



Question

Differential Equations: Resistive Forces 1ii

Subject & topics: Maths **Stage & difficulty:** Further A P2

A particle of mass 0.4 kg , moving on a smooth horizontal surface, passes through a point O with velocity 10 m s^{-1} .

At time $t \text{ s}$ after the particle passes through O , the particle has a displacement $x \text{ m}$ from O , has a velocity $v \text{ m s}^{-1}$ away from O , and is acted on by a force of magnitude $\frac{1}{8}v \text{ N}$ acting towards O .

Part A

Time taken

Find the time taken for the velocity of the particle to reduce from 10 m s^{-1} to 5 m s^{-1} .

Give your answer to 2 significant figures in seconds.

Part B

Average velocity

Find the average velocity of the particle over this time. Give your answer to 2 significant figures.

Adapted with permission from UCLES, A Level, June 2015, Paper 4730, Question 4.



Question

Acceleration and Displacement

Subject & topics: Maths | Calculus | Differential Equations

Stage & difficulty: Further A P3

A particle P is moving such that its acceleration is $(3 - e^{-x}) \text{ m s}^{-2}$, where $x \text{ m}$ is its displacement from the origin O. When P passes through O, its velocity is 2 m s^{-1} in the direction of x increasing.

Part A

Velocity

Find the velocity, $v \text{ m s}^{-1}$, of P in terms of its displacement.

The following symbols may be useful: e , v , x

Part B

Velocity when $x = 10$

Find the velocity of P when its displacement is 10 m . Give your answer to 2 significant figures.

Part C

Displacement with minimum velocity

Find the exact value of the displacement of P when its velocity takes its minimum value.

The following symbols may be useful: $\ln()$, $\log()$, x

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Question

Acceleration and Velocity

Subject & topics: Maths | Calculus | Differential Equations Stage & difficulty: Further A P3

A particle P is moving in a straight line with velocity $v \text{ m s}^{-1}$ and an acceleration of $(4 - v^2) \text{ m s}^{-2}$. Its displacement from the origin O is $x \text{ m}$. When P passes through O it has a velocity of $\sqrt{3} \text{ m s}^{-1}$ in the direction of x increasing.

Part A

Displacement in terms of velocity

Find the displacement of P from O in terms of its velocity.

The following symbols may be useful: $\ln()$, $\log()$, v , x

Part B

Displacement when P is at rest

Find the exact value of the displacement when P is instantaneously at rest.

Part C

Time to reach $\sqrt{3} \text{ m s}^{-1}$

Given that P is initially at rest, find the time that P takes to accelerate to $\sqrt{3} \text{ m s}^{-1}$. Give your answer to 3 significant figures.

Part D

Displacement in terms of time

Find the displacement of P in terms of time, t .

The following symbols may be useful: cosech(), cosh(), coth(), ln(), log(), sech(), sinh(), tanh()

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Question

Weight on Comet 67P

Subject & topics: Physics | Fields | Gravitational Fields

Stage & difficulty: A Level P2

The Philae lander has a mass of 100 kg.

Find the mass of an object that would have the same weight on Earth's surface as the Philae lander has on the surface of Comet 67P, given that Comet 67P has a mass of 1.0×10^{13} kg and the lander is sat on its surface a distance 2.0 km from the centre of mass of the comet.

Model the comet as spherical and give your answer to 2 significant figures.

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Question

Gravity and Orbits 1

Essential Pre-Uni Physics F6.1

Subject & topics: Physics | Fields | Gravitational Fields **Stage & difficulty:** A Level P2

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

The Earth takes a year to go round the Sun in an orbit with radius 1.50×10^{11} m. Calculate the Sun's mass.

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Question

Freefall to the Moon

Subject & topics: Physics | Fields | Gravitational Fields **Stage & difficulty:** A Level P2

A stationary piece of cargo is released from a point P a distance $3R$ from the centre of the Moon which has radius R and mass M .

