

APOLLO

Gravitational fields

HL

Physics

First assessment 2025

16 questions | questions

- 24.** 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 .

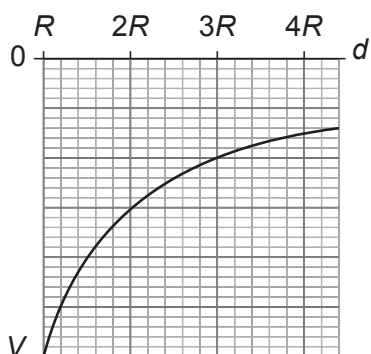
What is the gravitational field strength at the surface of P?

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

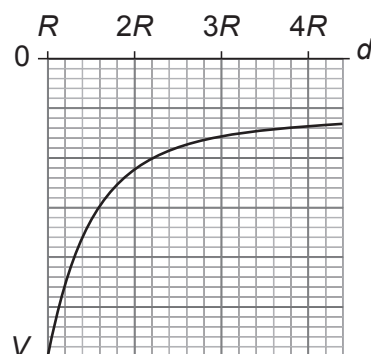
25. Which graph shows the variation of gravitational potential V with distance d from the surface of the Earth?

R is the radius of the Earth.

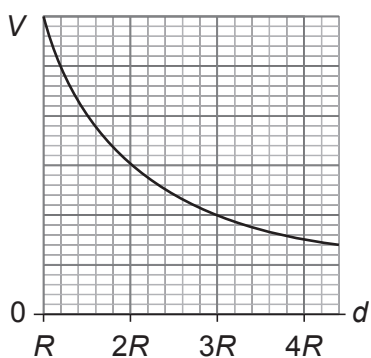
A.



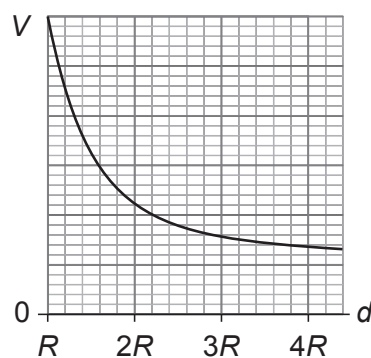
B.



C.



D.



- 21.** A planet of mass m is in a circular orbit of radius R around a star. The orbital speed of the planet is v . A second planet of mass $2m$ is in a circular orbit of radius $1.5R$ around the same star.

What is the orbital speed of the second planet?

- A. $\sqrt{\frac{2}{3}}v$
- B. $\sqrt{2}v$
- C. $\sqrt{3}v$
- D. $2v$

26. 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

- 27.** 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?

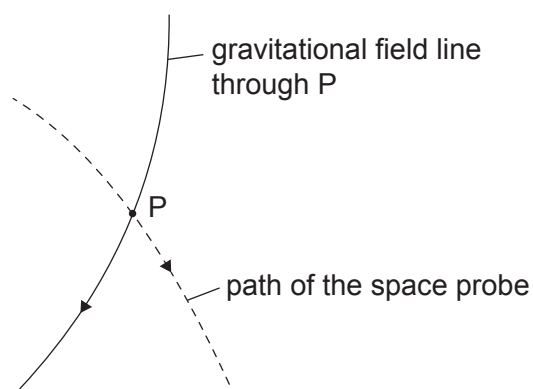
- A. $\frac{8g_x}{9}$
- B. $\frac{3g_x}{4}$
- C. $\frac{g_x}{4}$
- D. $\frac{g_x}{9}$

- 28.** The work done per unit mass to move a body from infinity to a point P in a gravitational field is the
- A. gravitational field strength at P.
 - B. gravitational force at P.
 - C. gravitational potential energy at P.
 - D. gravitational potential at P.

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- 24.** 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.

