Basic Forces and Kepler's Laws

1. Two identical spheres of gold are in contact with each other. The gravitational force of attraction between them is

1) Directly proportional to the square of their radius

2) Directly proportional to the cube of their radius

3) Directly proportional to the fourth power of their radius

4) Inversely proportional to the square of their radius.

2. Find the false statement

1) Gravitational force acts along the line joining the two interacting particles.

2) Gravitational force is independent of medium.

3) Gravitational force forms an action- reaction pair.

4) Gravitational force does not obey the principle of superposition.

3. Among the following find the wrong statement

1) Law of gravitation is framed using Newton's third law of motion.

2) Law of gravitation cannot explain why gravity exists.

3) Law of gravitation does not explain the presence of force even when the particles are not in physical contact.

4) When the range is long, gravitational force becomes repulsive.

4. Law of gravitation is not applicable if

A) Velocity of moving objects are comparable to velocity of light.

B) Gravitational field between objects whose masses are greater than the mass of sun.

1) A is true, B is false   2) A is false, B is true

3) Both A & B are true   4) Both A & B are false

5. **Statement A: Modification of space by a mass particle is called gravitational field**

Statement B: Law of gravitation is a consequence of "Action at a distance concept".

1) A is true, B is false 2) A is false, B is true

3) Both A & B are true 4) Both A & B are false

6. **The earth revolves round the sun in an elliptical orbit, its speed is**

1) Going on decreasing continuously 2) Greatest when it is closest to the sun

3) Greatest when it is farthest from the sun 4) Constant at all the points on the orbit

7. **How do you divide total mass M into two parts so that the gravitational force between them at a given distance is maximum?**

1) $\frac{M}{4}, \frac{3}{4}$ 2) $\frac{M}{3}, \frac{2M}{3}$ 3) $\frac{M}{5}, \frac{4M}{5}$ 4) $\frac{M}{2}, \frac{M}{2}$

8. **An infinite number of particles each of mass 1kg are placed on the positive x-axis at 1m, 2m, 4m, 8m…. from the origin. The magnitude of the resultant gravitational force on 1kg mass kept at the origin is**

1) 0 2) G 3) $\frac{3G}{4}$ 4) $\frac{4G}{3}$

9. **Two metal spheres of same material and radius 'r' are in contact with each other. The gravitational force of attraction between the spheres is given by (k in a constant).**

1) $F = kr^4$ 2) $F = k/r^2$ 3) $F = k/4r^2$ 4) $F = kr^2$

10. **Three uniform spheres each having mass 'm' and radius 'R' kept in such a way that each two touches the other. The magnitude of the gravitational force on any sphere, due to the other two is**

1) $\sqrt{3}\frac{Gm^2}{4R^2}$ 2) $\frac{Gm^2}{4R^2}$ 3) $\frac{\sqrt{3}Gm}{2R^2}$ 4) $\sqrt{3}\frac{Gm}{R^2}$

11. Two particles each of mass 'm' move in a circle of radius 'r' under the action of their mutual gravitational attraction. Then speed of each particle is

1) $\sqrt{\frac{Gm}{r}}$ 2) $\sqrt{\frac{Gm}{4r}}$ 3) $\sqrt{\frac{Gm}{2r}}$ 4) $\sqrt{\frac{2Gm}{r}}$

12. There are two bodies of masses 100kg and 10,000 kg separated by a distance of 1 metre. At what distance from the smaller body, will the intensity of the gravitational field be zero?

(1) 1/9m (2) 1/10m (3) 1/11m (4) 10/11m

13. If the distance between two bodies is increased by 25%, then the % change in the gravitational force is

1) Decreases by 36% 2) Increases by 36 %

3) Increases by 64% 4) Decreases by 64 %

14. The time period of revolution of a planet A around the sun is 8 times that of another planet B. The distance of planet A from the sun is how many times greater than that of the planet B from the sun

1) 2 2) 3 3) 4 4) 5

15. A planet revolves round the sun. Its velocity at the nearest point, distant d_1 from sun, is v_1. The velocity of the planet at the farthest point distant d_2 from sun will be.