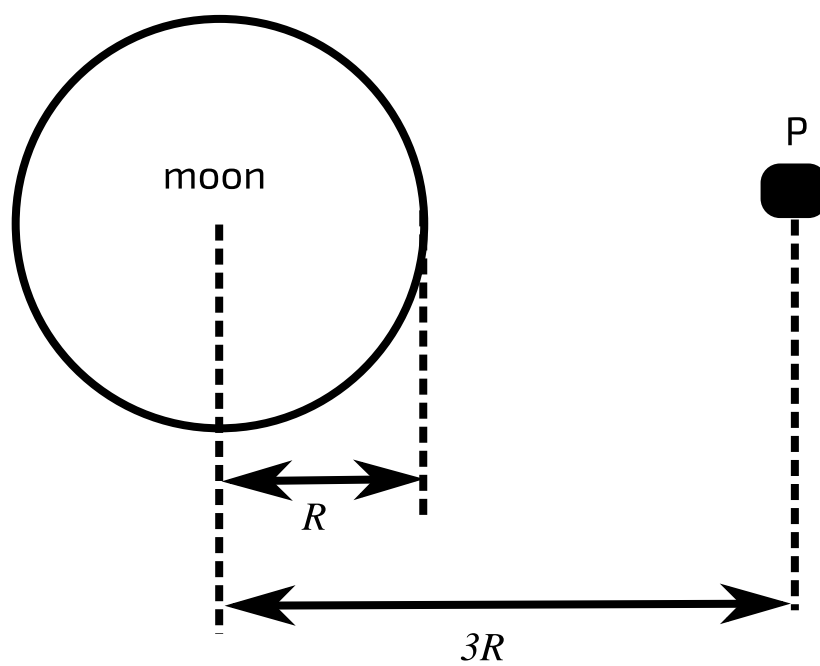


Figure 1: Diagram of the cargo above the moon.

Find an expression for the speed of the cargo upon hitting the moon.

The following symbols may be useful: G , M , R , v

Used with permission from UCLES, A Level Physics, June 1988, Paper 1, Question 18.

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Question

Differential Equations: Basic SHM 1ii

Subject & topics: Maths **Stage & difficulty:** Further A P2

A particle is moving with simple harmonic motion in a straight line. The period is 0.2 s and the amplitude of the motion is 0.3 m.

Give all answers to 2 significant figures.

Part A

Maximum speed

Find the maximum speed of the particle.

Part B

Maximum acceleration

Find the maximum acceleration of the particle.

Adapted with permission from UCLES, A Level, Specimen Paper 2004, Paper 4730, Question 1.

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Question

Safe Passage

Subject & topics: Physics | Mechanics | Oscillations **Stage & difficulty:** A Level P2

