

APOLLO

Gravitational fields

SL

Physics

First assessment 2025

11 questions | questions

17. A planet P has a diameter one-third that of the Earth. The mass of Earth is 18 times that of P.

The gravitational field strength at the surface of the Earth is g .

What is the gravitational field strength at the surface of P?

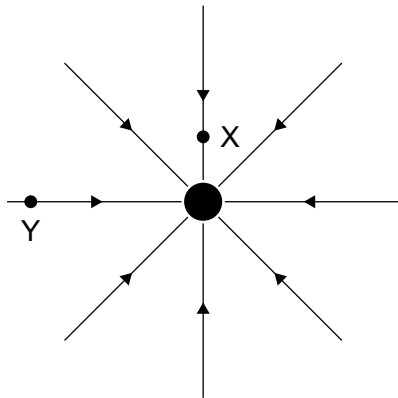
- A. $\frac{g}{6}$
- B. $\frac{g}{2}$
- C. $2g$
- D. $6g$

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Turn over

4445-0710

16. Two point masses X and Y are released from rest at different positions in the gravitational field of a planet. Y is further from the planet's surface than X. The masses of X and Y are much smaller than that of the planet.



Both masses eventually collide with the planet.

Which is the correct comparison of the initial and final accelerations of X and Y?

	Initial acceleration	Final acceleration
A.	different	same
B.	different	different
C.	same	same
D.	same	different

Turn over

17. The relationship between the period of a planet's orbit T and the distance to the Sun R can be expressed as $T^n \propto R^m$ where n and m are constants.

What is a possible pair of values for n and m ?

	n	m
A.	1.0	3.0
B.	1.0	1.5
C.	2.0	1.5
D.	2.0	1.0

- 18.** Point X is at a distance d from the centre of Earth. d is larger than the radius of Earth. The gravitational field strength at X is g_x . Point Y is at a distance $3d$ from the centre of Earth.

What is the difference in the magnitude of gravitational field strengths between X and Y?

- A. $\frac{8g_x}{9}$
- B. $\frac{3g_x}{4}$
- C. $\frac{g_x}{4}$
- D. $\frac{g_x}{9}$

4. Earth orbits the Sun at an average distance of 1.50×10^8 km.

The mass of the Sun is 2.0×10^{30} kg.

(a) Calculate the gravitational field strength of the Sun at a distance of 1.50×10^8 km from its centre. [2]

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The orbital speed of Earth around the Sun is not constant.

(b) (i) State Kepler’s first law of orbital motion. [1]

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(ii) Explain why the kinetic energy of Earth changes as it orbits the Sun. [2]

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4420-0127

17. Planets X and Y orbit the same star.

The orbital radius of planet X is R_X , and that of planet Y is R_Y . The orbital period of planet X is T_X , and that of Y is T_Y .

What is $\frac{T_Y}{T_X}$?

A. $\left(\frac{R_Y}{R_X}\right)^{\frac{3}{2}}$

B. $\left(\frac{R_X}{R_Y}\right)^{\frac{3}{2}}$

C. $\left(\frac{R_Y}{R_X}\right)^{\frac{2}{3}}$

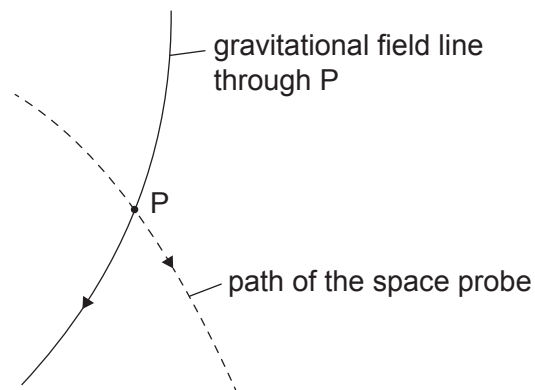
D. $\left(\frac{R_X}{R_Y}\right)^{\frac{2}{3}}$

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Turn over

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18. A space probe moves in a gravitational field. No other forces than the gravitational force act on the probe. At one instant, the probe is at point P. The diagram shows the path of the probe and the gravitational field line through P.



