Section A [40 Marks]

1. (a) Nandan tried to push a heavy rock of 200kg for 100s but could not move it. Find the work done by Nandan at the end of 100s. [2]

Sol:

Work done by Nandan in pushing a rock for 100s is zero. Because there is no displacement in this case,

i.e,

$W = F \times s = 0$ (Since, s = 0)

(b) A body of mass 2kg is dropped from second floor of a building which is at a height of 12 m. what is the force acting on it during its fall?(Take, g = 9.8m/s^2) [2]

Sol:

Given,

Mass, m= 1.5kg,

Height, h = 12m

Force acting on the body during its fall,

$mg = 2x9.8 = 19.6N$

(c)(i) Define 2 kgf. [2]

Sol:

2 kgf is the force with which the earth pulls an object of mass 2kg towards itself.

(ii) **How is it related to the SI unit of force? [2]**

Sol:

It is related by, 2kgf=mg=19.6N

(m=2kg, g= 9.8m/s^2)

(d) **Define clockwise and anti-clockwise moment of forces. When is it taken positive?[2]**

Sol:

For the system to balance, the sum of moment of anti-clockwise direction has to be equal to the sum of moment of clockwise direction. The weight in this case is generating moment in anti-clockwise direction.

Therefore, center of gravity must be situated at right side (D), so that it produces clockwise moment.

(e) Compute the speed of 2 kg ball having kinetic energy of 4J. [2]

Sol:

Given, mass of ball,

$m = 2kg$

Kinetic energy of ball, $KE = 4$

As,

$$KE = \frac{1}{2}mv^2$$

$$\Rightarrow v^2 = \frac{2KE}{m} = \frac{2\times 4}{2} = 4 \Rightarrow v = 2ms^{-1}$$

2. **(a) Determine the angle between force and displacement to get the work? [2]**

(i) Maximum

Sol:

if $\theta = 0^0$, i.e the angle between the force F and the displacement s is in the same direction.

$\therefore$ Work done,

$W = Fs\cos 0^0$

$\Rightarrow W = Fs = \text{maximum} \quad (\because \cos 0^0 = 1)$

(ii)Minimum

Sol:

If $\theta = 0^0$ i.e, the force under consideration is normal to the direction of motion,

$\therefore$ Work done,

$W = Fs\cos 90^0$

$\Rightarrow W = 0 = \text{minimum} \quad (\because \cos 90^0 = 0)$

(b) (i) Find the energy possessed by a body in a moving bullet. [2]

Sol:

Translational KE

(ii) Find the energy possessed by a body in a spinning top? [2]

Sol:

Rotational KE

(c) State why is the water in the bottom of waterfall, warmer then at the top? [2]

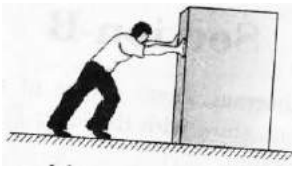
Sol:

When water falls on the ground, its mechanical energy $(KE + PE)$ is converted into heat energy, due to which the temperature of water at the bottom of the waterfall increase.

(d) Find the nature of centripetal force when the planet moves around the son? [2]

During the motion of the planet, centripetal force is provided by gravitational force of attraction which is directed towards the center of the circular path.

(e) A man pushes a heavy box across a floor. He exerts a force of 80N and the box moves 4.0 in 10.0s.



What useful power does the man develop? [2]

Sol:

Power is defined as the rate of work done.

It may be calculated by,

$$p = \frac{w}{t}$$

Given,

$t = 6.0s, W = F \times d = (80).(4.0) = 320J$

Note students need to know that

Work done = force x distance moved in the direction of the force.

Power developed by the man,

$$P = \frac{320}{10} = 32W$$

3.(i) Define, why the mechanical advantage is less than one in class III types of lever. [2]

Sol:

Mechanical advantage,

$$MA = \frac{\text{Effort arm length}}{\text{Load arm length}}$$

In class III order of lever,

Effort arm length < load arm length

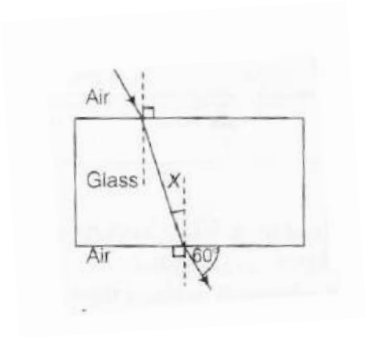
$\therefore MA < 1$

(ii)Explain the term "driving gear" in reference to gear system. [2]

Sol:

The gear wheel closer to the source of power is called driving gear.

