MODEL PAPER – 2
PHYSICS

I PUC

Time: 3 hours **Max Marks: 70**

General Instructions:

i) ***All parts are compulsory.***
ii) ***Answer without relevant diagram / figure/ circuit wherever necessary will not carry any marks.***
iii) ***Direct answers to the numerical problems without detailed solutions will not carry any marks.***

PART – A

I Answer the following: **10 X 1 = 10**

1. The SI prefix for 10^{-15} is "fermi"
2. The expression for centripetal acceleration in terms of angular velocity is "$a_c = r\omega^2$"
3. 1 kWh is equal to 3.6×10^6J
4. Gravitational constant is defined as the force of attraction which exists between two unit masses separated by a unit distance.
5. The value of absolute zero of temperature is 0 K or -273.5^0C
6. Perfect black body is defined as the body which absorbs all the radiations incident on it.
7. SI unit of specific heat of a substance is J kg^{-1} K^{-1}
8. The equation for frequency of a fundamental mode in open pipe is given by $f = \frac{v}{2L}$

   Here, $v = 322\,ms^{-1}$ $L = 0.2m$

   $f = \frac{322}{2 \times 0.2} = 805\,Hz$
9. λ = 4m

   The distance between a node and an antinode is given by $\frac{\lambda}{4}$

   But **λ = 4m**

   $\therefore \frac{4}{4} = 1m$
10. The particles attains a minimum acceleration at the mean position.

PART – B

II Answer any FIVE of the following: **5 X 2 = 10**

11. Consider the equation $\frac{1}{2}mv^2 = mgh$

According to the principle of homogeneity of dimensions, "each term of the physical quantity must be of equal dimensions".

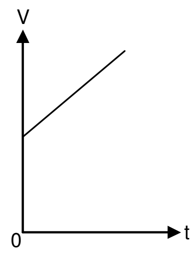
LHS	**RHS**
$[m] = [M]$	$[m] = [M]$
$[v^2] = [LT^{-1}]^2 = [L^2T^{-2}]$	$[g] = [LT^{-2}]$
$[mv^2] = [MLT^{-1}]$	$[h] = [L]$
	$[mgh] = [ML^2T^{-2}]$

$[ML^2T^{-2}] = [ML^2T^{-2}]$

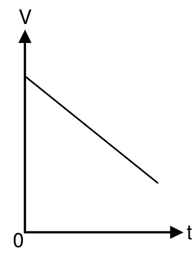
$\therefore$ The given equation is found to be dimensionally correct.

12. .

(i)



(ii)



13. The acceleration acting on a body executing circular motion is known as centripetal acceleration.

$$a_c = \frac{v^2}{r} \quad \Rightarrow a_c = \frac{(r\omega)^2}{r} = r\omega^2$$

14. A rigid body is said to be under mechanical equnium when it has no translational and rotational motion.
   - A rigid body is said to be at no translational motion when its linear velocity is zero or angular acceleration is 0. This happens only when vector sum of all forces acting on a body is zero.

   $\sum \vec{F} = 0$

   - A body is said to be at no rotational motion only wen vector sum of all the torque acting on the body is zero. i.e., $\sum \vec{\tau} = 0$

15. i) Thermal radiations do not require a material medium for propagation and can travel in vacuum also
   ii) Thermal radiations always travel in straight lines.
16. Co-efficient of performance of a refrigerator is defined as the ratio of heat removed from a low temperature region to the work done in order to remove heat.

   Mathematically, $\beta = \frac{Q_2}{W}$

   But $W = Q_1 - Q_2$

   $$\therefore \beta = \frac{Q_2}{Q_1 - Q_2}$$

   $$\beta = \frac{1}{\frac{Q_1 - Q_2}{Q_2}}$$

   $$\beta = \frac{1}{\left(\frac{Q_1}{Q_2} - \frac{\cancel{Q_2}}{\cancel{Q_2}}\right)}$$

   $$\beta = \frac{1}{\left(\frac{Q_1}{Q_2} - 1\right)} \qquad But\ \frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$

   $$\therefore \beta = \frac{1}{\left(\frac{T_1}{T_2} - 1\right)}$$

   $$\beta = \frac{1}{\left(\frac{T_1 - T_2}{T_2}\right)}$$

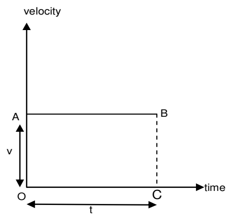
   $$\boxed{\beta = \frac{T_2}{T_1 - T_2}}$$

17. (i) The frequencies greater than the fundamental frequency are called overtones.
   (ii) The frequencies which are integral multiples of fundamental frequencies are known as harmonics.
18. I) Velocity is maximum at mean position
   ii) It is minimum at extreme position.

