Class XI Physics - Unit Test Question Paper - Gravitation

Time Allowed: 1 Hour 30 Minutes Maximum Marks: 40

Name: _____Roll No.: _____Date:_____

General Instructions

1. All questions are compulsory.
2. The question paper is divided into four sections: A, B, C and D.
3. Use of calculators is not permitted.
4. Draw neat, labelled diagrams wherever necessary.
5. Show all steps in numerical problems. Answers without proper working may not receive full marks.
6. Use the following values wherever required:

G = 6.67 x10^-11\ Nm^2kg^{-2} | g = 9.8\ ms^{-2} | R = 6.4 \times 10^6\ m

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SECTION A – OBJECTIVE TYPE QUESTIONS (8 × 1 = 8 Marks)

Q1. The square of the time period of revolution of a planet is proportional to:

(a) Its orbital radius (b) The square of its orbital radius
(c) The cube of its semi-major axis (d) The inverse of its semi-major axis

Q2. The gravitational force between two bodies becomes one-fourth of its initial value when the distance between them is:

(a) Doubled (b) Halved (c) Tripled (d) Quadrupled

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Q3. The value of acceleration due to gravity at the centre of the Earth is:

(a) (g) (b) (2g) (c) Zero (d) Infinite

Q4. The gravitational potential energy of two masses separated by a distance (r), taking zero potential energy at infinity, is:

(a) +(GMm/r) (b) -(GMm)/r (c) GMm/r2 (d) Zero

Q5. An astronaut experiences weightlessness inside an orbiting satellite because:

(a) There is no gravitational force in space.
(b) The astronaut is outside the Earth's gravitational field.
(c) Both the astronaut and satellite are in free fall.
(d) The mass of the astronaut becomes zero.

Q6. The escape speed from the Earth's surface is approximately:

(a) 7.9 km/s (b) 9.8 km/s (c) 11.2 km/s (d) 15.0 km/s

Q7. The gravitational force inside a uniform hollow spherical shell is:

(a) Maximum at the centre (b) Zero at every point inside (c) Constant everywhere
(d) Directed towards the nearest point on the shell

Q8. If the orbital radius of a satellite is increased, its orbital speed:

(a) Increases (b) Decreases (c) Remains constant (d) Becomes zero

SECTION B – VERY SHORT ANSWER QUESTIONS (4 × 2 = 8 Marks)

Q9. State Kepler's three laws of planetary motion.

Q10. Define the universal gravitational constant. Write its SI unit and dimensional formula.

Q11. Why is the gravitational potential energy of a body negative when the potential energy at infinity is taken as zero?

Q12. Distinguish between gravitational potential and gravitational potential energy. Write the SI unit of each.

SECTION C – SHORT ANSWER / NUMERICAL QUESTIONS (3 × 3 = 9 Marks)

Q13. Derive the expression for acceleration due to gravity at a height (h) above the Earth's surface. Hence, obtain the approximate expression for (h \ll R_E).

Q14. A body weighs 600 N on the surface of the Earth. Calculate its weight at a height equal to the radius of the Earth above the surface.

Q15. A planet revolves around the Sun in a circular orbit of radius (4R). Another planet revolves around the same Sun in an orbit of radius (R). Find the ratio of their time periods.

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SECTION D – LONG ANSWER / APPLICATION-BASED QUESTIONS (3 × 5 = 15 Marks)

Q16.
(a) State Newton's universal law of gravitation.
(b) Derive the mathematical expression for the gravitational force between two point masses.
(c) Explain the principle of superposition of gravitational forces.

Q17.
(a) What is escape speed?
(b) Derive an expression for the escape speed of a body projected from the Earth's surface.
(c) Calculate its approximate value using the given data.

Q18. A satellite of mass 500 kg revolves around the Earth in a circular orbit at a height of 640 km above its surface.

Calculate:

(a) The orbital radius of the satellite.
(b) The orbital speed of the satellite.
(c) The total mechanical energy of the satellite.

Given: M = 6.0 X 10^{24}\ kg R = 6.4 x 10^6\ m[G = 6.67 x 10^{-11}\ Nm^2kg^{-2}