CLASS – 11

WORKSHEET- GRAVITATION

A. KEPLER'S LAW

(1 Mark Questions)

1. Kepler's second law is a consequence of
   (a) conservation of energy (b) conservation of linear momentum
   (c) conservation of angular momentum (d) conservation of mass

2. When will the Kepler's law be applicable on the planets?

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(3 Marks Questions)

3. State and explain the Kepler's laws of planetary motion.

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4. State and explain Kepler's laws of planetary motion. Name the physical quantities which remain constant during the planetary motion.

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5. (a) According to Kepler's second law, the radius vector to a planet from the sun sweeps out equal areas in equal interval and time. The law is consequence of which conservation law.
   (b) State Kepler's third law.

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B. NEWTON'S LAW OF GRAVITATION

(1 Mark Questions)

1. What are the dimensions of gravitational constant?

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(2 Marks Questions)

2. Two bodies of masses 4kg and 9kg are separated by a distance of 60cm. A 1kg mass is placed in between these two masses. What is its distance from 4kg mass, if the net force on 1kg is zero?

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3. Calculate the force of attraction between two balls each of mass 1kg, when their centres are 10cm apart. Given $G = 6.67\times10^{-11}\ Nm^2\ kg^{-2}$. [Ans. 6.67×10^{-9} N]

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4. State Newton's law of gravitation. Hence define universal gravitational constant. Give the value and dimensions of G.

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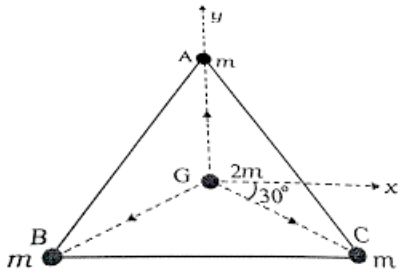
(5 Marks Questions)

5. Three equal mass of m kg each are fixed at the vertices of an equilateral triangle ABC as shown in figure.



(a) What is the force acting on a mass 2m placed at the centroid G of the triangle?
(b) What is the force if the mass at the vertex A is doubled?
Take AG = BG = CG = 1cm.

C. GRAVITATIONAL FIELD AND POTENTIAL

(1 Mark Questions)

1. Is it possible to shield a body from gravitational effects?

(3 Marks Questions)

2. Two identical heavy spheres are separated by a distance 10 times their radii. Determine the potential at the midpoint. Is an object placed at that point in stable or unstable equilibrium?

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3. Two bodies of mass 10kg and 1000kg are at a distance 1m apart. At which point on the line joining them will the gravitational field intensity be zero? [Ans. 1/11m]

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4. Two masses, 800kg and 600kg are at a distance 0.25m apart. Compute the magnitude of the intensity of the gravitational field at a point distant 0.20m from the 800kg mass and 0.15m from the 600kg mass. [Ans. 2.22×10^{-6}N]

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D. ACCELERATION DUE TO GRAVITY

(1 Mark Questions)

1. What would be the weight of the body inside the earth if it were a hollow sphere?

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2. Why does the weight of a body become zero at the centre of the earth?

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3. The mass and diameter of the planet are twice those of the earth. What will be the time period of the pendulum on this planet, which is a second's pendulum on the earth?

[Ans.$2\sqrt{2}$s]

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4. If the change in the value of 'g' at a height 'h' above the surface of the earth is same as that at a depth 'x' below it (both x and h being much smaller than the radius of earth), then how are x and h related to each other?

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5. If the radius of the earth shrinks by 1%, its mass remaining the same by what percentage will the acceleration due to gravity on its surface change?

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6. What is weightlessness?

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(2 Marks Questions)

7. A person sitting in a satellite of Earth feels weightlessness but a person standing on Moon has weight though Moon is also a satellite of Earth. Why?

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8. The acceleration due to gravity at the moon's surface is 1.67 ms^{-2}. If the radius of the moon is 1.74×10^{6}m, calculate the mass of the moon. Use the known value of G.

[Ans. 7.58×10^{22} kg]

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9. Prove that acceleration due to gravity on the surface of the earth is given by $g = 4/3\ \pi\ \rho$ GR, where G is gravitational constant, ρ is mean density and R is the radius of the earth.

10. Why is the weight of the body at the poles more than the weight at the equator? Explain.

11. Define acceleration due to gravity. Show that the value of 'g' decreases with altitude or height.

(3 Marks Questions)

12. How much above the earth surface does the acceleration due to gravity reduces by 36% if its value on the earth surface? Take the value of radius of earth 6400km.

13. If the earth were made of lead of relative density 11.3, what then would be the value of acceleration due to gravity on the surface of the earth? Radius of the earth = 6.4×10^{6}m and G = 6.67×10^{-11} Nm^2 kg^{-2}. [Ans. 22.21 m/s^2]

14. If the radius of the earth shrinks by 2.0%, mass remaining constant, then how would the value of acceleration due to gravity change?