(b) Find the value of the angle marked *x*, for a certain parallel sided glass block, the value of $\frac{\sin i}{\sin r} = 1.50$ A ray of light passes through the block and emerges an angle 60^0 to the surface of the block. [2]



Sol:

Using the reversibility of light and considering the air – glass boundary,

$i = (90^0 - 60^0) = 30^0$

$\sin ce,$

$X = r$

$\sin X = \frac{\sin 30^0}{1.5} = 0.333$

$X = 19.5^0$

(c)(i) Define the term resonance? [2]

Sol:

It is a special case of forced vibrations. When the natural frequency of the externally applied periodic force are equal, then the body vibrates with an increased amplitude.

(ii) State the causes in which the medium affect the amplitude of free vibrations? [2]

Sol:

Amplitude of free vibration decreases due to the force of friction between vibrating body and medium particles.

(d) An electrician puts a fuse of rating 5A in that part of domestic electrical circuit in which an electric heater of rating 3KW,220V is operating. What is likely to happen in this case and why? [2]

Sol:

Given,

$P = 3kW = 3\times10^{3}W$

$V = 220v$

The current draw by heater,

$$I = \frac{P}{V}$$

$$= \frac{3\times10^{3}}{220v} = 13.63$$

The above amount of current is greater then the rated value of fuse current. Hence, the fuse will melt and break the circuit.

(e)(i) Determine the range of the wavelength of y-radiations? [2]

Sol:

Range of wavelength for Y-radiations is $10^{-3}\,\overset{0}{A}$ to $0.1\overset{0}{A}$

(ii) Which radiation detected by a thermopile. [2]

Sol:

Radiation detected by thermopile is infracted radiation.

4**. (a) Explain the terms :- [2]**

(i) Heat capacity

Sol:

Heat capacity, It is the amount of heat required to raise the temperature of a body by 1^{0}C.Its units is $J^{0}C^{-1}$.

(ii) Specific heat capacity.

Sol:

Specific Heat Capacity, It is the amount of heat required to raise the temperature of unit mass of a substance throught 1^0C. Its unit is J $kg^{-1}\,{}^0C^{-1}$.

(b) What would happen to the direction of rotation of a motor, if [2]

(i) the current were reversed?

Sol:

Direction of rotation would be reversed.

(ii) both current and magnetic field were reversed simultaneously?

Sol:

Direction of rotation rotation would remain unchanged.

(c)How many charge passes through the lamp uses energy at the rate of 48W on a 12V supply. [2]

Sol:

Current through the lamp,

$$I = \frac{P}{V} = \frac{48}{12} = 4.0A$$

$\therefore$. Charge passing through the lamp,

$$Q = It = (4.0)(2.0)$$
$$= 8.0C$$

(d) State the principle of electric motor? [2]

Sol:

An electric motor is based on the principle that, when a rectangular coil is placed in a magnetic field and current is passed through it, two equal and opposite forces (on opposite side) act on coil which rotates it continuously.

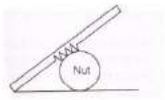
(e)Explain your answer with reason a magnetic compass shows a deflection when placed near a current carrying wire. How will the deflection of the compass get affected, if the current in the wire is increased? [2]

Sol:

If the current in the wire is increased, then the deflection increases. The strength of magnetic field is directly proportional to the magnitude of current passing through the straight conductor.

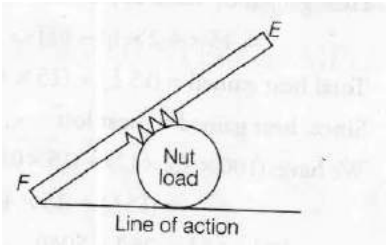
SECTION-B **[40 Marks]**

5. (a) The diagram shows a type of nut cracker. In diagram, show with the letter F, the position of the fulcrum. **[3]**



Sol:

The diagram showing fulcrum (F) and effort (E) is given below



(b) (i) Explain power and state its SI units. **[3]**

Sol:

The rate of doing work is called power.

