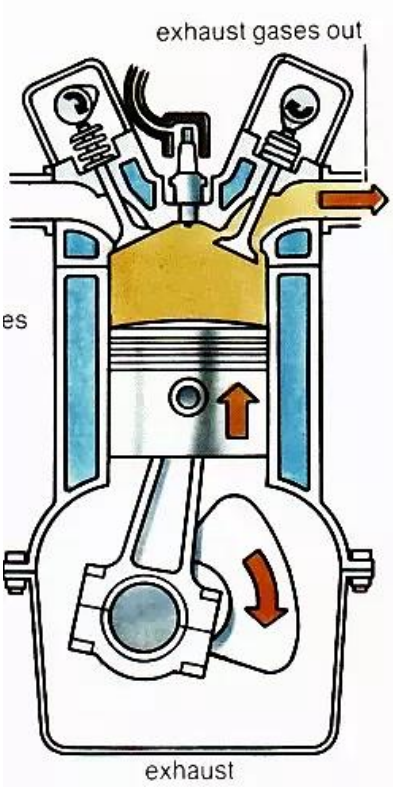
Isentropic Expansion (Process 3–4)

- This process is also isentropic.
- The gas inside the cylinder expands from V3 to V4 which is equal to V1.
- The ratio of V4 (or V1) and V3 is known as the expansion ratio.
- Work is done by the gases on the piston (positive work Wout), thus powering the engine by pushing the piston down.
- This process is characterized by the final part of the power stroke of the 4-stroke cycle, until volume has expanded to V4.



Isochoric Expansion (Process 4–1)

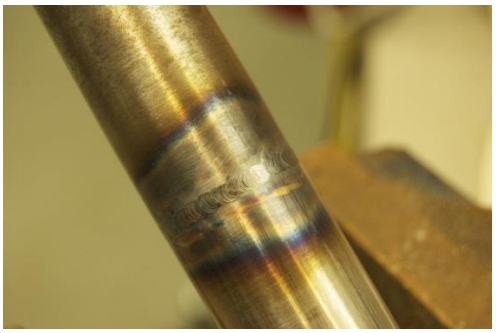
- Isobaric means that the process carried out at constant volume.
- With the volume being constant, heat is removed until pressure comes down to p1.
- Heat is removed from the system (negative heat Qout), by flushing out the combusted gases.
- This process is characterized by the exhaust and intake stroke of the 4-stroke cycle.



Question Thirty Eight

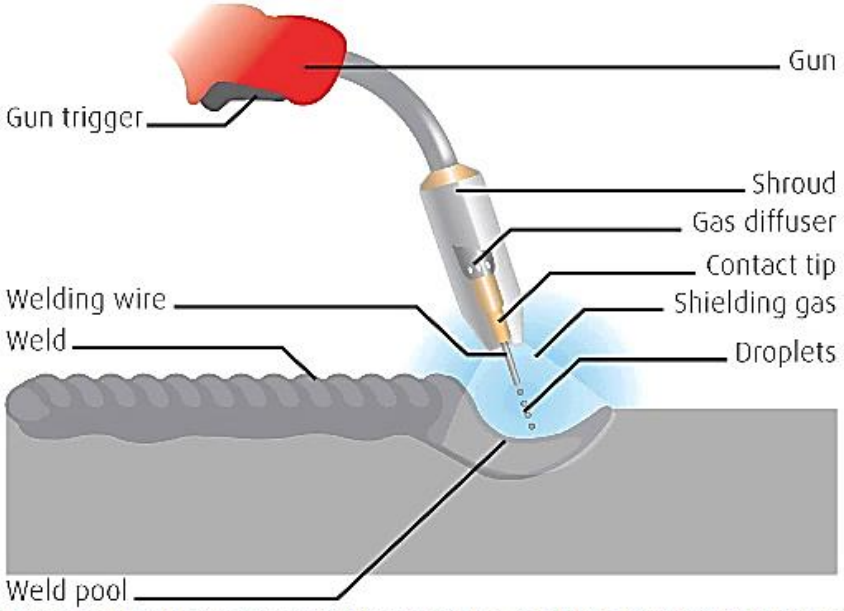
What Is Fusion Welding and Types of Fusion Welding

Fusion means the process or result of joining two or more things together to form a single entity. Fusion welding is done by melting the materials of same compositions and same melting points. you can see it in the picture below.



In the above picture, you can see two rods made up of same metal are joined together by melting their joining ends.

The fusion welding is widely used method in construction practices as besides rivets and bolts, there is no other method of joining pieces of metal securely. In case of fusion welding, the metal to be welded is heated up to molten state and re-solidification results in completion of the weld. Examples: Arc welding, Gas welding, TIG welding, MIG welding etc.



The welding circuit consists essentially of the following elements:

Fusion welding is used in the manufacture of many everyday items including aero planes, cars, and structures. A large community uses both arc and flame contact welding to create artwork.

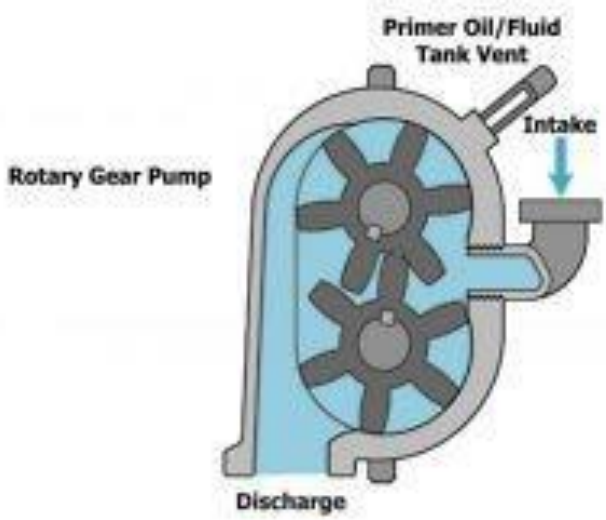
Question Thirty Nine

What is Gear Pump and how does it work?

The gear pump is one of the most important pumps. These types of pumps have gears in it which have the ability to provide pressure energy to the fluid in the pumps.

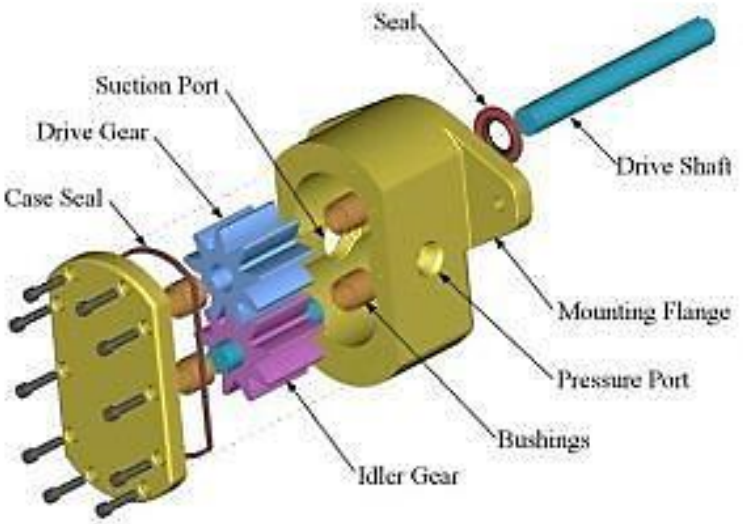
In simple words, we can say that the gear pumps transfer the fluids from one part to another using gear mechanism. If the pressure of the system remains same then they will provide you with the fix flow rate also. So let's discuss Gear pumps below.

So, what is a Gear Pump?



The Gear Pumps are basically positive displacement rotary pumps which helps you to transfer liquid or fluid by using its gears. It has more than two internal gears which create vacuum pressure to push the fluid in the pump.

The Gear pumps are the high-pressure pumps which come in small sizes to provide a pulseless as well as stable fluid flows as compared to other pumps like peristaltic and diaphragm pumps. There are many other advantages of the Gear pumps which are better than other pumps like it is a self-priming pump, can pump high viscosity fluids, user-friendly pump as it is easy to operate and to maintain as well.

