Questions and Answers in

Mechanical Engineering Part Two

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Question One

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-

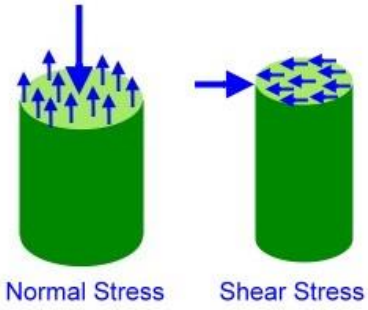
Stress

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-

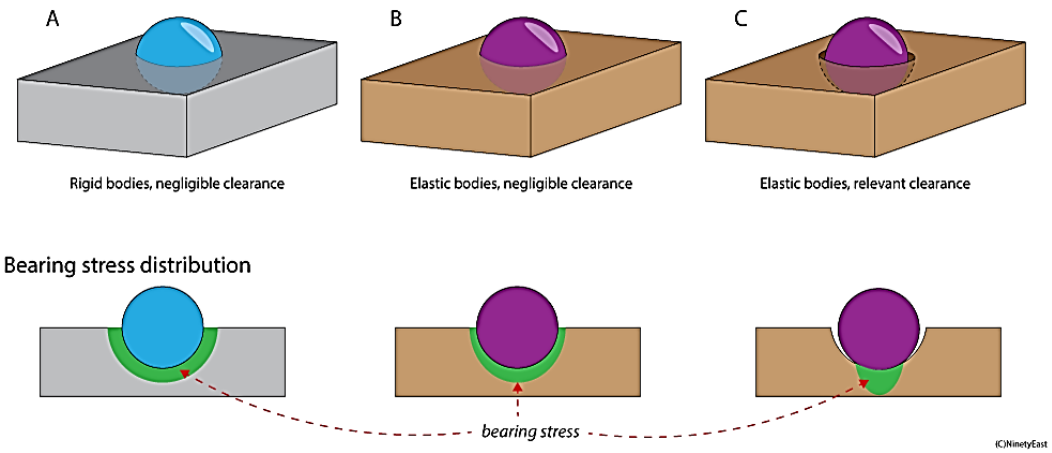
1) Normal Stress:

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

A. Axial Stress:

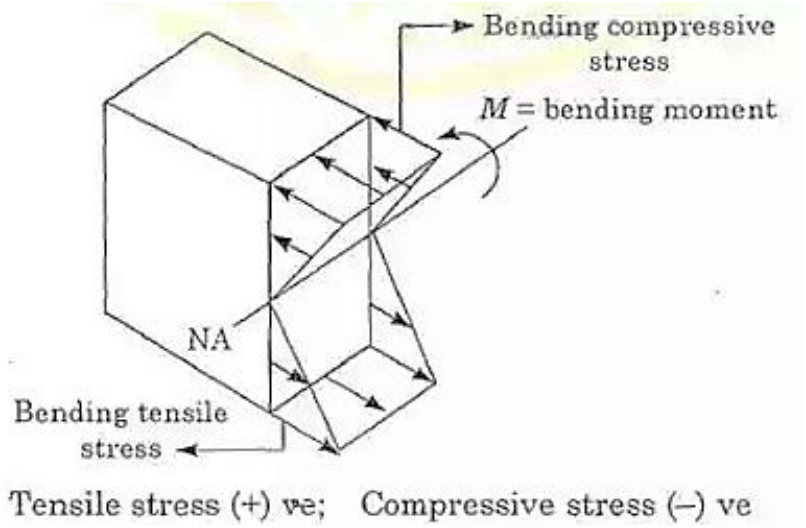
When Direction of the load is along the axis of the member i.e. normal to the cross-section of the member where it is applied it is known as Axial Stress.

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 Two

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 Three

Types of Fluid Flow

Laminar, Turbulent & Transitional Flow

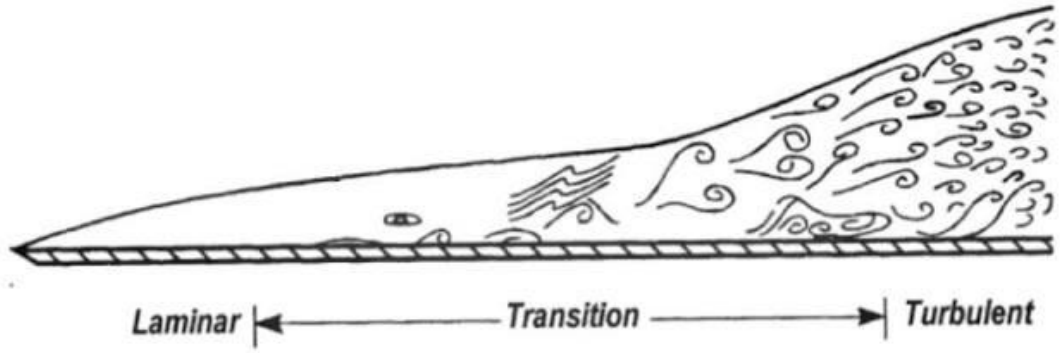
The matter is classified as Solids, Liquids and Gases. Out of these liquids and gases are termed as fluid. Thus, fluid is a substance that has the ability to flow in any direction. The shear force acting on any fluid due to the continuous relative motion between the fluid particles tends the particles 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:

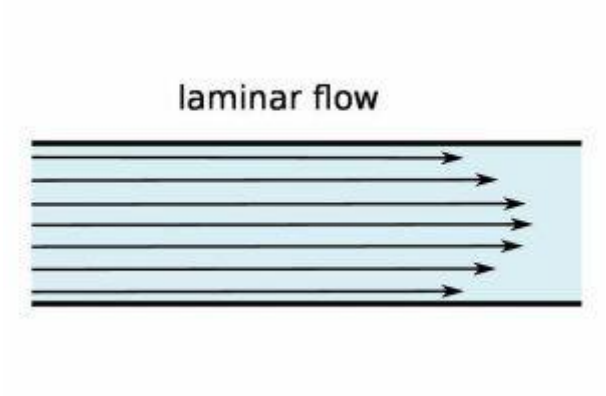
Considering the layers of fluid in a pipe, fluid flow is categorized into 3 types:

- **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**.**



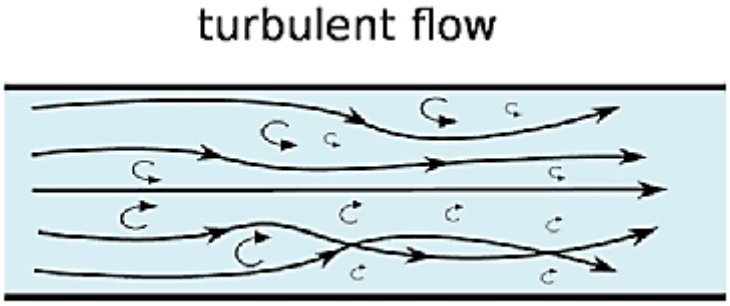
For a laminar flow, all the particles will follow a streamline and no two will intersect each other. The instantaneous velocity of the particle is in the direction of the tangent to the streamline.

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.

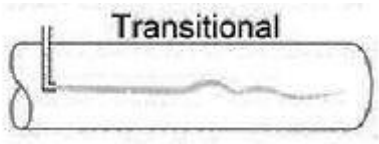
A laminar flow changes to turbulent flow when the flow rate suddenly increases making the steady flow unstable.



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:

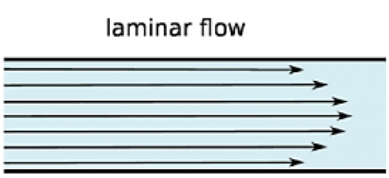
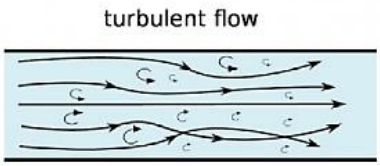
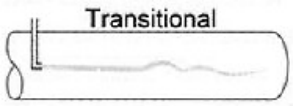
Reynolds number: The fluid flow depends upon this dimensionless quantity. This number is used to know whether the fluid flow is laminar or turbulent. It is the ratio of force of inertia to the viscous force.

Inertial force is due to the momentum of fluid and is given as ($\int v$) 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 Four

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

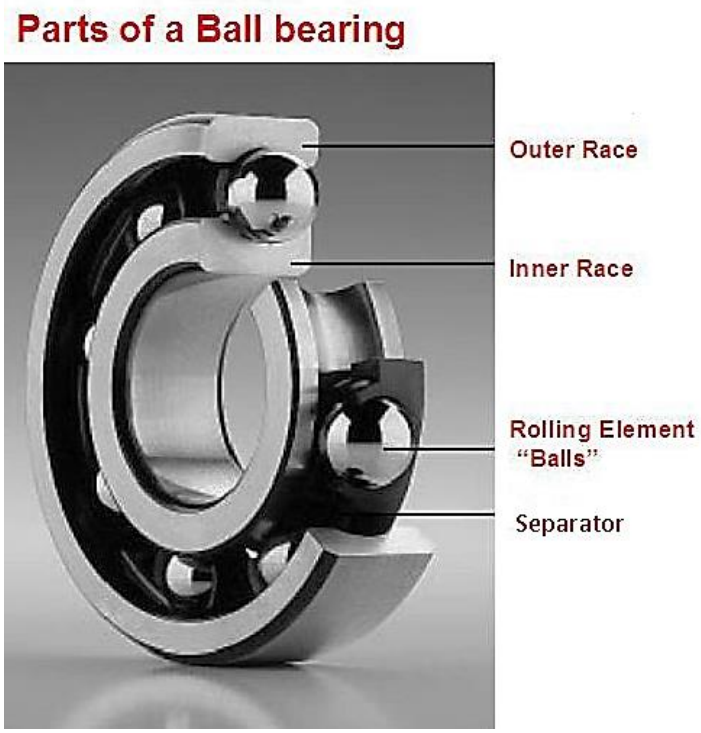
3. High thermal conductivity

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-

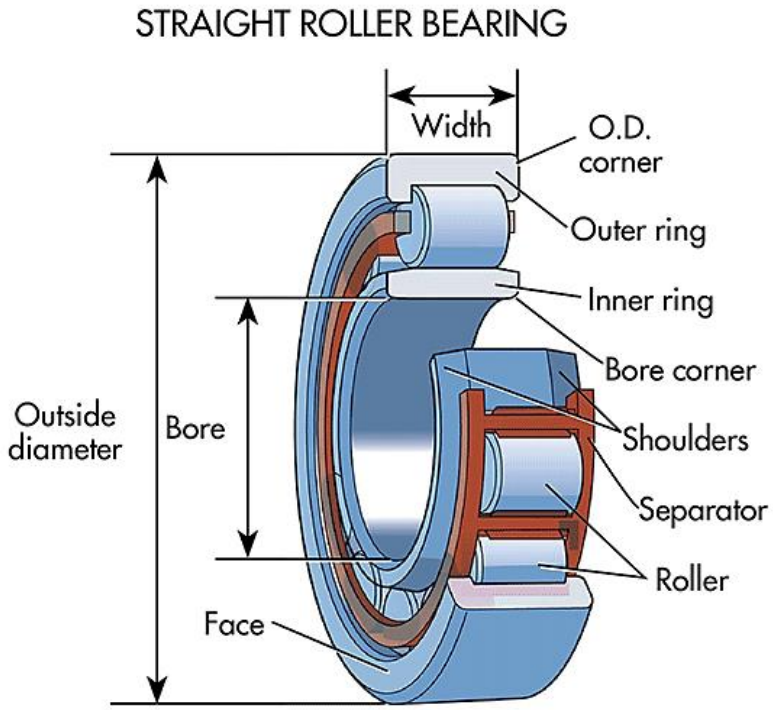
- **Ball Bearings**



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.

