PHYSICS – CLASS XI

Chapter 7 : Gravitation

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

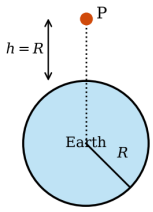
(d) Use of calculators is not permitted. Take $g = 10\ \text{m s}^{-2}$ at the surface of the Earth, $G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$ and $\pi = 3.14$ unless a different value is given in the question.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

Questions 1 to 8 carry 1 mark each.

1. A point P is at a height equal to the radius R of the Earth above its surface (figure). If g is the acceleration due to gravity on the surface, its value at P is **(1)**

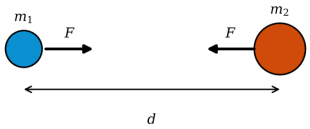


(a) $g/2$
(b) $g/4$
(c) $g/9$
(d) $g/3$

2. A planet moves around the Sun in a circular orbit of radius 9 times the radius of the Earth's orbit. Its time period of revolution, in years, is **(1)**

(a) 3
(b) 9
(c) 27
(d) 81

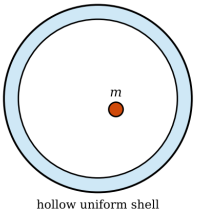
3. Two point masses m_1 and m_2 attract each other with a force F when separated by a distance d (figure). If the distance is doubled and each mass is also doubled, the force between them becomes **(1)**



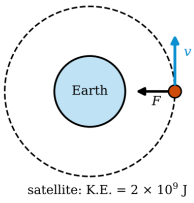
(a) $F/4$
(b) $F/2$
(c) F
(d) $4F$

4. **Assertion (A):** An astronaut inside an orbiting satellite experiences weightlessness. **(1)**
Reason (R): The gravitational force on the astronaut at that height is zero.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

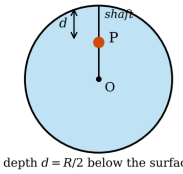
5. A small mass m is placed inside a hollow spherical shell of uniform density (figure). What is the net gravitational force on m due to the shell? **(1)**



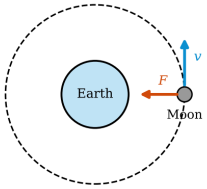
6. A satellite moves in a circular orbit around the Earth with kinetic energy 2×10^9 J (figure). Find its total mechanical energy. **(1)**



7. A body is taken to a point P in a mine at a depth $d = R/2$ below the Earth's surface (figure). Assuming uniform density, find the acceleration due to gravity at P. **(1)**



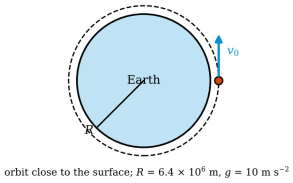
8. The Moon moves around the Earth in a nearly circular orbit (figure). How much work is done by the gravitational force of the Earth on the Moon in one complete revolution? Give a reason. **(1)**



SECTION B

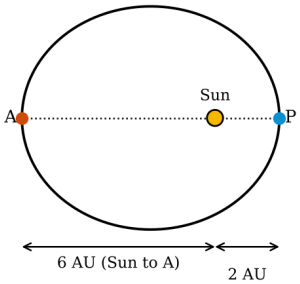
Questions 9 to 12 carry 2 marks each.

9. A satellite revolves very close to the surface of the Earth (figure). Taking $R = 6.4 \times 10^6$ m and $g = 10$ m s^{-2}, find (i) its orbital speed and (ii) its time period (in minutes). **(2)**

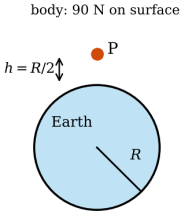


orbit close to the surface; $R = 6.4 \times 10^6$ m, $g = 10$ m s^{-2}

10. A planet moves around the Sun in an elliptical orbit. Its closest distance (perihelion P) from the Sun is 2 AU and its farthest distance (aphelion A) is 6 AU (figure). Find (i) the semi-major axis of the orbit and (ii) the time period of the planet, using Kepler's law of periods ($T^2 = a^3$, with T in years and a in AU). **(2)**



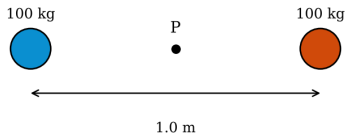
11. A body weighs 90 N on the surface of the Earth. What will be its weight at a height $R/2$ above the surface (figure), where R is the radius of the Earth? **(2)**



OR

A body weighs 90 N on the surface of the Earth. What will be its weight at a depth $R/3$ below the surface? Assume the Earth to be of uniform density.

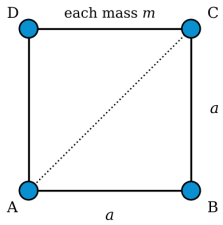
12. Two uniform spheres of mass 100 kg each are held 1.0 m apart, and P is the mid-point of the line joining their centres (figure). Find (i) the gravitational field and (ii) the gravitational potential at P. Take $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}. **(2)**



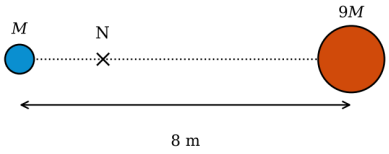
SECTION C

Questions 13 to 15 carry 3 marks each.