PART – C

III Answer any FIVE of the following: 5 X 3 = 15

19. Consider a particle moving along a straight line with uniform velocity.
Let 'x' be the distance covered by the particle in a time't' with a velocity 'v'.
Then, v – t graph of a particle moving with uniform velocity is as shown.



Area below the curve AB = area of rectangle OABC

$= OC \times OA$

$= v \times t$

= x (displacement)

20. Consider an object of mass 'm' moving with a velocity $'\vec{v}'$. Then, the linear momentum of the object is $\vec{p} = m\vec{v}$

let $\vec{F}$ be the force applied on the object

if $d\vec{p}$ is the small change in momentum during a certain time 'dt' then,

time rate of change of momentum = $\frac{d\vec{p}}{dt}$

then, according to the statement of Newton 2nd law of motion,

$$\vec{F} \propto \frac{d\vec{p}}{dt}$$

$\vec{F} = k\frac{d\vec{p}}{dt}$ where k = constant of proportionality

But $\vec{p} = m\vec{v}$

$$\vec{F} = k\frac{d(m\vec{v})}{dt}$$

$$\vec{F} = km\frac{d\vec{v}}{dt}$$

But $\frac{d\vec{v}}{dt} = \vec{a}$

$$\vec{F} = km\vec{a}$$

The value of k depends upon the system of units in SI system of unit. For the sake of simplicity

k = 1

$\Rightarrow F = ma$

21. "Time of flight is defined as the time taken by the projectile to reach a point of the same elevation along its parabolic path"

If 't_a' and 't_d' represent time of ascent and time of descent then,

$$t_a = t_d = t$$

$$\therefore t_f = t_a + t_d$$

$$t_f = t + t$$

$\boxed{t_f : 2t}$ ...(1)

Consider $v = v_0 + at$

but v = 0

a = - g

$v_0 = v_{y_0} = v_0 \sin\theta$

$$\Rightarrow 0 = v_0 \sin\theta + (-g)t$$

$$0 = v_0 \sin\theta - gt$$

$$gt = v_0 \sin\theta$$

$$t = \frac{v_0 \sin\theta}{g}$$

Substituting t in the equation (1)

$$t_f = \frac{2v_0 \sin\theta}{g}$$

22. Consider a body projected from the earth surface with a velocity equal to escape velocity (v_e)

Then the body will never return back to earth and easily escape from the gravitational field of the earth

At infinity, $E_K = 0 \quad E_P = 0$

Applying law of conservation of energy

$$(E_K + E_P)_{earth} = (E_K + E_P)_{infinity}$$

$$\frac{1}{2}mv_e^2 + \left[-\frac{GMm}{R}\right] = 0 + 0$$

$$\frac{1}{2}mv_e^2 - \frac{GMm}{R} = 0$$

$$\frac{1}{2}\cancel{m}v_e^2 = \frac{GM\cancel{m}}{R}$$

$$\frac{v_e^2}{2} = \frac{GM}{R}$$

$$v_e^2 = \frac{2GM}{R}$$

But $gR^2 = GM$

$$v_e^2 = \frac{2gR^{\cancel{2}}}{\cancel{R}}$$

$$v_e^2 = 2Rg$$

$$\boxed{v_e = \sqrt{2gR}}$$

This is the expression for escape velocity of the body from the surface of the earth

23.

Elastic collision	**Inelastic collision**
i) collisions in which linear momentum and kinetic energy are conserved	i) collision in which linear momentum is conserved and is always a loss of kinetic energy.
ii) elastic collisions rarely occur in nature.	ii) majority of the collisions are inelastic collisions.
Ex: collision between two sub-atomic particles.	Ex: A mud ball struck to the wall

24. Angular momentum of a particle is defined as the moment of linear momentum of the particle and is measured as the cross – product of position vector $[\vec{r}]$ and liner momentum of the particle $[\vec{p}]$

Consider a particle of mass 'm' rotating in a circular path. Let $[\vec{r}]$ be the radius vector of the particle.