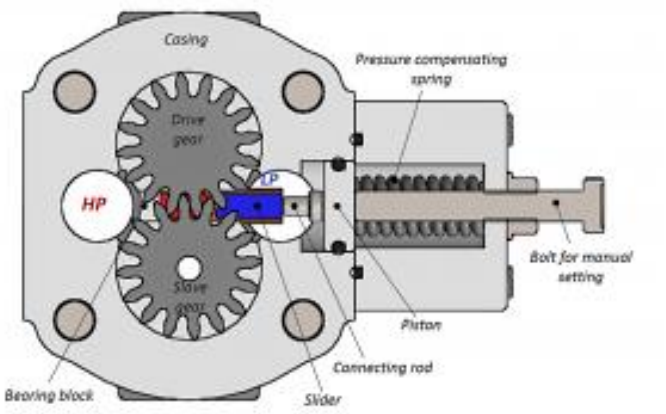


Exploded View

Working of a Gear Pump:

The Gear Pumps find their application in engine and transmission box of the slow speed engines as well as in oil transfer and combustion systems. With the help of gears, fluid displacement is possible in the Gear pumps. The fluid comes from the inlet port and after that reaches to the different parts of the Gear pump like spaces between the gear teeth and pump housing.

These pumps used rotating mechanism for contracting and expanding the chambers. The rotating assembly of gears will help you to create suction in the inlet of the pump to draw the fluid.



A pressure builds once fluid starts moving from inlet to outlet and with this the volume also decreases. There are pressure relief valves which protect the pumping system from the gear pumps.

The size of volume between teeth of the gear, amount of reverse flow and the speed of the rotation per minute is used to regulate the flow of gear pumps. To keep your pump maintenance free it is necessary to check the spring of relief valve, meshing clearance between teethes and casing of the pumps.

Types of Gear Pumps:

The Gear pumps are available in two types:

One is External Gear pump and the other is Internal Gear Pump. So, let's discuss the difference between internal and external Gear pumps below:

External Gear Pumps:

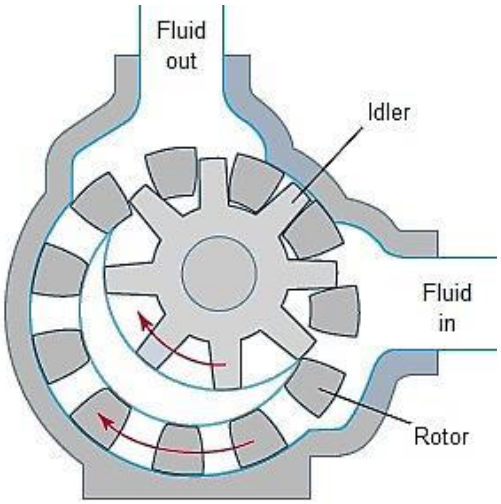
These types of pumps are not so costly and are easy to operate. You can find them in various machine tools, an oil pump of the engine and fluid power transfer units. To generate the flow these pumps used two gears with external cut teeth.

Features of External Gear Pump:

- They are compact in size and comes with an easy design
- They are capable enough to deliver high capacities due to their large outlets.
- It is capable of managing low, medium or high pressure
- On both sides of gears, it has close tolerances and shaft support.

Internal Gear Pumps:

In an internal gear pump, the rotor supports on one or two bearing and the design of the pump is bulky that makes it inefficient to work on high specification models. The pumping capacity of the internal gear pump is less in comparison to the external fear pumps. These gear pumps are highly versatile and can handle fluids having high viscosity at stable speeds.



Features of Internal Gear Pump:

- It can be run dry for a short period
- This pump has a bulky and large footprint
- The requirement of NPSH is very low

Question Forty

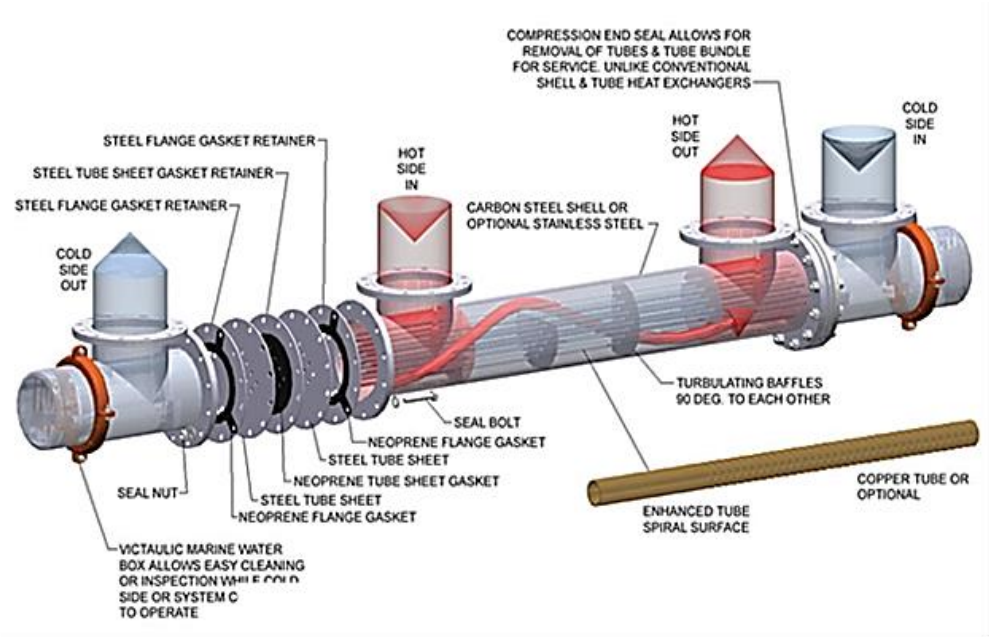
What Is Heat Exchanger? Types of Heat Exchanger

A heat exchanger is a device designed to **efficiently** transfer or "exchange" heat from one matter to another (between a solid object and a fluid, or between two or more fluids). When a fluid is used to transfer heat, the fluid could be a liquid, such as water or oil, or could be moving air. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact.

Their applications include:

1. Space heating
2. Refrigeration
3. Air conditioning
4. Power stations
5. Chemical plants
6. Petroleum refineries
7. Natural-gas processing
8. Sewage treatment

The classic example of a heat exchanger is found in an IC (Internal Combustion) Engine in which a circulating fluid known as engine coolant flows through **radiator** coils and air flows past the coils, which cools the coolant and heats the incoming air. Another example is the **heat sink**, which is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant.



Heat is transferred by conduction through the exchanger materials which separate the mediums being used. A shell and tube heat exchanger pass fluids through and over tubes, whereas an air-cooled heat exchanger passes cool air through a core of fins to cool a liquid.

There are various types of heat exchangers-

1. Shell and tube heat exchanger
2. Plate heat exchangers
3. Plate and shell heat exchanger
4. Adiabatic wheel heat exchanger
5. Plate fin heat exchanger
6. Pillow plate heat exchanger
7. Fluid heat exchangers
8. Waste heat recovery units Dynamic scraped surface heat exchanger
9. Phase-change heat exchangers
10. Direct contact heat exchangers
11. Micro-channel heat exchangers

Heat exchangers are commonly used for cooling of hot gasses and liquids, especially in industrial and manufacturing processes. They can also be used to generate heat; for example, an Exhaust Gas Heat Exchanger can use the heat from exhaust gasses to heat up a water circuit, which can then be used around a building.

Question Forty One

What is horsepower and torque? What is the difference between them?

We buy car or truck as per our choice and requirement. It can be a Sedan, SUV, Jeep or even a high-performance truck for transportation purposes. The usual question that often comes in our mind that what's the Horsepower of this vehicle is or how much Torque does it deliver? We hardly know this answer, but rely on the maximum value of such quantities in our vehicle.

Understanding the science behind the engine is very important. It helps in determining the power, longer running, and performance of the vehicle. As a fact, these two scientific measurements can even push the model to the head of its class. Let's have a brief study of these scientific terms and the core difference between them.

What is Horsepower?

Horsepower is basically a unit of measurement to determine the performance of the engine. This term came under development when we relied on horses and the use of steam engine was rising. To determine its performance the manufacturers required a way to value the steam with respect to horsepower.