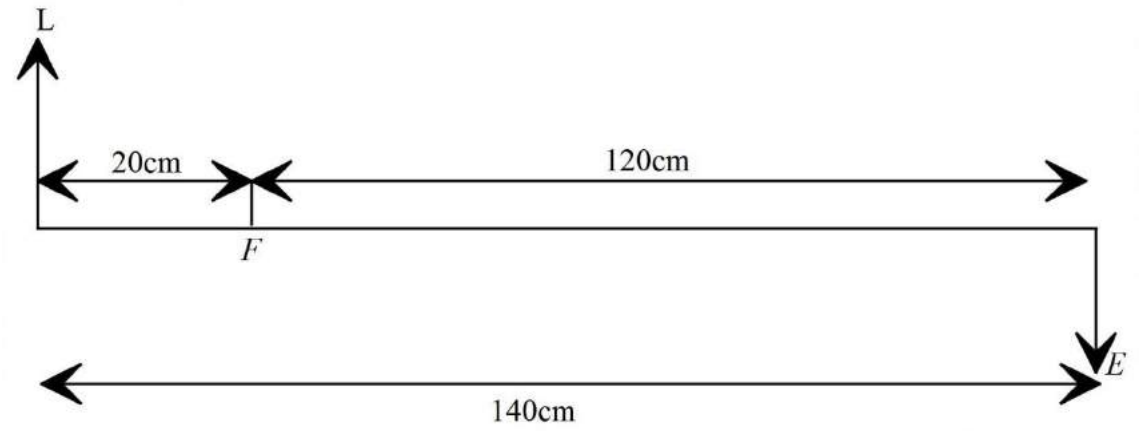
It is given,

$$Power = \frac{\text{work done}}{\text{Time taken}}$$

Its SI unit it watt (W).

$1W = 1Js^{-1}$

(ii) A crowbar of total length 140 cm is at a distance of 20cm from the load. What is the mechanical advantage of this crowbar?



Sol:

We have,

$L \times 20 = E \times 120$

Mechanical Advantage,

$$MA = \frac{\text{Effort arm length } (d_E)}{\text{Load arm length } (d_L)} = \frac{120}{20} = 6$$

MA = 5

(C) A body of mass 40 kg has a momentum of 2000kgms^{-1}. Calculate [3]

(i) The kinetic energy of the body

Sol:

$$KE = \frac{p^2}{2m} = \frac{2000 \times 2000}{2 \times 40} = 50000J$$

(ii) the velocity of the body.

Sol:

$p = mv$

where, p = momentum

and m = mass of the body

m = 40kg and p = 2000kg ms^{-1}

$$\therefore 2000 = 40 \times v \Rightarrow \frac{2000}{40} = v$$

$$\Rightarrow 50 m/s$$

6.(a)(i)What is the advantage of using the right angle prism over plane mirror in periscope. [3]

Sol:

The image is brighter and sharper as there is 100% reflection.

Presence of moisture and dust on the glass does not affect the clarity of image.

(ii) The statement "the critical angle of diamond is 24" states that.

Sol:

When light travels from diamond to air at an angle of incidence of 24^0, the corresponding angle of reflection is 90^0.

(b) (i) Determine the velocity of light in the medium of refractive index 1.5. [3]

Sol;

Given, velocity of light in air (c) $= 3\times10^8 m/s$

As we know,

Refractive index (μ)

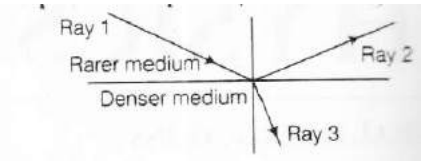
$$= \frac{\text{velocity of light in air}}{\text{velocity of light in a medium}}$$

$$\Rightarrow \text{velocity of light in a medium}$$

$$= \frac{\text{velocity of light in air}}{\text{Refractive index}}$$

$$= \frac{3\times10^8}{1.5} = 2\times10^8 m/s$$

(ii)Write down the name of the ray which represents the partially reflected ray. If a ray light moves from a rarer medium to denser medium as shown in the diagram.



Sol:

Ray 2 represents partially reflected ray.

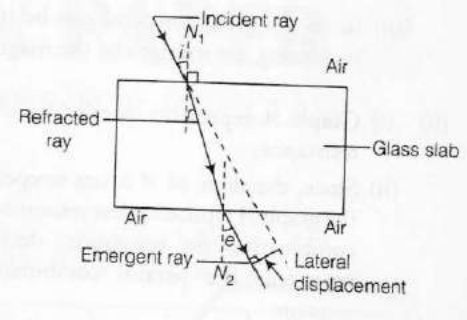
(c) If a ray of monochromatic light is incident from air to glass slab. [3]

(i) Sketch the labelled diagram showing the change in the path of the ray till it emerges from the glass slab.

(ii) Which are the parallel rays name them?

(iii) Show the lateral displacement.

Sol:



Incident ray and emergent ray are parallel to each other.

