The distance between the Sun and the Earth is 1.5×10^{11} m

What is the gravitational force exerted on the Sun by the Earth?

[1 mark]

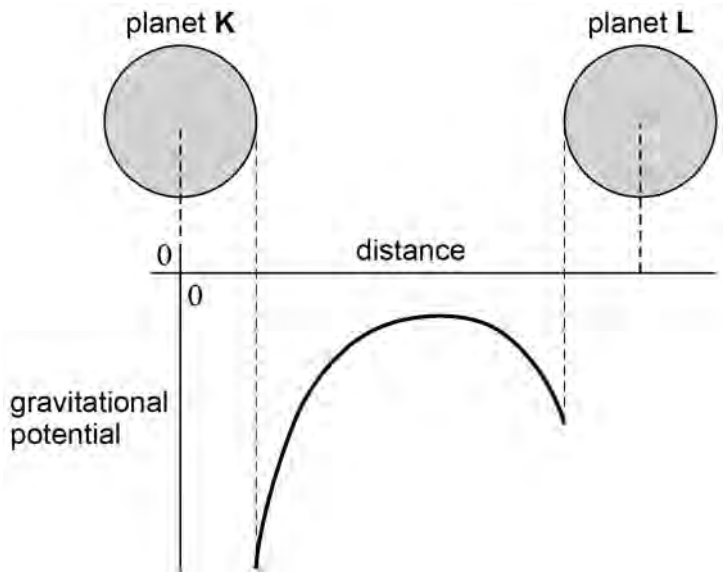
A 3.5×10^{22} N ⬭

B 1.7×10^{26} N ⬭

C 5.3×10^{33} N ⬭

D 8.9×10^{50} N ⬭

The graph shows how the gravitational potential varies with distance between two planets, **K** and **L**, that have the same radius.



Which statement is correct?

[1 mark]

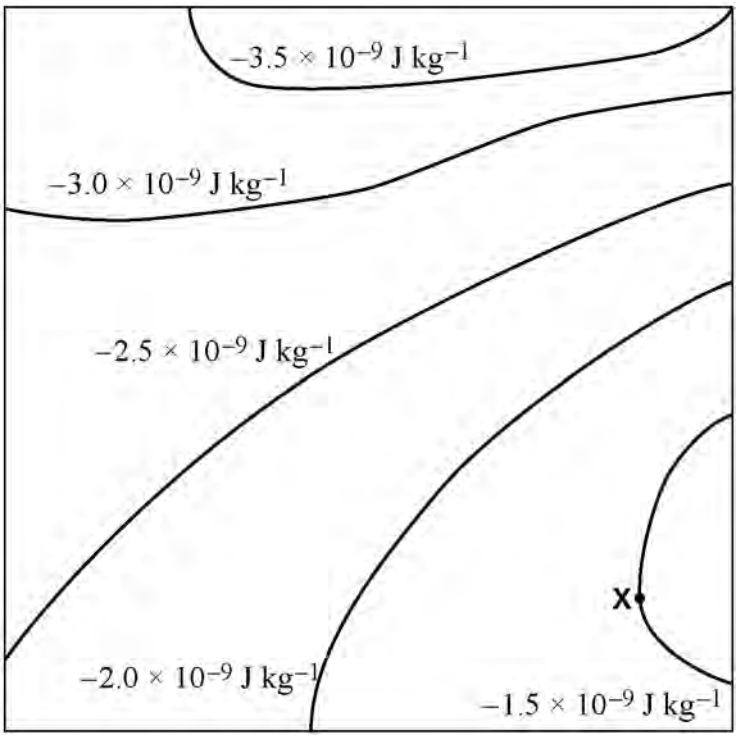
A The mass of **L** is greater than the mass of **K**.

B The gravitational field strength at the surface of **L** is greater than that at the surface of **K**.

C The escape velocity from planet **L** is greater than that from planet **K**.