The basic calculation was made that the amount of work done by a horse per minute, but it always varies with horses. So today, all the automobile manufacturers use a stabilized number for its representation. Basically, Horsepower is the amount of work done to move a weight of 33,000 pounds at a distance of one foot in one minute.

On focusing Horsepower, it's the continuous power of the vehicle as the high end of the engine performance. The more horsepower in the vehicle, the smoother ride we get after acceleration.

How does Torque come in?

Torque allows jumping off the starting line. Scientifically, it is the measurement of the force that causes an object to rotate. The torque value of the vehicle determines its acceleration. Most of the people generally confuse with these two terms, but they actually need torque than horsepower. When we look for zero to 60mph in just 4 seconds, this basically happens due to larger torque.

Basic Difference in Horsepower and Torque

Horsepower moves the vehicle, provides an ability to run on the highway and accelerate at normal conditions.

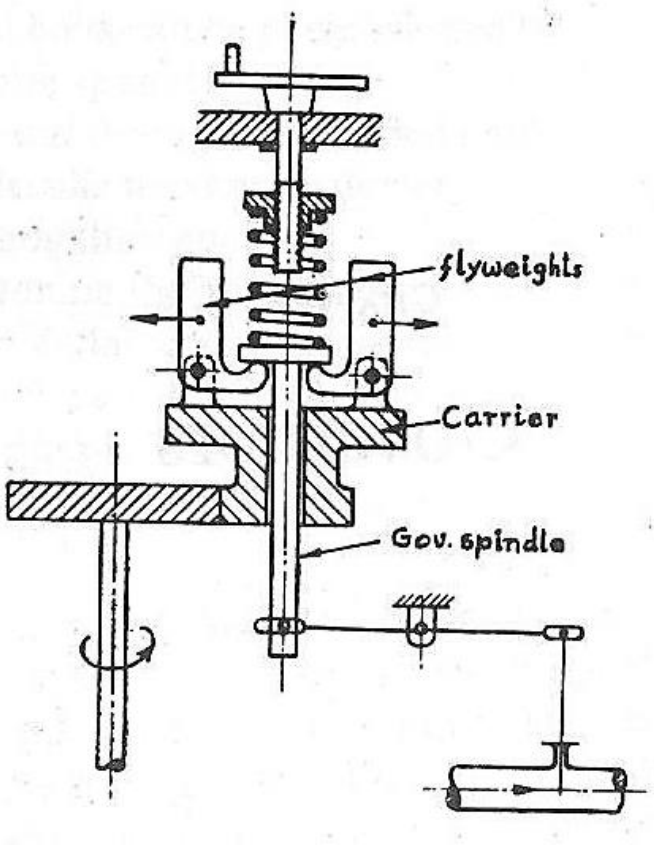
Torque is basically the force that starts the vehicle when at rest and pulls it to steep hills. It also provides power when we are towing a vehicle or hauling heavy material from behind.

Question Forty Two

What is mechanical governor? Explain its working

A Governor is a mechanical device used to govern the speed of machines like engines. From small engines to tractors to standby power systems even your automobiles are enabled with governors to regulate their speed. It allows the engine to run at the speed you select, without any effect of changing the load.

With the continuous change of load, the configuration of governor varies that helps to control the supply of fuel required by the engine. In simple words, Mechanical Governor is a speed control device, with suspended masses that respond to the changing speed with the help of inertia.

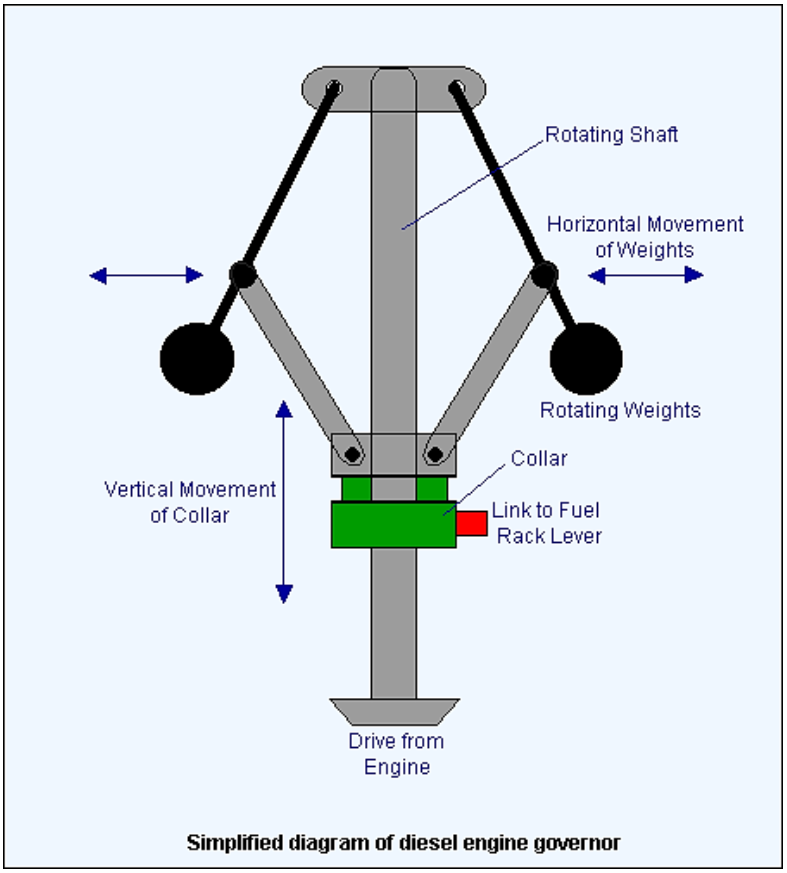


There are basically two types of governors namely Centrifugal Governor an Inertia Governor. Inertia Governors are more sensitive than Centrifugal Governor but on the other hand, it's very difficult in Inertia Governor to balance the revolving parts. Due to this reason Centrifugal Governors are used more than Inertia Governors.

Mechanical Governor (Centrifugal Governor):

This Speed- sensing device uses gears and flyweights to detect the changing load and adjusts the throttle accordingly. The mechanical governor works on balancing the centrifugal force of the flyweights and in return balances the equal and opposite radial force acting on these rotating balls which are termed as controlling force.

Suppose you are operating an engine at a light load applied to it. In this situation, the carburetor delivers small amount if air-fuel mixture to the combustion chamber. Now as the crankshaft spins, the centrifugal force created opens the flyweight. As they operate the pressure is applied on the governor cup and crank which are directly linked to the throttle valve. This action of the flyweights pulls the throttle to the closed position.



Simplified diagram of diesel engine governor

Now in other situation as the load on the crankshaft are increased leads to the slow spinning of the flyweights. This decreases the centrifugal force on the flyweights and leads to less pull of the throttle valve to the closed position and the supply of the working fluid increases.

How Mechanical Governor works:

The Mechanical Governor basically consists of two balls of equal mass, attached to the arms. The rotating ball is also termed as governor balls and fly balls. These balls are well attached to the arms and tend to revolve with the spindle.

The upper end of these arms is well attached to the spindle, which allows the ball in their up and down movement while revolving on the vertical axis. From below the arms are linked to the sleeve which is also keyed to the spindle and is allowed to revolve with the spindle. The sleeve is also allowed to slide up and down while revolving.

With the increase of speed, the balls and the sleeve rise up and tend to fall down with the decrease in speed. The up and down movement of the sleeve is controlled by stopper on the spindle. The sleeve is connected to the throttle valve with a bell crank lever. The supply of the air-fuel mixture increases when it falls and decreases with the rise of the sleeve.