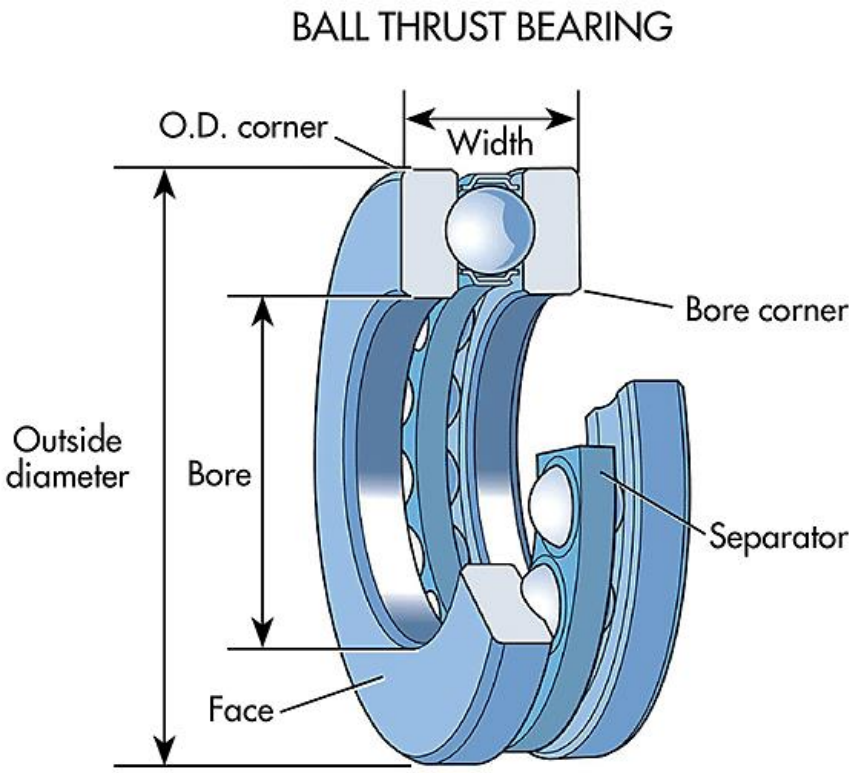
Learn in detail about ball bearings and their purpose here- **What are ball bearings and what is their purpose?**

- **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.

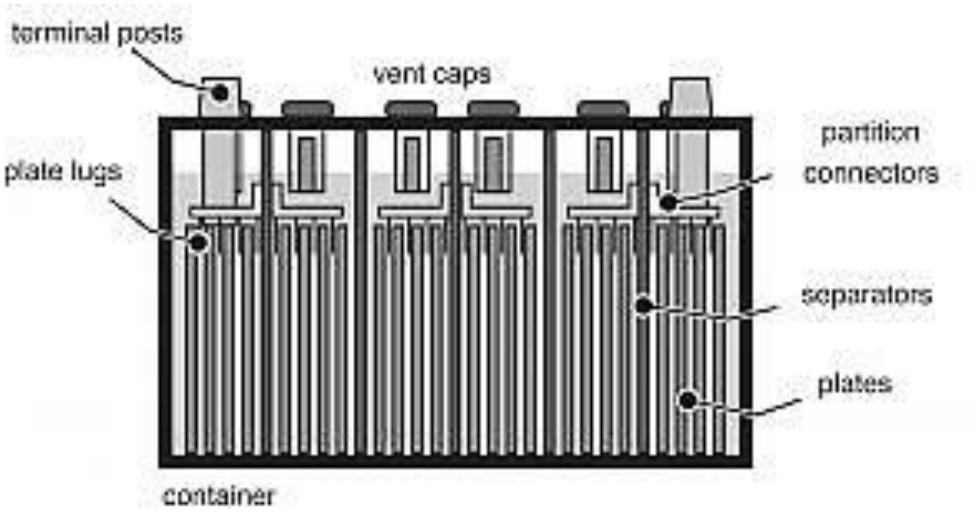
- **Specialized Bearings**

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 Five

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:

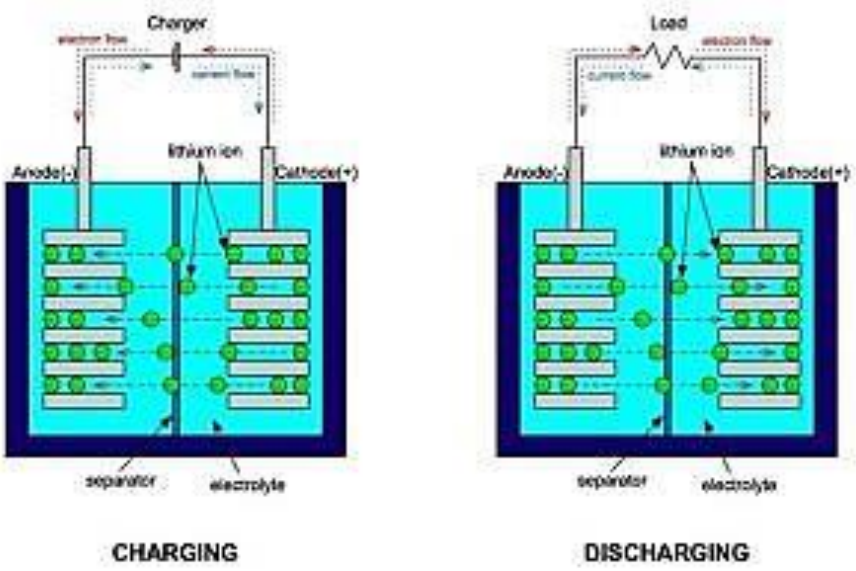
- Household Battery
- Industrial batteries
- Vehicle batteries.

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:



CHARGING DISCHARGING

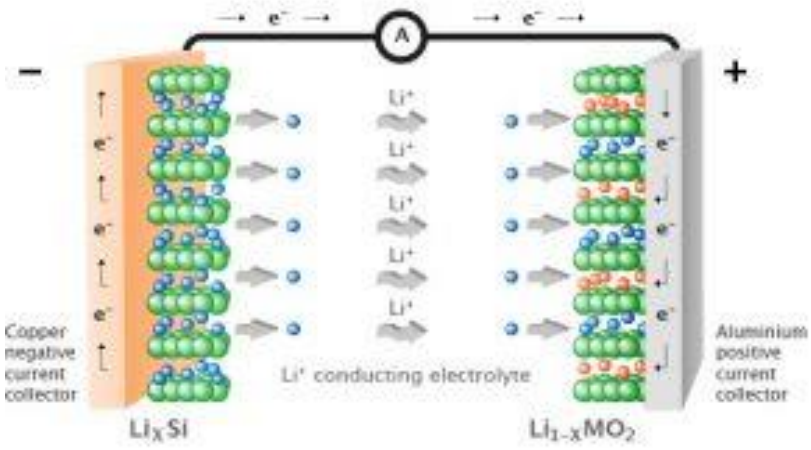
These are the batteries which can be charged using external sources. We can use them for multiple purposes by charging them until the battery is in the condition to get replaced.

Examples of rechargeable batteries are:

i). Lead Acid Gel battery:

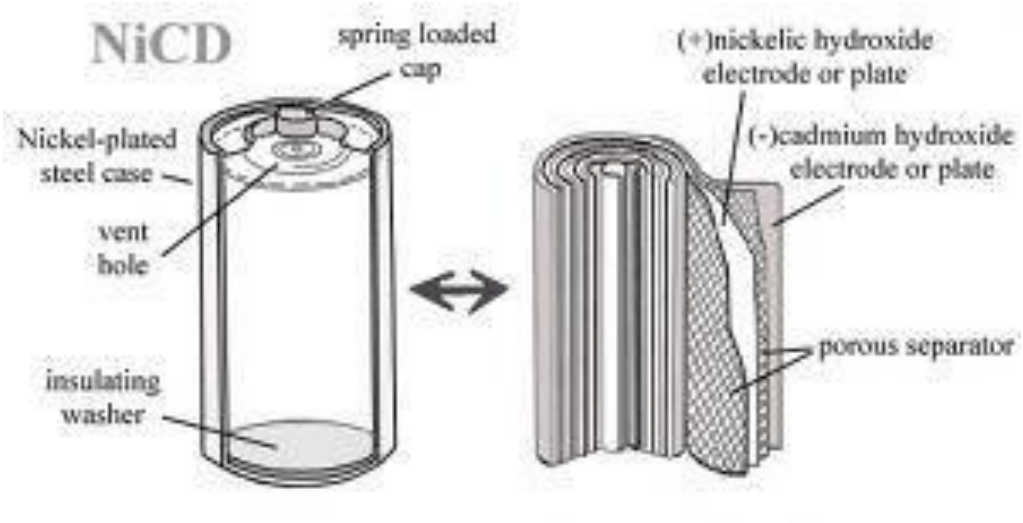
It is a rechargeable dry-cell battery, usually comes in rectangular hard plastic cases. It is used in Wheel Chairs, golf carts, military aircraft, RV's, and boats.

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:

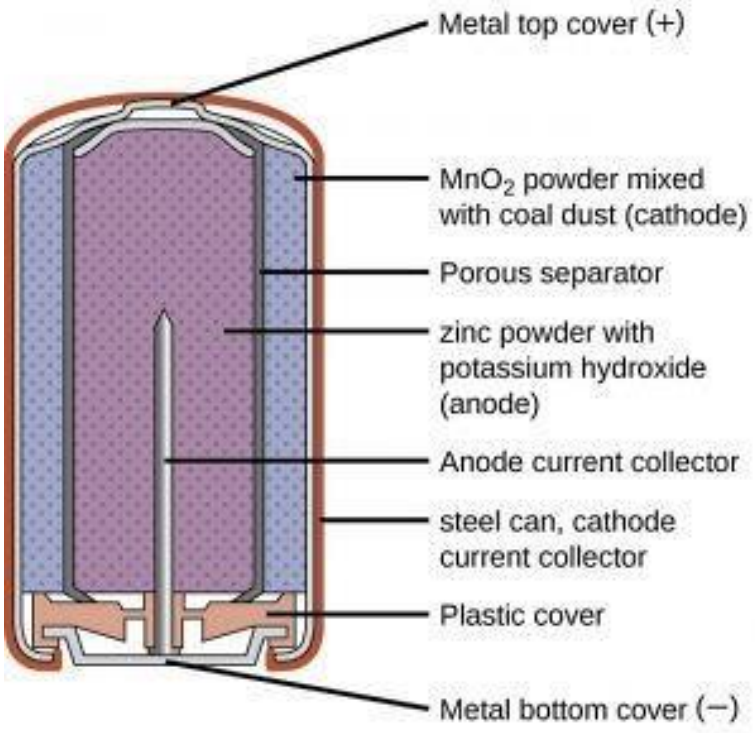
Nickel metal hydride batteries are small, dry-cell, rechargeable batteries. It comes in AAA, AA, C, D, 9volt and 12volt formats. These are used in power tools, PDAs, and cameras.

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.

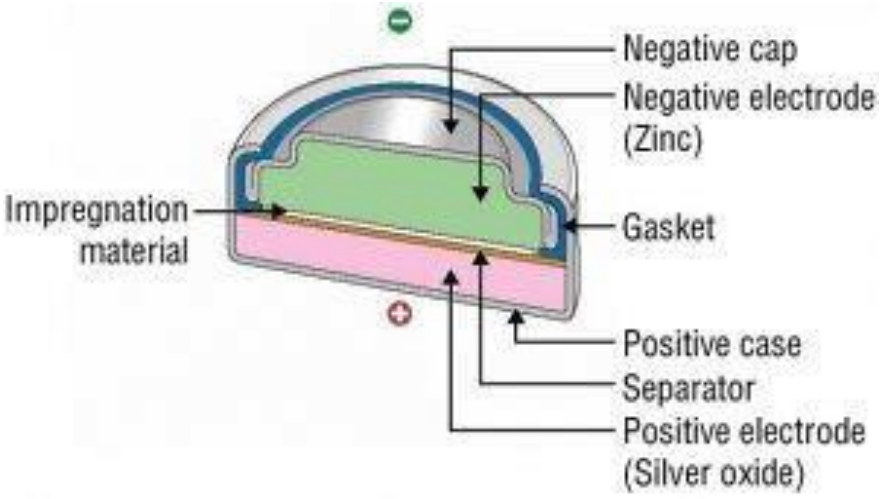
ii). Lithium(Primary):

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:

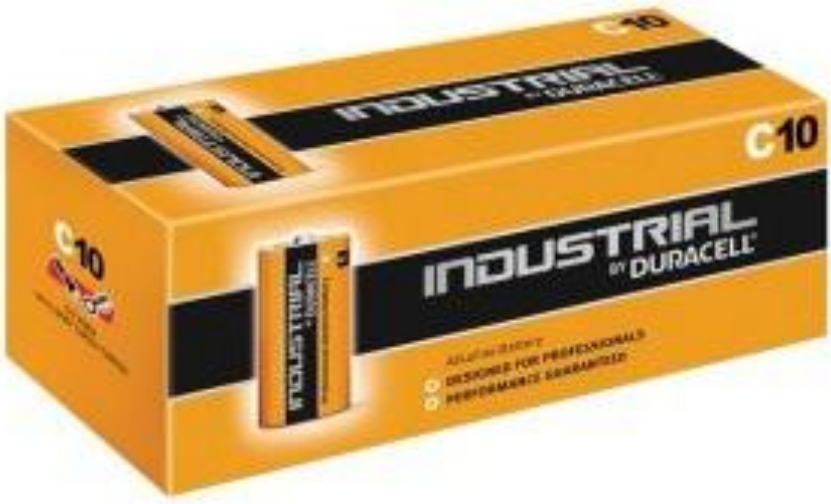


These batteries can be small or large, depending on how power is to be supplied. These are dry-cell, non-rechargeable batteries, comes in button cells, high voltage formats. These batteries are used in hearing aids, torpedoes and aircraft.