(1) $\frac{d_1^2 v_1}{d_2^2}$ (2) $\frac{d_2 v_1}{d_1}$ (3) $\frac{d_1 v_1}{d_2}$ (4) $\frac{d_2^2 v_1}{d_1^2}$

16. A tunnel is dug along a diameter of earth. The force on a particle of mass m distant x from the centre in this tunnel will be

(1) $\frac{GM_e m}{R^3 x}$ (2) $\frac{GM_e m R^3}{x}$ (3) $\frac{GM_e m x}{R^2}$ (4) $\frac{GM_e m x}{R^3}$

17. Imagine a light planet is revolving round a very massive star in a circular orbit of radius R with a time period of revolution T. If the gravitational force of attraction between the star and planet is proportional to R^{-n}, then T^2 is proportional to

1) R^{n+1} 2) R^{n+2} 3) R^{n-1} 4) R^{n-2}

18. If two planets have their radii in the ratio x:y and densities in the ratio m:n, then the acceleration due to gravity on them are in the ratio

(1) nx/my (2) mx/ny (3) ny/mx (4) my/nx

19. If a planet of mass 'm' is revolving around the sun in a circular orbit of radius 'r' with time period T, then the mass of the sun is

1) $\frac{4\pi^2 r^3}{GT}$ 2) $\frac{4\pi^2 r^3}{GT^2}$ 3) $\frac{4\pi^2 r}{GT}$ 4) $\frac{4\pi^2 r^3}{G^2 T^2}$

21. A satellite is launched into circular orbit of radius R around the earth while a second satellite is launched into an orbit of Radius 1.02R. The percentage change in the time periods of the two satellites is

1) 0.7 2) 1.0 3) 1.5 4) 3

22. In a double star system, two stars of masses m_1 and m_2 separated by a distance d rotate about their centre of mass. Then their common angular velocity would be

1) $\sqrt{\frac{Gm_1}{d^3}}$ 2) $\sqrt{\frac{Gm_2}{d^3}}$ 3) $\sqrt{\frac{G(m_1+m_2)}{d^3}}$ 4) $\sqrt{\frac{d^3}{G(m_1+m_2)}}$

23. The magnitudes of the gravitational field at distance and from the centre of a uniform sphere of radius R and mass M are and respectively. Then:

1. $\frac{E_1}{E_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$
2. $\frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ and $r_2 > R$
3. $\frac{E_1}{E_2} = \frac{r_1^3}{r_2^3}$ if $r_1 < R$ and $r_2 < R$
4. $\frac{E_1}{E_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$

24. **A solid sphere of uniform density and radius R exerts attractive gravitational force F_1 on a particle placed at a distance 2R from the centre of the sphere. Now a spherical cavity of radius $\frac{R}{2}$ is made as shown. The remaining part of the sphere exerts a force F_2 on the same particle. Then** F_2/F_1

1) 2: 9 2) 7: 9 3) 5: 9 4) 1: 9

25. Newton's law of gravitation is universal because

1) It is always attractive

2) It acts on all heavenly bodies and particles

3) It acts on all the masses at all the distances and is not affected by the medium

4) None of these

Key

1) 3	2) 4	3) 4	4) 3	5) 3	6) 2	7) 4	8) 4	9) 1	10) 1
11) 2	12) 3	13) 1	14) 3	15) 3	16) 4	17) 1	18) 2	19) 2	20) 2
21) 4	22) 3	23) 2	25) 3						

Hints

7. Let the mass M is divided into x and (M -x) As $F \propto x(M-x)$ or F = K (Mx - x^2)

For F_{max}, $\frac{dF}{dx}=0$

$\therefore \frac{dF}{dx}=k\,(M-2x)=0 \Rightarrow x=\frac{M}{2}$

The two parts are $\frac{M}{2},\frac{M}{2}$

8. $F=\frac{G(1\times1)}{1^2}+\frac{G(1\times1)}{2^2}+\frac{G(1\times1)}{4^2}+........$

$F=G\left(1+\frac{1}{4}+\frac{1}{16}+.........\right)$

$=G\left(\frac{1}{1-1/4}\right)=\frac{4G}{3}\left(\therefore S_{G-P}=\frac{a}{1-r}\right)$