Question Forty Three

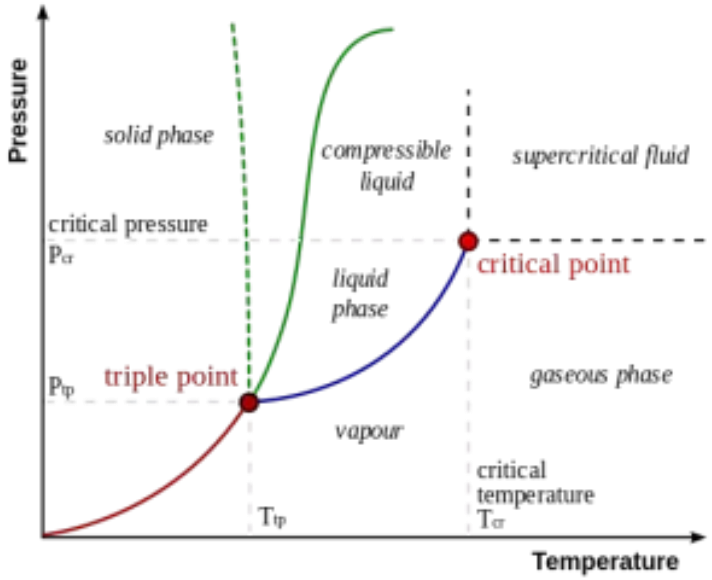
What Is Triple Point

The triple point is a Thermodynamic Phenomenon, it is a point where an element exists in Solid, Liquid and Gaseous form and in Thermodynamic Equilibrium. For example, the triple point of Acetylene occurs at -80.7° Celsius.

Triple Point of Water

As an addendum to the above definition, it becomes imperative to state here that, the Triple point is created with the perfect synergy of temperature and pressure. The best way to understand this is by observing the triple point of water.

Water reaches its triple point at exactly 0.01 Degree Celsius and at a pressure of 611.73 pascals. Now at this point, the water exists as vapor, liquid and solid ice at the same time. A small change in temperature and we would be able to convert it into any other form instantly.



In certain cases, like in case of Helium, a triple point may also occur involving more than one solid phase. This happens with things which have different polymorphs. For example, Helium 4 exhibits two different liquid states at the triple point. This is represented by Lambda Point.

Lambda Point:

Lambda point is the temperature at which normal helium makes a transition into super helium.

Coming back to the Triple point of water: Gas-Liquid-Solid Triple point-

The gas-liquid-solid triple point of water is nothing but a temperature and pressure point where all the three states of matter with respect to water are present at the same time. This we have already discussed before in the article. In case of pressure below the triple point as in space, the solid phase

i.e. ICE, when heated keeping the pressure constant directly, converts into gas or water vapor. This process is called sublimation. Now in case the parameters are above the triple point and keeping the pressure constant, the ice will first melt into water and then will get converted into water vapor.

In most of the cases, the gas-liquid-solid triple point is the minimum temperature at which the substance can exist in the liquid state. However, this is not true in the case of water. You see in the case of water; the melting point of solid ice will decrease with the pressure function. When we compress the water under constant temperature, then it first converts into solid from the liquid phase. This process is called liquefaction.

A very practical application of this phenomenon is seen in Mars Missions. The triple point of water is very efficiently used in measuring the sea level of Mars. This was done in the Mariner 9 mission of NASA. However, now laser altimetry is used to do the same.

High-Pressure Phases

At very high pressure the water shows a very complex behavior, which is still a point of research for scholars.

There exist 15 known phases of ice at high pressure. In case of water, the melting point increases with the rise in pressure. On raising the temperature above 273 K and increasing the pressures the water vapor first converts into liquid and then to ice. However, in range of 251 -273 kelvins the water first takes solid phase followed by liquid phase and then again enters solid phase.

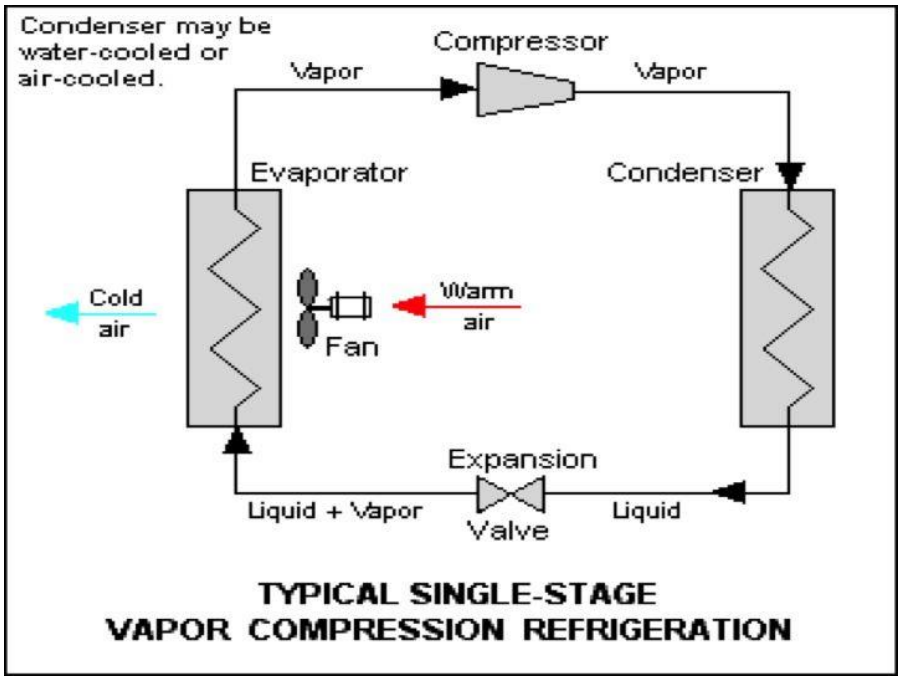
Further application of this phenomenon is found in calibrating the thermometers. For this, a device called triple point cell is utilized.

Hope our little informative piece of writing helps you out in your academic pursuits.

Question Forty Four

What is Vapor Compression Cycle?

It takes heat to vaporize a liquid. Therefore, when a liquid refrigerant evaporates, it cools the surrounding fluid as it extracts heat. As shown in the diagram below, warm air flowing across an evaporative radiator will cause a refrigerant to undergo a phase change from liquid to a gas, cooling the fluid flowing across the radiator, which in this case is air. This process occurs in the coils located inside a refrigerator or inside the cools side of an air conditioner unit.



Compression:

After vaporization, the gaseous refrigerant is compressed. The process of compression does work on the refrigerant, thereby increasing its pressure and temperature. By doing work on the refrigerant, the compressor adds energy in the form of heat, which will be released during the upcoming condensation process that converts the refrigerant gas back into a liquid. Compression takes place in the mechanical unit located in the bottom and backside of a refrigerator or on the outside of an air conditioner.

Condensation:

After compression, the superheated vapor is run through a condenser or condensing radiator that converts the refrigerant vapor back into liquid releasing its heat into surrounding fluid. Condensation occurs in the coils on the outside or back of a refrigerator or outside section of an air conditioner.

Expansion:

After the high-pressure refrigerant is condensed, the liquid refrigerant flows through an expansion valve that reduces its pressure and temperature. (When you use a spray can, the nozzle and spray can will get colder due to the expansion of the gas leaving the can.) The expansion process also extracts energy in the form of heat, which causes some of the liquid refrigerant to transition into a gas. The lower pressure and temperature of the refrigerants is necessary for the vaporization process. The expansion valve is located on an air conditioner’s cold side of a refrigerator.

