

STUDYNEST | CLASS 11 PHYSICS QUESTION PAPER 1

Chapter 7: Gravitation

Maximum Marks: 40 | Suggested time: 60 minutes

Instructions: Answer all questions. Show calculation steps and units. Original practice paper, not an official examination.

Section A 1-mark questions - $8 \times 1 = 8$ marks

1. Kepler's law of equal areas? [1]
2. Universal gravitation law? [1]
3. SI unit of G ? [1]
4. g at surface of a spherical planet? [1]
5. Gravitational potential energy zero at infinity? [1]
6. Does escape speed depend on launched mass? [1]
7. What supplies centripetal force to a satellite? [1]
8. Kepler's third law for fixed central mass? [1]

Section B 2-mark questions - $6 \times 2 = 12$ marks

9. Force between 2 kg and 3 kg 1 m apart; $G=6.67 \times 10^{-11}$. [2]
10. Weight of 50 kg for $g=9.8$? [2]
11. If orbit radius doubles, circular-speed factor? [2]
12. At altitude $h=R$, ratio g_h/g ? [2]
13. Approximate potential-energy change for small height h ? [2]
14. If orbital radius becomes $4r$, period factor? [2]

Section C 3-mark questions - $4 \times 3 = 12$ marks

15. Find g at height $h=R/2$ relative to surface g . [3]
16. Escape speed for $g=5 \text{ m/s}^2$ and $R=2 \times 10^6 \text{ m}$? [3]
17. $GM=4 \times 10^{14}$, $r=7 \times 10^6 \text{ m}$: orbital speed? [3]
18. Weight is 600 N at surface. Weight at $h=R$? [3]

Section D 4-mark questions - $2 \times 4 = 8$ marks

19. Derive circular orbital speed and period. [4]
20. 1000 kg satellite at $r=7 \times 10^6 \text{ m}$, $GM=4 \times 10^{14}$. Find speed and energy. [4]

End of question paper.

FORMULA AND EQUATION REFERENCE

Chapter-specific equations worth knowing

- Newton gravitation: $F = Gm_1m_2/r^2$; $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$.
- Surface gravity: $g = GM/R^2$; at radius r from the centre, $g(r) = GM/r^2$.
- At altitude h : $g_h/g = (R/(R+h))^2$; weight $W = mg$.
- Gravitational potential energy: $U = -GMm/r$; small-height change near surface $\Delta U \approx mgh$.
- Circular orbit: $v = \sqrt{GM/r}$; $T = 2\pi \sqrt{r^3/(GM)}$; hence T^2 proportional to r^3 .
- Escape speed: $v_e = \sqrt{2GM/R} = \sqrt{2gR}$.
- Circular orbit total energy: $E = -GMm/(2r)$; orbital kinetic energy $K = GMm/(2r)$.
- Kepler's second law: equal areas are swept in equal times.

Use each equation only when its assumptions apply; keep units consistent.

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STEP-BY-STEP SOLUTIONS

Solutions are grouped here after the question paper and formula reference.

Question 1

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: The radius vector sweeps equal areas in equal times.

Final answer: The radius vector sweeps equal areas in equal times.

Question 2

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: $F = Gm_1m_2/r^2$.

Final answer: $F = Gm_1m_2/r^2$.

Question 3

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: $N \text{ m}^2 \text{ kg}^{-2}$.

Final answer: $N \text{ m}^2 \text{ kg}^{-2}$.

Question 4

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: $g = GM/R^2$.

Final answer: $g = GM/R^2$.

Question 5

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: $U = -GMm/r$.

Final answer: $U = -GMm/r$.

Question 6

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: No.

Final answer: No.

Question 7

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: Gravity.

Final answer: Gravity.

Question 8

Principle / definition: Recall the relevant definition or equation from the formula reference.

Apply it to this question: T^2 proportional to r^3 .

Final answer: T^2 proportional to r^3 .

Question 9

Working: $F = Gm_1m_2/r^2 = (6.67 \times 10^{-11})(2)(3)/(1^2) = 4.002 \times 10^{-10} \text{ N}$, or $4.00 \times 10^{-10} \text{ N}$.

Final answer: $4.00 \times 10^{-10} \text{ N}$.

Question 10

Working: Weight $W = mg = 50(9.8) = 490 \text{ N}$.

Final answer: 490 N.

Question 11

Working: $v = \sqrt{GM/r}$. If r becomes $2r$, $v_{\text{new}}/v_{\text{old}} = \sqrt{r/(2r)} = 1/\sqrt{2}$.

Final answer: $1/\sqrt{2}$.

Question 12

Working: Altitude $h = R$ makes the distance from the centre $2R$. Since g is proportional to $1/r^2$, $g_h/g = R^2/(2R)^2 = 1/4$.

Final answer: $1/4$.

Question 13

Working: For a small height above the surface, $\Delta U = mgh$, assuming g is approximately constant.

Final answer: $\Delta U = mgh$.

Question 14

Working: Kepler's third law gives T proportional to $r^{3/2}$. If radius becomes $4r$, $T_{\text{new}}/T_{\text{old}} = 4^{3/2} = 8$.

Final answer: 8.

Question 15

Working: At $h = R/2$, the distance from centre is $R + h = 1.5R$. Therefore $g_h/g = (R/1.5R)^2 = 1/2.25 = 4/9$.

Final answer: $g_h/g=(2/3)^2=4/9$.

Question 16

Working: $v_{\text{escape}}=\sqrt{2gR}=\sqrt{2(5)(2\times 10^6)}=\sqrt{2\times 10^7}=4.47\times 10^3$ m/s.

Final answer: $\sqrt{2gR}=4.47 \times 10^3$ m/s.

Question 17

Working: $v=\sqrt{GM/r}=\sqrt{(4\times 10^{14})/(7\times 10^6)}=\sqrt{5.714\times 10^7}=7.56\times 10^3$ m/s.

Final answer: $\sqrt{GM/r}\approx 7.56 \times 10^3$ m/s.

Question 18

Working: At $h=R$, gravity is one quarter of surface gravity. Weight is therefore $600/4=150$ N.

Final answer: 150 N.

Question 19

Working: Set gravity equal to centripetal force: $GMm/r^2=mv^2/r$. Cancel m and solve: $v=\sqrt{GM/r}$. Then $T=2\pi r/v=2\pi \sqrt{r^3/GM}$.

Final answer: $GMm/r^2=mv^2/r$ $v=\sqrt{GM/r}$; $T=2\pi r/v=2\pi \sqrt{r^3/GM}$.

Question 20

Working: $v=\sqrt{GM/r}=\sqrt{(4\times 10^{14})/(7\times 10^6)}=7.56\times 10^3$ m/s. Total orbital energy

$E=-GMm/(2r)=-(4\times 10^{14})(1000)/(14\times 10^6)=-2.86\times 10^{10}$ J.

Final answer: $v\approx 7.56 \times 10^3$ m/s; $E=-GMm/(2r)\approx -2.86 \times 10^{10}$ J.

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