Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 8 January 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WPH11/01**

Physics

International Advanced Subsidiary/Advanced Level
UNIT 1: Mechanics and Materials

You must have:
Scientific calculator, ruler, protractor

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working out** in calculations and **include units** where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In the question marked with an **asterisk (*)**, marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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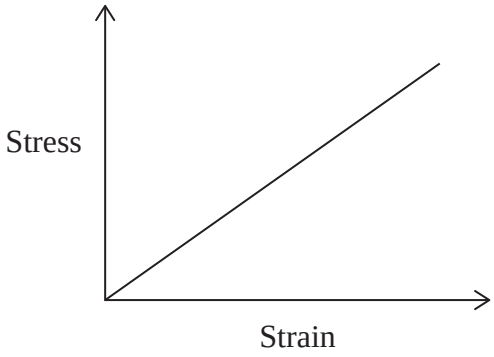
Pearson

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Stress is applied to a sample of a material. The stress is increased until the sample breaks. The graph shows the relationship between stress and strain for the sample.



Which of the following gives the Young modulus of the material?

☒ **A** The area between the line and the strain axis.

☒ **B** The gradient of the graph.

☒ **C** The maximum stress multiplied by the maximum strain.

☒ **D** The maximum strain divided by the maximum stress.

(Total for Question 1 = 1 mark)

2 A coin and a feather are dropped from the same height, through air.

Which row of the table is correct as the coin and feather fall to the ground?

	Initial acceleration	Time taken to reach the ground
☒ **A**	Greater for coin	Less for coin
☒ **B**	Greater for coin	Same for coin and feather
☒ **C**	Same for coin and feather	Less for coin
☒ **D**	Same for coin and feather	Same for coin and feather

(Total for Question 2 = 1 mark)

3 A physical quantity can be either a scalar or a vector.

Which row of the table is correct for acceleration and work done?

	Acceleration	Work done
☒ **A**	scalar	scalar
☒ **B**	scalar	vector
☒ **C**	vector	scalar
☒ **D**	vector	vector

(Total for Question 3 = 1 mark)

4 A spring is stretched beyond its elastic limit. The applied force is then removed.

Which of the following describes the behaviour of the spring?

☒ **A** The extension of the spring is always proportional to the force applied.

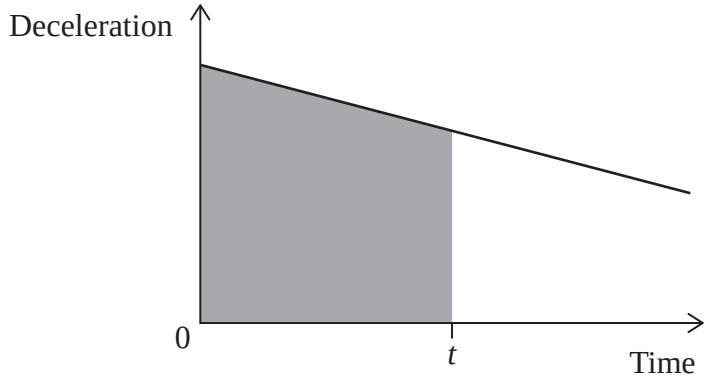
☒ **B** Plastic deformation occurs until the spring reaches its elastic limit.

☒ **C** The spring only shows elastic deformation.

☒ **D** The spring does not return to its original length.

(Total for Question 4 = 1 mark)

5 An aeroplane lands on a runway at time 0 and then decelerates.
The graph shows how the deceleration of the aeroplane varies with time.



Which of the following does the shaded area on the graph represent?

☒ **A** The displacement of the aeroplane at time *t*.

☒ **B** The change in displacement of the aeroplane during time *t*.

☒ **C** The velocity of the aeroplane at time *t*.

☒ **D** The change in velocity of the aeroplane during time *t*.