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:

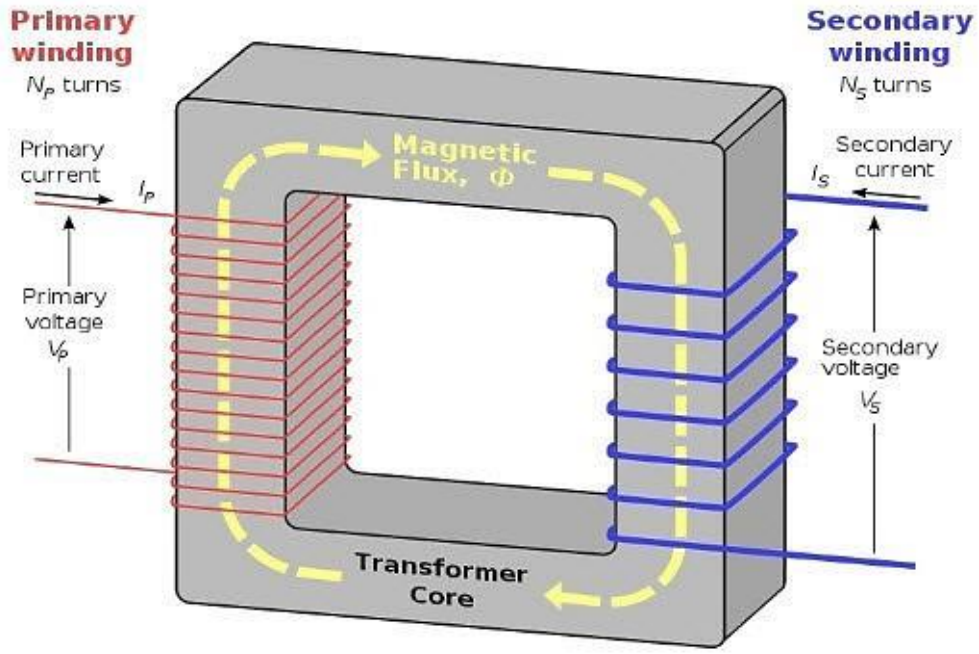
These are the vented, flooded cell, rechargeable batteries, which comes in a hard case format. These batteries are used in boats, motorcycles and in outdoor power equipment.

Question Six

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.



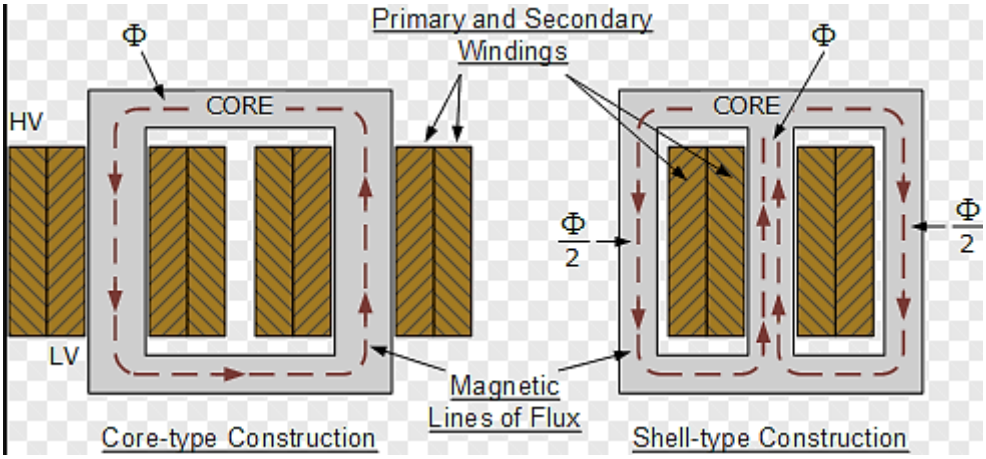
Classification / Types:

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

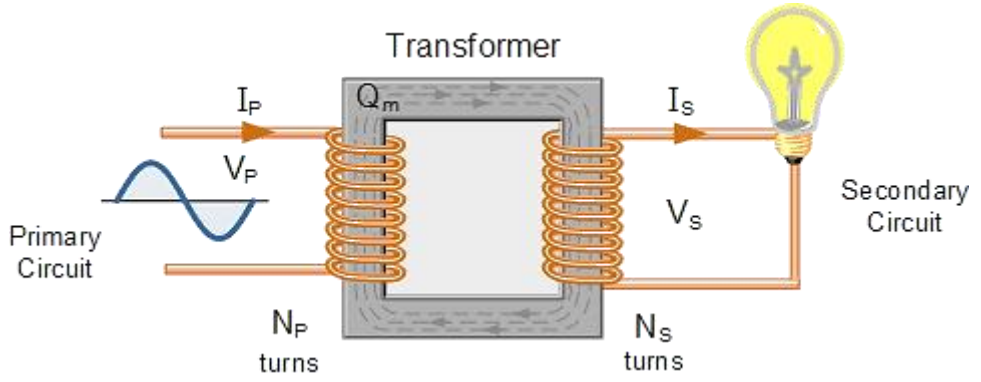
1. Oil-filled self-cooled type
2. Oil-filled water-cooled type
3. Air blast type (air cooled)

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 Seven

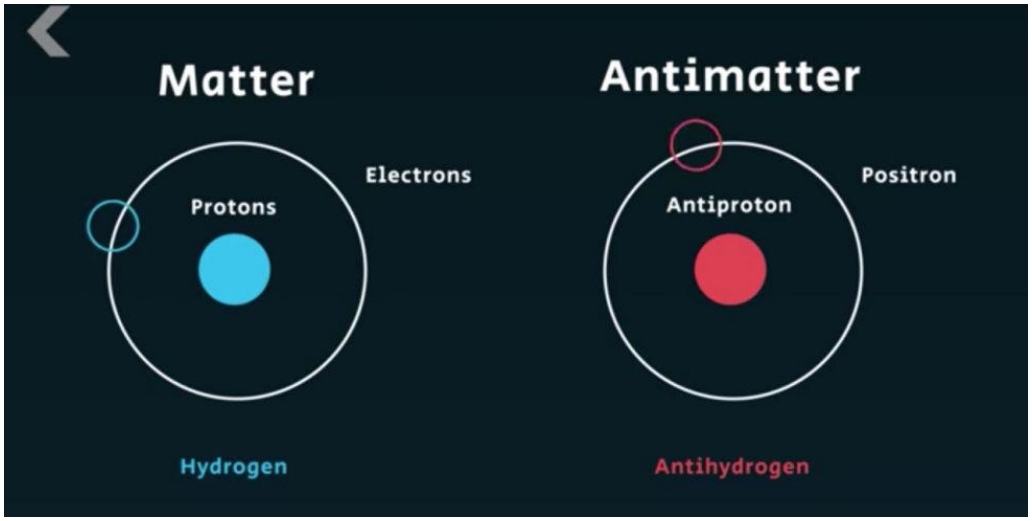
What is an anti-matter?

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.

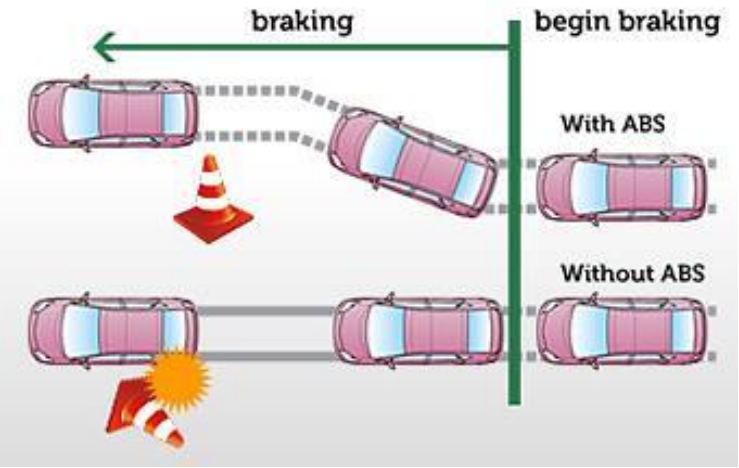
As Werner Karl Heisenberg said, "I think that the discovery of antimatter was perhaps the biggest jump of all the big jumps in physics of our century," the engineers had speculated the power of antimatter by considering the fact that when antimatter collides with matter particles, they annihilate each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

Question Eight

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.**

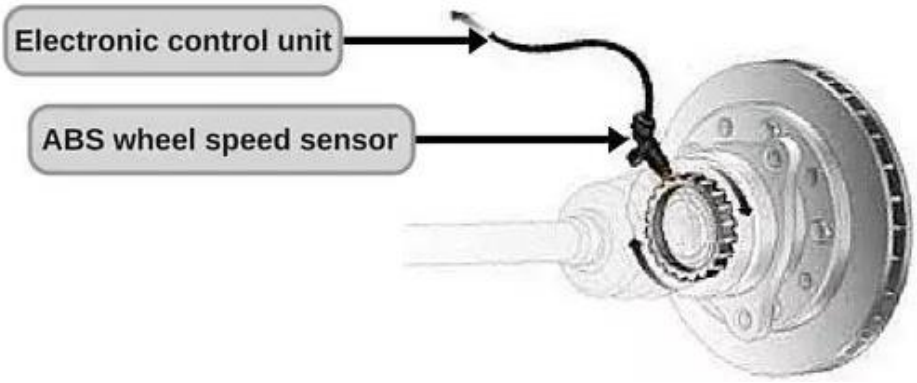
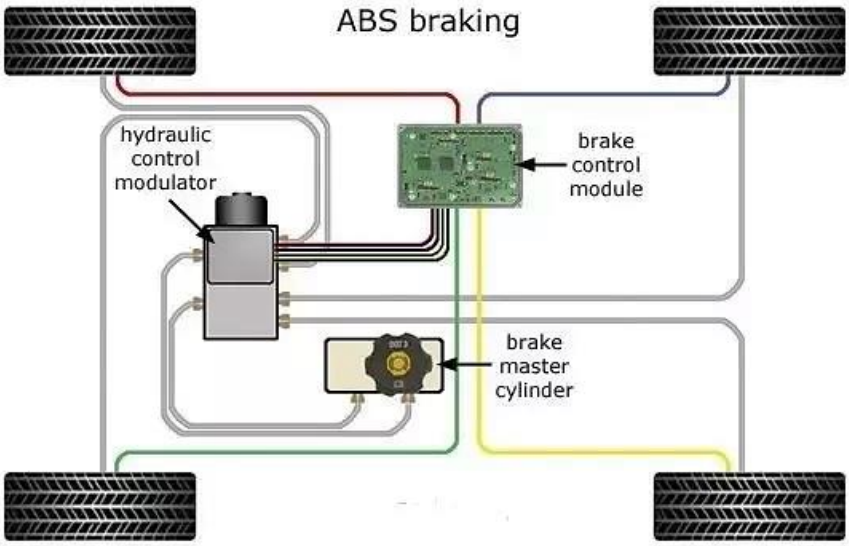


