HL Paper 1

Which single condition enables Newton's universal law of gravitation to be used to predict the force between the Earth and the Sun?

A. The Earth and the Sun both have a very large radius.

B. The distance between the Earth and the Sun is approximately constant.

C. The Earth and the Sun both have a very large mass.

D. The Earth and the Sun behave as point masses.

Markscheme

D

Examiners report

[N/A]

The magnitude of the potential at the surface of a planet is *V*. What is the escape speed from the surface of the planet?

A. $\sqrt{V}$
B. $\sqrt{2V}$
C. $\sqrt{VR}$
D. $\sqrt{2VR}$

Markscheme

B

Examiners report

As R is not defined in the stem it can be assumed it is irrelevant and therefore both C and D are incorrect. As we need to equate kinetic energy with potential energy to solve this problem, we can expect a factor of 2 from 1⁄2 mv^2. Hence B.

An object rotates in a horizontal circle when acted on by a centripetal force *F*. What is the centripetal force acting on the object when the radius of the circle doubles and the kinetic energy of the object halves?

A. $\frac{F}{4}$

B. $\frac{F}{2}$

C. *F*

D. 4*F*

Markscheme

A

Examiners report

[N/A]

A car travels in a horizontal circle at constant speed. At any instant the resultant horizontal force acting on the car is

A. zero.
B. in the direction of travel of the car.
C. directed out from the centre of the circle.
D. directed towards the centre of the circle.

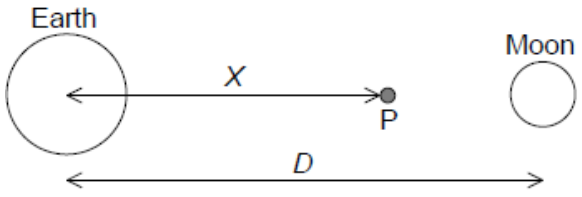
Markscheme

D

Examiners report

[N/A]

The centre of the Earth is separated from the centre of the Moon by a distance *D*. Point P lies on a line joining the centre of the Earth and the centre of the Moon, a distance *X* from the centre of the Earth. The gravitational field strength at P is zero.



What is the ratio $\frac{\text{mass of the Moon}}{\text{mass of the Earth}}$?

A. $\frac{(D-X)^2}{X^2}$

B. $\frac{(D-X)}{X}$

C. $\frac{X^2}{(D-X)^2}$

D. $\frac{X}{D-X}$

Markscheme

A

Examiners report

[N/A]

A particle of mass *m* is moving with constant speed *v* in uniform circular motion. What is the total work done by the centripetal force during one revolution?

A. Zero

B. $\frac{mv^2}{2}$

C. mv^2

D. $2\pi mv^2$

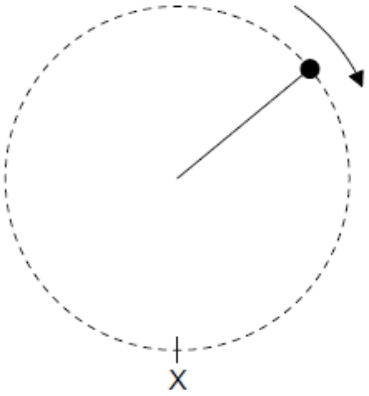
Markscheme

A

Examiners report

[N/A]

A small ball of weight W is attached to a string and moves in a vertical circle of radius R.



What is the smallest kinetic energy of the ball at position X for the ball to maintain the circular motion with radius *R*?

A. $\frac{W R}{2}$

B. $W R$

C. $2 W R$

D. $\frac{5W R}{2}$

Markscheme

D

Examiners report

[N/A]

An object of mass *m* moves in a horizontal circle of radius *r* with a constant speed *v*. What is the rate at which work is done by the centripetal force?