Then, angular momentum of the particle is given by

$$\vec{L} = \vec{r} \times \vec{p}$$

On differentiation,

$$\frac{d\vec{L}}{dt} = \frac{d}{dt}(\vec{r} \times \vec{p})$$

$$\frac{d\vec{L}}{dt} = \frac{d\vec{r}}{dt} \times \vec{p} \quad + \vec{r} \times \frac{d\vec{p}}{dt}$$

But, $\frac{d\vec{r}}{dt} = \vec{v}$

Also, $\frac{d\vec{p}}{dt} = \vec{F}$

$$\frac{d\vec{L}}{dt} = \vec{v} \times \vec{p} \; + \; \vec{r} \times \vec{F}$$

But, $\vec{p} = m\vec{v} \quad \&$

$$\vec{r}\times\vec{F}=\vec{\tau}=torque$$

$$\frac{d\vec{L}}{dt}=\vec{v}\times m\vec{v}+\vec{\tau}$$

$$\frac{d\vec{L}}{dt}=(\vec{v}\times\vec{v})m+\vec{\tau}$$

$$\frac{d\vec{L}}{dt}=0+\vec{\tau}$$

$$\boxed{\vec{\tau}=\frac{d\vec{L}}{dt}}$$

25. Stefan 4th power law states that "The total radiation 'E' from a perfectly black body per second per unit area is directly proportional to the fourth power of its absolute temperature".

Mathematically,

$$\frac{E}{At}\propto T^4$$

$$\frac{E}{At}=\sigma T^4$$

$$\boxed{E=\sigma T^4 At}$$

where σ = constant of proportionality called Stefan constant and its value is 5.67 x 10^{8} Wm^{-2} K^{-4}

26. The apparent change in frequency of sound due to the relative motion between source of sound and the listener is called Doppler effect

i) The source and listener approach each other

$$\boxed{f'=\left[\frac{v+v_L}{v-v_s}\right]f}$$

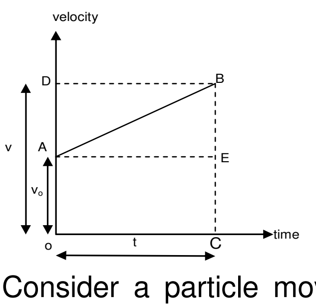
ii) The listener moves away from the stationary source

$$\boxed{f'=\left[\frac{v-v_L}{v}\right]f}$$

PART – D

IV Answer any TWO of the following: **2 X 5 = 10**

27.



Consider a particle moving with uniform acceleration along a straight line. Then the v–t graph of the particle moving with uniform acceleration is shown above, where

OC = t = time

OA = v_0= initial velocity

OD = v= final velocity

The area below the v-t curve represents distance travelled

Mathematically,

Distance travelled = area blow the curve AB

x = area of trapezium OABC

x = $\frac{1}{2}$(sum of parallel sides) ($\perp$distance)

x = $\frac{1}{2}$ (OA + BC)(OC)

$$x = \frac{1}{2}[v_0 + v][t]$$

But, $v = v_0 + at$

$$\Rightarrow x = \frac{1}{2}[v_0 + v_0 + at]t$$

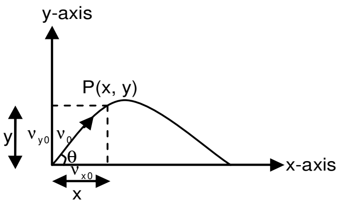
$$x = \frac{1}{2}[2v_0 + at]t$$

$$x = \frac{1}{2}\left[2v_0 t + at^2\right]$$

$$x = \frac{1}{\cancel{2}}\left[\cancel{2}v_0 t\right] + \frac{1}{2}\left[at^2\right]$$

$$\therefore x = v_0 t + \frac{1}{2}at^2$$

28.



Consider a projectile projected upwards with projectile velocity v_0.

Let θ be the angle of projection. Let P(x, y) be the point reached by the projectile after a certain time along the trajectory.

On resolving projectile velocity v_0, horizontal component v_{xo} and vertical component v_{y0} are obtained as shown in the diagram.

Let x and y be the distance covered by the projectile with respect to point P.