(Total for Question 5 = 1 mark)

6 When a force F is applied to a spring of stiffness k, the extension of the spring is Δx.

A force $2F$ is applied to a second spring of stiffness $3k$.

Which of the following expressions gives the extension of the second spring?

☒ **A** $\frac{2}{3}\Delta x$

☒ **B** $\frac{3}{2}\Delta x$

☒ **C** $\frac{1}{6}\Delta x$

☒ **D** $6\Delta x$

(Total for Question 6 = 1 mark)

7 A student drops a ball and measures the time taken for the ball to reach the ground.
He repeats this for different heights.

He uses a graphical method to determine a value for g, the acceleration of free fall.

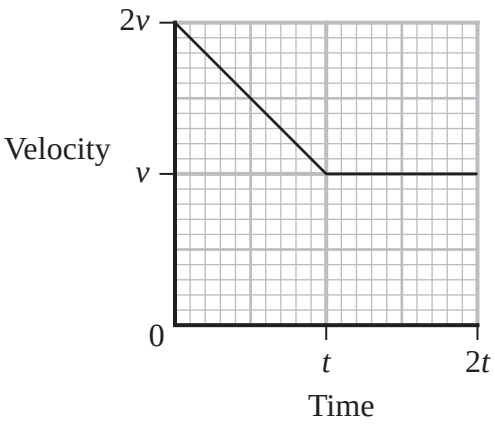
He plots height on the y-axis of his graph.

Which row of the table is correct for the student's graph?

	Quantity plotted on x-axis	Gradient of graph
☒ **A**	time	$\frac{1}{g}$
☒ **B**	time	g
☒ **C**	$(\text{time})^2$	$\frac{g}{2}$
☒ **D**	$(\text{time})^2$	$2g$

(Total for Question 7 = 1 mark)

8 The velocity-time graph for a train journey is shown.



Which of the following expressions gives the distance travelled by the train in time $2t$?

☒ **A** $4vt$

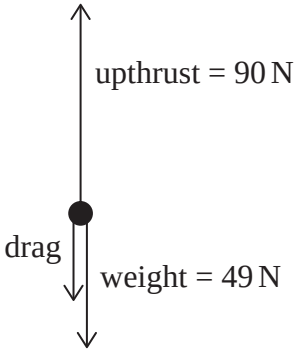
☒ **B** $5vt$

☒ **C** $\frac{3vt}{2}$

☒ **D** $\frac{5vt}{2}$

(Total for Question 8 = 1 mark)

9 A free-body force diagram for an object moving through a fluid is shown.



Not to scale

The mass of the object is 5 kg.
The object is accelerating upwards at $4\,m\,s^{-2}$.

Which of the following gives the magnitude of the drag force in newtons?

☒ **A** 5×4

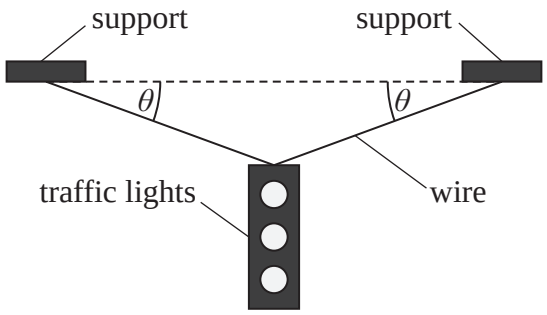
☒ **B** $90 - 49$

☒ **C** $90 - 49 - (5 \times 4)$

☒ **D** $90 - 49 + (5 \times 4)$

(Total for Question 9 = 1 mark)

10 Traffic lights of weight W are suspended from a wire.
The wire is held at an angle θ to the horizontal by two supports, as shown.



Which of the following expressions gives the tension in the wire?

☒ **A** $2W \sin\theta$

☒ **B** $\dfrac{W}{2\sin\theta}$

☒ **C** $2W \cos\theta$

☒ **D** $\dfrac{W}{2\cos\theta}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 The mass of a car is 1850 kg.