Fig: - **The speed sensor**

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.**

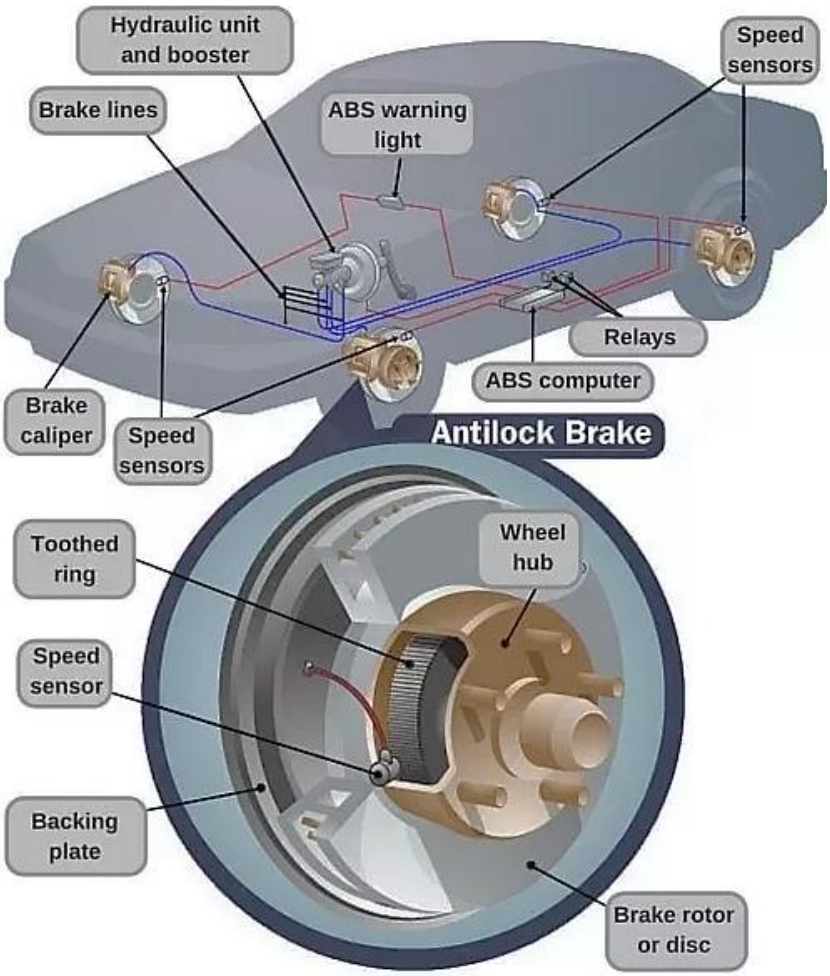


3) Electronic Control Unit (ECU)

- 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).

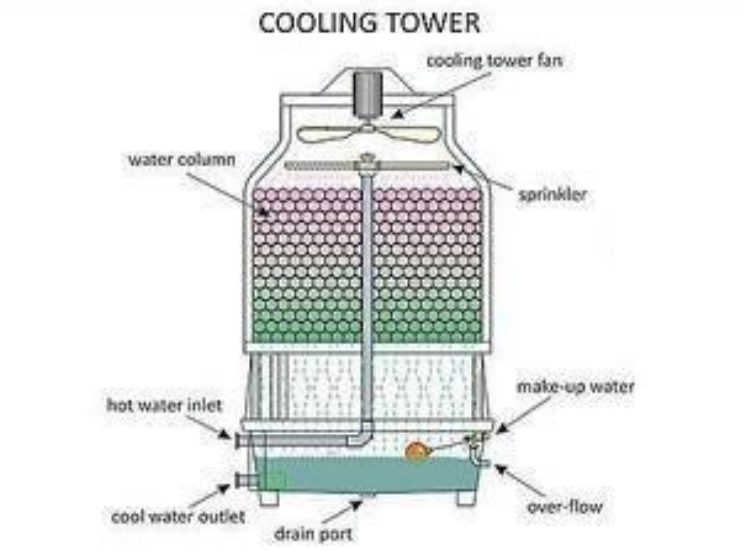
The Hydraulic Control Unit controls the **brake pressure in each wheel cylinde**r based on the inputs from the system sensor. As a result, this controls the **wheel speed.** This process is repeated for the next braking operation.

Question Nine

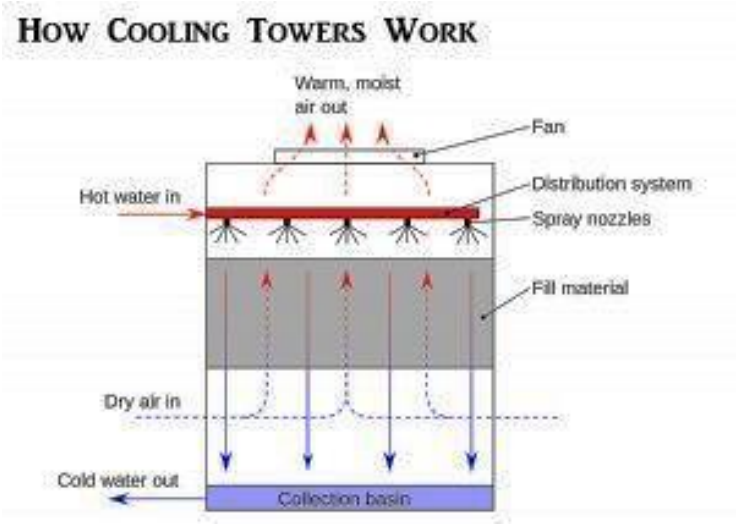
What is Cooling Tower? What are main Types of Cooling Tower?

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.

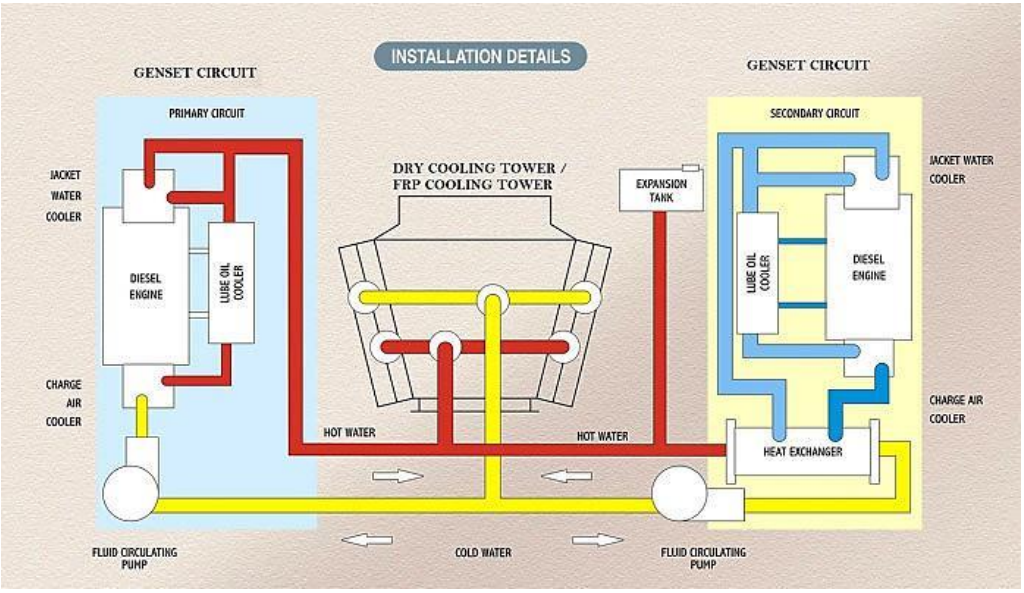
Types of Cooling Towers:

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.

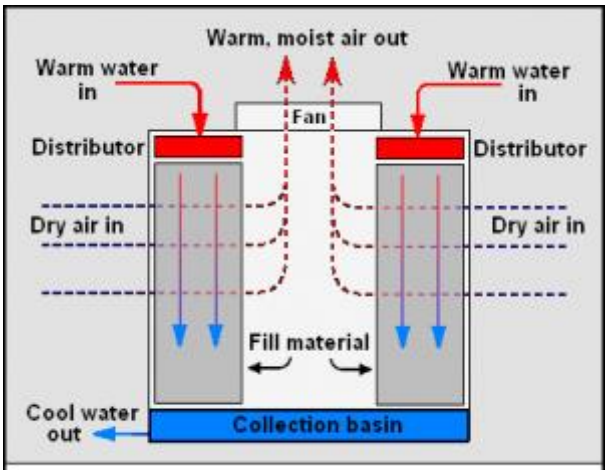


Fig. 6: Schematic diagram of a cross-flow wet cooling tower

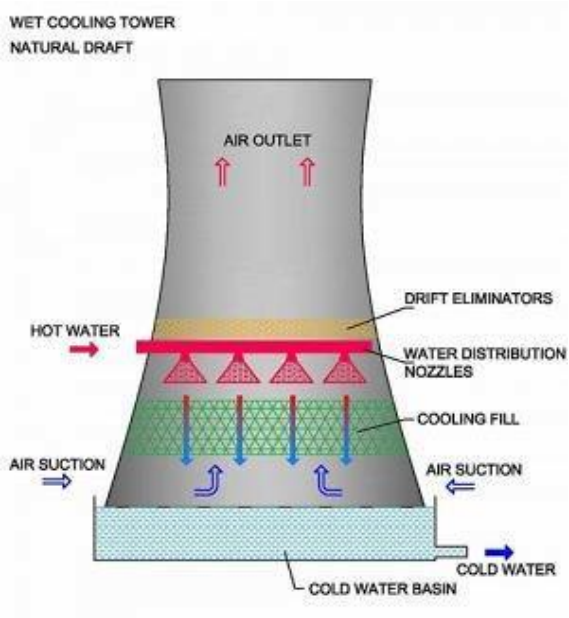
Fluid Coolers:

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 :

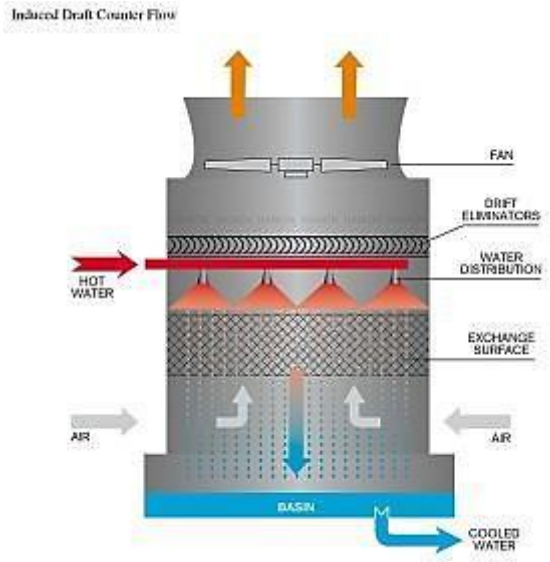
Natural draft cooling tower:

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.



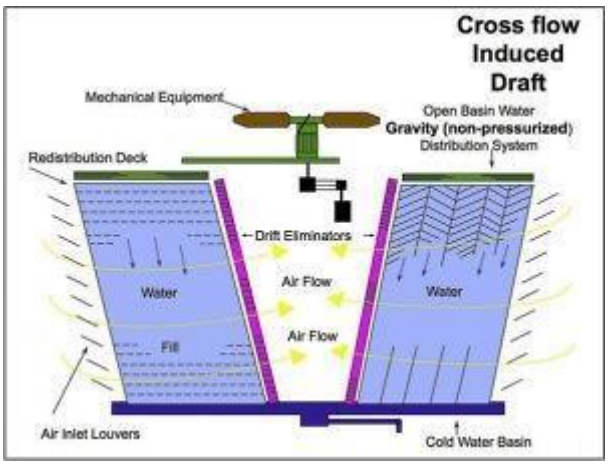
Mechanical Draft Cooling tower:

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.