7. (a)(i) sketch a diagram to show the propagation of sound and denote compression and rarefaction. [3]

Sol:

Propagation of sound waves are follows

Compression→B,D,F

Rarefaction → A, C, E, G

(ii) what is the conditions required to hear an echo?

Sol:

The condition required to hear echo is as follows

The time interval between source sound and reflected sound must be at least 0.15s.

The minimum distance between the obstacle and source of sound be at least 17.2m.

(b) When sending an ultrasonic wave from a ship towards the bottom of a sea, the time interval between sending the wave and receiving it back is found to be 1.5s and the velocity of wave in sea water is 400ms^{-1}. [3]

(i) What is the formula for distance?

(ii) Determine the given depth of the sea.

Sol:

let, depth of sea = d meter

$\therefore$ Total distance travelled by ultrasonic wave before it is received back at the ship = 2dm

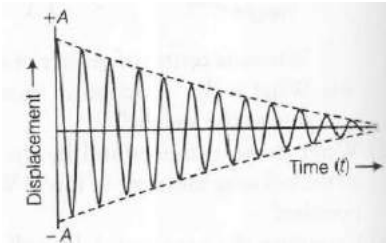
Time taken =1.5s

Velocity of ultrasonic wave in sea-water $=1400ms^{-1}$

As, we know, distance $=$ velocity $\times$ time

$\therefore 2d = 1400 \times 1.5 or\ d = \frac{1400 \times 1.5}{2} m = 1050m$

(C) The diagram below shows the displacement-time graph for a vibrating body. [4]



(i) which the type of vibrations produced by the vibrating body.

Sol:

Damped vibrations are produced by the vibrating body.

(ii) Subject one example of a body producing such vibrations.

Sol:

A simple pendulum oscillating in air, tuning fork vibrating in air are examples of a body producing such vibrations.

(iii) what is the reason the amplitude of the wave gradually decreasing?

Sol:

The amplitude of the wave gradually decreasing due to friction as energy is continuously losing.

(iv) Determine the vibrations of the body after sometime?

Sol:

Its amplitude decreases and finally stops.

8. (a)(i)Describe the purpose of a fuse in an electrical circuit? [3]

Sol:

The electric fuse is a device, to limit the current in an electric circuit so that the appliances connected in the circuit may be safeguarded from over loading or short circuiting.

(ii) What is the reason that more economical to transmit electrical energy at high voltage and low current?

Sol;

The loss of energy along the transmission liens is proportional to the square of current, hence the transmission of energy is economical at high voltage and low current.

(iii) Describe one ways by which the emf an AC generator can be increased.

Sol:

In an AC generator, emf can be increased by increasing the strength of the magnetic field.

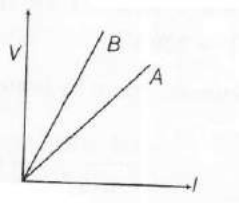
(b)The V-I graph for a series commination and for a parallel combination of two resistors is as shown in the figure below. [3]

(i) Find of the A or B, represents the parallel combination?

Sol:

Graph A represents parallel combination of resistance.

(ii) Given a reason for any your answer.



Sol:

Since, the slope of *A* is less steeper then *B*, so the graph *A* represents less resistance. In parallel combination the resistance decreases, so *A* represents the parallel combination of two resistors.

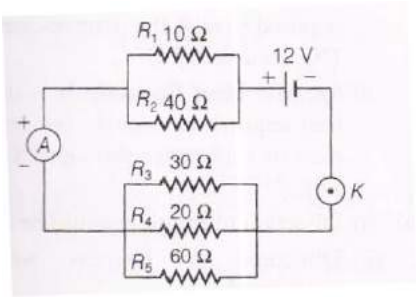
(iii) Find the SI unit of electrical power? Name the unit in which electric energy consumed for domestic or commercial purposes is measured.

Sol:

SI unit of electrical power is watt. Electrical energy is measured in kilo-watt hour.

(c) Five resistors of different resistance are connected together as shown in the figure.A 12V battery is connected to the arrangement. [4]

Calculate



(i) Find total resistance in the circuit.

Sol:

$$\frac{1}{R_{12}} = \frac{1}{10} + \frac{1}{40} = \frac{4+1}{40} = \frac{5}{40} = \frac{1}{8}$$

$$\Rightarrow R_{12} = 8\Omega$$

$$\frac{1}{R_{345}} = \frac{1}{30} + \frac{1}{20} + \frac{1}{60} = \frac{2+3+1}{60}$$

$$\Rightarrow \frac{1}{R_{345}} = \frac{6}{60} = \frac{1}{10} \Rightarrow R_{345} = 10\Omega$$

(ii) Find the total current flowing in the circuit.

