JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 11th **PAPER CODE :- CWT-9**
CHAPTER :- GRAVITATION

ANSWER KEY

1.	(C)	**2.**	(C)	**3.**	(C)	**4.**	(A)	**5.**	(C)	**6.**	(B)	**7.**	(C)
8.	(B)	**9.**	(C)	**10.**	(C)	**11.**	(B)	**12.**	(C)	**13.**	(C)	**14.**	(C)
15.	(B)	**16.**	(C)	**17.**	(A)	**18.**	(B)	**19.**	(A)	**20.**	(A)	**21.**	4
22.	2	**23.**	2	**24.**	3	**25.**	80	**26.**	16	**27.**	8	**28.**	8
29.	14 kg	**30.**	4 J										

SOLUTIONS

1. (C)

Sol. $F = \dfrac{GM(M-m)}{r^2}$

For F_{min}, $\dfrac{dF}{dm} = 0$

$M - 2m = 0 \Rightarrow \dfrac{m}{M} = \dfrac{1}{2}$

2. (C)

Sol. The acceleration due to gravity at a distance x (x < R) from centre of earth (of radius R) is

$g(x) = g\,\dfrac{x}{R} \quad \therefore \quad g\left(\dfrac{R}{2}\right) = \dfrac{g}{2}$

3. (C)

Sol. In case of planet total energy of planet is always nagtive.

4. (A)

Sol. $T^2 \propto r^3$

$\left(\dfrac{T_1}{T_2}\right)^2 = \left(\dfrac{r_1}{r_2}\right)^3$

$\left(\dfrac{1}{8}\right)^2 = \left(\dfrac{10^4}{r}\right)^3$

$r = 4 \times 10^4$ km

$T = \dfrac{2\pi r}{v} \quad V_1 - V_2 = \dfrac{2\pi r_1}{T_1} - \dfrac{2\pi r_2}{T_2}$

$= 2\pi\left(\dfrac{10^4}{1} - \dfrac{4\times10^4}{8}\right) = \pi \times 10^4$ km/hr

5. (C)

Sol. From energy conservation

$PE_i + KE_i = PE_f + KE_f$

$-\left(\dfrac{GM_1}{d/2} + \dfrac{GM_2}{d/2}\right) m + \dfrac{1}{2} mv^2 = 0 + 0$

$V^2 = \dfrac{4G}{d}(m_1 + m_2)$

$V = \sqrt{\dfrac{4G(m_1+m_2)}{d}}$

6. (B)

Sol. $V_e = \sqrt{\dfrac{2GM_e}{R^2}R}$

So V_e does not depend on mass of the body.

7. (C)

Sol. $v_C = \sqrt{2gR}$

$v = \dfrac{\sqrt{2gR}}{4} = \dfrac{\sqrt{gR}}{2\sqrt{2}}$

$\dfrac{1}{2}mv^2 - \dfrac{GMm}{R} = 0 - \dfrac{GMm}{R+h}$

$\dfrac{1}{2} m \dfrac{gR}{8}$ a mg R $= \dfrac{gR^2 m}{R+h}$

$\dfrac{1}{16} = 1 - \dfrac{R}{R+h}$

$\dfrac{1}{16} = \dfrac{h}{R+h}$

R + h = 16 h

R = 15 h

$h = \dfrac{R}{15}$

8. (B)

Sol. $dv = -Edr = \dfrac{k}{r}dr$

Integrating both sides

$[v]_{v_i}^{v} = k\,[\log r]_{d_i}^{r} \Rightarrow v - v_i = k \log \dfrac{r}{d_i}$

$\Rightarrow \quad v = v_i + k \log \dfrac{r}{d_i}$ **Ans.**

9. (C)

Sol. Angular momentum of satellite remains constant.