The distance covered along x-axis is

$$\text{velocity} = \frac{\text{distance covered}}{\text{time taken}}$$

$$v_{xo} = \frac{x}{t}$$

$$t = \frac{x}{v_{xo}}$$

$$\Rightarrow t = \frac{x}{v_0 \cos\theta}$$

Similarly, distance alone y axis is

$$\Rightarrow y = v_{yo}t + \frac{1}{2}(-g)t^2$$

$$y = v_{yo}t - \frac{1}{2}gt^2$$

$$y = (v_0 \sin\theta)\frac{x}{v_0 \cos\theta} - \frac{1}{2}g\left(\frac{x}{v_0 \cos\theta}\right)^2$$

$$y = (\tan\theta)x - \frac{1}{2}\frac{gx^2}{v_0^2 \cos^2\theta}$$

$$y = (\tan\theta)x + \left[\frac{-g}{2v_0^2 \cos^2\theta}\right]x^2$$

This equation resembles the general equation of a parabola

$$y = ax + bx^2$$

where $a = \tan\theta$

$$b = \frac{-g}{2v_0^2 \cos^2\theta}$$

This clearly shows that, trajectory of a projectile is a parabola.

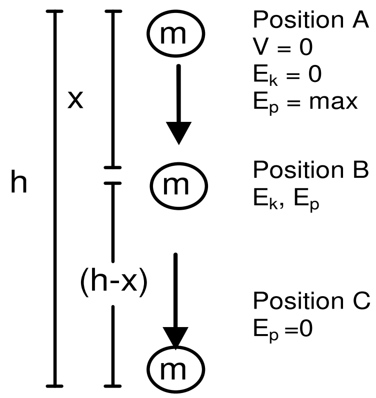
29. Law of conservation of energy states that energy can neither be created nor be destroyed but can only be transformed from one form into another form such that the net energy of an isolated system always remains unaltered.

Consider a body of mass 'm' at a certain height 'h' from the ground.

The body is then allowed to fall freely under the influence of earth's gravity.

The total energy 'E' of the body is the sum of its kinetic energy [E_k] and potential energy [E_p]

$$E = E_k + E_p$$



At position A,

v = 0

$\therefore$ $E_k = \frac{1}{2}mv^2$ $\boxed{E_k = 0}$

But $\boxed{E_p = mgh}$

$\therefore E = E_k + E_p$

$E = 0 + mgh$

$\boxed{E = mgh}$ .....(1)

At position B,

$\boxed{E_p = mg(h-x)}$

Consider, $v^2 = v_0^2 + 2ax$

But, $v_0 = 0,\ a = +g$

$v^2 = 2gx$

Consider, $E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{\cancel{2}}m(\cancel{2}gx)$

$\boxed{E_k = mg\ x}$

E = E_k + E_p

= mg x + mg (h - x)

$\cancel{mgx} + mgh = \cancel{mgx}$

$\boxed{E = mgh}$ .....(2)

At position C,

Height = h = 0

$\boxed{E_p = 0}$

Consider , $v^2 = v_0^2 + 2ax$

But $v_0 = 0,\ a = g,\ x = h$

$v^2 = 0 + 2gh$

$v^2 = 2gh$

$E_k = \frac{1}{2}mv^2 \quad \Rightarrow \frac{1}{\cancel{2}}m(\cancel{2}gh)$

$\therefore\ E = E_p + E_k$

E = 0+ mgh

$\boxed{E = mgh}$ .....(3)

Comparing eqns. (1), (2) and (3) it is very clear that a freely falling body is in accordance with law of conservation of energy.

V Answer any TWO of the following: 2 X 5 = 10

30. Consider an object of mass ‘m’ placed on the surface of the earth. Let 0 be the center of the earth, M be the mass of the earth.

Applying Newton universal law of gravitation

$$F = \frac{GMm}{R^2}$$

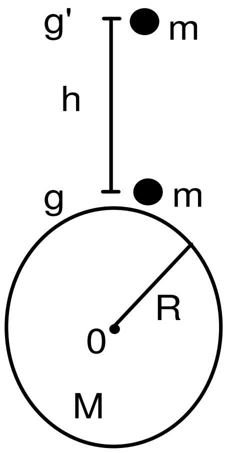
The force exerted by the earth on the object itself is regarded as the weight of the object.

