Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 10 October 2024

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

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 ▶

P78391RA

©2024 Pearson Education Ltd.
V:1/1/1/1/

P 7 8 3 9 1 R A 0 1 2 8

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 Which of the following units is equivalent to the watt?

☒ **A** $\mathrm{N\,m}$

☒ **B** $\mathrm{N\,m^{-1}}$

☒ **C** $\mathrm{J\,s}$

☒ **D** $\mathrm{J\,s^{-1}}$

(Total for Question 1 = 1 mark)

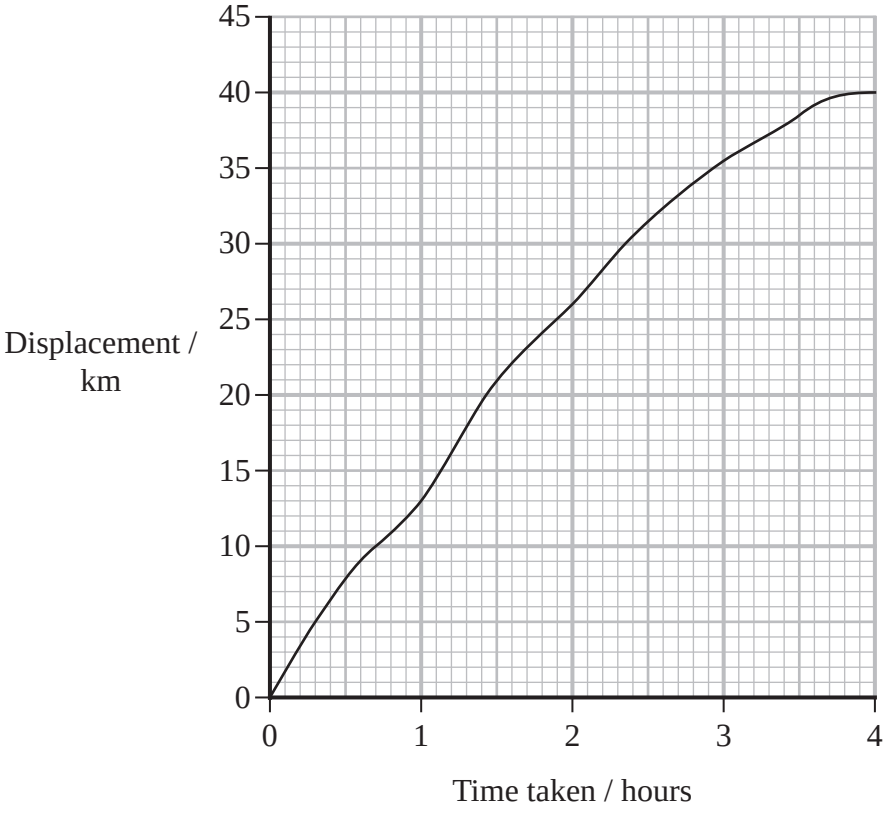
2 Which row of the table gives **two** vector quantities?

☒ **A**	acceleration	weight
☒ **B**	displacement	kinetic energy
☒ **C**	strain	velocity
☒ **D**	Young modulus	mass

(Total for Question 2 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

3 The displacement-time graph for a person running a race is shown.



Which of the following gives the average velocity of the person?

☒ **A** area between the curve and the *x*-axis from 0 hours to 4 hours

☒ **B** gradient of a tangent to the curve at 4 hours

☒ **C** gradient of a tangent to the curve at 2 hours

☒ **D** displacement at 4 hours divided by a time of 4 hours

(Total for Question 3 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

4 The photograph shows a cable car hanging from a cable. The cable car is in equilibrium.



(Source: © zefart/Getty Images)

Which of the following forms a Newton's third law pair of forces with the weight of the cable car?