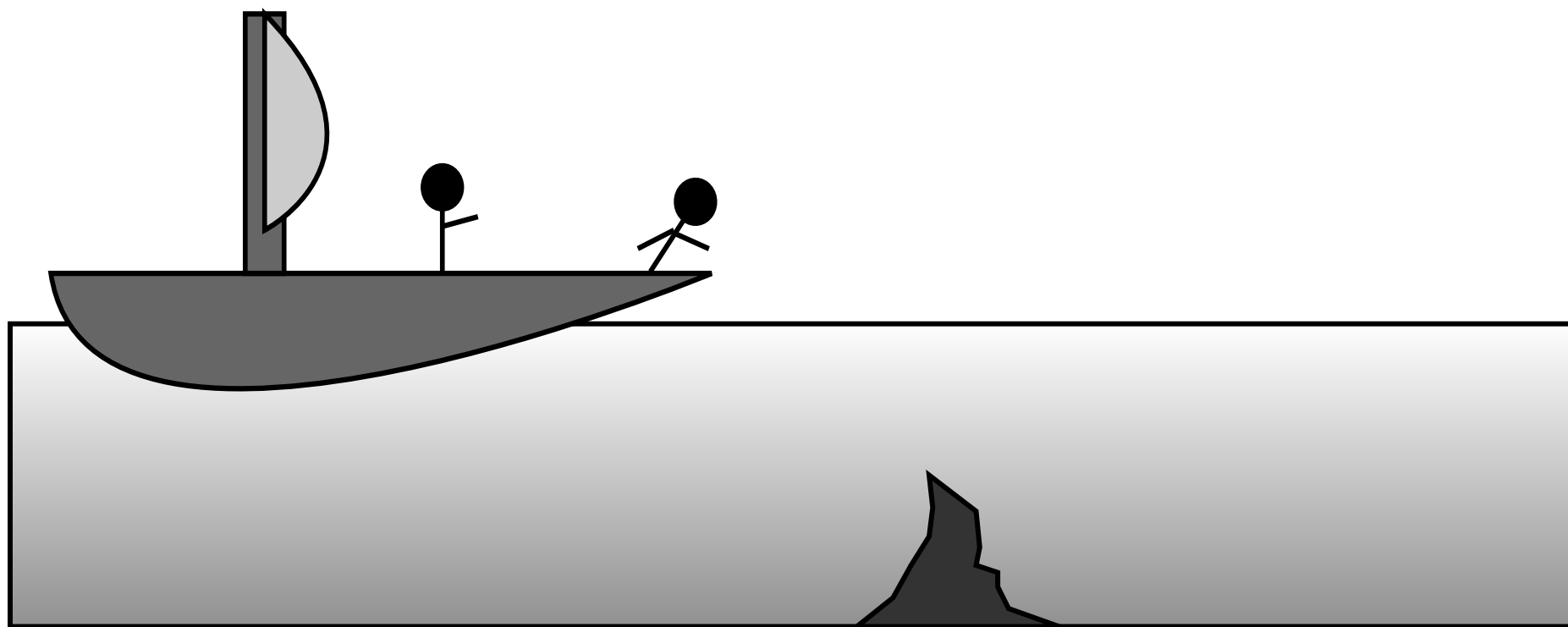


Figure 1: The river is at its shallowest for a very short distance.

For safe passage a ship needs 9.0 m of water. At the shallowest point of a tidal river in which the ship is travelling, the depth of the water at low tide, which occurs at 12 noon, is 6.0 m and the depth of the water at high tide, which occurs at 6:20 pm, is 11.0 m.

What is the earliest time in the afternoon at which the ship can pass this point safely, assuming that the water surface moves up and down in simple harmonic motion? Give your answer 24 hour time format, e.g. 0000 for midnight or 1600 for 4 pm. Give your answer correct to the nearest minute.

Used with permission from UCLES, A Level Applied Mathematics, Paper 1, Question 5.

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Question

Mass on a Horizontal Spring

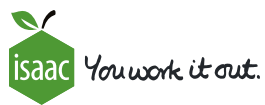
Subject & topics: Physics | Mechanics | Oscillations **Stage & difficulty:** A Level P2

An object of mass $m = 1.0 \text{ kg}$ is attached to an ideal horizontal spring. The spring is initially stretched by $x_0 = 0.10 \text{ m}$, and the object is released from rest there. It proceeds to move without friction. The next time the speed of the object is zero is 0.50 s later.

What is the maximum speed of the object?

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Question

SHM of a Simple Scale

Subject & topics: Physics | Mechanics | Oscillations **Stage & difficulty:** A Level C2

The upper end of an ideal vertical spring is fixed and its lower end is hanging freely. A scale pan of mass 20.0 g is then attached to the free end without extending the spring.

If the scale pan is then released from rest then the resulting motion is simple harmonic.

Part A

Amplitude

Calculate the amplitude of the oscillation if the spring constant is 98.1 N m^{-1} .

Part B

Period

Calculate the period of the oscillation.

Part C

Modified amplitude

The oscillating pan is held at the new equilibrium position of the pan. A mass of 20.0 g is then placed in the scale pan, which is then released, so that it once again moves with simple harmonic motion.

Find the new amplitude.

Part D

Modified period

Find the new period after the mass of 20.0 g is introduced into the scale pan when it was previously at equilibrium.

Used with permission from UCLES, A Level Physics, June 1951, Paper 1, Question 3.