$\therefore$ F = W = mg

Equating the above 2 equations,

$$\frac{GMm}{R^2} = mg$$

$$\therefore \boxed{g = \frac{GM}{R^2}} \qquad (1)$$



Let the object be now placed at a height of ‘h’ from the earth surface.

Let g be the acceleration due to gravity at height ‘h’ Applying Newton Universal law of gravitation.

$$F = \frac{GMm}{(R+h)^2}$$

But , F = W = mg

Equating the above 2 eqns.

$$\frac{GM\cancel{m}}{(R+h)^2} = \cancel{m}g' \Rightarrow \boxed{g' = \frac{GM}{(R+h)^2}} \qquad (2)$$

Eqn.(2) : Eqn. (1) gives

$$\frac{g'}{g} = \frac{\frac{\cancel{GM}}{(R+h)^2}}{\frac{\cancel{GM}}{R^2}}$$

$$\frac{g'}{g} = \frac{R^2}{(R+h)^2}$$

$$\frac{g'}{g} = \frac{R^2}{R^2\left[1+\frac{h}{R}\right]^2}$$

$$\frac{g'}{g} = \frac{1}{\left[1+\frac{h}{R}\right]^2}$$

$$\frac{g'}{g} = \left[1+\frac{h}{R}\right]^{-2}$$

Using binomial expansion and neglecting higher order terms, we write,

$$\left[1+\frac{h}{R}\right]^{-2} = \left[1-\frac{2h}{R}\right]$$

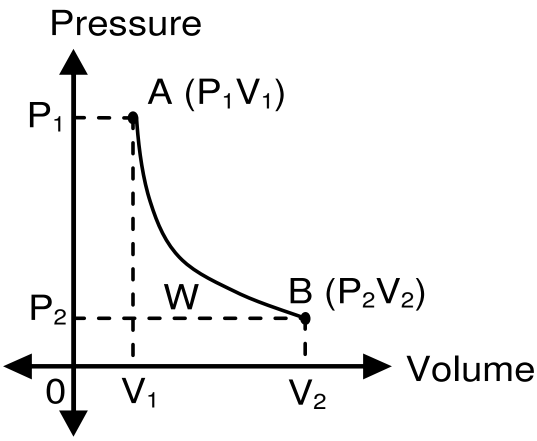
$$\frac{g'}{g} = \left[1-\frac{2h}{R}\right]$$

$$\boxed{g' = g\left[1-\frac{2h}{R}\right]}$$

From the eqn. it is clear that, acceleration due to graving decreases with the increase in height.

31. Consider 'n' moles of an ideal gas filled in a cylinder. Let the gas be allowed expand very slowly at constant temperature as described in the P-V diagram.

Total work done during isothermal process to expand the gas from A to B is



$$W = \int_{v_1}^{v_2} dw$$

But dw = PdV

$$W = \int_{v_1}^{v_2} PdV$$

But PV = nRT

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

$$W = \int_{v_1}^{v_2} \frac{nRT}{V} dV$$

$$W = nRT \int_{v_1}^{v_2} \frac{1}{V} dV$$

$$\boxed{\int \frac{1}{x} dx = \log_e x}$$

$$W = nRT \left[\log_e V\right]_{v_1}^{v_2}$$

$$W = nRT \left[\log_e V_2 - \log_e V_1\right]$$

$$W = nRT \log_e \left[\frac{V_2}{V_1}\right]$$

$$W = 2.303\ nRT\ \log_{10} \left[\frac{V_2}{V_1}\right]$$

Consider PV = nRT, If T is constant, PV = constant

Hence, $P_1V_1 = P_2V_2$ $\quad \therefore \frac{V_2}{V_1} = \frac{P_1}{P_2}$

$$\Rightarrow \boxed{W = (2.303)\ nRT\ \log_{10}\left(\frac{P_1}{P_2}\right)}$$

32. Newton formula for speed of sound is given by

$$\boxed{v = \sqrt{\frac{P}{\rho}}}$$

According to Newton, speed of sound is given by

$$\boxed{v = \sqrt{\frac{E}{\rho}}}$$

where E is modulus of elasticity

ρ is the density of air.

