DPP

DAILY PRACTICE PROBLEMS

CLASS : XIth
Date :

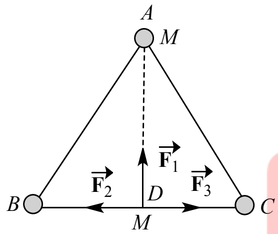
Solutions

SUBJECT: PHYSICS
DPP No. : 6

Topic :- GRAVITATION

1 **(b)**

(i)Gravitational force on the particle placed at mid point D of side BC of length a is



$\vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 + \vec{\mathbf{F}}_3$

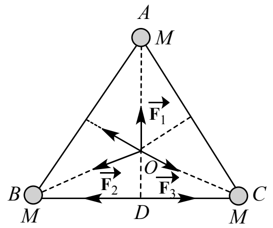
Here, $\vec{\mathbf{F}}_2 = -\vec{\mathbf{F}}_3$

$\therefore \vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + 0 = \vec{\mathbf{F}}_1$

or $F = F_1 = \frac{GMM}{[AD]^2} = \frac{GM^2}{(3a^2/4)} = \frac{4GM^2}{3a^2}$

(ii)gravitational force on the particle placed at the point O, *ie* the intersection of three medians is

$\vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 + \vec{\mathbf{F}}_3 = \vec{\mathbf{0}}$ or $F = 0$



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

2 **(b)**

If g is the acceleration due to gravity of earth at the position of satellite, the apparent weight of a body in the satellite will be

$W_{\text{app}} = m(g' - a)$

But as satellite is a freely falling body, *ie*, $g' = a$

So, $W_{\text{app}} = 0$

3 **(d)**

$$\frac{K_A}{K_B} = \frac{r_B}{r_A} = \left(\frac{R + h_B}{R + h_A}\right) = \left(\frac{R + 2R}{R + R}\right) = \frac{3}{2}$$

4 **(b)**

As mass, $M = \frac{4}{3}\pi R^2 \rho$

or $\rho = \frac{3M}{4\pi R^3}$

$$\therefore \frac{\rho_s}{\rho_s} = \frac{M_s}{M_e} \times \frac{R_e^3}{R_s^3} = 330 \times \left(\frac{1}{100}\right)^3 = 3.3 \times 10^{-4}$$

5 **(c)**

$U = \frac{-GMm}{r}, K = \frac{GMm}{2r}$ and $E = \frac{-GMm}{2r}$

For a satellite U,K and E varies with r and also U and E remains negative whereas K remain always positive

6 **(a)**

$$g' = g - \frac{10g}{100} - \frac{90}{100}g$$

$$g' = g\frac{R^2}{(R+h)^2} \text{ or } \frac{9}{10} = \frac{R^2}{(R+h)^2}$$

or $\frac{3}{\sqrt{10}} = \frac{R}{R+h}$

or $h = (\sqrt{10} - 3)R/3$

$$\frac{(\sqrt{10} - 3) \times 6400}{3} = 345.60 \text{ km}$$

7 **(d)**

The minimum velocity of projection to achieve escape velocity can be calculated as

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

$$= \frac{1}{2} \times m(4 \times 11.2)^2 = 16 \times \frac{1}{2}mv_e^2$$

As $\frac{1}{2}mv_e^2$ energy is used up in coming out from the gravitational pull of the earth, so final KE should be $15 \times \frac{1}{2}mv_e^2$

Hence, $\frac{1}{2}mv_e^2 = 15 \times \frac{1}{2}mv_e^2$

$\therefore \quad v'^2 = 15v_e^2$

or $\quad v' = \sqrt{15}v_e$

$= \sqrt{15} \times 11.2\text{kms}^{-1}$

8 **(c)**

$$\frac{T_{\text{mercury}}}{T_{\text{earth}}} = \left(\frac{r_{\text{mercury}}}{r_{\text{earth}}}\right)^{3/2} = \left(\frac{6 \times 10^{10}}{1.5 \times 10^{11}}\right)^{3/2} = \frac{1}{4}$$

(approx.)

$\therefore T_{\text{mercury}} = \frac{1}{4}\text{year}$

9 **(c)**

$$\frac{g_m}{g_e} = \frac{M_m}{M_e} \times \left(\frac{R_e}{R_m}\right) = \frac{1}{81} \times (4)^2 = \frac{16}{81}$$

$g_m = \frac{16}{81} g_e$

$\therefore v_e = \sqrt{2 g_e R_e} = \sqrt{2 \times 9.8 \times (6400 \times 1000)}$

≈ 11.2 kms^{-1}

$v_m = \sqrt{2 g_m R_m} = \sqrt{2 \times \frac{16}{81} g_e \times \frac{1}{4} R_e}$

$= \frac{2}{9}\sqrt{2 g_e R_e} = \frac{2}{9} \times 11 \approx 2.5$ kms^{-1}

10 **(a)**

Acceleration due to gravity is given by

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

where G is gravitational constant.

