DPP

DAILY PRACTICE PROBLEMS

CLASS : XIth
Date :

Solutions

SUBJECT : PHYSICS
DPP No. : 10

Topic :- GRAVITATION

1 **(d)**

$F \propto \frac{1}{r^2}$. If r becomes double then F reduces to $\frac{F}{4}$

2 **(b)**

We know that $g = \frac{GM}{R^2}$

On the planet $g_p = \frac{GM/7}{R^2/4} = \frac{4}{7}g$

Hence weight on the planet $= 700 \times \frac{4}{7} = 400\ gm\ wt$

3 **(c)**

According to Kepler's third law

$$T^2 \propto R^3$$

$$\Rightarrow \quad \frac{T_2}{T_1} = \left(\frac{R_2}{R_1}\right)^{3/2}$$

$$\therefore \quad \frac{T_2}{T_1} = \left(\frac{3R}{R}\right)^{3/2}$$

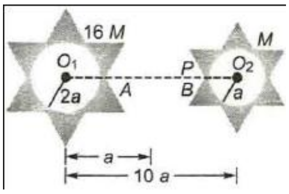
$$\Rightarrow \quad \frac{T_2}{T_1} = \sqrt{27}$$

$\therefore \quad T_2 = \sqrt{27}T_1 = \sqrt{27} \times 4 = 4\sqrt{27}$h

4 **(b)**

First we have to find a point where the resultant field due to both is zero. Let the point P be at a distance x from centre of bigger star.

$\Rightarrow \frac{G(16M)}{x^2} = \frac{GM}{(10a - x)^2} \Rightarrow x = 8a$ (from O_1)



ie, once the body reaches P, the gravitational pull of attraction due to M takes the lead to make m move towards it automatically as the gravitational pull of attraction due to

16 Mvanishes ie, a minimum KE or velocity has to be imparted to m from surface of 16 M such that it is just able to overcome the gravitational pull of 16M. By law of conservation of energy.

(Total mechanical energy at A) = (Total mechanical energy at P)

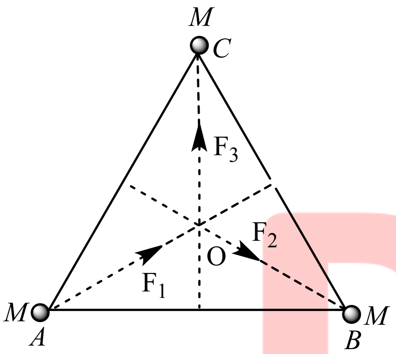
$$\Rightarrow \frac{1}{2}mv_{min}^2 + \left[\frac{G(16M)m}{2a} - \frac{GMm}{8a}\right]$$

$$= 0 + \left[\frac{GMm}{2a} - \frac{G(16M)m}{8a}\right]$$

$$\Rightarrow \frac{1}{2}mv_{\text{min}}^2 = \frac{GMm}{8a}(45) \Rightarrow v_{\text{min}} = \frac{3}{2}\sqrt{\frac{5GM}{a}}$$

5 **(a)**

The net force acting on a unit mass placed at O due to three equal masses M at verities A,B and C is the gravitational field intensity at point O. The gravitational force on the particle placed at the point of intersection of three medians.



Since, the resultant of $\mathbf{F}_1$ and $\mathbf{F}_2$ is equal and opposite to $\mathbf{F}_3$.

6 **(b)**

By the law of conservation of energy

$$(U + K)_{\text{surface}} = (U + K)_{\infty}$$

$$\Longrightarrow \quad -\frac{GMm}{R} + \frac{1}{2}m(3v_e)^2 = 0 + \frac{1}{2}mv^2$$

$$\Longrightarrow \quad -\frac{GM}{R} + \frac{9v_e^2}{2} = \frac{1}{2}v^2$$

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

$$\therefore \quad -\frac{v_e^2}{2} + \frac{9v_e^2}{2} = \frac{1}{2}v^2 \Rightarrow v^2 = 8v_e^2$$

$$v = 2\sqrt{2}v_e$$

$$= 2\sqrt{2} \times 11.2 = 31.7\text{kms}^{-1}$$

7 **(b)**

6R from the surface of earth and 7R from the centre

8 **(b)**

$\frac{dA}{dt} = \frac{L}{2m} =$ constant

9 **(b)**

$F(r) = \begin{cases} \frac{GMm}{r^2} \\ \frac{4\pi G\rho r m}{3} \end{cases}, r < R$ (where ρ is density of sphere)