Some people sit in the car. The car then accelerates at $0.230\,m\,s^{-2}$ when the resultant force on the car is 460 N.

Calculate the total mass of the people in the car.

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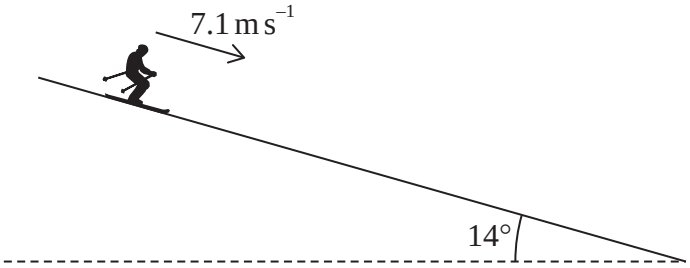
Total mass of people = ...

(Total for Question 11 = 3 marks)

12 A person on skis slides down a slope. The slope is at an angle of 14° to the horizontal. The initial speed of the person is $7.1\,m\,s^{-1}$, as shown.



The resistive forces acting on the person are negligible.

Calculate the speed of the person after moving 15 m down the slope.

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Speed = ...

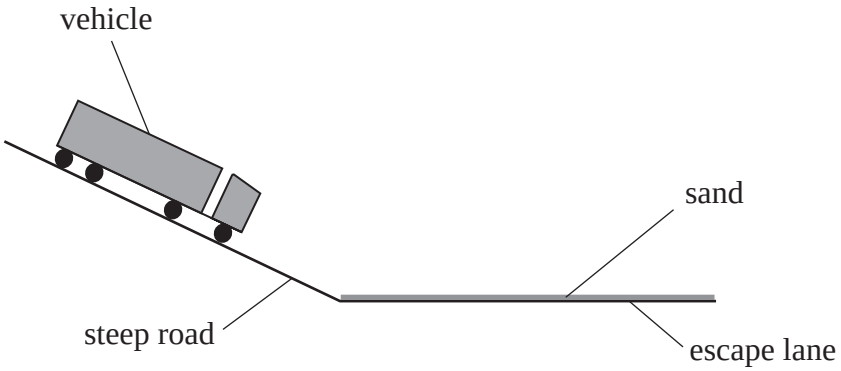
(Total for Question 12 = 3 marks)

13 An 'escape lane' can stop cars or trucks safely if the brakes stop working when moving downhill.

The photograph shows an escape lane.

(Source: adapted from © Presse03)

The escape lane is made of sand and is horizontal, as shown below. The resistive force of the sand on a vehicle reduces the kinetic energy of the vehicle.



(a) As a truck enters the escape lane, the kinetic energy of the truck is 8.0×10^6 J.

The sand exerts an average resistive force of 3.5×10^5 N on the truck as the truck comes to rest.

Calculate the distance moved by the truck on the escape lane.

(2)

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Distance = ...

(b) The resistive force exerted by the sand on a vehicle is proportional to the weight of the vehicle.

The weight of a car is less than the weight of a truck.

Explain how the deceleration of a car on the escape lane would compare with the deceleration of a truck.

(2)

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(Total for Question 13 = 4 marks)

14 An air track is a straight tube with holes along its length. Air forced through the holes lifts the gliders, preventing friction between the gliders and the air track.

A teacher uses an air track and two gliders, A and B, to demonstrate the principle of conservation of linear momentum.

Gliders A and B move towards each other and then collide.

(a) State how Newton's third law applies to the gliders during the collision.