For earth: $g_e = \frac{GM_e}{R_e^2}$

For planet: $g_p = \frac{GM_p}{R_p^2}$

Therefore, $\frac{g_e}{g_p} = \frac{GM_e/R_e^2}{GM_p/R_p^2}$

or $\frac{g_e}{g_p} = \frac{M_e}{M_p} \times \frac{R_p^2}{R_e^2}$ ...(i)

Given, $M_p = 2M_e$, $R_p = 2R_e$

Putting the values in the Eq. (i), we obtain

$$\frac{g_e}{g_p} = \frac{M_e}{2M_e} \times \frac{(2R_e)^2}{R_e^2} = \frac{1}{2} \times \frac{4}{1} = 2$$

$\therefore \quad g_p = \frac{g_e}{2}$

11 **(c)**

$v_e = \sqrt{\frac{2GM}{R}}$ *i.e.* escape velocity depends upon the mass and radius of the planet

12 **(b)**

When the spaceship is to take off, gravitational pull of earth requires more energy to be spent to overcome it

13 **(d)**

Acceleration due to gravity on earth is given by $g = \frac{GM}{R^2}$

$$\left(\text{Here, } M_m = \frac{M_e}{9}, R_m = \frac{R_e}{2}\right)$$

Hence, $\frac{g_e}{g_m} = \frac{M_e}{M_m} \times \frac{R_m^2}{R_e^2} = \frac{9M_e}{M_e} \times \left(\frac{R_e}{2R_e}\right)^2$

or $\frac{g_e}{g_m} = \frac{9}{4}$

So, $\frac{g_m}{g_e} = \frac{4}{9}$

$\because$ Weight of body on moon

$= \text{weight of body on earth} \times g_m/g_e$

$= 90 \times \frac{4}{9} = 90 \times \frac{4}{9} = 40\text{kg}$

14 **(b)**

$\omega_{\text{body}} = 27\omega_{\text{earth}}$

$T^2 \propto r^3 \Rightarrow \omega^2 \propto \frac{1}{r^3} \Rightarrow \omega \propto \frac{1}{r^{3/2}}$ $\therefore$ $r \propto \frac{1}{\omega^{2/3}}$

$\Rightarrow \frac{r_{\text{body}}}{r_{\text{earth}}} = \left(\frac{\omega_{\text{earth}}}{\omega_{\text{body}}}\right)^{2/3} = \left(\frac{1}{27}\right)^{2/3} = \frac{1}{9}$

15 **(d)**

$L = mvr = m\left(\sqrt{\frac{GM}{r}}\right)r = m\sqrt{GMr}$ $\therefore L \propto \sqrt{r}$

16 **(c)**

$H = \frac{u^2}{2g} \Rightarrow H \propto \frac{1}{g} \Rightarrow \frac{H_B}{H_A} = \frac{g_A}{g_B}$

Now $g_B = \frac{g_A}{12}$ as $g \propto \rho R$

$\therefore \frac{H_B}{H_A} = \frac{g_A}{g_B} = 12$

$\Rightarrow H_B = 12 \times H_A = 12 \times 1.5 = 18m$

17 **(b)**

$T^2 \propto r^3$

18 **(c)**

Force acting on a body of mass M at a point at depth d. Inside the earth is

$F = mg' = mg\left(1 - \frac{d}{R}\right)$

$$= \frac{mGM}{R^2}\left(\frac{R - d}{R}\right) = \frac{GM\,m}{R^3} r \;\; (\because R - d = r)$$

So, $F \propto r$; Given $F \propto r^n$

$n = 1$

19 **(d)**

Let the gravitational force on a body mass m at O due to moon of mass M and earth of mass $8/M$ be zero, where $EO = x$ and $MO = (r - x)$. Then,

$$\frac{G81M \times m}{x^2} = \frac{GM\,m}{(r - x)^2}$$

or $\frac{81}{x^2} = \frac{1}{(r - x)^2}$

or $\frac{9}{x} = \frac{1}{(r - x)}$

On solving; $x = 9r/10$

20 **(b)**

Gravitational force on a body at a distance x from the centre of earth $F = \frac{GMm}{x^2}$

Work done,

$$W = \int_R^{R+h} F\,dx = \int_R^{R+h} \frac{GM\,m}{x^2} dx$$

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

This work done appears as increase in potential energy

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

$$= mg(5h)^2\left[\frac{1}{5h} - \frac{1}{6h}\right] = \frac{5}{6}\text{mgh}$$

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