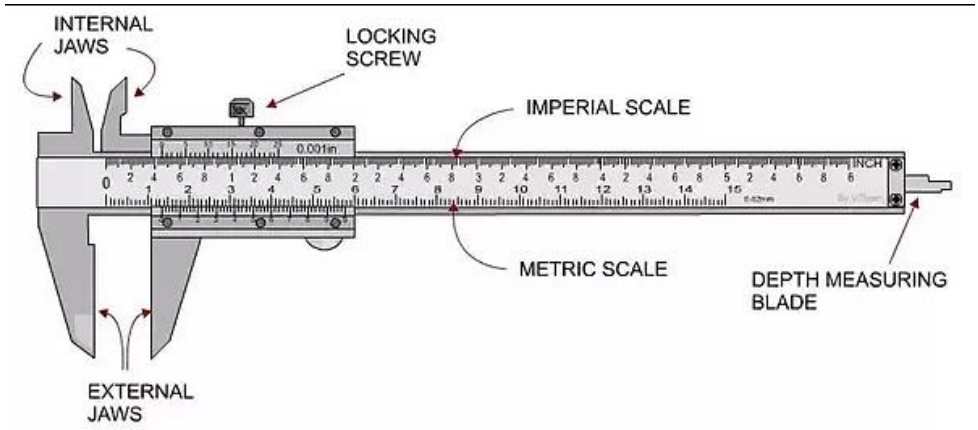
Question Forty Five

What Is Vernier Caliper? Principle of Working of The Vernier Scale

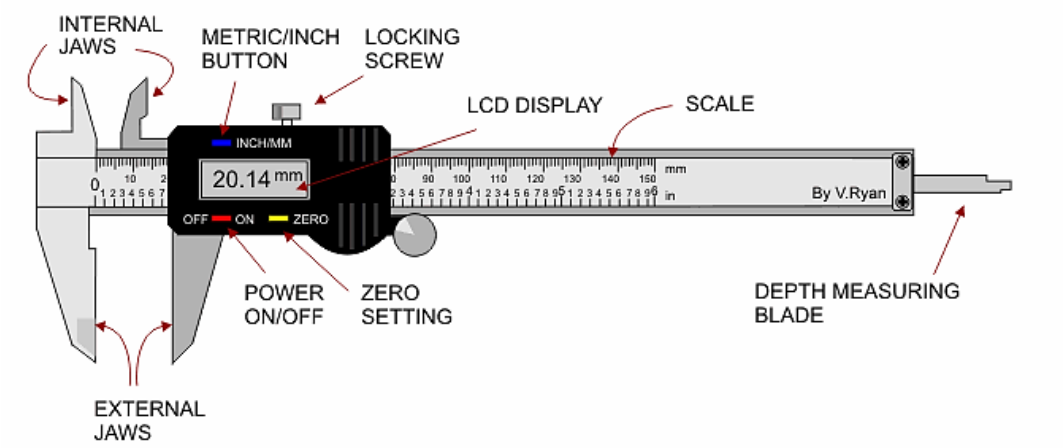
The Vernier caliper is an extremely precise measuring instrument; it is used to measure internal and external distances extremely accurately – the error may be as little as 0.05 mm – depending on the make. The VERNIER is a small movable graduated scale for obtaining fractional parts of subdivisions on a fixed main scale of any measuring instrument. With a normal scale we may be able to measure down to 0.50 mm or so, while with a Vernier scale the least count may be 0.10 mm. Usually Vernier calipers have both imperial (inches) and metric (mm) scales.

A Vernier caliper is a precision measuring tool. It can be used for three types of measurements, outside distance (such as the length of an object) , inside distance such as the width of a groove or the diameter of a large hole, and depth, such as the depth of a hole or the height of a step.

Vernier calipers come in many sizes. A common type measures 0 to 6 inches.



Modern calipers are digital – in the sense it has an LCD display on which the reading appears – there is no possibility of human error in reading the scale.

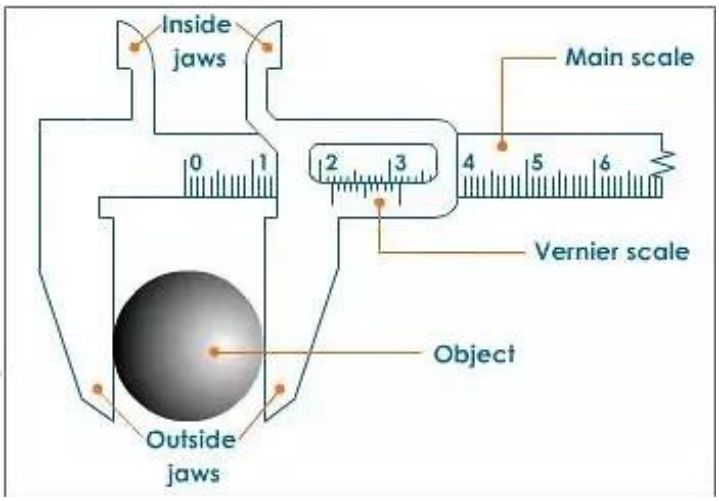


The smallest Vernier caliper that can be bought off-the-shelf is 150 mm – meaning the jaws open to a maximum of 150 mm. The largest ones go up to 2000 mm.

Principle of Working of Vernier Scale-

The Vernier scale works on the principle of using alignment of line segments displaced by a small amount to make fine measurements. Human eye can easily detect this alignment of lines which is the main fact that drives a Vernier.

A Vernier scale has a main scale and a Vernier scale. The main scale has the normal resolution with a least count of 1 mm. The Vernier scale is attached to the main scale which can slide on it and has graduations that are spaced by the same 1 mm only but are slightly displaced with respect to the marks on the main scale. The displacement is the key here.



When the Vernier scale is closed, that is, it is making a 0 measurement, you will see that the zeros of the main scale and the Vernier scale coincide but the first mm mark on the Vernier is 1/10th mm short of the first mm mark of the main scale. The second mm mark of the Vernier is 2/10th of an mm short of the corresponding main scale mark. Similarly, the third is 3/10th short, fourth is 4/10th short until the ninth mark which is 9/10th of an mm short. The 10th mark is 10/10th = 1 mm short of the corresponding mark of the main scale and therefore aligns with the previous main scale reading which is 9 (10-1) mm.

Now say you need to measure 5 mm. The zero of the Vernier scale will move 5 mm forward and align with the 5 mm mark on the main scale. You will simply take the reading as 5 mm.

Now let us suppose we need to measure a length which is 5.4 mm. You will slide the Vernier scale to the requisite length. The zero of the Vernier scale will be slightly ahead of the 5 mm mark of the main scale. Thus 5 mm becomes the main scale reading. The amount by which the zero of the Vernier is ahead of the 5 mm mark is 0.4 mm which is 4/10th of an mm.

The first mark after the zero on Vernier scale which was earlier short by 1/10th of an mm will now march ahead by a net distance of 3/10th (4/10 – 1/10) of an mm of the corresponding mark on the main scale and will still be misaligned. Similarly, the second one will march ahead by a net distance of 2/10th (4/10 – 2/10) of an mm. The third one will be ahead by 1/10th (4/10-3/10) of an mm. However, the fourth one which was previously short by 4/10th of an mm will now march ahead by 4/10th of an mm and come into alignment with the main scale mark.

This coincident mark can be seen by the naked eye and can be recorded easily. Thus, we say that the fourth mark of the Vernier coincides with a main scale mark and thus the Vernier scale reading is 4*1/10 = 0.4 mm. hence the total length measurement becomes 5 + 0.4 = 5.4 mm.

Question Forty Six

What will happen If we use Petrol in Diesel Engine or Vice Versa?

Now, this is a question for a curious mind, what will happen if I fill up a diesel engine with petrol or a petrol engine with diesel? Will it run or will it not? In order to get to the bottom of this curious question, let us first try to understand the basic differences between the two engine types.

Petrol engines use a carburetor to feed the engine with a mixture of petrol and air which is then ignited by a spark from the spark-plugs mounted on every cylinder. In simpler terms the gaseous mixture of fuel is ignited in the cylinder with help of a spark, this explosive mixture then powers the vehicles. A noticeable thing here is that petrol engines are designed to operate at a lower pressure in comparison to their diesel counterparts. Reason being the volatility and combustibility of the fuel utilized.

Petrol by its nature is a volatile fuel and does not need high pressures for ignition. Whereas a diesel engine owing to the nature of the fuel used has to operate at high pressures in order to achieve combustion of fuel.

Diesel being a thicker and heavier fuel is also non-volatile in nature. Diesel engines utilize an array of fuel injectors which spray the fuel into the cylinder at a high pressure, this pressurized fuel then comes in contact with the hot pressurized air in the cylinder and ignites generating power for the engine.

Now coming to the point!

what will happen if we use the wrong fuel? There are two scenarios that we need to deal with while answering this question-

(a) Filling up a Petrol engine with diesel

(b) Filling up a diesel engine with petrol.

Scenario A: Filling up a petrol engine with diesel-

As already cited, diesel is heavier than petrol and needs pressure to ignite owing to its non-volatile nature. So, when you fill up a petrol vehicle with diesel the fuel injectors will push the fuel into the cylinder and the spark will try to ignite the fuel mix, which in any case will not happen i.e. the car just won't start and the most probably the damage to the engine will be very limited. Damage or no damage one thing is for sure that the engine will surely not run.