☒ **A** air resistance acting on the cable car

☒ **B** gravitational pull of the cable car on the Earth

☒ **C** upthrust of the displaced air acting on the cable car

☒ **D** normal contact force of the cable car on the cable

(Total for Question 4 = 1 mark)

5 A box slides down a slope at a constant speed. Weight and resistive forces both act on the box.

Which of the following is a reason why the speed of the box is constant?

☒ **A** The component of the weight parallel to the slope is equal to the sum of the resistive forces.

☒ **B** The component of the weight parallel to the slope is greater than the sum of the resistive forces.

☒ **C** The component of the weight perpendicular to the slope is equal to the sum of the resistive forces.

☒ **D** The component of the weight perpendicular to the slope is greater than the sum of the resistive forces.

(Total for Question 5 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

6 A person stands on a moving staircase.

The moving staircase increases the gravitational potential energy of the person by 5000 J in a time of 42 s.

The efficiency of the moving staircase is 0.63

Which of the following expressions gives the power input to the moving staircase in watts?

☒ **A** $\frac{42}{5000 \times 0.63}$

☒ **B** $\frac{42 \times 0.63}{5000}$

☒ **C** $\frac{5000}{42 \times 0.63}$

☒ **D** $\frac{5000 \times 0.63}{42}$

(Total for Question 6 = 1 mark)

7 A student applies a force to stretch a thin metal wire.

Which of the following describes the wire at the elastic limit?

☒ **A** The wire is elastically deformed.

☒ **B** The wire is plastically deformed.

☒ **C** The wire is at its maximum extension.

☒ **D** The wire snaps.

(Total for Question 7 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

8 A student uses a wooden bat to hit a stationary ball of mass m.

As the bat hits the ball, the momentum of the bat decreases by Δp.
The ball then moves with velocity v.

The student then uses the bat to hit a stationary ball of mass $3m$.
The momentum of the bat decreases by $2\Delta p$.

Which of the following expressions gives the velocity of the ball of mass $3m$ after being hit?

☒ **A** $\frac{1}{6}v$

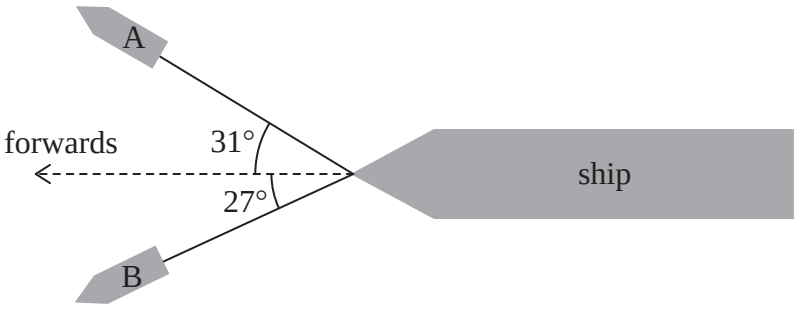
☒ **B** $\frac{2}{3}v$

☒ **C** $\frac{3}{2}v$

☒ **D** $6v$

(Total for Question 8 = 1 mark)

9 Two boats, A and B, are pulling a ship. Each boat is attached to the ship by a rope, as shown.



The force from boat A on the ship is F_A.

The force from boat B on the ship is F_B.

Which of the following expressions gives the forwards component of the total force of the boats on the ship?

☒ **A** $F_A\sin(31°) + F_B\cos(27°)$

☒ **B** $F_A\sin(31°) + F_B\sin(27°)$

☒ **C** $F_A\cos(31°) + F_B\cos(27°)$

☒ **D** $F_A\cos(31°) + F_B\sin(27°)$

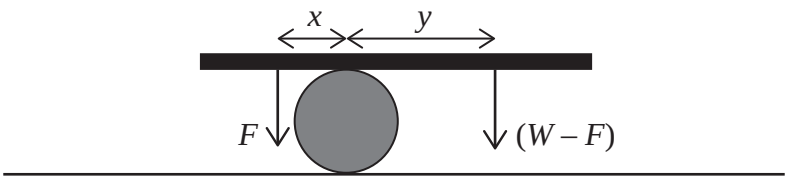
(Total for Question 9 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

10 A student puts a piece of wood on top of a cylinder. He stands on the wood with his feet at distances x and y from the cylinder.