D More work must be done to move a mass of $1\ \text{kg}$ from the surface of **K** to a distant point, than $1\ \text{kg}$ from the surface of **L**.

The diagram shows equipotential lines near a group of asteroids.



Which arrow shows the direction of the gravitational field at **X**?

[1 mark]

A ↑ ⬭

B ↓ ⬭

C ← ⬭

D → ⬭

Planet **N** has a gravitational potential $-V$ at its surface. Planet **M** has double the density and double the radius of planet **N**. Both planets are spherical and have uniform density.

What is the gravitational potential at the surface of planet **M**?

[1 mark]

A $-16V$ ⬭

B $-8V$ ⬭

C $-4V$ ⬭

D $-0.2V$ ⬭

A spacecraft of mass 1.0×10^6 kg is in orbit around the Sun at a radius of 1.1×10^{11} m
The spacecraft moves into a new orbit of radius 2.5×10^{11} m around the Sun.

What is the total change in gravitational potential energy of the spacecraft?

[1 mark]

A -6.76×10^{14} J ⬭

B -3.38×10^{14} J ⬭

C 3.38×10^{14} J ⬭

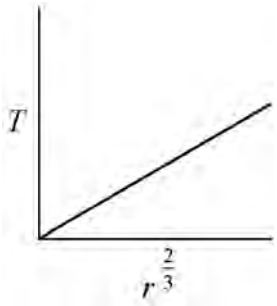
D 6.76×10^{14} J ⬭

Turn over for the next question

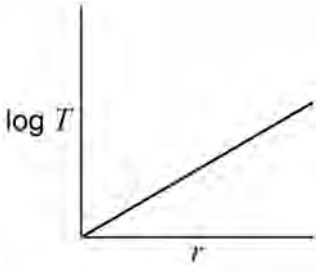
Which graph shows the relationship between the time period T and the orbital radius r of a planet in orbit around the Sun?

[1 mark]

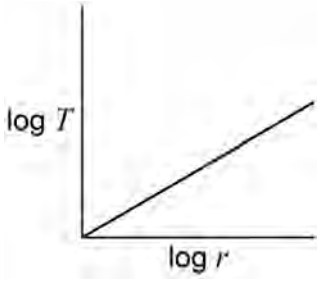
A



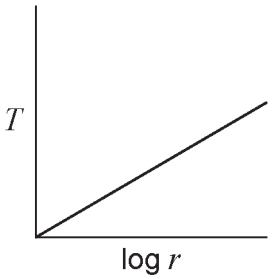
B



C



D



A ⬭

B ⬭

C ⬭

D ⬭

The Earth can be assumed to be a uniform sphere of radius R.

What is the mean density of the Earth?

[1 mark]

A $\frac{3g}{4\pi RG}$ ⬭

B $\frac{3RG}{4\pi g}$ ⬭

C $\frac{3G}{4\pi Rg}$ ⬭

D $\frac{3Rg}{4\pi G}$ ⬭

Turn over for the next question

Which row shows two scalar quantities?

[1 mark]

A	gravitational potential	gravitational field strength	⬭
B	mass	gravitational potential	⬭
C	gravitational field strength	weight	⬭
D	weight	gravitational potential	⬭

What is the angular speed of a satellite in a geostationary orbit around the Earth?

[1 mark]

A 1.2×10^{-5} rad s^{-1} ⬭

B 7.3×10^{-5} rad s^{-1} ⬭

C 4.2×10^{-3} rad s^{-1} ⬭

D 2.6×10^{-1} rad s^{-1} ⬭

A planet of mass M and radius R rotates so quickly that material at its equator only just remains on its surface.

What is the period of rotation of the planet?

[1 mark]

A $2\pi\sqrt{\frac{R}{GM}}$ ⬭

B $2\pi\sqrt{\frac{GM}{R}}$ ⬭

C $2\pi\sqrt{\frac{R^3}{GM}}$ ⬭

D $2\pi\sqrt{\frac{GM}{R^3}}$ ⬭

Satellites **N** and **F** have the same mass and are in circular orbits about the same planet. The orbital radius of **F** is greater than that of **N**.