9. $F=\frac{Gm_1m_2}{r^2}=\frac{G\left(\frac{4}{3}\pi r^3\right)\rho\left(\frac{4}{3}\pi r^3\right)\rho}{r^2}$

$F\propto r^4$ or $F=Kr^4$

10. $F_R=\sqrt{3}\,F$ $F_R=\sqrt{F^2+F^2+2F^2\cos 60}$

$=\sqrt{3}\,\frac{Gm^2}{(2R)^2}=\sqrt{3}\,\frac{Gm^2}{4R^2}$

11. The gravitational force between the two particles provides the necessary centripetal force for rotation

$\frac{Gm^2}{(2r)^2}=\frac{mv^2}{r}\Rightarrow V=\sqrt{\frac{Gm}{4r}}$

12. Let the intensity be zero at a distance from 100kg mass. Then,

$\frac{G\times100}{x^2}=\frac{G\times10,000}{(1-x)^2}$

Taking root $\frac{1}{x}=\frac{10}{1-x}$ or $x=\frac{1}{11}m$

13. $\frac{F_1}{F_2}=\frac{d_2^2}{d_1^2}$

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

15. According to law of conservation of angular momentum $v_1d_1=v_2d_2$

Or $v_2=\frac{v_1d_1}{d_2}$

16. $F=G=\frac{M_xm}{x^2}$

Or $F=\frac{Gm}{x^2}.\frac{M}{\left(\frac{4}{3}\pi R^3\right)}\times\left(\frac{4}{3}\pi x^3\right)$

Or $F=\frac{GMm}{R^3}x$

17. If $\frac{GMm}{R^2}=m\ R\left(\frac{2\pi}{T}\right)^2 \Rightarrow T^2 \propto R^3$

But $\frac{GMm}{R^n}=m\ R\left(\frac{2\pi}{T}\right)^2$

$T^2 \propto R^{h+1}$

18. $g \propto Rd, g_1=k.xm, g_2=k.yn$

$\therefore g_1:g_2::xm:yn$

19. $\frac{GM_sm}{r^2}=m\ r\left(\frac{2\pi}{T}\right)^2$

$\Rightarrow M_s=\frac{4\pi^2r^3}{GT^2}$

20. $F_R=\sqrt{3}\ F=\frac{\sqrt{3}\ Gm}{a^2}$

But $F_R = F_{cp}$ for rotation

$$\sqrt{3}\,\frac{Gm}{a^2} = m\left(\frac{a}{\sqrt{3}}\right)\omega^2$$

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

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

$$2\frac{\Delta T}{T} = 3\frac{\Delta r}{r}$$

$$\frac{\Delta T}{T}\times 100 = \frac{3}{2}\left(\frac{\Delta r}{r}\times 100\right) = \frac{3}{2}\,(0.02)\times 100 = 3$$

22. $\frac{Gm_1m_2}{d^2} = m_1d_1\omega^2 = m_1\left(\frac{m_2d}{m_1+m_2}\right)\omega^2$

$$\Rightarrow \omega = \sqrt{\frac{G(m_1+m_2)}{d^3}}$$

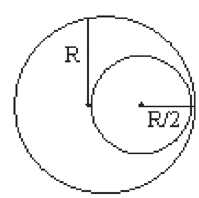
23. : If r≤R, then $E = \frac{GM}{R^3}(r) \Rightarrow E \propto r$

$\frac{E_1}{E_2} = \frac{r_1}{r_2}$ if r_1 < R and r_2 < R

If r≥R, then $E = \frac{GM}{r^2}(r) \Rightarrow E \propto \frac{1}{r^2}$

$\Rightarrow \frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$ if r_1 > R and r_2 > R

24. Gravitational force on mass m due to whole sphere



$$F_1 = \frac{GMm}{(2R)^2} = \frac{GMm}{4R^2}$$

Gravitational force due to the removed sphere,

$$F_2^1 = \frac{G\frac{M}{8}\times m}{\left(R+\frac{R}{2}\right)^2} = \frac{GMm}{18R^2} \quad F_2 = F_1 - F_2^1 = \frac{GMm}{4R^2} - \frac{GMm}{18R^2}$$

$$F = \frac{7}{36}\,\frac{GMm}{R^2} \Rightarrow \frac{F_2}{F_1} = \frac{7}{9}$$