The weight of the student is W.

The diagram shows the force of each foot acting on the wood.



The wood is horizontal and in equilibrium.

The weight of the wood is negligible.

Which of the following expressions is equal to W?

☒ **A** $\frac{Fx}{y} + F$

☒ **B** $\frac{Fx}{y} - F$

☒ **C** $\frac{Fy}{x} + F$

☒ **D** $\frac{Fy}{x} - F$

(Total for Question 10 = 1 mark)

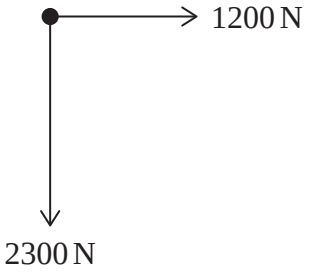
TOTAL FOR SECTION A = 10 MARKS

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

SECTION B

Answer ALL questions in the spaces provided.

11 Two forces act on an object. The forces are perpendicular, as shown.



Not to scale

Determine the magnitude of the resultant force using a scaled vector diagram.

Magnitude of resultant force = ... N

(Total for Question 11 = 2 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

12 A student has a spring of length 0.18 m. The spring has a stiffness constant of 25 N m^{-1}.

The student applies a force of 7.0 N to stretch the spring.

Calculate the new length of the spring.

.....

.....

.....

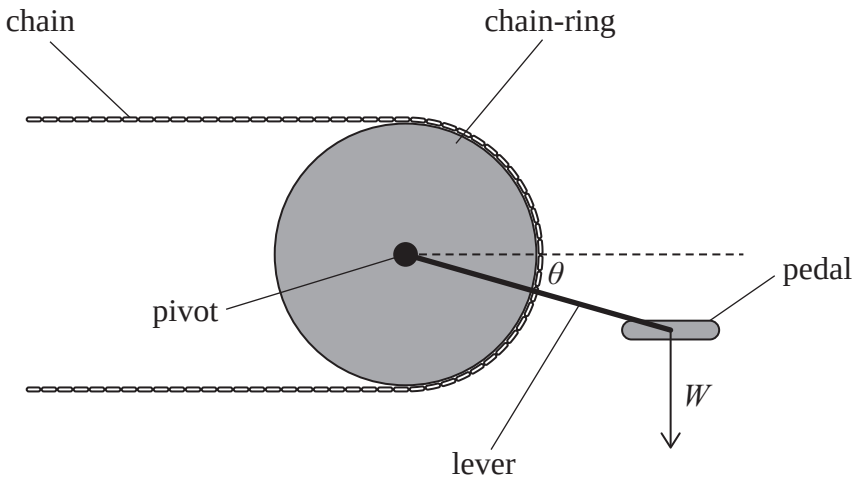
New length = ...

(Total for Question 12 = 2 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

13 A bicycle pedal is connected to a circular 'chain-ring' by a lever. A person of weight W stands on the pedal.

The lever is at an angle θ to the horizontal, as shown.



(a) Determine the moment of W about the pivot when θ is 24°.

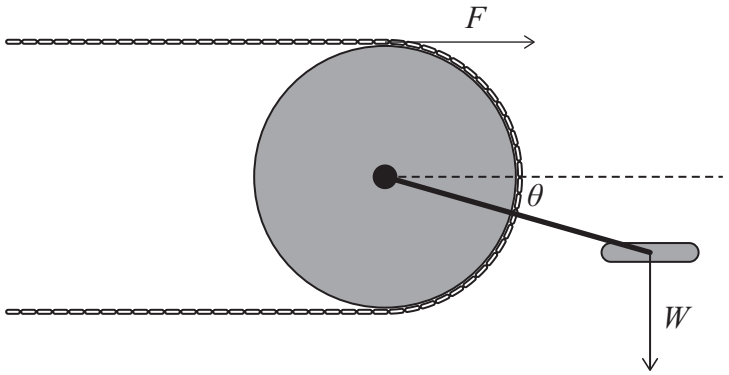
$W = 580\,\text{N}$
length of lever = 0.21 m

(3)

Moment = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The chain-ring exerts a force F on the chain, as shown.