10. (C)

Sol. $PE = \dfrac{-G(\lambda 2\pi R)m}{R} = G\lambda 2\pi m$

i.e. independent of R

11. (B)

Sol. $V_e \propto \sqrt{gR}$

$$\frac{V_p}{V_e} = \sqrt{\frac{g_pR_p}{g_eR_e}}$$

$$\frac{V_p}{V_e} = \sqrt{\frac{10g_e}{g_e}} \Rightarrow V_p = \sqrt{10}\ V_e$$

12. (C)

Sol. $V_e = \sqrt{2gR}$

$$V_e = \sqrt{\frac{2GM_eR}{R^2}}$$

$$V_e = \sqrt{\frac{2G\left(\frac{4}{3}\pi R^3\rho\right)R}{R^2}}$$

$$V_e \propto \sqrt{\rho R^2}$$

$$\frac{V}{v_0} = \sqrt{\frac{\rho(2R)^2}{\rho R^2}}$$

$V = 2V_0$

13. (C)

Sol. Initial total energy = Initial kinetic energy + initial potential energy

$$= \frac{1}{2}m(0)^2 + \left(-\frac{GMm}{R_0}\right) = -\frac{GMm}{R_0}$$

Total energy, when it reaches the surface of earth

$$= \frac{1}{2}mv^2 + \left(-\frac{GMm}{R}\right)$$

Applying energy conservation,

$$\frac{1}{2}mv^2 - \frac{GMm}{R} = -\frac{GMm}{R_0}$$

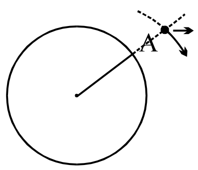
$$v = \sqrt{2GM\left\{\frac{1}{R} - \frac{1}{R_0}\right\}}$$ **Ans.**

14. (C)

Sol. $w_E - w_S = \frac{2\pi}{T}$

$$w_S - w_E = \frac{2\pi}{T}$$

$$\frac{2\pi}{8} - \frac{2\pi}{24} = \frac{2\pi}{T}$$



$$w_S - \frac{2\pi}{24} = \frac{2\pi}{8}$$

$$\frac{2\pi(3-1)}{24} = \frac{2\pi}{T}$$

$$w_S = 2\pi\left[\frac{1}{24} + \frac{1}{8}\right]$$

$$w_S - w_E = \frac{2\pi}{T} \qquad w_S = 2\pi\left[\frac{1+3}{24}\right]$$

$$\frac{2\pi}{6} - \frac{2\pi}{24} = \frac{2\pi(4-1)}{24} = \frac{2\pi}{8}$$

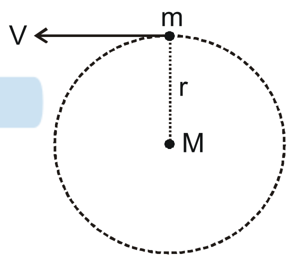
$$w_S = \frac{2\pi}{6}$$

$T_{satellite} = 6$ hr

15. (B)

Sol. $\frac{GMm}{r^2} = \frac{mv^2}{r}$

$$v = \sqrt{\frac{GM}{r^2}}$$



$$T = \frac{2\pi r}{v} = \frac{2\pi r^{\frac{3}{2}}}{\sqrt{GM}} = \frac{2\pi r^{\frac{3}{2}}}{\sqrt{G\rho \times \frac{4}{3}\pi r^3}}$$

$$T \propto \frac{1}{\sqrt{\rho}}$$ **Ans.**

16. (C)

Sol. PE = $-G\,m_1 m_2/r$,

ME = $-G\,m_1 m_2 / 2r$

On decreasing the radius of orbit PE and ME decreases

17. (A)

Sol. In case of earth the gravitational field is zero at infinity as well as the the centre and the potential is minimum at the centre .

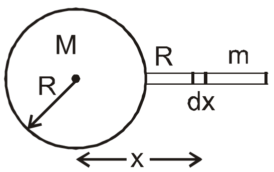
18. (B)

Sol. $\frac{kq_a q_b}{d^2} = \frac{Gm_a m_b}{d^2}$

If masses are doubled attraction forces increases.

19. (A)

Sol. $F = \int_R^{2R} \frac{GM\left(\frac{m}{R}\right)dx}{x^2} = \frac{GMm}{2R^2}$



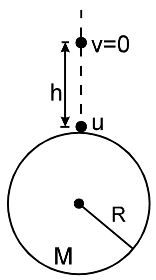
20. (A)

Sol. Let the object of mass m projected with speed $u = \sqrt{gR}$ reach a height 'h' above surface of earth.