Which is greater for **F** than for **N**?

[1 mark]

A gravitational force on the satellite ⬭

B angular speed ⬭

C kinetic energy ⬭

D orbital period ⬭

An object moves freely at $90°$ to the direction of a gravitational field.

The acceleration of the object is

[1 mark]

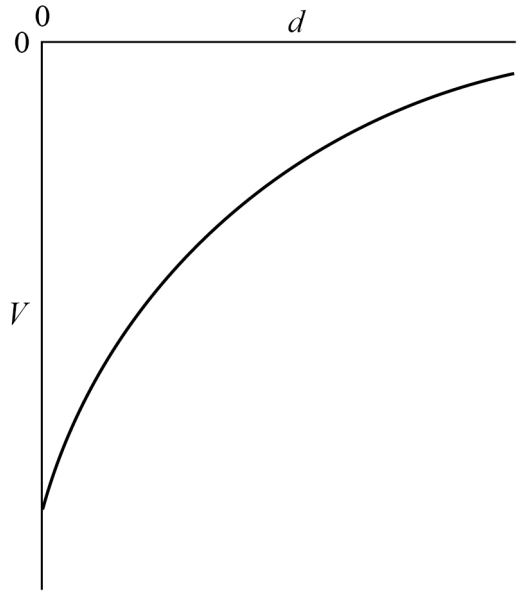
A zero. ⬭

B opposite to the direction of the gravitational field. ⬭

C in the direction of the gravitational field. ⬭

D at $90°$ to the direction of the gravitational field. ⬭

The graph shows how the gravitational potential V varies with the vertical distance d from the surface of the Earth.



What does the gradient of the graph represent at the surface of the Earth?

[1 mark]

A potential energy ⬭

B mass of the Earth ⬭

C magnitude of the gravitational constant ⬭

D magnitude of the gravitational field strength ⬭

What is the angular speed of a satellite in a geostationary orbit around the Earth?

[1 mark]

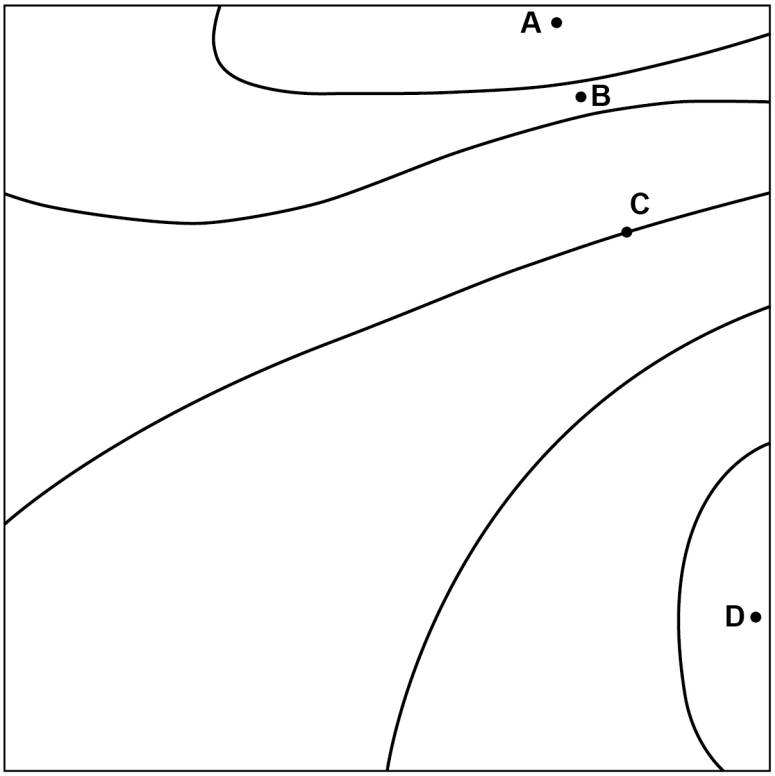
A 1.2×10^{-5} rad s^{-1} ⬭

B 7.3×10^{-5} rad s^{-1} ⬭

C 4.4×10^{-3} rad s^{-1} ⬭

D 2.6×10^{-1} rad s^{-1} ⬭

The diagram shows gravitational equipotentials. Adjacent equipotentials are separated by an equal gravitational potential difference V.



