IMPORTANT QUESTIONS CLASS – 11 PHYSICS CHAPTER – 7 GRAVITATION

1.State two essential requisites of geostationary satellite?

Ans.(1) The period of revolution of a satellite around the earth should be same as that of earth about its own axis (T=24hrs)

(2) The sense of rotation of satellite should be same as that of the earth about its own axis i.e. from west to east in anti-clockwise direction

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2.Show that an artificial satellite circling round the earth in an orbit of radius obeys keeper's third low?

Ans. Orbital velocity of a satellite is

$$\upsilon = \sqrt{\frac{GM}{r}}$$

Where M is the crass of earth $\frac{2\pi r}{\sqrt{\frac{GM}{r}}}$

Time period of satellite T = $\frac{2\pi r}{\upsilon}$

T =

T = $2\pi\sqrt{\frac{r^3}{GM}}$

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

Thus $T^2 \alpha r^3$

$\frac{4\pi^2}{GM}$ = R (constant)

Hence proved.

3.A 400kg satellite in a circular orbit of radius 2 Re about the earth calculate the kinetic energy potential energy and total energy of the satellite?

$R_E = 6.4\times10^6$m

$M = 6\times10^{24}$kg

Ans. $M = 6\times10^{24}$ kg M = 400 kg

$R_E = 6.4\times10^6$m

Hence $r = 2R_E = 12.8\times10^6$m

$G = 6.67\times10^{-4}$ N m²/kg²

KE = $\frac{Gmm}{2r} = \frac{6.67\times10-11\times6\times1}{}$

$$\frac{Gmm}{2r} = \frac{6.67\times10^{-11}\times6\times10^{24}\times400}{2(12.8\times10^6)}$$

$$KE = 6.25\times10^9\ Joules$$

P. E. = $\frac{-2GMm}{2r} = -2K.E$

PE = -2 x 6.25 x 10^9 = -12.5× 10^9 Joules

T. E. = K. E + P. E

T. E. = 6.25 ×10^9 – 12.50 × 10^9

T. E. = 6.25 × 10^9 Joules

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4. Answer the following:

(a) You can shield a charge from electrical forces by putting it inside a hollow conductor. Can you shield a body from the gravitational influence of nearby matter by putting it inside a hollow sphere or by some other means?

(b) An astronaut inside a small space ship orbiting around the earth cannot detect gravity. If the space station orbiting around the earth has a large size, can he hope to detect gravity?

(c) If you compare the gravitational force on the earth due to the sun to that due to the moon, you would find that the Sun's pull is greater than the moon's pull. (You can check this yourself using the data available in the succeeding exercises). However, the tidal effect of the moon's pull is greater than the tidal effect of sun. Why?

Ans. (a) No (b) Yes

(a) Gravitational influence of matter on nearby objects cannot be screened by any means. This is because gravitational force unlike electrical forces is independent of the nature of the material medium. Also, it is independent of the status of other objects.

(b) If the size of the space station is large enough, then the astronaut will detect the change in Earth's gravity (g).

(c) Tidal effect depends inversely upon the cube of the distance while, gravitational force depends inversely on the square of the distance. Since the distance between the Moon and the Earth is smaller than the distance between the Sun and the Earth, the tidal effect of the Moon's pull is greater than the tidal effect of the Sun's pull.

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5. Does the escape speed of a body from the earth depend on

(a) the mass of the body,

(b) the location from where it is projected,

(c) the direction of projection,

(d) the height of the location from where the body is launched?

Ans.

(a) No

(b) No

(c) No

(d) Yes

Escape velocity of a body from the Earth is given by the relation:

………………(i)

g = Acceleration due to gravity

R = Radius of the Earth

It is clear from equation (i) that escape velocity *v*esc is independent of the mass of the body and the direction of its projection. However, it depends on gravitational potential at the point from where the body is launched. Since this potential marginally depends on the height of the point, escape velocity also marginally depends on these factors.