Scenario B: Filling up a diesel engine with petrol:

Now here the things can get quite messy and complicated. Petrol being a volatile fuel has a tendency to ignite easily. A diesel engine as we know is designed to burn fuels at high pressures. The situation becomes more critical with the modern diesel cars in which the engine generally

operates at extremely high pressures, and as an icing, on the cake, these new age diesel engines have a system which circulates the fuel into the system even before you turn the key for the ignition.

Diesel also acts as a lubricant for the engine, and since we have filled up petrol in lieu of diesel the circulating petrol will act as a thinner and make engine prone to friction. With the first crank, the engine might start prematurely as petrol will surely ignite much before the proper cycle has commenced damaging the engine block badly. In this scenario, the car or the vehicle will also definitely not run but the damage to the engine can be serious.

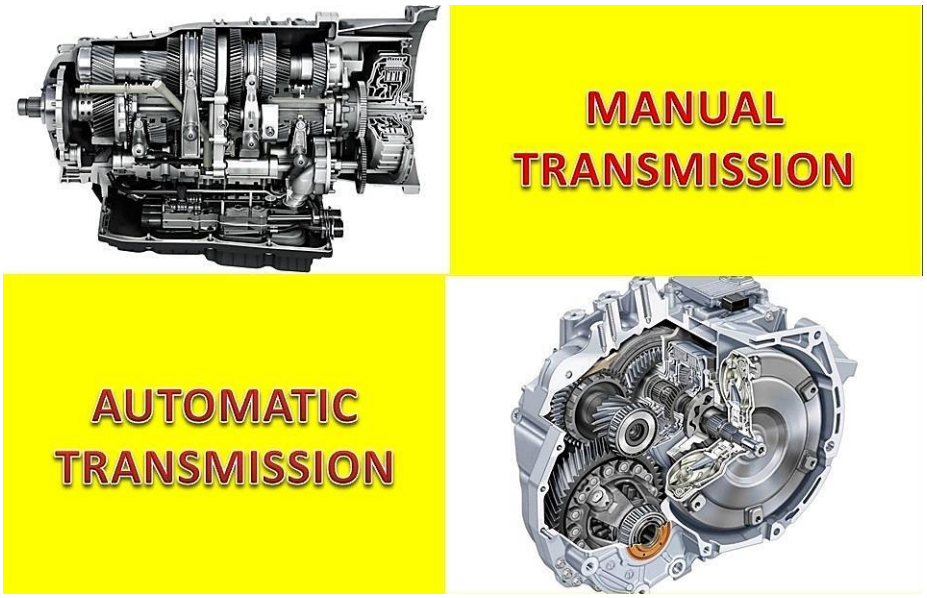
So here we have the critical evaluation of the things that can happen if we fill diesel into petrol and petrol into diesel engine.

Question Forty Seven

Which has better fuel economy: manual or automatic?

You often get into the dilemma of buying a right vehicle that doesn't break your banks over the years. The primary thing we look at while buying a new car is its fuel economy. The cost of fuel is one of the expenses that you can't control while owning a car. So, it makes you to choose your car wisely so that it can save your hard-earned money. Generally, a car is available in manual and automatic transmission. Whenever, a buyer looks for a car the first question that pops up in his/her mind is which variant in the car has a better fuel economy, manual or automatic?

Hereby, you will get the answer to this question. Well, the manual transmission tends to save more fuel as compared to the automatic transmission system. However, today's automatic transmissions are more fuel efficient because of the improved automatic transmission technology. The automatic transmission system has started using continuously variable transmissions (CVTs).



The working of CVTs is quite different from the previous automatic transmission systems, though both the systems provide the same operation for a driver. Unlike, the manual and automatic transmission systems that run on fixed gear ratios, CVTs can have variable gear ratios; hence it performs better in fuel economy as compared to the manual or automatic transmission systems.

Moreover, a traditional automatic system works more efficiently than a manual system. This is due to the fact that they have more number of gears that move the car forward than manual transmission system. Therefore, with those extra gears, the engine works at lower speed and delivers high power.

There are various new technologies in automatic transmission system adopted by the car makers that provides them better fuel economy. Most car sellers are selling automatic transmission cars

over the world, and are simultaneously working on the new transmission technologies that will be accepted by their consumers and get paid higher, thus promising a better fuel economy.

The car companies are also obliged to meet the strict laws for fuel economy standards made by the government. This helps and drives car makers to develop the more fuel-efficient automatics.

So, what is the point in buying a car with a manual transmission system that won't be fuel efficient? A manual transmission system in the car allows you to have more control over your engines and deliver desired power to the wheels. If you want something like this and at the same time also want to feel the power of car at different speeds, then go for the manual one. But if you are more intended towards getting good fuel economy and running your car smoothly, go for the automatic.

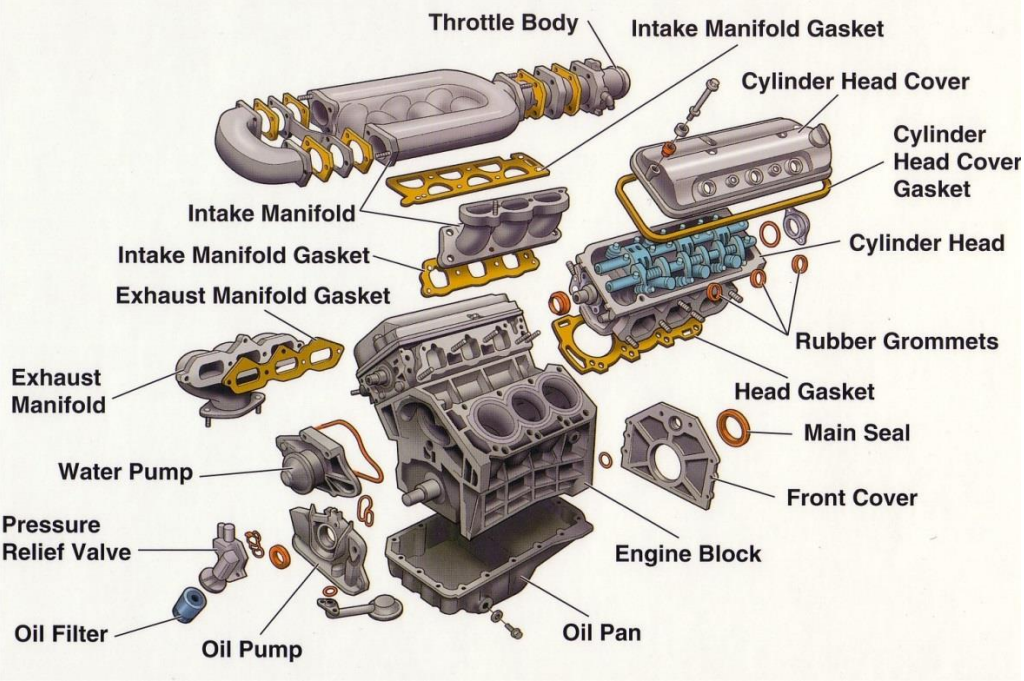
Now, you would have got the right answer which will help you in choosing among the two, easily. So, make sure that you buy the right car as per your requirement.

Question Forty Eight

Why Diesel Engines Are Heavier Than Petrol Engines?

You might have noticed that petrol engines are less noisy and vibrate less compared to diesel engines. This is because the combustion process in a pre-mixed mixture is smooth and propagates well.

But in a diesel engine, the combustion could begin anywhere in the combustion chamber, and it turns out to be an uncontrolled process. For this reason, to reduce the excessive vibration and noise problem, diesel engines require a more rugged structural design than petrol engines.



Fundamentally, a diesel engine makes more power than a gasoline engine of similar displacement. This is due to the fact a diesel engine is a compression ignition engine, and so must utilize a compression ratio roughly twice that of the gasoline engine in order to ignite its fuel. Now, in an internal combustion engine the compression ratio is directly related to the amount of power created; therefore, in similar sized engines, the diesel is creating much more power than the gas engine. So, the diesel engine simply has to be built of sturdier construction than a similar displacement gasoline engine to handle these extra forces created. And this is done by manufacturing all the diesel engine components from denser, more substantial materials. The gas engine will be built lighter because the extra strength is not needed, the extra weight not desired, and it is cheaper to build it lighter. Consequently, the diesel engine is heavier than a similarly sized gasoline engine.

