DPP
DAILY PRACTICE PROBLEMS

CLASS : **XIth**
Date :

Solutions

SUBJECT : PHYSICS
DPP No. : 8

Topic :- GRAVITATION

1 **(c)**

Mass of two planets is same, so

$$\frac{4}{3}\pi R_1^3 \rho_1 = \frac{4}{3}\pi R_2^3 \rho_2$$

or $\frac{R_1}{R_2} = \left(\frac{\rho_2}{\rho_1}\right)^{1/3} = \left(\frac{1}{8}\right)^{1/3} = \frac{1}{2}$

$$\frac{g_1}{g_2} = \frac{GM/R_1^2}{GM/R_2^2} = \left(\frac{R_2}{R_1}\right)^2 = (2)^2 = 4$$

2 **(d)**

Gravitational potential energy is given as

$$U = -\frac{GMm}{r}$$

$$U_1 = -\frac{GMm}{r_1}, U_2 = -\frac{GMm}{r_2}$$

As $r_2 > r_1$, hence,

$$U_1 - U_2 = GMm\left[\frac{r_2 - r_1}{r_1 r_2}\right] \text{ is positie}$$

ie, $U_1 > U_2$

or $U_2 < U_1$

ie, gravitational potential energy increases.

3 **(a)**

The earth behaves for all external points as if its mass M were concentrated at its centre. When man of mass m walks from a point on earth's surface and reaches diagonally opposite point, then gravitational potential energy given by

$$U = -\frac{GMm}{R}$$

Will remain same.

Hence, no work is done by the man against gravity.

4 **(b)**

Given, $g_h = 9 = \frac{gR^2}{(R + R/20)^2} = \frac{20 \times 20}{21 \times 21} g$

or $g = \frac{9 \times 21 \times 21}{20 \times 20}$

Now, $g_d = g\left(1 - \frac{d}{R}\right)$

$$= \frac{9 \times 21 \times 21}{20 \times 20}\left[1 - \frac{R/20}{R}\right] = 9.5\text{ms}^{-2}$$

5 **(b)**

Gravitational potential at a point on the surface of earth

$$V = \frac{-GM}{R} = \frac{-gR^2}{R} = -gR$$

7 **(a)**

Earth is surrounded by an atmosphere of gases (air). The reason is that in earth's atmosphere the average thermal velocity of even the highest molecules at the maximum possible temperature is small compared to escape velocity which in turn depends upon gravity ($v_e = \sqrt{gR_e}$). Therefore, the molecules of gases cannot escape from the earth. Hence, an atmosphere exists around the earth.

8 **(c)**

$$\frac{g'}{g} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{2} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{1}{2} = \left(\frac{4000}{4000+h}\right)^2$$

By solving we get $h = 1656.85\ mile\ \approx 1600\ mile$

9 **(d)**

It is given that, acceleration due to gravity on planet A is 9 times the acceleration due to gravity on planet B *ie*,

$g_A = 9g_B$ ...(i)

From third equation of motion

$v^2 = 2gh$

At planet A, $h_A = \frac{v^2}{2g_A}$ ...(ii)

At planet B, $h_B = \frac{v^2}{2g_B}$ ...(iii)

Dividing Eq. (ii) by Eq. (iii), we have

$$\frac{h_A}{h_B} = \frac{g_B}{g_A}$$

From Eq. (i), $g_A = 9g_B$

$$\therefore \quad \frac{h_A}{h_B} = \frac{g_B}{9g_B} = \frac{1}{9}$$

or $h_B = 9h_A = 9 \times 2 = 18$ m $(\because h_A = 2\text{m})$

11 **(b)**

Gravitational force provides the required centripetal force *ie*,

$$m\omega^2 R = \frac{GMm}{R^{\frac{5}{2}}}$$

$$\Rightarrow \qquad \frac{m4\pi^2}{T^2} = \frac{GMm}{R^{\frac{7}{2}}}$$

$$\Rightarrow \qquad T^2 \propto R^{7/2}$$

12 **(a)**

Escape velocity, $v_e = \sqrt{\frac{2GM_e}{R_e}}$

Given, $M_p = 6M_e, R_p = 2R_e$

$$\therefore \qquad v_p = \sqrt{\frac{2G \cdot 6M_e}{(2R_e)}} = \sqrt{3}\, v_e$$

13 **(d)**

$$T = 2\pi\sqrt{\frac{r^3}{GM}} \Rightarrow r^3 = \frac{GMT^2}{4\pi^2} \Rightarrow r = \left[\frac{GMT^2}{4\pi^2}\right]^{1/3}$$

14 **(c)**

If M be mass of earth and R its radius, the acceleration due to gravity is given by

$$g = \frac{GM}{R^2} \qquad ....(i)$$

Where, G is gravitational constant.