Sol:

Total current, $I = \frac{V}{R} = \frac{12}{18} = \frac{2}{3} = 0.67A$

9. (a) In which radiations the green house gases are [3]

(i) Transparent

Sol:

Green house gases are transparent to short wavelength infrared radiations from the Sun.

(ii) Opaque

Sol:

Green house gases are opaque to long wavelength infrared radiation emitted by the hot surface of the earth.

(b)Describe in brief, the meaning of each of the following: [3]

(i) The specific latent heat of fusion of ice is 336000Jkg^{-1}

Sol:

$336000 J\ kg^{-1}$ means that every 1 kg of ice will require 336000 J of heat energy to melt and form water without change in its temperature by 1^0C.

(ii) The specific heat capacity of copper is 0.4Jg^{-1}^{0}C^{-1}

Sol:

$0.4 Jg^{-1}{}^0C^{-1}$ means that 1 g of copper will require 0.4J of heat energy to melt temperature by 1^0C.

(iii) Define the principle of method of mixtures?

Sol:

When a hot body is mixed or kept in contact with a cold body, there is a transfer of heat from the body at higher temperature to a body at lower temperature till both the bodies attain the same temperature, i.e heat lost by the by the hot body is equal to the heat gained by the cold body provided there is no heat loss to the surroundings.

(iv) What is the law on which this principles is based?

Sol:

Law of conservation of energy.

(C)A piece of ice of mass 15g is added to water of mass 100g in a Cu calorimeter of mass 50g. The temperature of water is 15^{0}C but falls 3^{0}C, after the addition of ice. Calculate the latent heat of fusion of ice.(Take, specific heat of Cu = 0.42J/g^0 and specific heat of water = 4.2J/g^{0}C) [4]

Sol:

Let the latent heat of fusion ice be LJ/g.

Heat lost by water =100 x 4.2 x (15-3)J

Heat lost by calorimeter = 50 x 0.42 x (15-3)

Total heat lost by water and calorimeter

= (100 x 4.2 x 12)+(15 x 0.42 x 12)

Heat gained by ice at 0 degree = 15L

Heat gained by water formed from ice

= 15 x 4.2 x (3-0)J

Total heat gained = (15L)+(15 x 4.2 x 3)

Since, heat gained = heat lost

We have,

(100 x 4.2 x12)+(15 x 0.42 x 12)

= (15L)+(15 x 4.2 x 3)

189+15L = 252 + 5040

$15L = 5292 - 189 = 5103$

$\Rightarrow L = \frac{5103}{15} = 340.2 J / g$

10.(a) (i) Transformer works in which principle. [3]

Sol:

A transformer works on the principle of electromagnetic induction.

(ii) Find the function of a step-up transformer?

Sol:

A step- up transformer convert a low AC voltage to a high AC voltage.

(iii) find the reason if the transformer work when it is connected to a DC source. Define reason.

Sol:

No, as DC source provides a steady voltage, due to which there will be zero change in magnetic flux across the secondary coil. Hence, transformer cannot work when it is connected to a DC source.

(b)(i) what do you mean by radioactivity? What type of radiations are emitted in it? Describe briefly the nature of these radiations.
[3]

Sol:

Radioactivity is the process of spontaneous disintegration of the atomic nuclei with the emission of particles from within the nuclei of atoms. Experimental investigations reveal that the radiations emitted by radioactive elements are of three types: First type of radiations with least penetrating power was named as α-rays. Second type of radiations with comparatively larger penetrating power was celled β-rays. Third type of radiations with maximum penetrating power was celled γ-rays.

(ii) An atomic nucleus denoted by $^{A}_{Z}X$ emits an alpha particle.

Sol:

(c)(i) A fusion reaction is represented as follows

$_{1}^{2}H + _{1}^{2}H \rightarrow _{2}^{4}He + x$ **Identify X.** **[4]**

Sol:

(ii)When do αand β-emissions take place?

Sol:

If an unstable nucleus contains excess of neutrons or protons is emits α-emission. Is an unstable nucleus contains more neutrons than protons, it emits β-emissions.

(iii) Explain, how β-emission changes the nucleus of an unstable element?

Sol:

In emitting a β-particle, the mass number of the nucleus remains same but the number of neutrons decrease by one and number of protons, i.e, atomic number increase by one. Thus, the element moves forward one place in the periodic table.