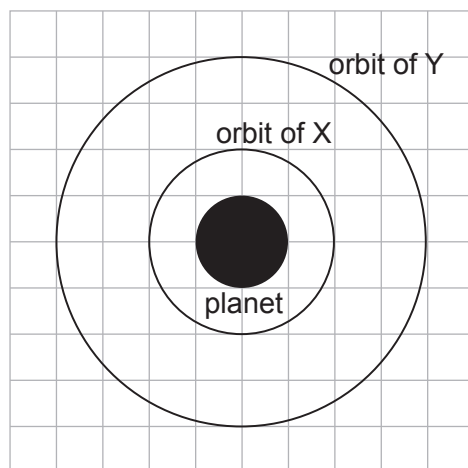


What is the direction of the acceleration of the probe at P?

- 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

Turn over

- 25.** Two satellites X and Y with the same mass orbit a planet. The scaled diagram shows the orbits of the satellites.



What is $\frac{\text{kinetic energy of X}}{\text{kinetic energy of Y}}$?

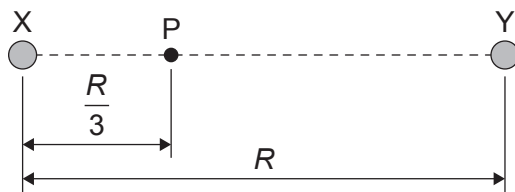
- A. 2
- B. 3
- C. 4
- D. 9

26. 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.

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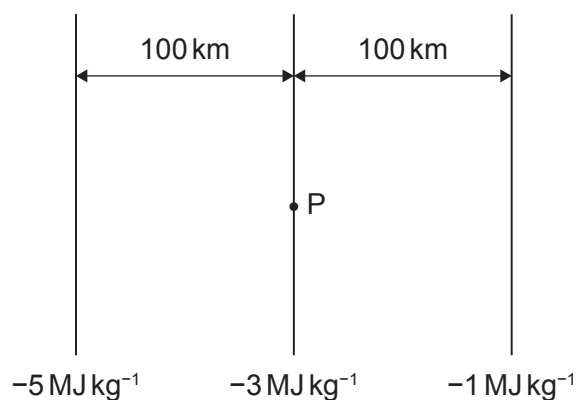
27. Isolated planets X and Y have masses M_x and M_y respectively and are separated by a distance R . A point P is located at a distance $\frac{R}{3}$ from planet X, as shown. The gravitational field strength at P is zero.



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

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

28. A point mass of 5 kg is placed at point P located on one of three gravitational equipotential lines, each separated by a distance of 100 km, as shown.



What is the initial acceleration of the point mass?

- A. 4 m s^{-2} to the left
- B. 4 m s^{-2} to the right
- C. 20 m s^{-2} to the left
- D. 20 m s^{-2} to the right

29. Four planets have masses M or $2M$ and radii R or $2R$ as shown.

Which planet has the largest escape speed?

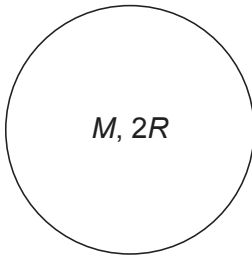
A.



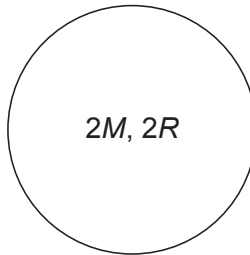
B.



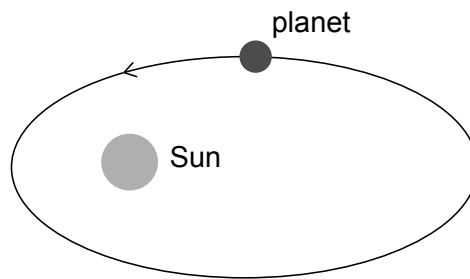
C.



D.



25. A planet orbits the Sun in an elliptical orbit moving in the direction shown.



At the position shown, which quantity is decreasing for the planet?