Given, $R = 0.99R$

$$\therefore \qquad g' = \frac{GM}{(0.99R)^2} \qquad ...(ii)$$

$$= 1.02\left(\frac{GM}{R^2}\right)$$

From Eq. (i), we get

$$g' = 1.02g$$

Hence, acceleration due to gravity increases by

$$g' - g = 1.02 - 1 = 0.02g$$

Hence, percentage increases =2%.

15 **(c)**

Acceleration due to gravity at a height h above the earth's surface is $g_h = \frac{g}{(1+\frac{h}{R})^2}$

Where g is the acceleration due to gravity on the earth's surface

At $h = \frac{R}{2}, g_h = \frac{g}{(1+\frac{R}{2R})^2} = \frac{4g}{9}$

At $h = R, g_h = \frac{g}{(1+\frac{R}{R})^2} = \frac{g}{4}$

Acceleration due to gravity at a depth d below the earth's surface is $g_d = g\left(1 - \frac{d}{R}\right)$

At $d = \frac{R}{2}, g_d = g\left(1 - \frac{2}{2R}\right) = \frac{g}{2}$

At the centre of earth, $d = R$

$$g_d = g\left(1 - \frac{R}{R}\right) = 0$$

Thus, the acceleration due to gravity is maximum on the earth's surface

16 **(a)**

As in case of elliptic orbit of a satellite mechanical energy

$E = -(GMm/2a)$ remains constant, at any position of satellite in the orbit,

$\text{KE} + \text{PE} = -\frac{GMm}{2a}$ ...(i)

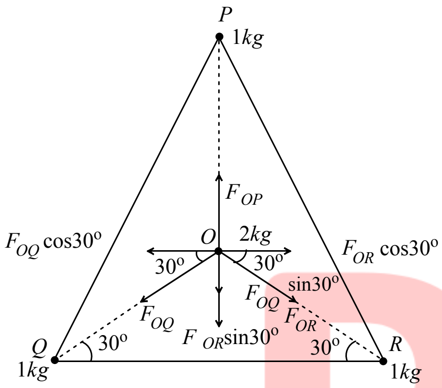
Now, if at position r,v is the orbital speed of satellite

$\text{KE} = \frac{1}{2}mv^2$ and $\text{PE} = -\frac{GMm}{r}$ ...(ii)

So, from Eqs. (i) and (ii), we have

$$\frac{1}{2}mv^2 - \frac{GMm}{r} = -\frac{GMm}{2a}, ie, v^2 = GM\left[\frac{2}{r} - \frac{1}{a}\right]$$

17 **(d)**



Here, $OP = OQ = OR = \sqrt{2}\ m$

The gravitational force on mass 2 kg at O due to mass

1 kg at P is $F_{OP} = \frac{G \times 2 \times 1}{(\sqrt{2})^2} = G$ along OP

The gravitational force on mass 2 kg at O due to mass

1 kg at Q is $F_{OQ} = \frac{G \times 2 \times 1}{(\sqrt{2})^2} = G$ along OQ

The gravitational force on mass 2 kg at O due to mass

1 kg at R is $F_{OR} = \frac{G \times 2 \times 1}{(\sqrt{2})^2} = G$ along OR

Resolve forces F_{OQ} and F_{OR} into two rectangular components

$F_{OQ}\cos 30°$ and $F_{OR}\cos 30°$ are equal in magnitude of equal and opposite direction

$= F_{OP} - (F_{OQ}\sin 30° + F_{OR}\sin 30°)$

$= G - \left(G \times \frac{1}{2} + G \times \frac{1}{2}\right) = G - G = \text{Zero } N$

18 **(c)**

Landsats 1 through 3 operated in a near polar orbit at an altitude of 920 km with an 18 day repeat coverage cycle. These satellites circled the earth every 103 min completing 14 orbits a day.

19 **(d)**

$$U_i = -\frac{GMm}{r}$$

$$U_i = \frac{6.67 \times 10^{-11} \times 100 \times 10^{-2}}{0.1}$$

$$U_i = -\frac{6.67 \times 10^{-11}}{0.1}$$

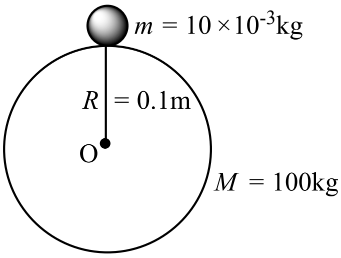
$$= -6.67 \times 10^{-10}\text{J}$$

We know

$\therefore \quad W = \Delta U$

$= U_f - U_i \qquad (\therefore U_f = 0)$

$\therefore \quad W = U_i = 6.67 \times 10^{-10}\text{J}$



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