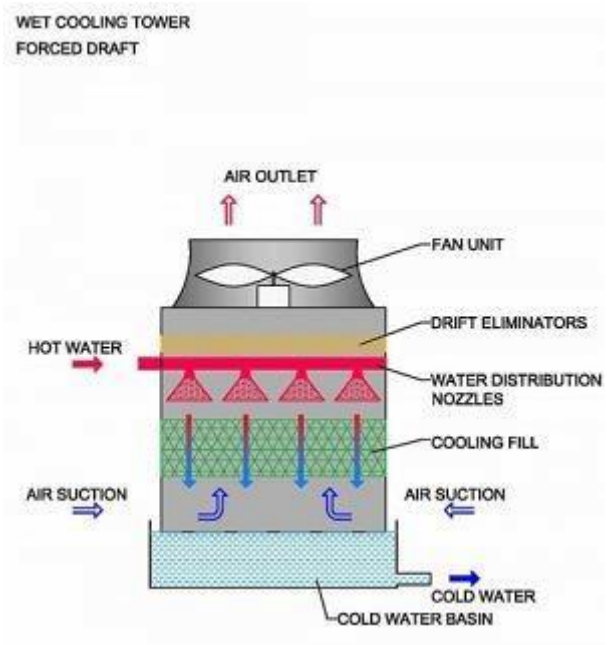
Induced Draft Towers:

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:

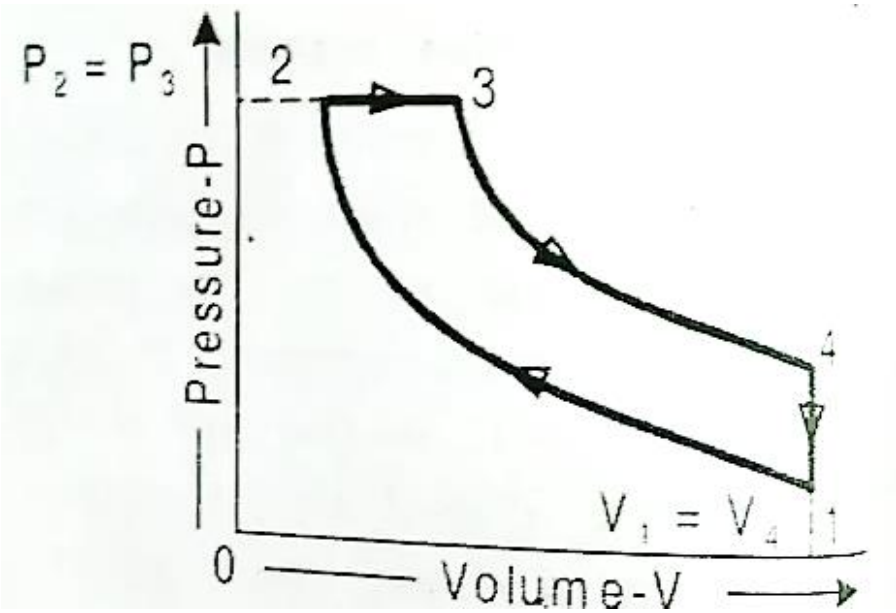
This is just the opposite of induced draft system, in this set up the fan blows in the air at high velocities in to the tower rather than forcing it out. Here the entry velocity of the air is quiet high in comparison to the exit velocity. This type of cooling tower not only cools but also raises the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



Question Ten

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

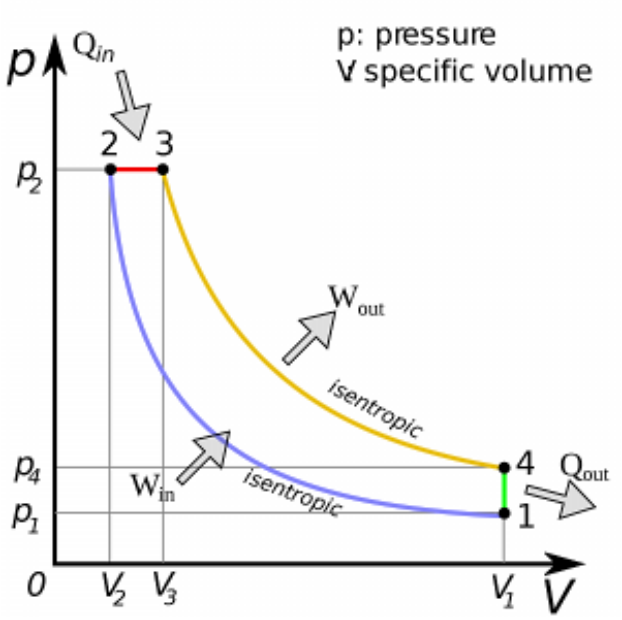
Diesel cycle is also called as constant pressure cycle. The diesel engine operates on this cycle. This cycle also contains four processes, out of which two processes are adiabatic, the third one is constant pressure process and forth process is constant volume process. Diesel cycle is an air-standard 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-

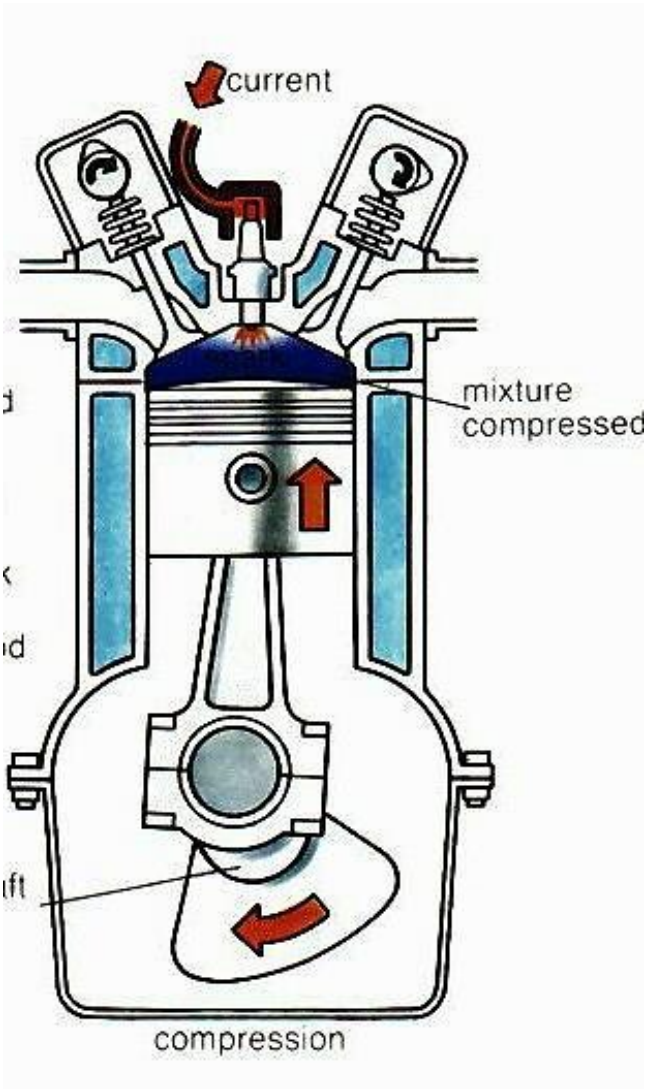
1. 1–2= Adiabatic compression
2. 2–3= Heat addition at constant pressure
3. 3–4= Adiabatic expansion
4. 4–1= Heat rejected at constant volume

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



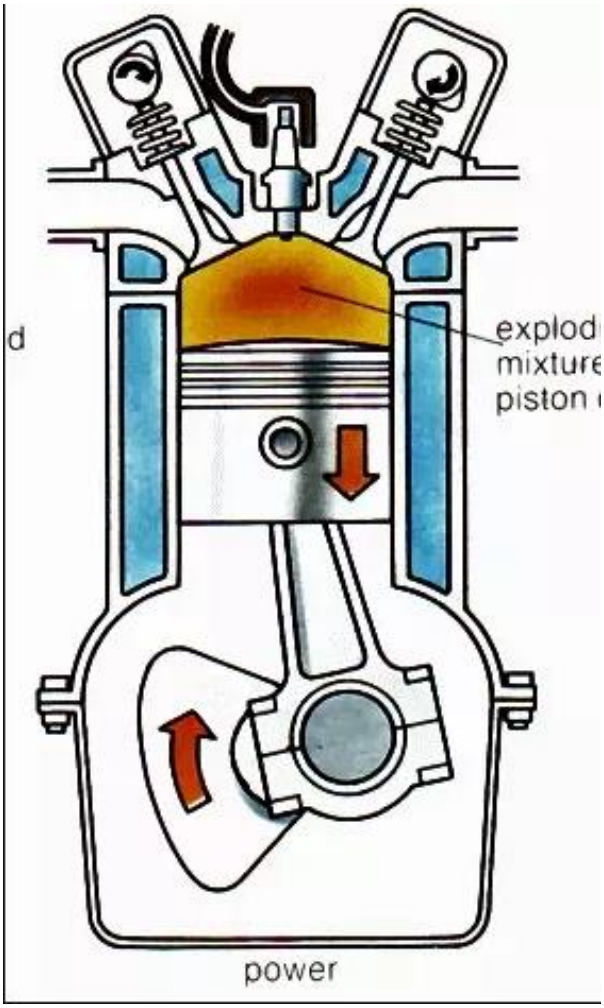
Isentropic Compression (Process 1–2)

- 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.



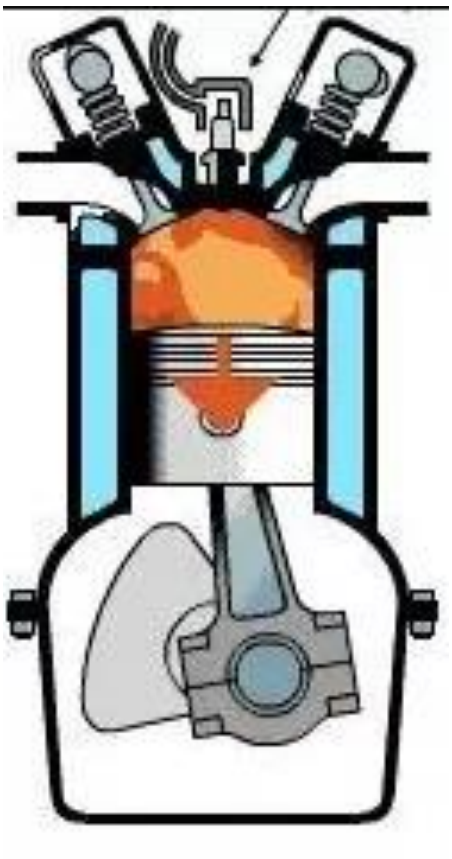
Isobaric Heat Addition (Process 2–3)-

- 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.



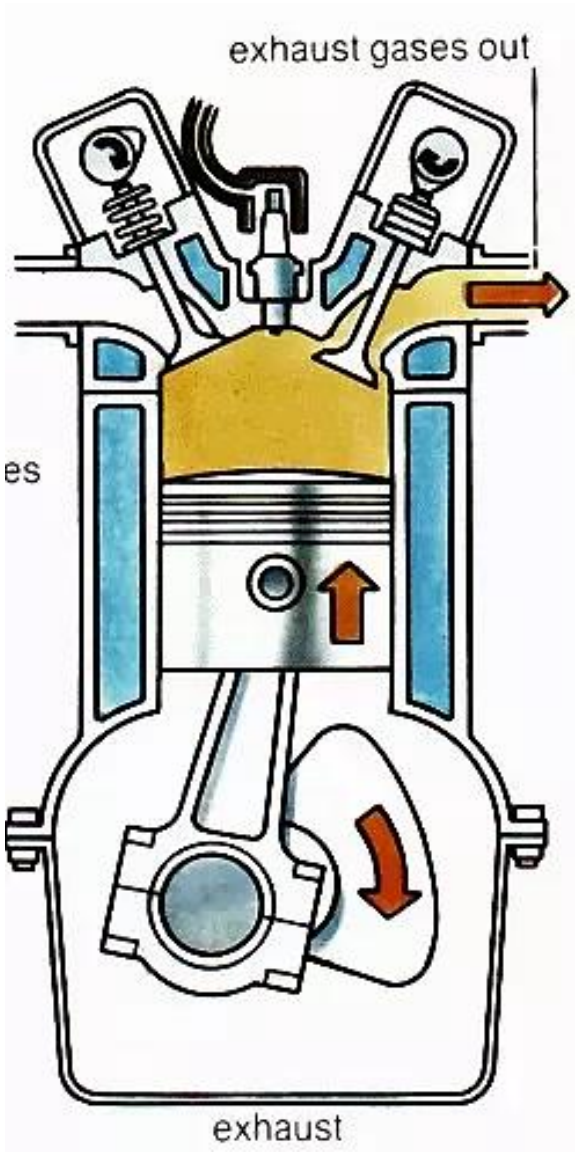
Isentropic Expansion (Process 3–4)

- 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)