(1)

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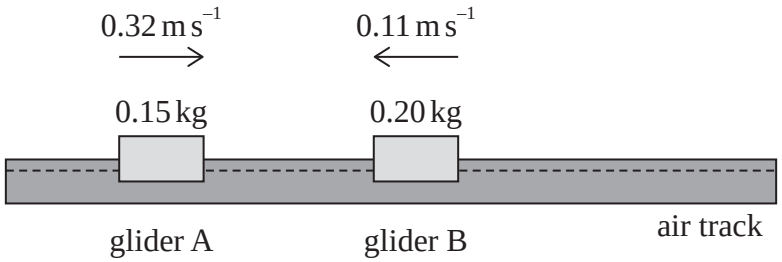
(b) Gliders A and B have different masses and move at different velocities before the collision, as shown.



The gliders stick together in the collision.

A student predicts that the gliders will move to the left after the collision.

Deduce whether the prediction is correct.

(3)

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(Total for Question 14 = 4 marks)

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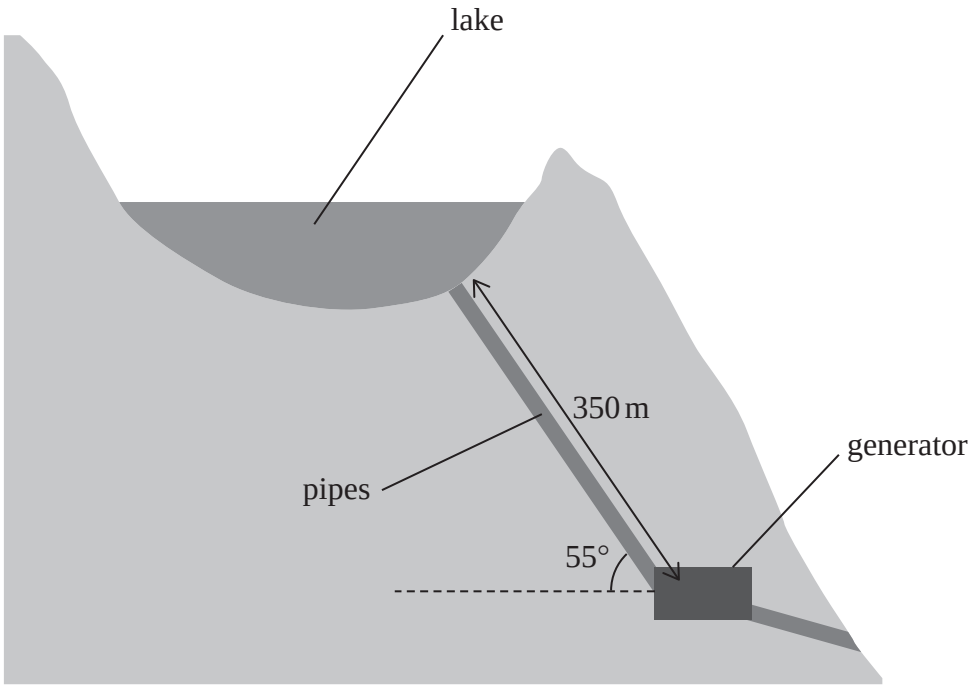
15 The Cruachan hydroelectric power station in Scotland is built inside a mountain.

Water from a lake near the top of the mountain flows through straight pipes to a generator. The pipes have a length of 350 m and are inclined at an angle of 55° to the horizontal, as shown.



The gravitational potential energy of the water in the lake is used to generate electrical power.

(a) In one minute, each pipe transfers 1700 m^3 of water to the generator. The density of the water in the lake is 1100 $kg\,m^{-3}$.

Show that the power transferred by the water in each pipe is about 88 MW.

(5)

(b) Water travels from the lake to the generator through 4 identical pipes.

As water moves through the 4 pipes to the generator, the total power wasted is 256 MW.

Calculate the efficiency of the power station.