To normalize the heavy unbalanced power production of diesel engines a heavy fly wheel is often required. This is why petrol engines are always preferred for light-weight applications, such as in 2-wheeler or portable devices.

Question Forty Nine

Why do ants walk in a line?

We have seen ants traveling in our homes, especially at places where some food is available. In a very short time, a large number of ants accumulate to that place and start consuming that food. By looking at them, we come to know that they travel in a line as if a trail has been made for them and they are walking through it. So, why do ants travel in a line and not in a random manner?

Ants are social insects with organized social life and live in big colonies. We have often seen red ants building their colonies inside the walls of our homes. They travel large distances in search of food. Moreover, they don't use any maps or navigation aids and solely depend on their own mechanism to find the route.

So How Do Ants Walk Along the Same Path/Line?

Usually, ants walk in a straight line in a definite manner for foraging. Their travel line is the shortest route between their home and the source of food. They use a chemical substance called rail pheromones to communicate with each other, which is a volatile hydrocarbon and evaporates rapidly. To keep it present for a long time, it needs to be renewed continuously by the ants.

An ant returning to the home from the food source will release trail pheromones which will be perceived by other working ants. They will follow this trail and similarly, every worker ant returning to the home will be releasing the trail pheromones from their abdominal glands. This will help to maintain the concentration of trail pheromones as long as the food source exists. Once the food source is consumed, the returning ants will not leave any trail pheromones on the way and eventually, the concentration of trail pheromones will get faded.

The worker ants will stop following the path and will start their search for more food. The other species of ants, like army ants, are completely blind and live in the colonies by the strength of

thousands or millions. They carry out the foraging raid in an organized manner by using the chemical communication system which has chemical pheromones.

When you look closely, you can see the way, how they communicate and maintain the line of their traveling. You would have also had an experience of breaking the line of ants and then observing the ants getting confused for some time.

These ants reconnect in their way shortly due to their chemical trail pheromones; thus, allowing the followers to resume the walking. Generally, ants alter their way when they come against an obstacle and choose the shortest route to reach their food source.

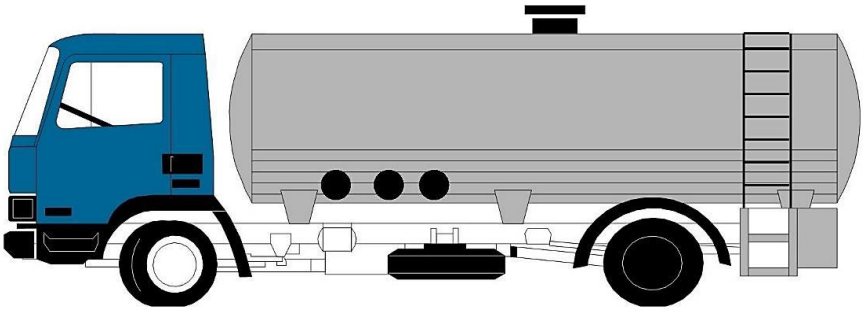
So, from next time whenever you locate a single ant running on the floor, you know what is it looking for!

Question Fifty

Why Do Liquid-Carrying Trucks Have Cylindrical Shaped Tankers?

You would have often seen oil or water tankers in your city & surroundings and wondered why they are in such cylindrical shape? Why these tankers only have a cylindrical shape but not cubical or some ideal box based shape?

A vehicle that is designed to carry liquefied loads like water, highly pressurized gases or oil is called a 'tank truck'. There are many types of tank trucks in terms of their size, insulation, pressure holding capacity and type of liquid that is transported in them. There are many benefits of a tank truck having such a cylindrical shape. The reasons are listed below:



- **Greater Stability**

A transport vehicle carrying liquids like liquefied flammable gases and oils needs utmost stability to transport them safely because the liquid has a property of agility. For the commute to happen successfully, the correct shape of tanker matters a lot.

The shape of tanker should have a low center of gravity and this can be attained only through a cylindrical-shaped tanker. The rectangular or square shaped tankers have comparatively a high center of gravity, which risks the vehicle's stability.

- **No weak points**

A cylindrical-shaped container doesn't have structural weak points that require reinforcing. In fact, a rectangular or a square shaped container has corners and flat sides that can easily break under high pressure. It means conventional rectangular container will lead to failure over time quicker than a cylindrical container.

- **Sloshing liquid**

When a tanker accelerates or de-accelerates, the liquid in the tank sloshes around due to the law of inertia i.e., "a body at rest remains at rest and a body in motion continues to move until an opposite external force acts on it". The phenomenon of sloshing is called as 'surge'. To reduce the surge effect while slowing down or accelerating during the travel, the tankers have metal sheets placed

inside them that reduce the to-and-fro surging of liquid. That's why experienced drivers maintain a habit of slowing down or accelerating their tanker trucks smoothly.

Moreover, a spherical container counters the surging of liquid better as compared to other shapes.

- **Extraction of liquid**

A cylindrical container is most favorable in extracting the liquid from the truck in an easier way than the other shaped containers. This is because the liquid gets funneled down to bottom of a cylindrical tank and even the least of drops flow out. On the other hand, a rectangular tank would not allow the movement of liquid at the vent point and all the time some amount of product will always be left behind.

- **Maintenance**

A cylindrical container is easier to clean than any rectangular container because in a box-shaped tank the traces of liquid will get stuck at the corners and eventually be harder to remove. A cylindrical container contains no such corners; therefore, their cleaning is easy.

Question Fifty One

Why do wheels appear to spin backwards at high speeds?

While standing on the footpath or while watching movies, have you ever wondered? Why the wheels of the cars appear to spin backward when they are at high speeds?

Let me explain why this happens with a short example. Suppose a car is moving forward and with time it is gaining momentum and speed. The wheels of the car moving forward, at first will appear to spin in one direction and as the speed of the car increases, its wheels will also rotate faster. But then, something weird happens.

At a certain point, the spin of the wheels appears to get slower and at some point, the rotation stops. But when it resumes, we see that the spin is in opposite direction. Due to this type of rotation, the car should be moving backward, isn't it? But the car is moving forward. This phenomenon is known as **The Wagon Wheel Effect**. Most of the people, including you, are likely to see wagon wheel effect in movies or televisions. Let us see why the effect appears to our eyes like this?

In movies or TV's, the cameras record footage by capturing a series of images in a quick session and not recording it continuously. The cameras capture the images at a specified rate called "frame rate". Many movie cameras have a frame rate of 24 frames per second, and when the frame rate of this camera matches with the frequency of a wheel's spin (i.e. 24 revolutions per second), each of the wheel's spoke completes a full revolution every 1/24 seconds, and due to this it ends up in the same position every time a frame is captured by the camera.

So, we can say that when a wheel seems to spin in the direction opposite to that of its actual rotation is because each spoke has come up a few degrees shy of the position it occupied when it was last imaged by the camera. It is sometimes referred to as a reverse-rotation effect. But if the spoke somehow over-shoots, the wheel will appear to rotate in the right direction, but very, very slowly. The appearance and effect of the effect also depend upon the exposure time of the camera and also the design of the wheel.

The optical illusion that we see requires nothing but a repeating motion that must be visible intermittently.

A similar phenomenon like this can be achieved with a strobe light, which gives rise to an effect called "stroboscopic effect".

So now you know about the wagon wheel effect that you usually see on TV and movies. The wagon wheel effect that we normal people see in the real world is not due to strobe of light or through the screen, but under constant lighting conditions. Presently, there are 2 hypotheses that give an explanation for this effect.

The first hypotheses were proposed by a neuroscientist **Dave Purves** and his colleagues in the year 1996. The theory says that we humans perceive motion in a manner which is very similar to a movie camera i.e. by processing a series of visual episodes or like the sequential presentation of discrete scenes. But in the year 2004, a researcher's team led by neuroscientist David Eagleman explained with his tests that the 2 identical wheels spinning adjacent to one other often perceived their rotation as switching direction independently of one another. This result of the Eagleman contradicts the Purve's team's discrete-frame processing model of human perception.

For a better explanation of motion reversal, Eagleman and his team concluded that motion reversal is a form of 'perceptual rivalry', a phenomenon by which the brain multiple interpretations of a visually ambiguous scene.

Question Fifty Two

Why Do Wind Turbines Have Three Blades?