F is proportional to the moment of W about the pivot.

Explain how F changes as θ increases from 0° to 90°.

You do not need to do any calculations.

(2)

.....

.....

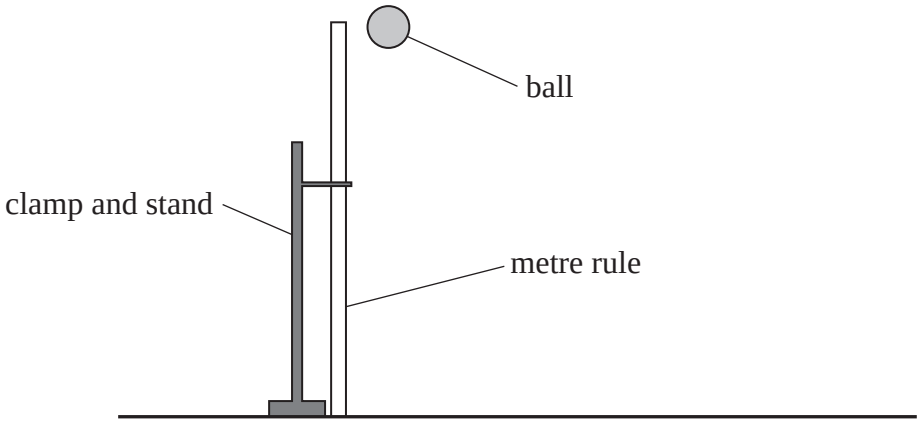
.....

.....

(Total for Question 13 = 5 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

14 A student clamped a metre rule so that it was vertical. She dropped a ball from rest near the top of the metre rule, as shown.



A strobe emits flashes of light. The time interval between flashes is constant.

The student photographed the falling ball using strobe lighting. The ball can be seen at different heights in the photograph, as shown.



(Source: © sciencephotos/Alamy Stock Photo)

For each flash of light, the student determined the distance fallen by the ball.

(a) She took one photograph using a strobe app on a mobile phone.
She took a second photograph using a laboratory strobe.

The time interval between flashes was the same for the strobe app and for the laboratory strobe. Each flash of light from the laboratory strobe has a smaller duration than each flash from the mobile phone.

Explain how the smaller duration of each flash from the laboratory strobe affected the uncertainty in the measurement of the distance fallen.

(2)

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The student recorded the distances s fallen by the ball and corresponding values of the time t.

(i) Explain why a graph of s against t^2 gives a straight line.

(2)

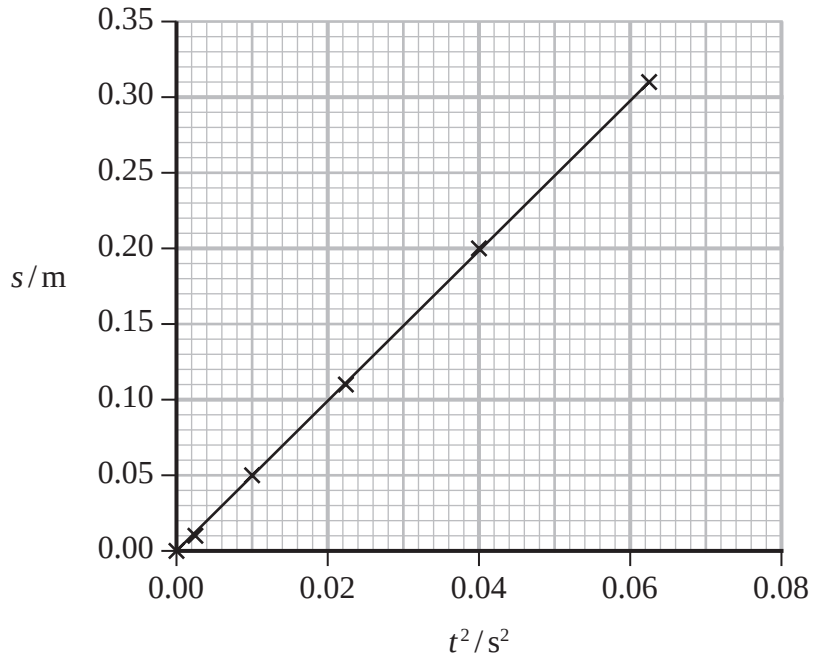
.....