- A. Acceleration
- B. Angular momentum
- C. Kinetic energy
- D. Gravitational potential energy

28. Planets X and Y orbit the same star.

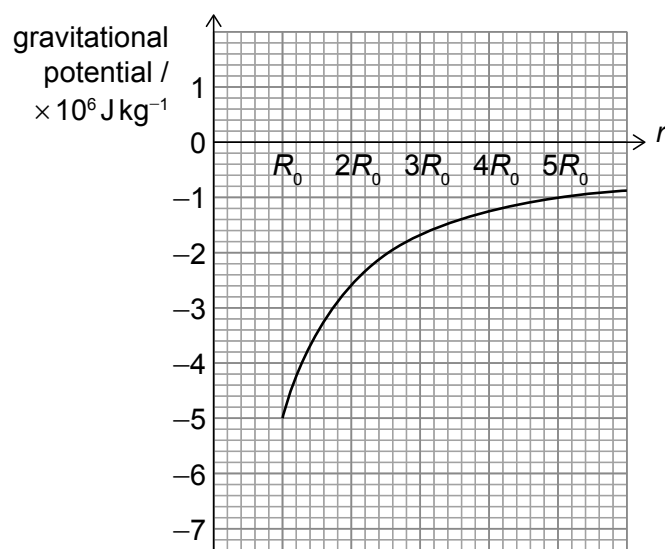
The average distance between planet X and the star is five times greater than the average distance between planet Y and the star.

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. $\sqrt{5^3}$

30. A spherical planet has a radius R_0 .

The graph shows the variation of the gravitational potential due to the planet with distance r from the centre of the planet.

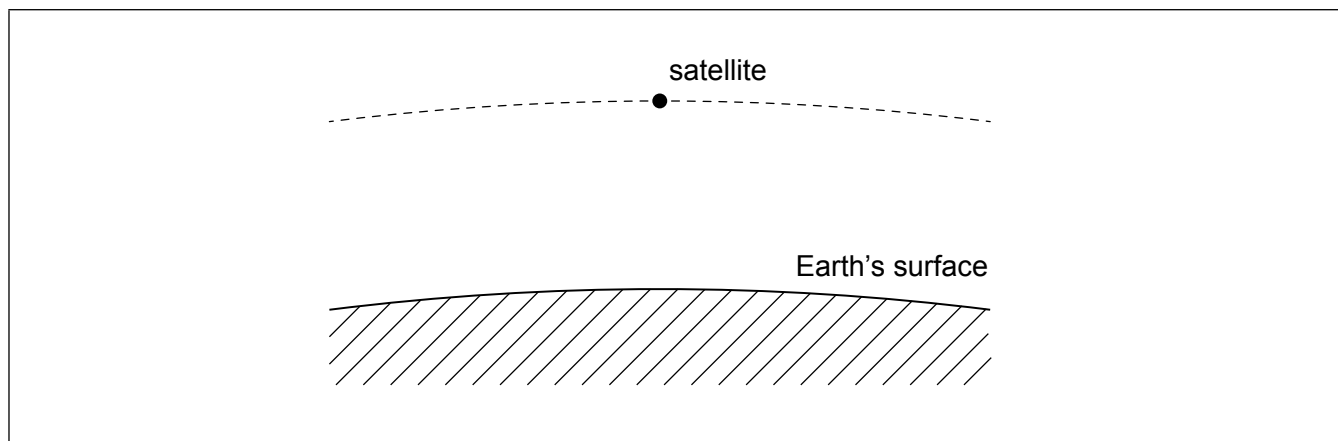


What is the escape speed from the surface of the planet?

- A. $1.6 \times 10^3 \text{ ms}^{-1}$
- B. $2.2 \times 10^3 \text{ ms}^{-1}$
- C. $3.2 \times 10^3 \text{ ms}^{-1}$
- D. $4.5 \times 10^3 \text{ ms}^{-1}$

Turn over

4. 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:

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

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

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.

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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(Question 4 continued)

(c) The atmosphere exerts a small viscous drag force on the satellite.

Outline how the total energy, kinetic energy, and gravitational potential energy change for the satellite during one orbit around Earth.

[3]



Turn over

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