Which point has the greatest gravitational field strength?

[1 mark]

A ⬭

B ⬭

C ⬭

D ⬭

A planet has radius R and density ρ. The gravitational field strength at the surface is g.

What is the gravitational field strength at the surface of a planet of radius $2R$ and density 2ρ?

[1 mark]

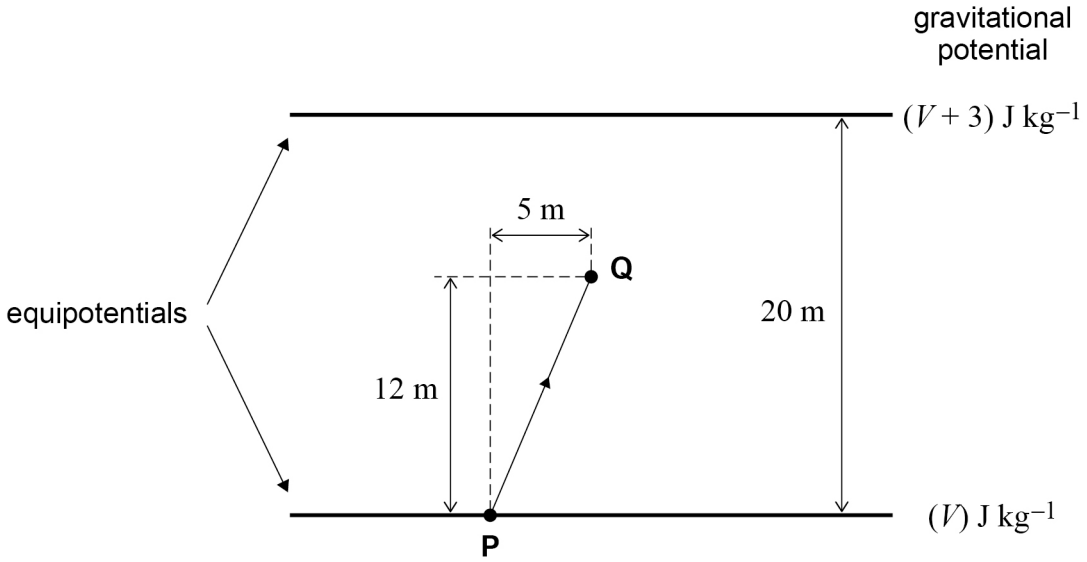
A $2g$ ⬭

B $4g$ ⬭

C $8g$ ⬭

D $16g$ ⬭

The diagram shows equipotential lines for a uniform gravitational field. The lines are separated by 20 m.



An object of mass 4 kg is moved from **P** to **Q**.

What is the work done against gravity to move the object?

[1 mark]

A 7.2 J

B 7.8 J

C 10.2 J

D 36 J

A planet of radius R and mass M has a gravitational field strength of g at its surface.

Which row describes a planet with a gravitational field strength of $4g$ at its surface?

[1 mark]

	Radius of planet	Mass of planet	
A	$2R$	$2M$	⬭
B	$R\sqrt{2}$	$\frac{M}{2}$	⬭
C	$\frac{R}{\sqrt{2}}$	$\frac{M}{2}$	⬭
D	$\frac{R}{\sqrt{2}}$	$2M$	⬭

The Moon orbits the Earth in 27 days.

What is the angular speed of the Moon's orbit?