(2)

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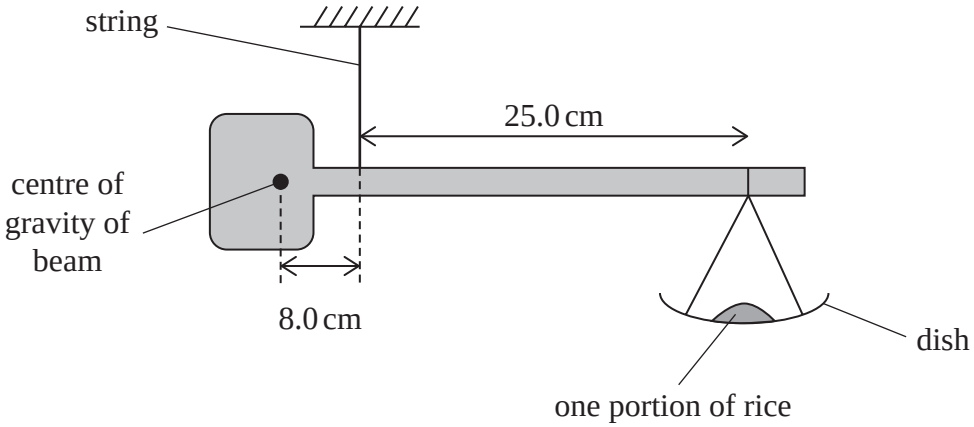
Efficiency = ...

(Total for Question 15 = 7 marks)

16 A balance is formed by a beam suspended from a string. A dish is hung from the beam and the balance is used to measure a fixed portion of rice.

When the dish contains one portion of rice, the balance is in equilibrium, as shown.



(a) State the conditions needed for an object to be in equilibrium.

(2)

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(b) The dish is moved along the beam so that the horizontal distance from the string to the dish is 7.0 cm.

Rice is added to the dish until the balance is in equilibrium.

Deduce whether the dish now contains 3 portions of rice.
You should include a calculation of the weight of 1 portion of rice.

weight of beam = 3.1 N
weight of empty dish = 0.64 N

(6)

(Total for Question 16 = 8 marks)

17 A tugboat is a small boat that can be used to pull large ships. A tugboat is attached to a ship using a thick rope.

A sample of the rope is tested to make sure that the rope will not break when a ship is pulled.

(a) The original length of the sample was 36.8 m.

Calculate the strain in the sample when the length of the sample increased to 38.1 m.

(2)

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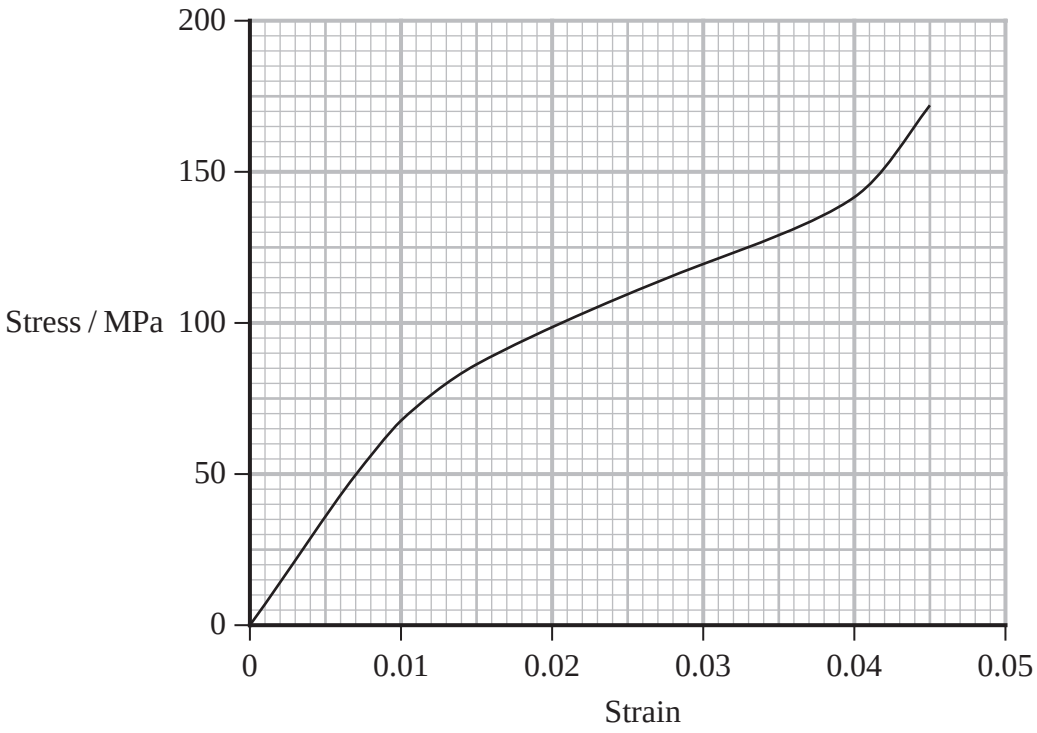
Strain = ...