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15. A body weighs 90kg f on the surface of the earth. How much will it weight on the surface of Mars whose mass is 1/9 and the radius is ½ of that of the earth? [Ans. 40 kg f]

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16. Determine the speed with which the earth would have to rotate on its axis so that a person on the equator would weigh $3/5^{th}$ as much as a t present. Take the equatorial radius as 6400 km. [Ans. 7.8×10^{-4} rad s^{-1}]

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(5 Marks Questions)

17. (a) Derive an expression showing variation of acceleration due to gravity with height.
(b) (i) A body weighs 6.3N on the surface of the earth. What is the geometrical force on it due to the earth at a height equal to half the radius of the earth?
(ii) Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to the centre of the earth if it weighed 250N on the surface?

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E. GRAVITATIONAL POTENTIAL ENERGY AND ESCAPE VELOCITY

(1 Mark Questions)

1. Why do different planets have different escape velocities?

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(2 Marks Questions)

2. The escape speed of a projectile on the earth's surface is 11.2 km/s. A body is projected out with thrice this speed. What is the speed of the body far away from the earth? Ignore the presence of the sun and other planets.

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3. Determine the escape velocity of a body from the moon. Take the moon to be uniform sphere of radius 1.76×10^{6}m, and mass 7.36×10^{22}kg. Given G = 6.67×10^{-11} Nm^2 kg^{-2}. [Ans. 2.375 km s^{-1}]

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(3 Marks Questions)

4. A rocket is fired from the earth towards the sun. At what distance from the earth's centre is the gravitational force on the rocket zero? Mass of the sun = 2×10^{30} kg, mass of the earth = 6×10^{24} kg. Neglect the effect of other planets etc. (orbital radius = 1.5×10^{11} m).

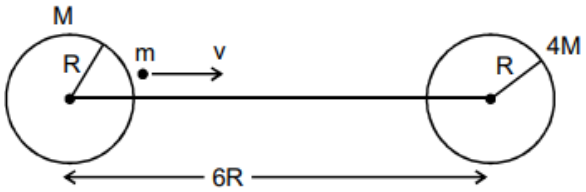
5. Define escape velocity. Derive and expression for the escape velocity of a body from the surface of the earth. Write any two significant features of this velocity.

6. Find the potential energy of a system of four particles, each of mass m, placed at the vertices of a square of side 1. Also obtain the potential at the centre of the square.

(5 Marks Questions)

7. Calculate the speed v with which a projectile should be launched from the surface of Earth so as to reach a height equal to one fourth of Earth's radius, R.

8. Two uniform solid spheres of equal radii R , but mass M and 4M have a centre to centre separation 6R, as shown in the figure. The two spheres are held fixed. A projectile of mass m is projected from the surface of the sphere of mass M directly towards the centre of the second sphere. Obtain an expression for the minimum speed v of the projectile so that it reaches the surface of the second sphere.



F. PLANET AND SATELLITES

(1 Mark Questions)

1. The orbit of satellite is
   (a) circular (b) elliptic (c) helical (d) both (a) and (b)

2. A satellite of small mass burns during its descent and not during ascent. Why?

3. Why are space rockets usually launched from west to east in the equatorial plane?

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4. Two satellites are at different heights. Which would have greater velocity?

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5. What is parking orbit?

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6. The height of a geostationary satellite is
(a) 1000 km (b) 32000 km (c) 36000 km (d) 850 km

7. Weightlessness in satellite is due to
(a) zero gravitational acceleration (b) zero acceleration
(c) zero mass (d) none of these

8. The artificial satellite does not have any fuel, but even it remains in its orbit around the earth. Why?

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9. A satellite revolves close to the surface of a planet. How is its orbital velocity related with velocity of escape from that planet?

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10. What is (i) period of revolution and (ii) sense of rotation of a geostationary satellite?

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11. What are the time period and height of a geostationary satellite above the surface of the earth?

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(2 Marks Questions)

12. What is the direction of a real velocity of the earth around the sun?

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13. What are the necessary conditions for a satellite to appear stationary?

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14. A geo-stationary satellite orbits around the earth in a circular orbit of radius 36,000km. Then what will be the time period of a spy satellite orbiting a few hundred km above the earth's surface (R_{earth} = 6,400km)? [Ans. 2h]

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(3 Marks Questions)

15. Two mean orbital radius of the earth around the sun is 1.5×10^{8} km. Calculate the mass of the sun if $G = 6.67\times10^{-11}$ Nm^2 kg^{-2}. [Ans. 2.01×10^{30}kg]

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16. An earth's satellite makes a circle around the earth in 90 minutes. Calculate the height of the satellite above the earth's surface. Given radius of the earth is 6400 km and g = 980 cms^{-2}. [Ans. 268km]

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17. Define the term orbital speed, Establish a relation for orbital speed of a satellite orbiting very close to the surface of the earth. Find the ratio of this orbital speed and escape speed.

(5 Marks Questions)

18. (a) Define Orbital Velocity and establish an expression for it.
(b) Calculate the value of orbital velocity for an artificial satellite of earth orbiting at a height of 1000 km.
Given: Mass of earth = 6×10^{24} kg, Radius of earth = 6400 km