Have you heard about wind turbines? Most of you must have and probably seen one too. Whenever you get to drive by a farm, you get to see them. A wind turbine is a set up to harvest wind energy. It converts the wind's kinetic energy into electric energy. The wind's kinetic energy helps in the rotation of the blades of the turbine which ultimately rotates the rotor to which they are attached. The road is linked to a shaft which sets in motion a generator to produce electricity.

Wind turbines have been in existence for a longer time. Earlier they were used for pulverizing grains and pumping water, but, nowadays, there use is mostly limited to generating electric energy. Over the years, they have undergone a huge change. From being available in various shapes to down to the turbines with only three blades.

Ever wondered why a wind turbine has only three blades?

There are various reasons behind its appearance. Let's discuss them all one by one. Firstly, three blades make the whole component cost effective. If 4 blades are put instead of three blades, it will ultimately increase the cost of a wind turbine, thereby making it less cost-efficient. Moreover, putting four blades of size equal to that of a three-blade wind turbine will make it heavier.

why can't we use wind turbines with only 2 blades? –

Then another question arises that why can't we use a wind turbine with only 2 blades? Each blade of a wind turbine helps the following blade in rotation by disturbing the air so you want to keep a minimum number of blades. Although two blades are the minimum requirement to balance the turbine and harvest maximum energy, it has its own negative effects.

A two-blade wind turbine can match the power output of a three blade wind turbine if we increase the length of the blades by 50% which ultimately increases the cost of the turbine. Moreover, it will also increase the height of the mast for providing more ground clearance.

We can also increase the rotational speed of the two-blade wind turbine by 22.5% to match the efficiency of a three-blade wind turbine. This will spin the blades faster but it is entirely difficult. Rotating blades of a wind turbine make noise. So, when the blades of two-blade wind turbine rotate faster, they make more noise. We know that people don't like living in a noisy neighborhood. So, we can't increase the speed of the blades as it will be very disturbing for the people living in the surrounding area.

Question Fifty Three

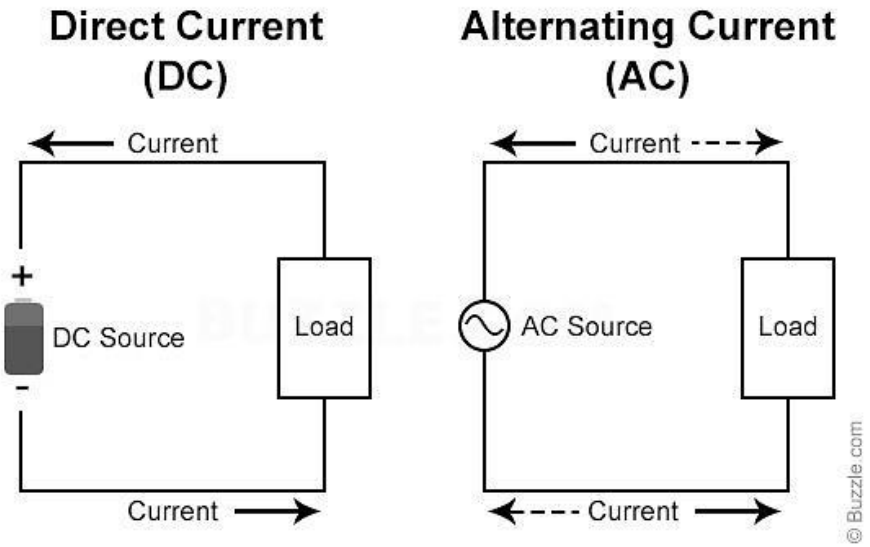
Questions and Answers on Engineering Fundamentals

Why is AC better than DC?

In today's world, next to oxygen lies the most important need of human and that is the electricity. Over the developing years, many changes have taken place. All the gadgets need electricity to run. Here electricity flows in two forms – AC i.e. Alternating Current and DC i.e. Direct Current.

The main difference between an AC and DC is the electron flow direction. During the flow of electricity, in AC, the electrons keep on changing their direction, i.e. moving forward and backward whereas, in DC, electrons move in a single direction, steadily.

During the flow of electricity, both the currents carry a different amount of energy. As the DC cannot travel larger distances, it begins to lose the energy gradually. Whereas, the AC can be transferred safely over long distances and thus can provide more amount of energy.



The source of current is the important aspect to be considered. AC is initiated from the AC generator, power plants and mains whereas, DC can be obtained from the solar panels and any cell or a battery.

As we know that AC and DC travel in different directions so this direction of flow of electrons is caused due to a reason. AC continuously changes its direction due to the presence of the rotating magnet along the wire whereas, in DC flow, the wire consists of steady magnetism.

In AC, the frequency changes from country to country. It is basically taken as 50 Hz to 60 Hz depending upon the country whereas there is zero frequency in DC.

AC carries a current which varies with the time whereas, in case of DC, the magnitude of the current is constant.

A passive parameter does not require any energy to operate and also, it is not a source of energy. AC and DC have varying passive parameters. In AC, impedance has a significant role whereas, in DC, only resistance is the passive parameter.

The power factor of the AC lies between 0 and 1 whereas, for DC, it is always 1. AC is of many types including sinusoidal, trapezoidal, square and triangular, whereas the DC is of two types, i.e. pure and pulsating.

Moving further, now you must have gained enough knowledge and a better understanding of how AC is better than DC. Transformation of the AC between voltage level is easier, thus making the high voltage transmission attainable. Whereas DC is found in most of the electronic devices. These two forms of current do not mix together very well and for using the electronics by connecting them to the wall outlet, the conversion of AC to DC is necessary. Even if the device contains AC, then also you should be mastered at working on more complicated circuits. After reading this article, I hope now you have understood that why AC is better than DC.

Question Fifty Four

Why Is There Fuzz on A Tennis Ball?

Tennis matches fascinate everyone because of their intensity which consistently locks the audience's eyes to the ball, but it is hard to master even its basic strokes when it comes to playing. This game was originated around the 12th century in the court of Louis X in France. At that time, balls used for playing were made from strips of wool.

Since there has been a tremendous evolution in the tennis balls and now they are made from raw rubber pellets molded into hemispherical shells and glued together with adhesive. The ball is also inflated with pressurized air to achieve the optimum bounce.

The outer layer of the ball is fuzz covered which impacts the ball's pace and bounce. This fuzzy covering is called 'nap' and it is collectively made from wool, cotton, and nylon.

The nap on the ball gives it resistance while moving through the air. If a ball has a smooth surface, there will be very small friction between its surface and air which will make it move at high speed. When a nap is present around the ball, its rough surface creates good required friction (drag force) with the surrounding air thereby slowing down the speed of the ball.

This drag force is known as skin friction drag. Moreover, when the ball moves through the air it tries to knock the air out of its way and turbulent swirls of air are created behind it known as 'wake'. This wake is a region of low air pressure and the larger its size is, the larger the area of low pressure becomes. The front area of the ball still has a high pressure, and due to this pressure difference in the front and the back of the ball, a drag force acts on the ball in the opposite direction of its movement. Therefore, the speed of the ball is reduced.

Due to a drag force around the ball, there is suction action behind the ball that imparts the curve to the trajectory of the ball and induces the spin to it. From the figure given below, we can see the ball is moving to left and the air is moving against it with the airlines on the top of ball pushing it down.

Turbulent wake is generated behind the ball and causes it to spin in the clockwise direction. As the ball is spinning, its bottom surface is forcing air upwards which is known as backspin. If the ball is spinning in the anti-clockwise direction, then it is known as topspin. This drag force is created by professional players using the forehand and backhand shots, sending their opponents a swinging ball.

The ball's speed almost gets down to about one-third of its original speed due to the drag force and its speed is also reduced when it bounces off the court. Usually, after few shots, the ball's fibers get loose and tend to decrease the speed of the ball even more. Therefore, players change the ball and take those that are tightly woven and have a uniform nap.

Furthermore, the color of tennis balls is kept yellowish-green because of the fact that this color carries maximum visibility to the human's eye, thus making players and spectators easily see the ball when it is punched rapidly back and forth between the players. So next time when you play tennis, make sure to check the nap condition of the ball and use the drag force to beat your opponent.

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