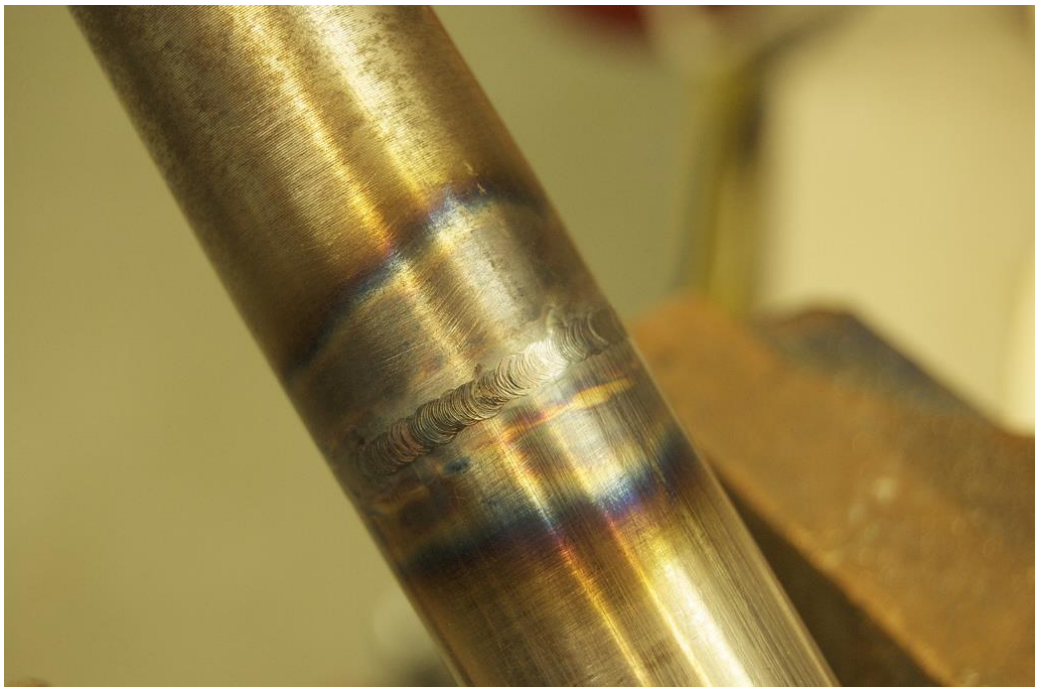
- Isobaric means that the process carried out at constant volume.
- With the volume being constant, heat is removed until pressure comes down to p1.
- Heat is removed from the system (negative heat Qout), by flushing out the combusted gases.
- This process is characterized by the exhaust and intake stroke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


exhaust gases out
es
exhaust

Question Eleven

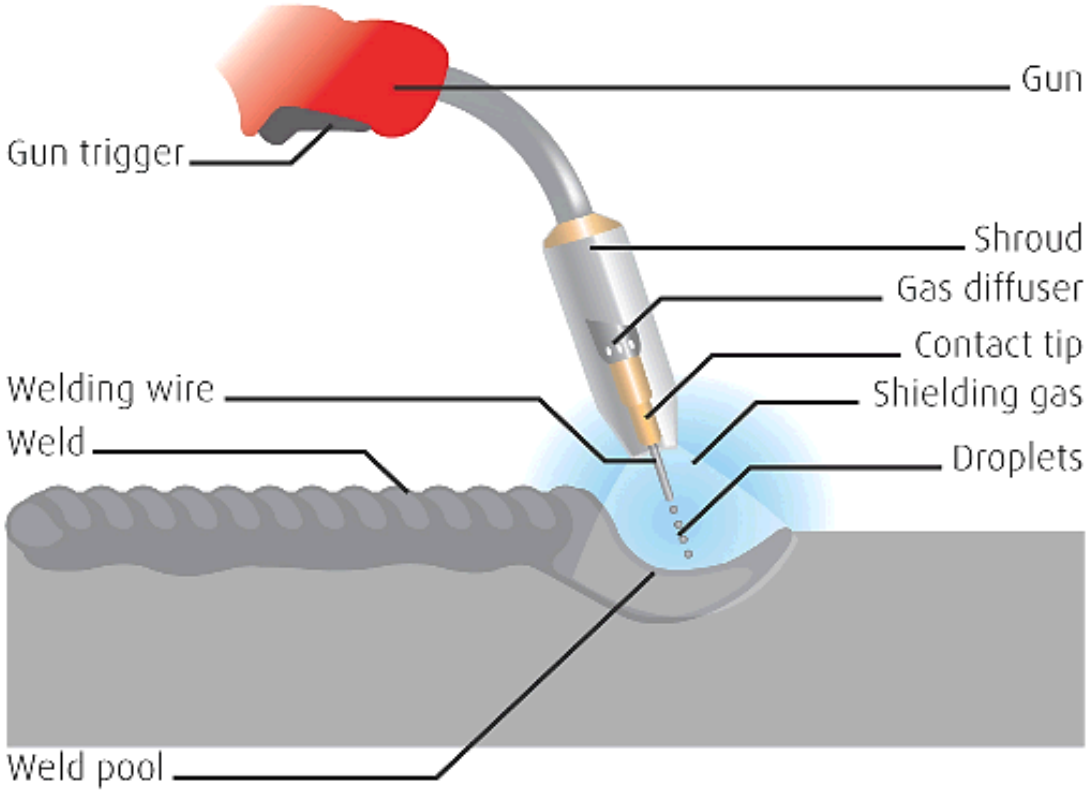
What Is Fusion Welding and Types of Fusion Welding

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.

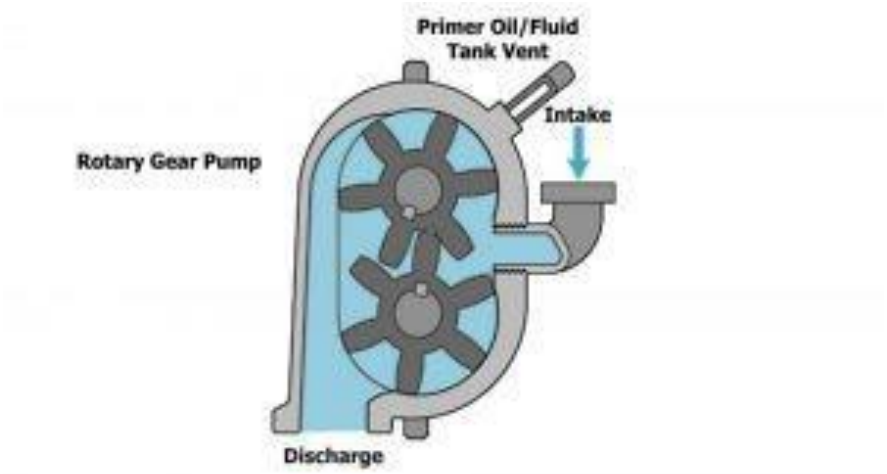
Question Twelve

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.

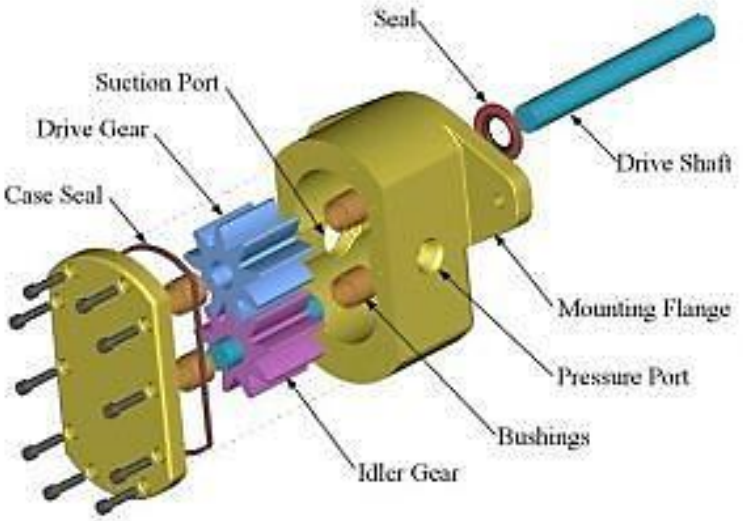
In simple words, we can say that the gear pumps transfer the fluids from one part to another using gear mechanism. If the pressure of the system remains same then they will provide you with the fix flow rate also. So let's discuss Gear pumps below.

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.

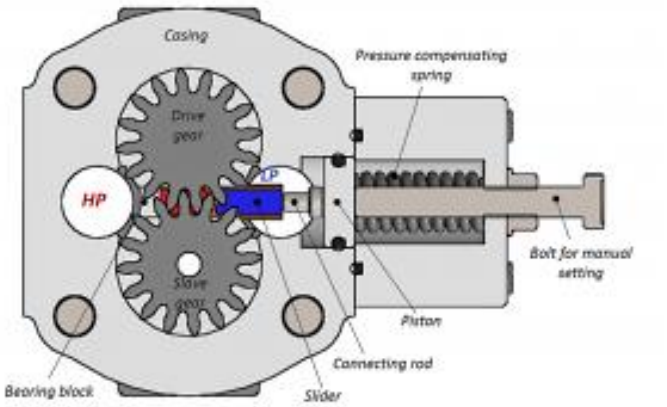


Exploded View

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:

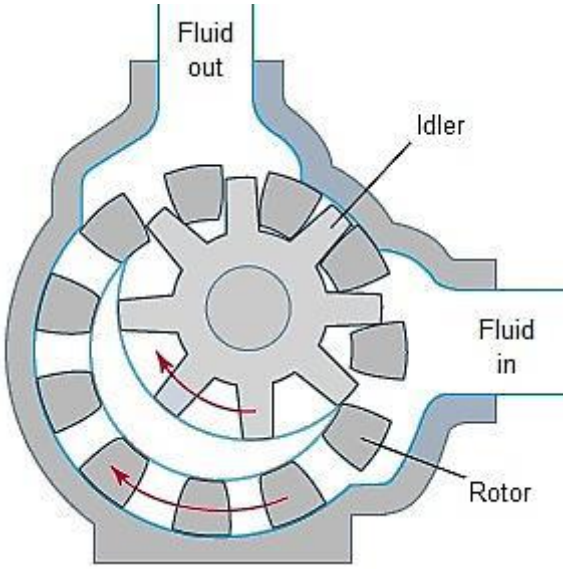
These types of pumps are not so costly and are easy to operate. You can find them in various machine tools, an oil pump of the engine and fluid power transfer units. To generate the flow these pumps used two gears with external cut teeth.

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 Thirteen

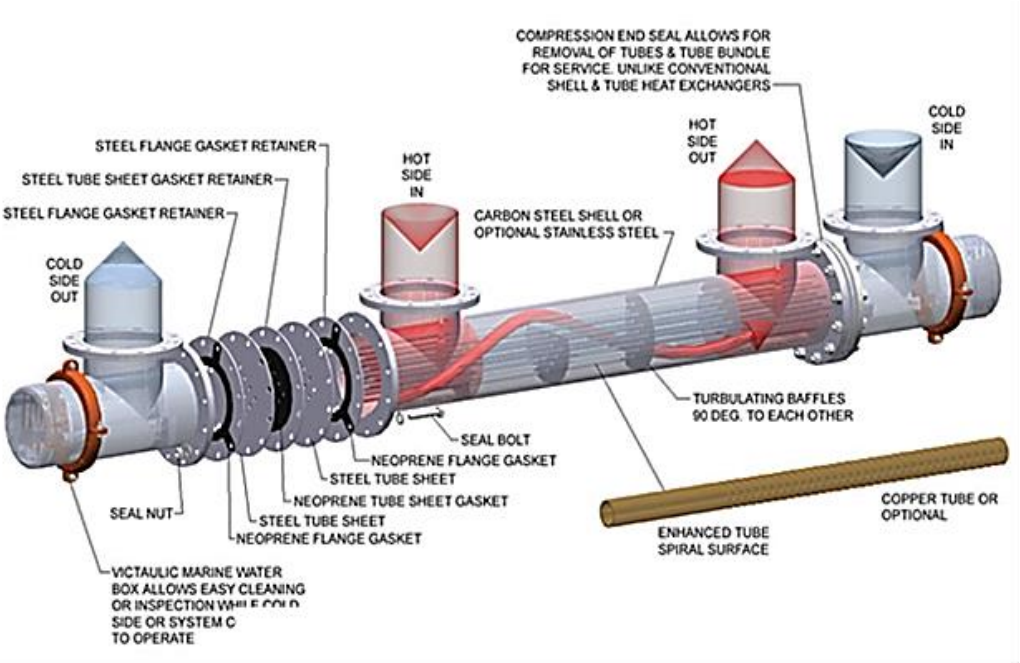
What Is Heat Exchanger? Types of Heat Exchanger

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 Fourteen

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.