13. Four equal point masses m are placed at the corners A, B, C and D of a square of side a (figure). Find (i) the magnitude of the force on the mass at A due to the mass at B (or at D), (ii) the magnitude of the force on it due to the mass at C, and (iii) the magnitude and direction of the resultant force on the mass at A. **(3)**

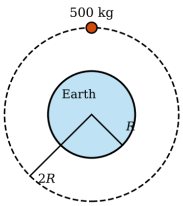


14. Two stars of masses M and $9M$ are 8 m apart (figure). N is the neutral point on the line joining them where the net gravitational force on a small mass is zero. (i) Write the condition satisfied at N. (ii) Find the distance of N from the mass M. (iii) Is a small mass placed at N in stable or unstable equilibrium? Give a reason. **(3)**

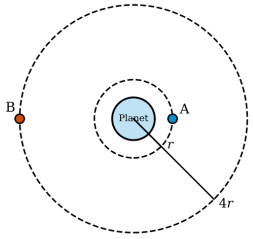


OR

A satellite of mass 500 kg moves in a circular orbit of radius $2R$ around the Earth (figure). Taking $g = 10$ m s^{-2} and $R = 6.4 \times 10^6$ m, find (i) its kinetic energy, (ii) its potential energy and (iii) its total energy. (Use $GM = gR^2$.)



15. Two satellites A and B of the same mass revolve in circular orbits of radii r and $4r$ around the same planet (figure). Find the ratio (i) of their time periods T_B/T_A, (ii) of their orbital speeds v_A/v_B and (iii) of their centripetal accelerations a_A/a_B. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

16. A rocket is launched radially from the surface of a planet X of radius $R = 5 \times 10^6$ m, on which the acceleration due to gravity is 10 m s^{-2} (figure). **(5)**

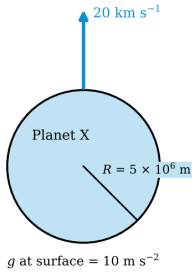
(a) Define escape speed. (1)

(b) Show that the escape speed from the surface of a planet is $\sqrt{(2gR)}$. (1)

(c) Find the escape speed from planet X. (1)

(d) Show that the escape speed is $\sqrt{2}$ times the orbital speed of a satellite revolving very close to the surface. (1)

(e) The rocket is launched at 20 km s^{-1}. Find its speed very far away from the planet (neglect air resistance). (1)



OR

A satellite of the planet in Q.16 (radius $R = 5 \times 10^6$ m, $g = 10$ m s^{-2}) revolves at a height $h = R$ above its surface (figure). Take $\pi = 3.14$.

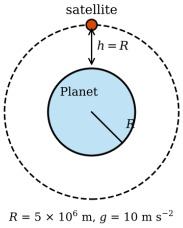
(a) Write the expression for the orbital speed of a satellite at a distance r from the centre of the planet. (1)

(b) Find the acceleration due to gravity at the height of the satellite. (1)

(c) Find the orbital speed of the satellite. (1)

(d) Find its time period in seconds. (1)

(e) Why does an astronaut in the satellite feel weightless? (1)



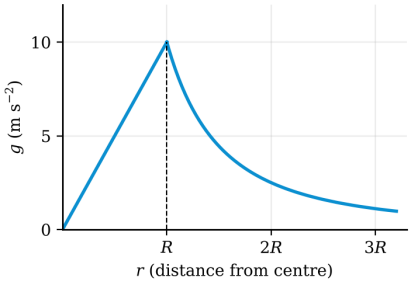
17. The graph shows how the acceleration due to gravity g varies with the distance r from the centre of the Earth, assumed to be a uniform sphere of radius R, with $g = 10\ \text{m s}^{-2}$ at the surface (figure). **(5)**

(a) Write the expression for g at a distance $r < R$ from the centre in terms of g, r and R. (1)

(b) Find g at $r = R/2$. (1)

(c) Find g at $r = 2R$. (1)

(d) At what two distances from the centre is the value of g equal to $5\ \text{m s}^{-2}$? (2)



OR

In a Cavendish experiment (figure) two small lead spheres, each of mass $m = 0.1$ kg, are fixed at the ends of a light rod of length $L = 0.2$ m suspended by a fine wire. Two large spheres, each of mass $M = 10$ kg, are brought near them so that the centre-to-centre distance is $d = 0.1$ m.

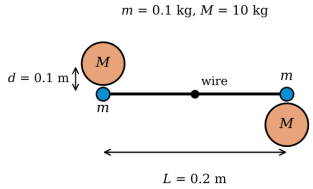
(a) What was the aim of this experiment? (1)

(b) Find the force between a large sphere and its neighbouring small sphere. (1)

(c) Find the torque on the rod. (1)

(d) The restoring torque per unit twist of the wire is $4 \times 10^{-7}\ \text{N m rad}^{-1}$. Find the angle of twist θ. (1)

(e) Write the expression for G in terms of the measured quantities. (1)



— END OF QUESTION PAPER —