(b) The stress-strain graph for the sample is shown.



(i) The diameter of the sample is 220 mm.

Determine the force applied to the sample when the strain was 0.025

(4)

Force = ...

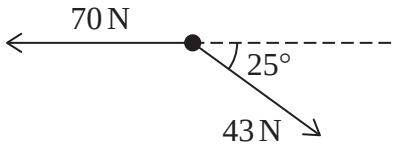
(ii) Explain how the area under the stress-strain graph and the volume of the sample can be used to determine the energy stored.

(3)

(Total for Question 17 = 9 marks)

18 A small, remotely controlled submarine is used to explore the sea.

(a) The engine of the submarine produced a horizontal force of 70 N. The drag force on the submarine was 43 N at an angle of 25° to the horizontal, as shown.



Not to scale

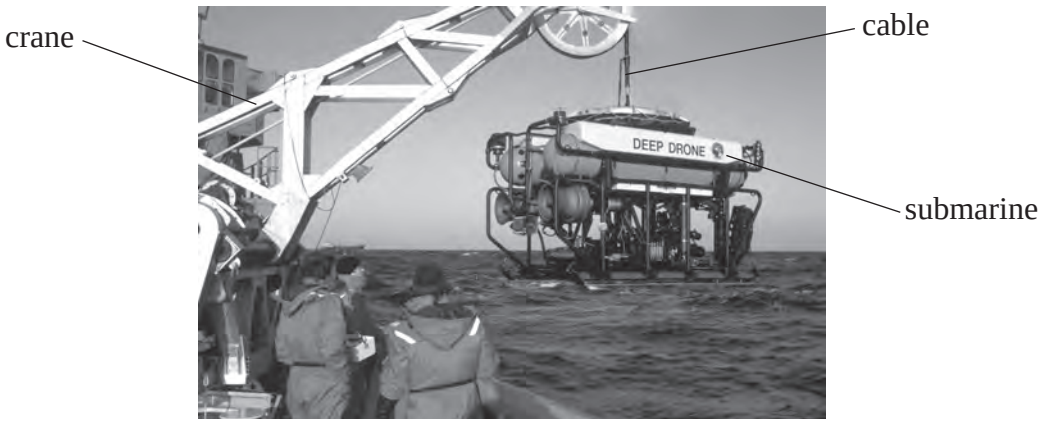
Determine the resultant of these two forces on the submarine by drawing a scaled vector diagram in the space below.

(5)

Magnitude of resultant force = ...

Angle of resultant force to horizontal = ...

*(b) A crane on a ship can lift the submarine out of the sea, as shown.



(Source: adapted from © PJF Military Collection/Alamy Stock Photo)

The submarine is initially completely underwater and at rest just below the surface. A cable from the crane is attached to the submarine, so that the cable is vertical.

The crane pulls on the cable. The submarine moves vertically upwards at a constant speed until the whole submarine is out of the water.

Explain how the tension in the cable changes as the submarine moves from below the surface of the water to being completely out of the water.