[1 mark]

A 4.3×10^{-7} rad s^{-1} ⬭

B 2.7×10^{-6} rad s^{-1} ⬭

C 3.7×10^{-2} rad s^{-1} ⬭

D 2.3×10^{-1} rad s^{-1} ⬭

The radius of the Earth is R and the acceleration due to gravity at the surface of the Earth is g.

What is the escape velocity for a mass m at the surface of the Earth?

[1 mark]

A $\sqrt{gR}$ ⬭

B $\sqrt{2gR}$ ⬭

C $\sqrt{2mgR}$ ⬭

D $\sqrt{\frac{2gR}{m}}$ ⬭

A planet has a mass M and a radius R.
Loose material at the equator only just remains in contact with the surface of the planet.
This is because the speed at which the planet rotates is very large.

What is the period of rotation of the planet?

[1 mark]

A $2\pi\sqrt{\frac{R^2}{GM}}$ ⬭

B $2\pi\sqrt{\frac{GM}{R^2}}$ ⬭

C $2\pi\sqrt{\frac{R^3}{GM}}$ ⬭

D $2\pi\sqrt{\frac{GM}{R^3}}$ ⬭

Satellites **N** and **F** have the same mass and move in circular orbits about the same planet. The orbital radius of **N** is less than that of **F**.

Which is smaller for **N** than for **F**?

[1 mark]

A the gravitational force on the satellite ⬭

B the speed of the satellite ⬭

C the kinetic energy of the satellite ⬭

D the orbital period of the satellite ⬭

Data are collected for the mass M, radius R and escape velocity u for each planet in the Solar System.

The data show that u is directly proportional to

[1 mark]

A $\left(\frac{M}{R}\right)^{-\frac{1}{2}}$ ⬭

B $\left(\frac{M}{R}\right)^{\frac{1}{2}}$ ⬭

C $\frac{M}{R}$ ⬭

D $\left(\frac{M}{R}\right)^{2}$ ⬭

A satellite is in a circular orbit at a height h above the surface of a planet of mass M and radius R.

What is the linear speed of the satellite?

[1 mark]

A $\dfrac{\sqrt{GM}}{(R+h)}$ ⬭

B $\sqrt{\dfrac{GM}{(R+h)}}$ ⬭

C $\dfrac{GM}{\sqrt{R+h}}$ ⬭

D $\dfrac{GM}{(R+h)}$ ⬭

Which statement is **not** true for a satellite in a geostationary orbit?

[1 mark]

A The satellite orbits in the plane of the Earth's equator. ⬭

B The satellite has the same angular velocity as a point on the Earth's surface. ⬭

C The satellite takes 24 hours to orbit the Earth. ⬭

D Signals from the satellite can be sent to any point on the Earth's surface during one orbit. ⬭

A synchronous orbit of the Earth has a radius R.
A planet has a mass twice the mass of the Earth. A day on the planet is one quarter of an Earth day.

What is the radius of a synchronous orbit for this planet?

[1 mark]

A $\frac{R}{\sqrt[3]{2}}$ ⬭

B $\frac{R}{\sqrt[3]{16}}$ ⬭

C $\frac{R}{2}$ ⬭

D $\frac{\sqrt{2}R}{8}$ ⬭

An asteroid has a mass of 2×10^{17} kg and an escape velocity of 40 m s^{-1}.

What is the order of magnitude of the radius of the asteroid?