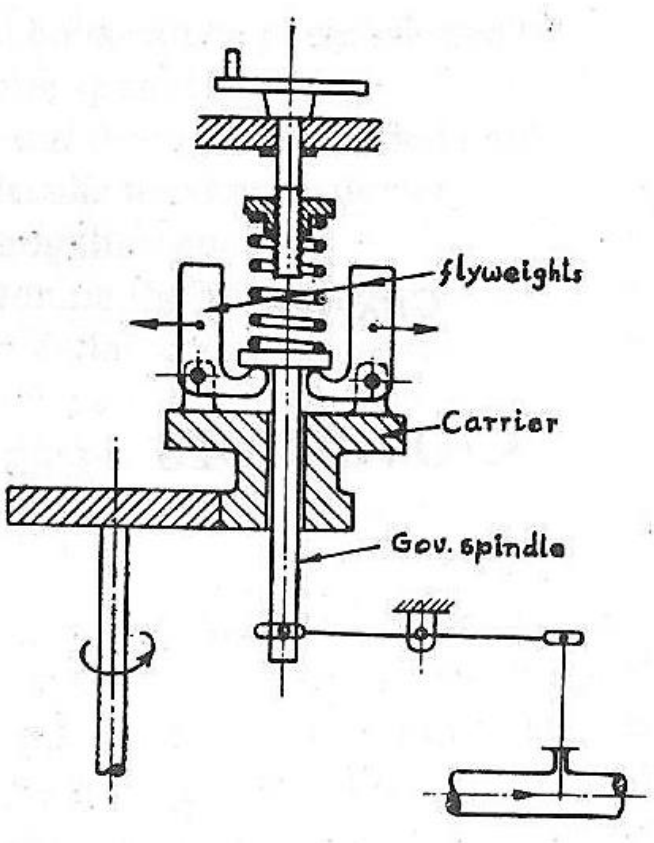
Torque is basically the force that starts the vehicle when at rest and pulls it to steep hills. It also provides power when we are towing a vehicle or hauling heavy material from behind.

Question Fifteen

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.

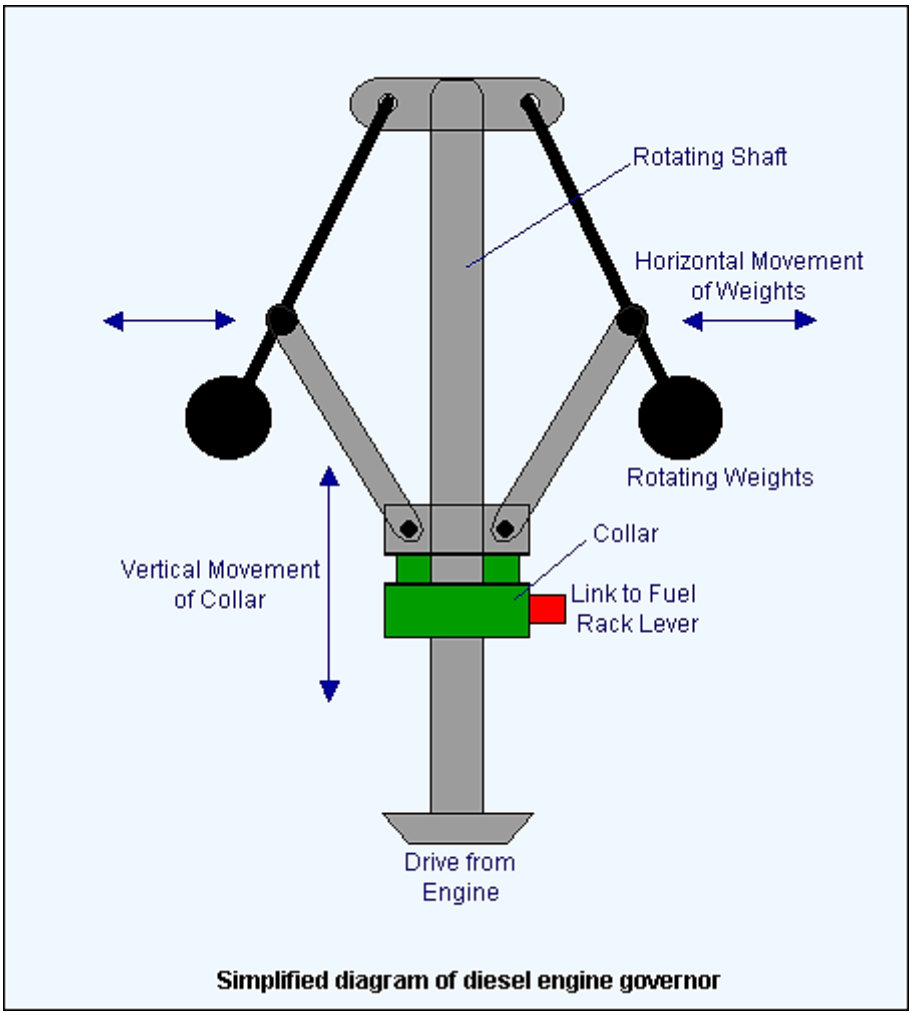


There are basically two types of governors namely Centrifugal Governor an Inertia Governor. Inertia Governors are more sensitive than Centrifugal Governor but on the other hand, it's very difficult in Inertia Governor to balance the revolving parts. Due to this reason Centrifugal Governors are used more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

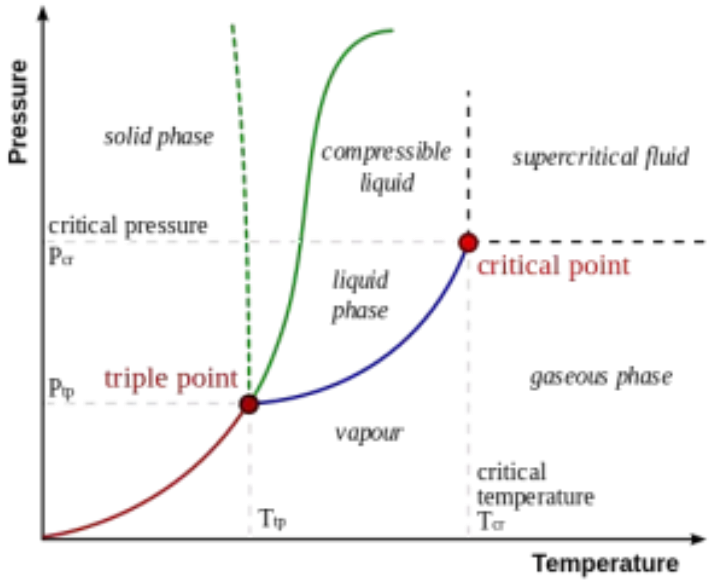
What Is Triple Point

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.

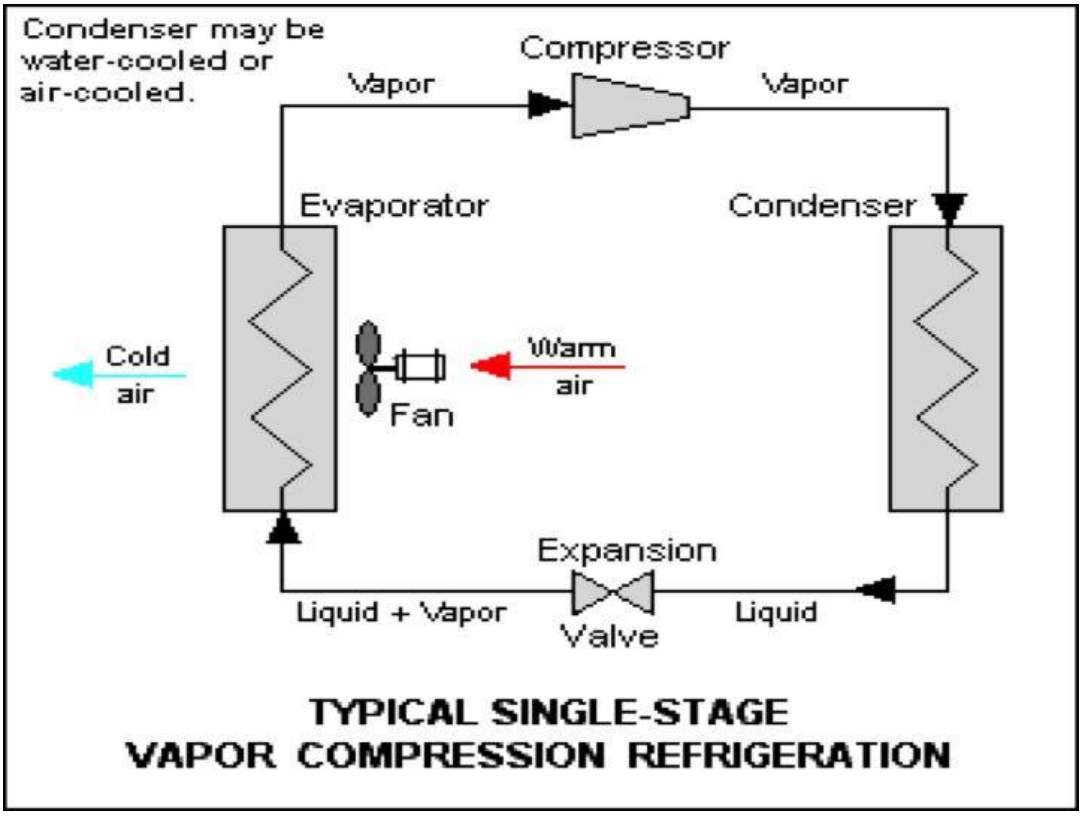
Further application of this phenomenon is found in calibrating the thermometers. For this, a device called triple point cell is utilized.

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

Question Seventeen

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.