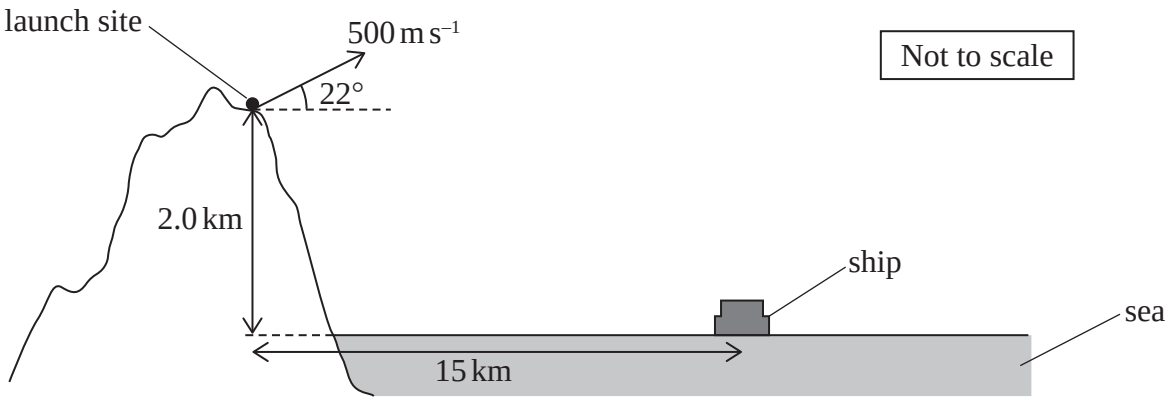
You should assume the drag force on the submarine is negligible.

(6)

(Total for Question 18 = 11 marks)

19 Scientists launched a projectile from a mountain. The launch site was 2.0 km above sea level. The projectile initially moved with a speed of 500 m s^{-1} at an angle of 22° to the horizontal.

A ship was a horizontal distance of 15 km from the launch site, as shown. The projectile passed over the ship.



(a) (i) Show that the projectile was vertically above the ship about 30 s after launch.

You should ignore the effects of air resistance.

(3)

(ii) Determine the height above sea level of the projectile as it passed over the ship.

You should ignore the effects of air resistance.

(4)

Height above sea level = ...

(b) The scientists launched several more projectiles. Each projectile was launched at the same speed but at a different angle to the horizontal.

As the launch angle was increased, the horizontal distance travelled before landing in the sea increased to a maximum value and then decreased.

Explain why the horizontal distance travelled reached a maximum value.

You should consider the components of the initial velocity.

(4)

(Total for Question 19 = 11 marks)

20 A student determined the terminal velocity of a metal sphere falling through a container of oil.

(a) The student released the sphere from rest in the oil.

Explain why the sphere reached terminal velocity.

(4)

(b) The student measured the time taken for the sphere to fall through 0.45 m of the oil at terminal velocity.

(i) Calculate the viscous drag force on the sphere.

Assume the conditions for Stokes' law applied.

time taken = 7.3 s
radius of sphere = 0.90×10^{-3} m
viscosity of oil = 2.1×10^{-1} Pa s

(3)

Viscous drag force = ...

(ii) The student repeated the experiment using a second sphere with a greater diameter.

The density of the second sphere was the same as the density of the original sphere.

The temperature of the oil was the same and the conditions for Stokes' law applied.

Explain how the time taken for the second sphere to fall through 0.45 m at terminal velocity compares with the time taken for the original sphere.

(3)

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(Total for Question 20 = 10 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density

$$\rho = \frac{m}{V}$$

Stokes' law

$$F = 6\pi\eta rv$$

Hooke's law

$$\Delta F = k\Delta x$$

Elastic strain energy

$$\Delta E_{el} = \frac{1}{2}F\Delta x$$

Young modulus

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

$$\text{Stress } \sigma = \frac{F}{A}$$

$$\text{Strain } \varepsilon = \frac{\Delta x}{x}$$