A. $\frac{mv^3}{r}$

B. $\frac{mv^3}{2\pi r}$

C. $\frac{mv^3}{4\pi r}$

D. zero

Markscheme

D

Examiners report

[N/A]

An astronaut of mass 60 kg is on board the International Space Station, which is in low orbit around the Earth. The gravitational force of attraction between the Earth and astronaut is approximately

A. zero.
B. 6 N.
C. 60 N.
D. 600 N.

Markscheme

D

Examiners report

[N/A]

The Earth is a distance r_S from the Sun. The Moon is a distance r_M from the Earth.

The ratio $\frac{\text{gravitational field strength at the Earth due to the Sun}}{\text{gravitational field strength at the Earth due to the Moon}}$ is proportional to

A. $\frac{r_M}{r_S}$

B. $\frac{r_S}{r_M}$

C. $\frac{r_S^2}{r_M^2}$.

D. $\frac{r_M^2}{r_S^2}$

Markscheme

D

Examiners report

Think proportionality.

Clearly the masses of the Sun and Moon do not change so we are only considering the distances. Considering Newton's inverse square law of gravitation, all that is needed is to switch the variables, r_S and r_M, and then square the ratio.

The acceleration of free fall of a mass of 2.0 kg close to the surface of Mars is 3.6 ms^{-2}. What is the gravitational field strength at the surface of Mars in N kg^{-1}?

A. 1.8
B. 3.6
C. 7.2
D. 9.8

Markscheme

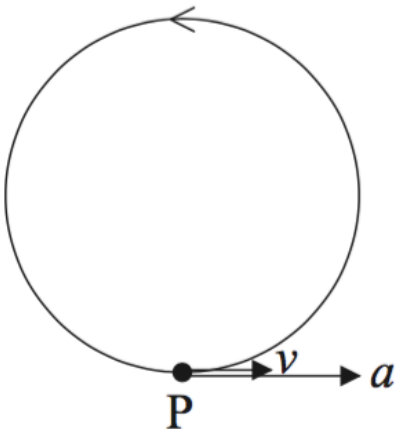
B

Examiners report

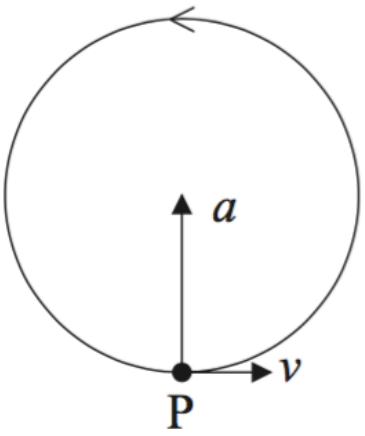
[N/A]

Particle P is moving with uniform speed in a horizontal circle. Which of the following shows the correct directions of the acceleration *a* and the velocity *v* of P at the position shown?

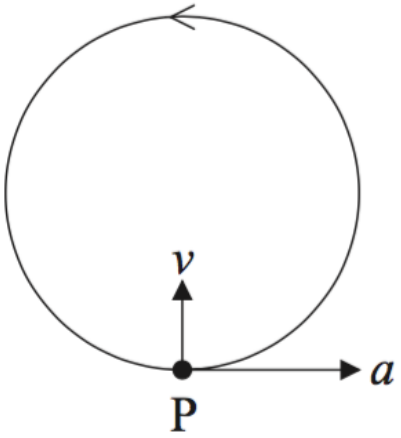
A.



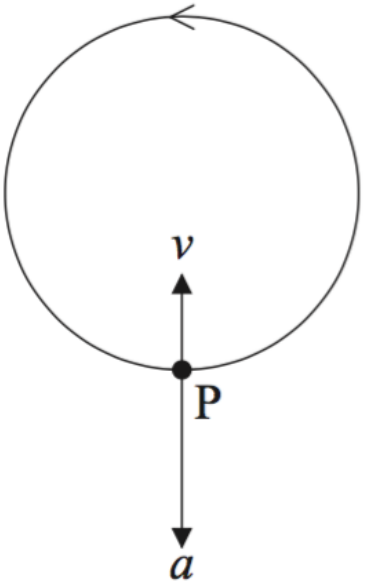
B.



C.



D.



Markscheme

B

Examiners report