10 **(b)**

Weight of body on the surface of earth $mg = 12.6$ N

At height h, the value of g' is given by

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

Now, $h = \frac{R}{2}$

$\therefore$ $g' = g\left(\frac{R}{R+(R/2)}\right)^2 = g\frac{4}{9}$

Weight at height h $= mg\frac{4}{9}$

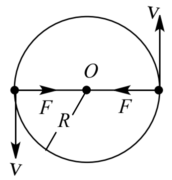
$$= 12.6 \times \frac{4}{9} = 5.6 \text{ N}$$

12 **(d)**

$F = \left\{\frac{GMm}{r^2}\right\}, r \geq R$

13 **(c)**

Here the force of attraction between them provides the necessary centripetal force



$\therefore$ $\frac{mv^2}{R} = \frac{Gm^2}{(4R)^2}$

$\therefore$ $v = \sqrt{\frac{Gm}{4R}}$

14 **(b)**

If a body is projected from the surface of earth with a velocity v and reaches a height h, applying conservation of energy (relative to surface of earth)

$\frac{1}{2}mv^2 = \frac{mgh}{[1+(h/R)]}$

h $= R = 6400$ km, g $= 10$ms^{-2}

So, $v^2 = gh$ *ie*, $v = \sqrt{10 \times 6400 \times 10^3} = 8$ kms^{-1}

15 **(b)**

The value of g at latitude λ is ; $g' = g - R\omega'^2\cos^2\lambda$. If earth stops rotating, $\omega = 0; g' = g$. It means the weight of body will increase

16 **(b)**

Gravitational force $\left(=\frac{GM\,m}{R^{3/2}}\right)$ provides the necessary centripetal force $(ie,m\,R\,\omega^2)$

So, $\frac{GM\,m}{R^{3/2}} = mR\omega^2 = mR\left(\frac{2\pi}{T}\right)^2 = \frac{4\pi^2 mR}{T^2}$

or $T^2 = \frac{4\pi^2 R^{5/4}}{GM} ie, T^2 \propto R^{5/2}$

17 **(c)**

$\frac{dA}{dt} = \frac{L}{2m} \Rightarrow \frac{dA}{dt} \propto vr \propto \omega r^2$

18 **(d)**

Gravitational potential energy of body will be

$$E = \frac{GM_e m}{r}$$

At $r = 2R$,

$$E_1 = -\frac{GM_e m}{(2R)}$$

At $r = 3R$

$$E_2 = -\frac{GM_e m}{(3R)}$$

Energy required to move a body of mass m from on orbit of radius $2R$ to $3R$ is

$$\Delta E = \frac{GM_e m}{R}\left[\frac{1}{2} - \frac{1}{3}\right] = \frac{GM_e m}{6R}$$

19 **(a)**

$v = \sqrt{\frac{GM}{R+h}} = \frac{1}{2}\sqrt{\frac{2GM}{R}}$

$\Rightarrow 4R = 2(R+h) \Rightarrow h = R = 6400\ km$

20 **(b)**

Here, $m_1 = m_2 = 100$ kg ; $r = 100$m

Acceleration of first astronaut,

$a_1 = \frac{Gm_1 m_2}{r^2} \times \frac{1}{m_1} = \frac{Gm_1}{r^2}$

Acceleration of second astronaut,

$a_2 = \frac{Gm_1 m_2}{r^2} \times \frac{1}{m_2} = \frac{Gm_2}{r^2}$

Net acceleration of approach

$a = a_1 + a_2 = \frac{Gm_2}{r^2} + \frac{Gm_1}{r^2} = \frac{2Gm_1}{r^2}$

$= \frac{2 \times (6.67 \times 10^{-11}) \times 100}{(100)^2}$

$= 2 \times 6.67 \times 10^{-13} \text{ms}^{-2}$

As $s = \frac{1}{2}at^2$

$$\therefore t = \left(\frac{2s}{a}\right)^{1/2} = \left[\frac{2 \times (1/100)}{2 \times 6.67 \times 10^{-13}}\right]^{1/2} \text{second}$$

On solving we get $t = 1.41$ days

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	D	B	C	B	A	B	B	B	B	B
Q.	11	12	13	14	15	16	17	18	19	20
A.	C	D	C	B	B	B	C	D	A	B