[1 mark]

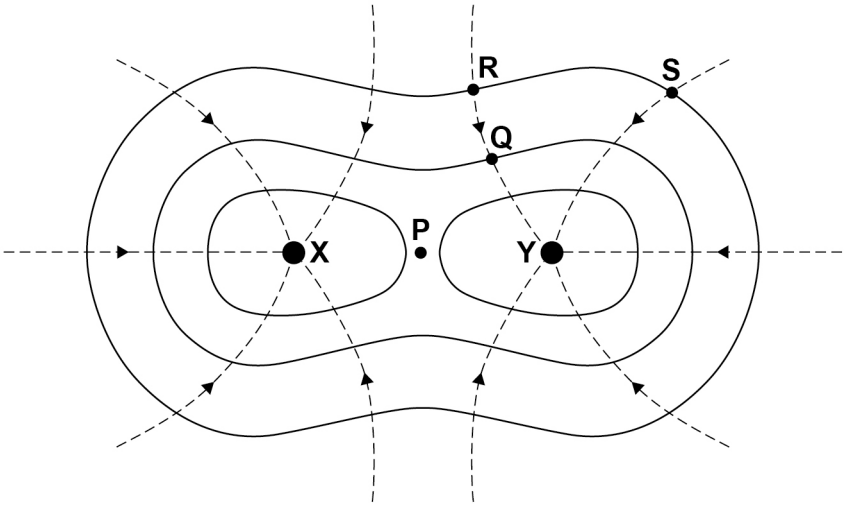
A 10^3 m ⬭

B 10^4 m ⬭

C 10^5 m ⬭

D 10^6 m ⬭

The diagram shows the gravitational field for a binary star system consisting of two stars **X** and **Y** of equal mass.



Equipotential lines are shown as solid lines.
Gravitational field lines are shown as dashed lines.

Which statement is correct?

[1 mark]

A More work is done moving from **Q** to **S** to **R** than moving directly from **Q** to **R**. ⬭

B No work is done moving from **Q** to **R**. ⬭

C The gravitational field strength is the same at **R** and **S**. ⬭

D The work done moving from **Q** to **R** and moving from **Q** to **S** is the same. ⬭

Which of the following gives a correct unit for $\left(\frac{g^2}{G}\right)$?

[1 mark]

A N ⬭

B $\mathrm{N\,kg^{-1}}$ ⬭

C N m ⬭

D $\mathrm{N\,m^{-2}}$ ⬭

A planet has a radius half the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

[1 mark]

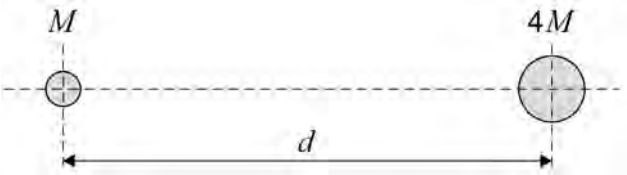
A $1.6\ \mathrm{N kg^{-1}}$ ⬭

B $5.0\ \mathrm{N kg^{-1}}$ ⬭

C $10\ \mathrm{N kg^{-1}}$ ⬭

D $20\ \mathrm{N kg^{-1}}$ ⬭

Two stars of mass M and $4M$ are at a distance d between their centres.



The resultant gravitational field strength is zero along the line between their centres at a distance y from the centre of the star of mass M.

What is the value of the ratio $\frac{y}{d}$?

[1 mark]

A $\frac{1}{2}$ ⬭

B $\frac{1}{3}$ ⬭

C $\frac{2}{3}$ ⬭

D $\frac{3}{4}$ ⬭

Which of the following statements about Newton's law of gravitation is correct?

Newton's gravitational law explains

[1 mark]

A the origin of gravitational forces. ⬭

B why a falling satellite burns up when it enters the Earth's atmosphere. ⬭

C why projectiles maintain a uniform horizontal speed. ⬭

D how various factors affect the gravitational force between two particles. ⬭

A simple pendulum and a mass-spring system have the same oscillation frequency f at the surface of the Earth. The pendulum and the mass-spring system are taken down a mine where the acceleration due to gravity is less than at the surface. What is the change in the frequency of the simple pendulum and the change in the frequency of the mass-spring system?

[1 mark]

	simple pendulum	**mass-spring**	
A	f increases	f decreases	⬭
B	f decreases	f decreases	⬭
C	f increases	f stays unchanged	⬭
D	f decreases	f stays unchanged	⬭