For gaseous medium,

E = k

k = bulk modulus

$$\therefore \boxed{v = \sqrt{\frac{k}{\rho}}} \qquad (1)$$

According to Laplace, the changes in pressure and volume occur under adiabatic conditions instead of isothermal conditions.
The eqn. of state for an adiabatic process is

$Pv^{\gamma} = \text{constant}$

Where $\gamma = \dfrac{c_p}{c_v}$

Consider $PV^{\gamma} = \text{constant}$

Taking log on both sides,

$\log_e(PV^{\gamma}) = \text{constant}$

$\log_e P + \log_e V^{\gamma} = \text{constant}$

On differentiation,

$$\frac{1}{P}dP + \gamma\frac{1}{V}dV = 0$$

$$\frac{dP}{P} + \gamma\frac{dV}{V} = 0$$

$$\frac{dP}{P} = -\frac{\gamma dV}{V}$$

The –ve sign indicates that with the increase in pressure volume decreases.

$$\frac{dP}{P} = \frac{\gamma dV}{V}$$

$$\frac{dP}{\frac{dV}{V}} = \gamma P$$

But $\dfrac{dP}{\frac{dV}{V}} = k$

$\Rightarrow K = \gamma P$

Substituting K in eqn. (1), we get

$$\boxed{\mathrm{v} = \sqrt{\frac{\gamma P}{\rho}}}$$

This mathematical relation is called Newton – Laplace formula for speed of sound.

VI Answer any THREE of the following: 3 X 5 = 15

33. M = 10kg V = 36kmph = 10m/s M_1 = ? V_1 = 25m/s M_2 = ? V_2 = 12.5 m/s

By law of conservation of energy

$$\frac{1}{2}mv_1^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$$\Rightarrow \frac{1}{\cancel{2}}(\cancel{10})(10)^2 = \frac{1}{2}\left[m_1v_1^2 + m_2v_2^2\right]$$

$$500 = \frac{1}{2}\left[m_1(25)^2 + m_2(12.5)^2\right]$$

$$\boxed{1000 = 625m_1 + 156.25m_2} \qquad (1)$$

By applying conservation of momentum,

$$m_1u_1 = m_1v_1 + m_2v_2$$

$$\Rightarrow (10)(10) = m_1(25) + m_2(12.5)$$

$\boxed{1000 = 25m_1 \ + 12.5m_2}$ (2)

On solving (1) and (2)

$\Rightarrow (100 = 25m_1 + 12.5m_2) \times 25$

$1000 = 625m_x + 156.125m_2$

$2500 = 625m_1 + 312.5m_2$

$$\begin{array}{l} \underset{(-)}{1000} = \underset{(-)}{625m_1} + \underset{(-)}{156.25m_2} \\ \hline \quad 1500 = 156.25m_2 \end{array}$$

$m_2 = \dfrac{1500}{156.25}$

$m_2 = 9.6kg$

$100 = 25m_1 + 12.5m_2$

$100 = 25m_1 + 12.5(9.6)$

$100 = 25m_1 + 120$

M_1 = 0.8 kg $\therefore$ The masses of the fragments is 0.8kg and 9.6 kg.

34. $\omega_i = 1800rpm \ = 1800 \times \dfrac{2\pi}{60} = 60\pi rads^{-1}$

$\omega_f = 1200rpm \ = 1200 \times \dfrac{2\pi}{60} = 40\pi rads^{-1}$

t = 2min = 120s

$\alpha = ? \quad \theta = ? \quad n = ?$

$\omega_f = \omega_i + \alpha t \ \Rightarrow \alpha = \dfrac{\omega_f - \omega_i}{t}$

$= \dfrac{60\pi - 40\pi}{120} = \dfrac{20\pi}{120}$

$\Rightarrow \dfrac{20 \times 3.14}{120} = 0.5233 rads^{-2}$

$\theta = \omega_i t + \dfrac{1}{2}\alpha t^2$

$\Rightarrow (40\pi)(120) + \dfrac{1}{2}(0.5233)(120)^2$

$= 15072 + \dfrac{1}{2}(0.5233)(14400)$

$= 15072 + 3767.7$

= 18839.7 rad

$\theta = 2\pi n \qquad \Rightarrow n = \dfrac{\theta}{2\pi}$

$n = \dfrac{18839.7}{2 \times 3.14}$

$n = 2999.9$

$\simeq 3000$ rotations

for 120S = 3000 rotations

2s = ?