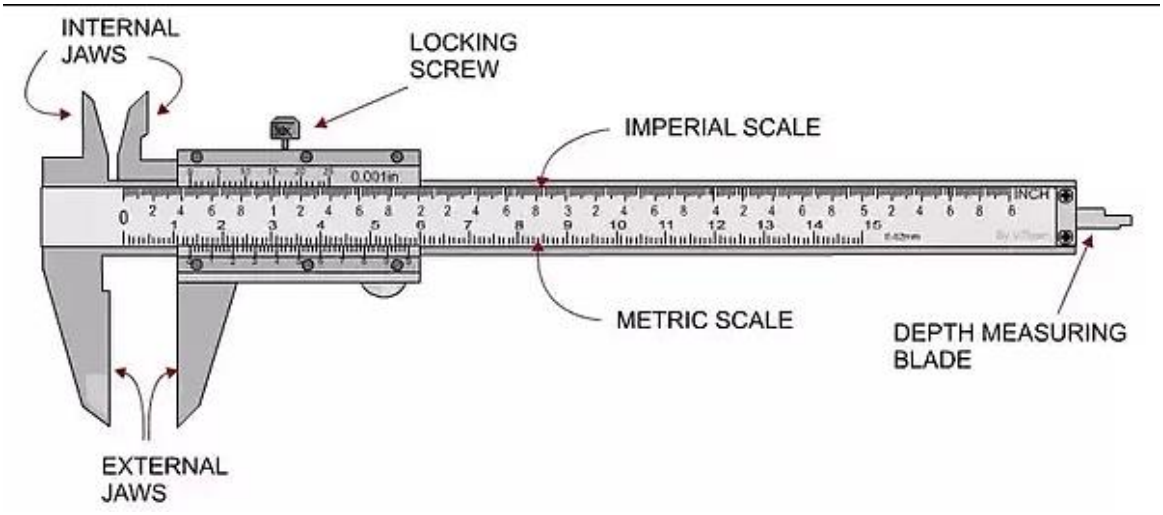
Question Eighteen

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

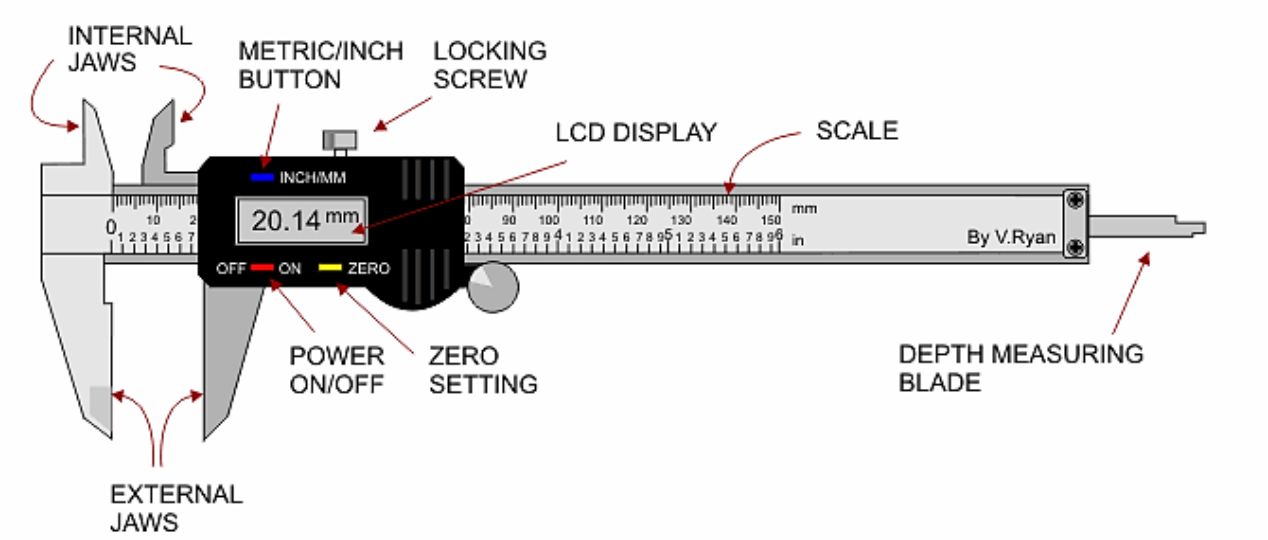
The Vernier caliper is an extremely precise measuring instrument; it is used to measure internal and external distances extremely accurately – the error may be as little as 0.05 mm – depending on the make. The VERNIER is a small movable graduated scale for obtaining fractional parts of subdivisions on 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.

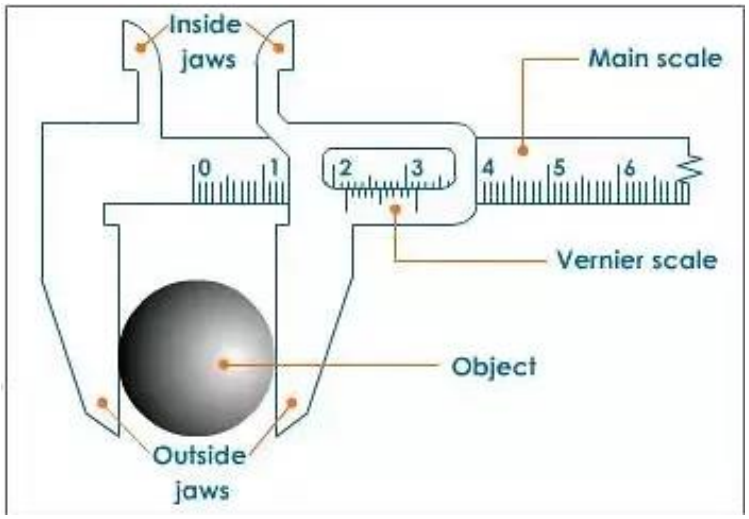


The smallest Vernier caliper that can be bought off-the-shelf is 150 mm – meaning the jaws open to a maximum of 150 mm. The largest ones go up to 2000 mm.

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 Nineteen

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.

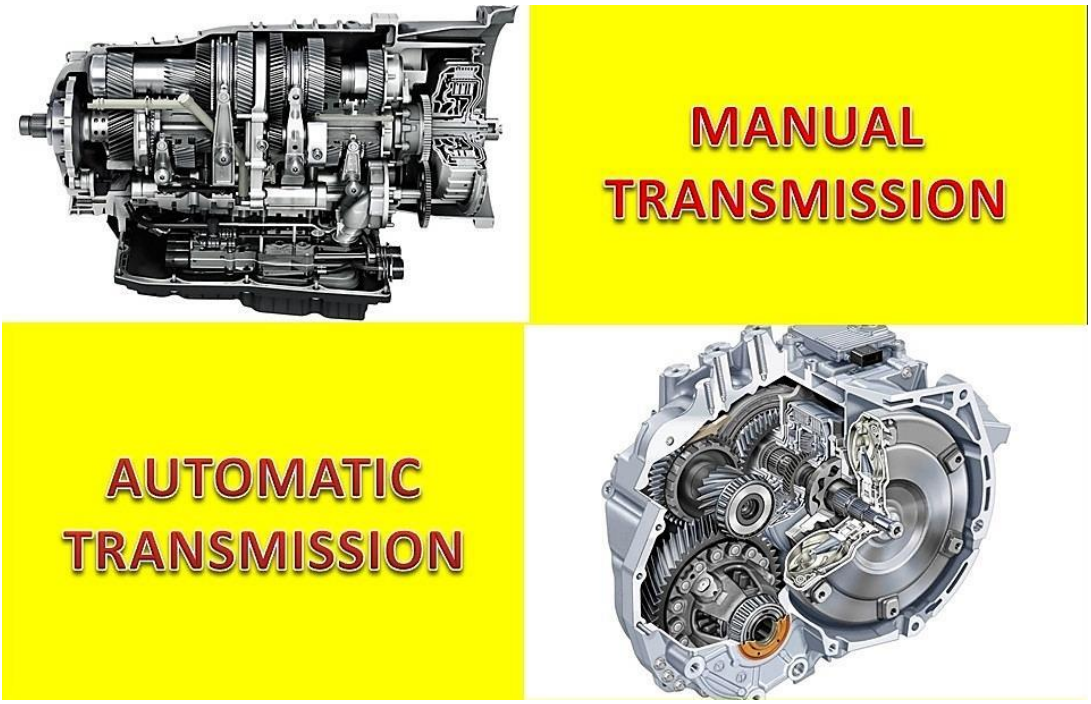
So here we have the critical evaluation of the things that can happen if we fill diesel into petrol and petrol into diesel engine.

Question Twenty

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.

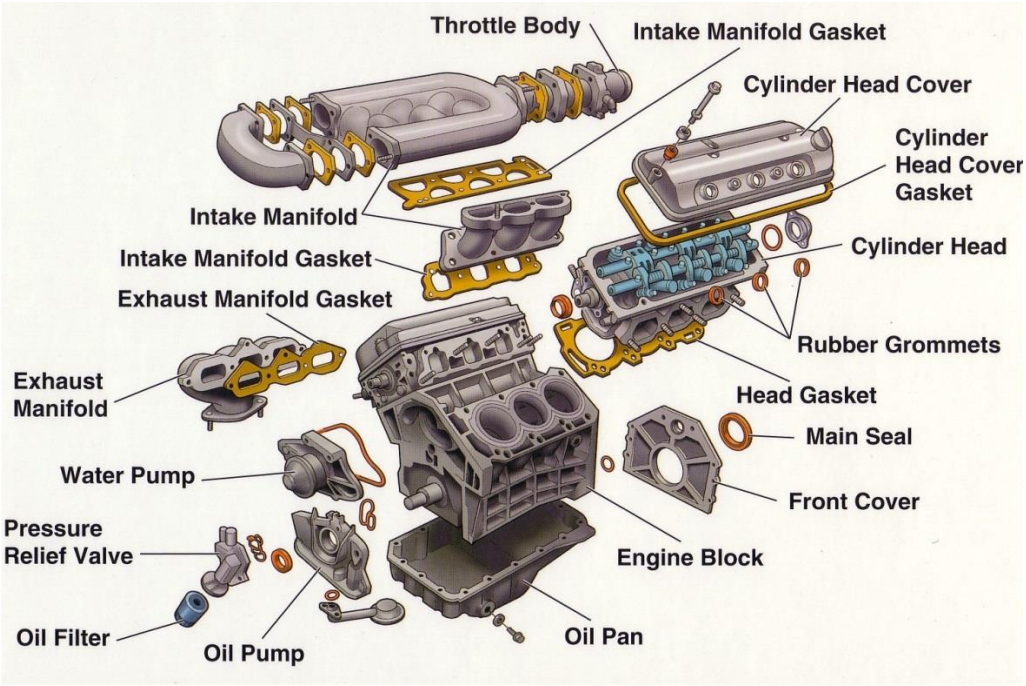
Now, you would have got the right answer which will help you in choosing among the two, easily. So, make sure that you buy the right car as per your requirement.

Question Twenty One

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 Twenty Two

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.

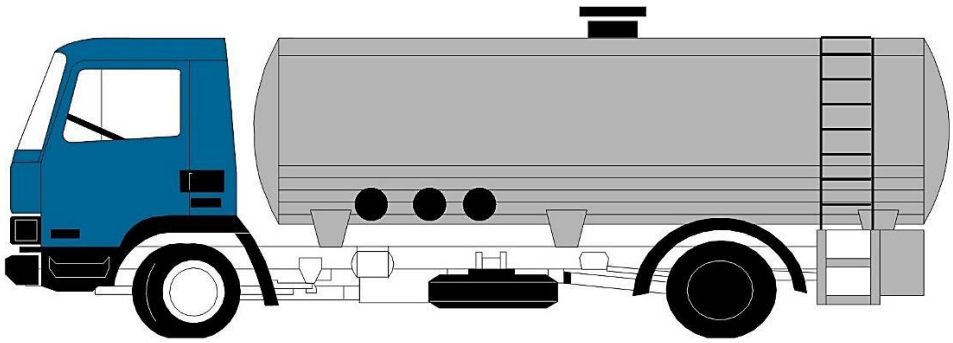
So, from next time whenever you locate a single ant running on the floor, you know what is it looking for!

Question Twenty Three

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 Twenty Four

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 Twenty Five

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 Twenty Six

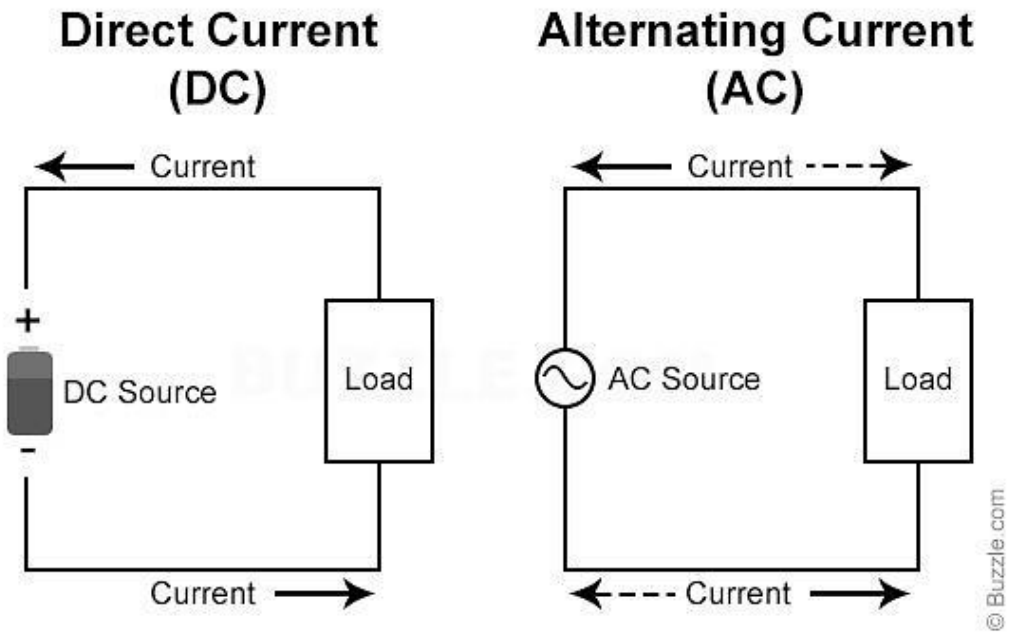
Questions and Answers on Engineering Fundamentals

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 Twenty Seven

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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