Then from conservation of energy

$\frac{1}{2}mu^2 - \frac{GMm}{R} = -\frac{GMm}{R+h}$

$u^2 = gR = \frac{GM}{R}$



$\Rightarrow \quad \frac{1}{2}\frac{GMm}{R} - \frac{GMm}{R} = -\frac{GMm}{R+h}$ or

h = R

21. 4

Sol. $\frac{GMm}{r^2} = m\omega^2 r$

$\omega = \sqrt{\frac{GM}{r^2}}$

$T^2 = Cr^4$

22. 2

Sol. $V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G\left(\frac{4}{3}\pi R^3\right)\rho}{R}}$

$= V \propto R$

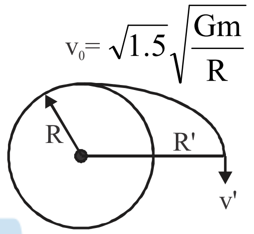
$\frac{V_1}{V_2} = \frac{R_1}{R_2} = 2$

23. 2

Sol. Apply momentum & energy conservation

momentum conservation

$mv_0 R = mv'R'$ ...(i)



R' → Maximum height

Energy conservation

$-\frac{GMm}{R} + \frac{1}{2}mV_0^2$

$= -\frac{GMm}{R'} + \frac{1}{2}mv'^2$ ...(ii)

From eq^n (i) & (ii)

R' = 3R

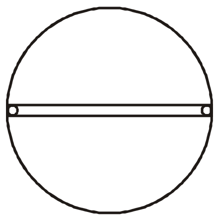
$\Rightarrow$ R = h = 3R

[$\therefore$ h $\rightarrow$ heigh from earth surface]

h = 2R

24. 3

Sol. T same $\Rightarrow$ they collide at mean



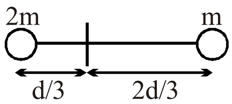
$\Rightarrow$ 2m × Rω – m × Rw

= 3 mAw

$\Rightarrow$ $A = \frac{R}{3}$

25. 80

Sol.



$$\Rightarrow \frac{G \times 2m^2}{d^2} = 2m \times \omega^2 \times d/3$$

$$\omega = \sqrt{\frac{3Gm}{d^3}}$$

$$T = 2\pi\sqrt{\frac{d^3}{3Gm}}$$

$$= 2\pi\sqrt{\frac{64 \times 10^{12}}{\pi^2 \times 3 \times \frac{2}{3} \times 10^{-10} \times 10^{20}}} = 80 \text{ ec.}$$

26. 16

Sol. $\frac{dA}{dt} = \frac{\pi R^2}{T}$

$$T^2 = \frac{4\pi^2}{GM}R^3$$

$$T = \frac{2\pi}{\sqrt{GM}}R^{3/2} \Rightarrow \frac{dA}{dT} = \frac{\pi R^2}{\frac{2\pi}{\sqrt{GM}}R^{3/2}}$$

$$\frac{\frac{dA_1}{dt}}{\frac{dA_2}{dt}} = \sqrt{\frac{R_1}{R_2}} = n \quad \Rightarrow \frac{R_1}{R_2} = n^2$$

27. 8

Sol. $v = \sqrt{\frac{GM}{R}} = \frac{11.2}{\sqrt{2}} \simeq 8$km/sec.

28. 8

Sol. $\frac{-GM \times 3M}{d} + \frac{1}{2}\mu V_{rel}^2 = 0$

$$\frac{+3GM^2}{d} = \frac{1}{2} \times \frac{3M^2}{4M} \times V_{rel}^2$$

$$\Rightarrow V_{rel}^2 = \frac{8GM}{d}$$

$$V_{rel} = \sqrt{\frac{8GM}{d}} \Rightarrow \eta = 8 \text{ Ans.}$$

29. 14 kg

Sol. $g = \omega^2 R = \frac{GM}{R^2}$

30. 4 J

Sol. $W_{ext} + W_g = 4K = 0$

$W_{ext} - m_4 V = 0$

$Wext = 2 \times \frac{4}{2} = 4$ J