$\Rightarrow \dfrac{2 \times 3000}{120}$

= 50

$\therefore$ 50 rotations in 2s

35. h = 2600 km = 2.6 x 10^6 m

R = 6400 km = 6.4 x 10^6 m

M = 6 x 10^{24} kg

g = 9.8ms^{-2}

i) orbital velocity

$$\nu_0 = \sqrt{\frac{gR^2}{R+h}}$$

$$\nu_0 = \sqrt{\frac{9.8\times(6.4\times10^6)^2}{6.4\times10^6+2.6\times10^6}}$$

$$\nu_0 = \sqrt{\frac{62.72\times10^{12}}{(6.4+2.6)\times10^6}}$$

$$\nu_0 = \sqrt{\frac{62.72\times10^{12}\times10^{-6}}{9}}$$

$$\nu_0 = \sqrt{\frac{62.72\times10^6}{9}}$$

$$\nu_0 = \frac{7.9195}{3}\times10^3$$

$$\nu_0 = 2.639\times10^3 ms^{-1}$$

$$\nu_0 = 2.639 kms^{-1}$$

ii) Period of revolution

$$T = 2\pi\sqrt{\frac{(R+h)^3}{gR^2}}$$

$$T = 2\pi\sqrt{\frac{((6.4+2.6)\times10^6)^3}{9.8(6.4\times10^6)^2}}$$

$$T = 2\pi\sqrt{\frac{9\times10^{18}}{401.408\times10^{12}}}$$

$$T = 2(3.14)\left(\frac{3\times10^3}{20.0351}\right)$$

$$T = \frac{6.28(3\times10^3)}{20.0351}$$

$$T = \frac{18.84}{20.0351}\times10^3$$

$$T = 0.9403\times10^3$$

$$T = 940.3 \text{ s}$$

36. T_1 = 1000 K

T_2 = 300 K $\quad\quad \eta = 0.8$

$$\eta = 1-\frac{T_2}{T_1}$$

$$\eta = 1-\frac{300}{1000}$$

$$\eta = 1-0.3 \Rightarrow \eta = 0.7$$

i) $T_1' \rightarrow$ New temp of the source

$$\eta' = 1-\frac{T_2}{T_1'}$$

$$0.8 = 1-\frac{300}{T_1'}$$

$$\frac{300}{T_1'} = 1-0.8$$

$$\frac{300}{T_1'} = 0.2$$

$$\frac{300}{0.2} = T_1'$$

$$1500 = T_1'$$

$$T_1' = 1500 K$$

$\therefore$ Increase in temp of source = $T_1' - T_1$

= 1500 – 1000

= 500 K

ii) $T_2' \rightarrow$ New temp of the sink

$$\eta' = 1-\frac{T_2'}{T_1}$$

$$0.8 = 1 - \frac{T_2'}{1000}$$

$$\frac{T_2'}{1000} = 1 - 0.8$$

$$T_2' = 1000(0.2)$$

$$T_2' = 200K$$

$\therefore$ Decrease in the temperature of the sink

$$= T_1 - T_2'$$

$$= 300 - 200$$

$$= 100K$$

37. $v = 332 ms^{-1}$

$\xrightarrow{v}$ $\qquad\qquad$ $\xleftarrow{v}$

$\dot{s} \xrightarrow{v_s} \dot{o}$ $\qquad\qquad$ $\dot{\gamma} \qquad \dot{s} \xrightarrow{v_s}$

$$f' = \left(\frac{\nu}{\nu - \nu_s}\right) f \qquad \text{...(1)} \qquad F' = \left(\frac{\nu}{\nu + \nu_s}\right) f \qquad \text{...(2)}$$

(1) $\div$ (2)

$$\frac{f'}{F'} = \frac{6}{5} = \frac{\left(\frac{\nu}{\nu - \nu_s}\right) f}{\left(\frac{\nu}{\nu + \nu_s}\right) f}$$

$$\frac{6}{5} = \frac{\frac{\nu f}{\nu - \nu_s}}{\frac{\nu f}{\nu + \nu_s}}$$

$$\frac{6}{5} = \frac{\nu + \nu_s}{\nu - \nu_s}$$

$$6\nu - 6\nu_s = 5\nu + 5\nu_s$$

$$6\nu - 5\nu = 5\nu_s + 6\nu_s$$

$$\nu = 11\nu_s$$

$$\nu_s = \frac{\nu}{11}$$

$$\nu_s = \frac{332}{11}$$

$$\nu_s = 30.181\, ms^{-1}$$

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