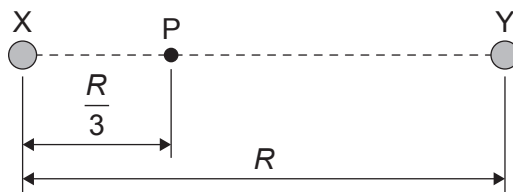
What is the direction of the acceleration of the probe at P?

- A. Tangent to the path of the probe
- B. Perpendicular to the path of the probe
- C. Tangent to the gravitational field line through P
- D. Perpendicular to the gravitational field line through P

17. Which is a statement of one of Kepler's laws of orbital motion?

- A. The square of the planet's orbital period is proportional to the cube of the length of the semi-major axis of its orbit.
- B. A line segment joining a planet and the Sun sweeps out equal arc lengths during equal intervals of time.
- C. A planet's orbital period is proportional to the cube of the length of the semi-major axis of its orbit.
- D. The orbit of a planet is an ellipse with the Sun positioned at the centre.

18. Isolated planets X and Y have masses M_x and M_y respectively and are separated by a distance R . A point P is located at a distance $\frac{R}{3}$ from planet X, as shown. The gravitational field strength at P is zero.



What is $\frac{M_y}{M_x}$?

- A. 2
- B. 3
- C. 4
- D. 9

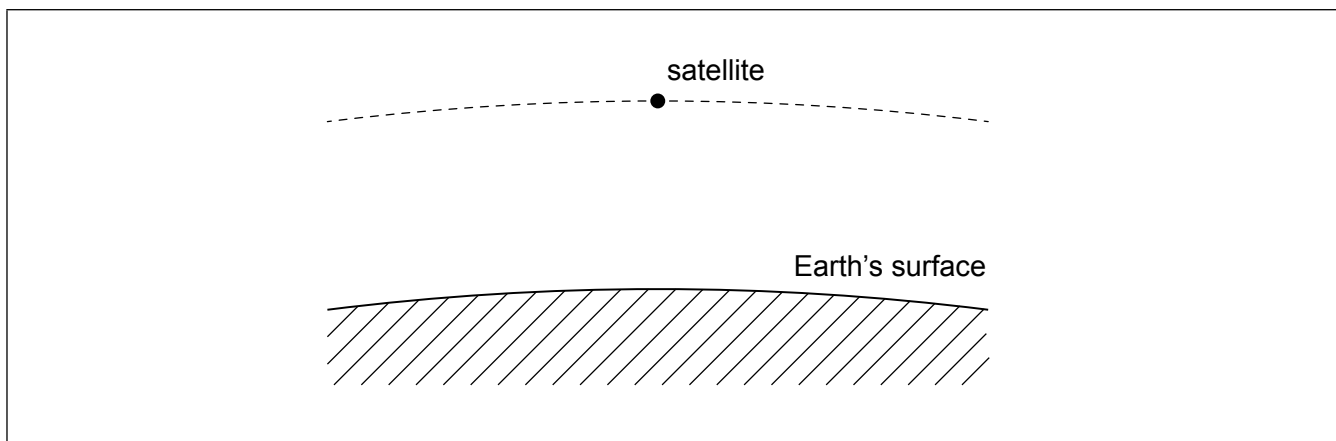
18. Planets X and Y orbit the same star.

The average distance between planet X and the star is five times greater than the average distance between planet Y and the star.

What is $\frac{\text{orbital period of planet X}}{\text{orbital period of planet Y}}$?

- A. $\sqrt[3]{5}$
- B. $\sqrt{5}$
- C. $\sqrt[3]{5^2}$
- D. $\sqrt{5^3}$

3. A satellite moves around Earth in a circular orbit.



- (a) Draw an arrow on the diagram to represent the direction of the acceleration of the satellite. [1]

- (b) The following data are given:

$$\text{Mass of Earth, } M = 5.97 \times 10^{24} \text{ kg}$$

$$\text{Radius of Earth, } R = 6.37 \times 10^6 \text{ m}$$

$$\text{Orbital period of the satellite, } T = 5.62 \times 10^3 \text{ s}$$

- (i) Kepler's Third Law of orbital motion states that $T^2 = kr^3$ where k is a constant and r is the orbital radius of the satellite.

$$\text{Show that } k = \frac{4\pi^2}{GM}.$$

[1]

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- (ii) Determine the height of the satellite above the Earth's surface. [2]

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