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6. A comet orbits the Sun in a highly elliptical orbit. Does the comet have a constant (a) linear speed, (b) angular speed, (c) angular momentum, (d) kinetic energy, (e) potential energy, (f) total energy throughout its orbit? Neglect any mass loss of the comet when it comes very close to the Sun.

Ans.

(a) No

(b) No

(c) Yes

(d) No

(e) No

(f) Yes

Angular momentum and total energy at all points of the orbit of a comet moving in a highly elliptical orbit around the Sun are constant. Its linear speed, angular speed, kinetic, and potential energy varies from point to point in the orbit.

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7. As you have learnt in the text, a geostationary satellite orbits the earth at a height of nearly 36,000 km from the surface of the earth. What is the potential due to earth's gravity at the site of this satellite? (Take the potential energy at infinity to be zero). Mass of the earth = kg, radius = 6400 km.

Ans. Mass of the Earth, M = 6.0×10^{24} kg

Radius of the Earth, R = 6400 km = 6.4×10^{6} m

Height of a geostationary satellite from the surface of the Earth,

h = 36000 km = 3.6×10^{7} m

Gravitational potential energy due to Earth's gravity at height h,

$$= \frac{-GM}{(R+h)}$$

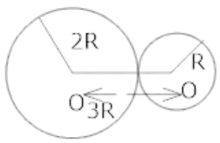
$$= \frac{6.67\times10^{-11}\times6.0\times10^{24}}{3.6\times10^{7}+0.64\times10^{7}}$$

$$= \frac{6.67 \times 6}{4.24} \times 10^{13-7}$$

$$= -9.4 \times 10^6 J/kg$$

8.Two uniform solid spheres of radii R and 2R are at rest with their surfaces just touching. Find the force of gravitational attraction between them if density of spheres be P?

Ans. Two spheres of density p and radii R and 2R



s = oo^1 = 2R+R=3R

$$F = \frac{Gm_1m_2}{r^2}$$

$$F = \frac{G\left(\frac{4}{3}\pi p(2R)^3\right)\left(\frac{4}{3}\pi pR^3\right)}{(3R)^2}$$

$$F = \frac{128}{27}\pi^2 GP^2R^4$$

9.Find expressions for (1) potential energy (2) kinetic energy (3) total energy for an artificial satellite.

Ans. Potential energy of a satellite

$$U = \int_{\infty}^{r} F \, dx$$

$$U = \int_{\infty}^{r} \frac{GMm}{x^2} dx$$

$$U = GMm \int_{\infty}^{r} \frac{1}{x^2} dx$$

$$U = GMm \left| -\frac{1}{x} \right|_{\infty}^{r}$$

U =GMm $\left[-\frac{1}{r}+\frac{1}{\infty}\right]$

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

Kinetic energy KE = $\frac{1}{2}mv^2$

But $v=\sqrt{\frac{GM}{r}}$

K. E = $\frac{1}{2}m\left(\frac{GM}{r}\right)$

KE = $\frac{GMm}{2r}$

Total energy of satellite E = $U+v$

E = − $\frac{GMm}{r}+\frac{GMm}{2r}$

E = − $\frac{GMm}{2r}$

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10. Suppose there existed a planet that went around the sun twice as fast as the earth. What would be its orbital size as compared to that of the earth?

Ans. Lesser by a factor of 0.63

Time taken by the Earth to complete one revolution around the Sun,

T_e = 1 year

Orbital radius of the Earth in its orbit, R_e = 1 AU $T_p=\frac{1}{2}T_e=\frac{1}{2}\,year$

Time taken by the planet to complete one revolution around the Sun,

Orbital radius of the planet = R_p

From Kepler's third law of planetary motion, we can write:

$$\left(\frac{R_p}{R_e}\right)^3 = \left(\frac{T_p}{T_e}\right)^2$$

$$\frac{R_p}{R_e} = \left(\frac{T_p}{T_e}\right)^{\frac{2}{3}}$$

$$= \left(\frac{\frac{1}{2}}{1}\right)^{\frac{2}{3}} = (0.5)^{\frac{2}{3}} = 0.63$$

Hence, the orbital radius of the planet will be 0.63 times smaller than that of the Earth.