.....

.....

.....

(ii) The student plotted a graph of s against t^2, as shown.



Determine the acceleration of free fall, g, using the student's graph.

(2)

.....

.....

.....

.....

g = ...

(Total for Question 14 = 6 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

15 In a high jump competition, athletes jump over a bar.

An athlete has a weight of 680 N.

(a) The athlete exerts a force of 890 N on the ground as he jumps into the air.

Explain why the athlete accelerates upwards.

Your answer should refer to Newton's third law.

(3)

(b) The athlete moves horizontally as he passes over the bar.

(i) The kinetic energy of the athlete is 409 J.

Show that the athlete has a horizontal speed of about 3.4 $m\,s^{-1}$.

(3)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) After passing over the bar, the athlete moves through a vertical distance of 1.4 m before he lands.

Calculate the velocity of the athlete as he lands.

(5)

Magnitude of velocity = ...

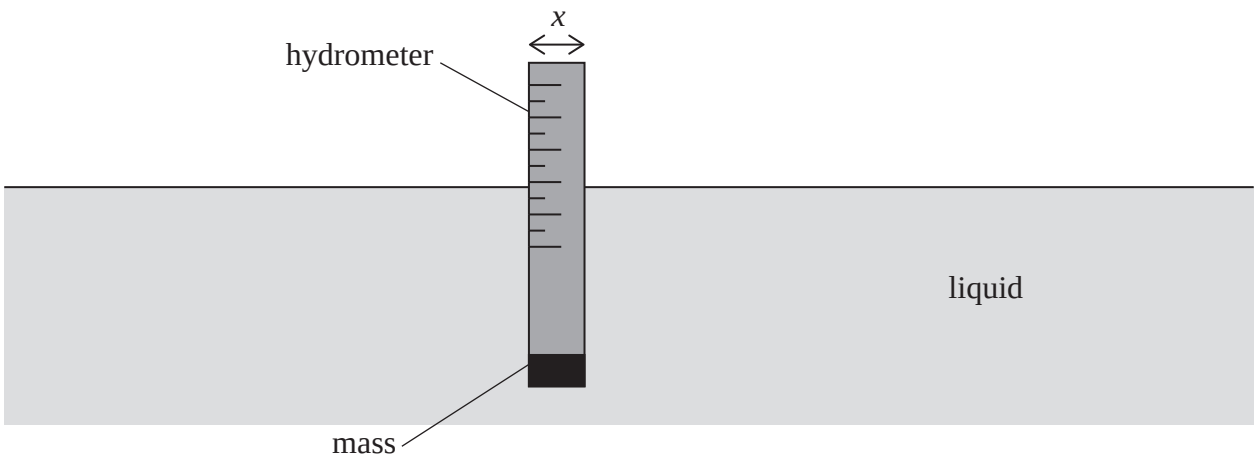
Angle from vertical = ...

(Total for Question 15 = 11 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

16 A simple hydrometer is a cylinder with a mass at one end. The cylinder floats vertically in a liquid.

The diameter of the hydrometer is x. A scale on the side of the hydrometer shows the vertical position of the hydrometer in the liquid, as shown.



A student placed the hydrometer in a sample of pure water.

(a) Complete the free-body diagram below to show the forces acting on a hydrometer when floating in water at equilibrium.

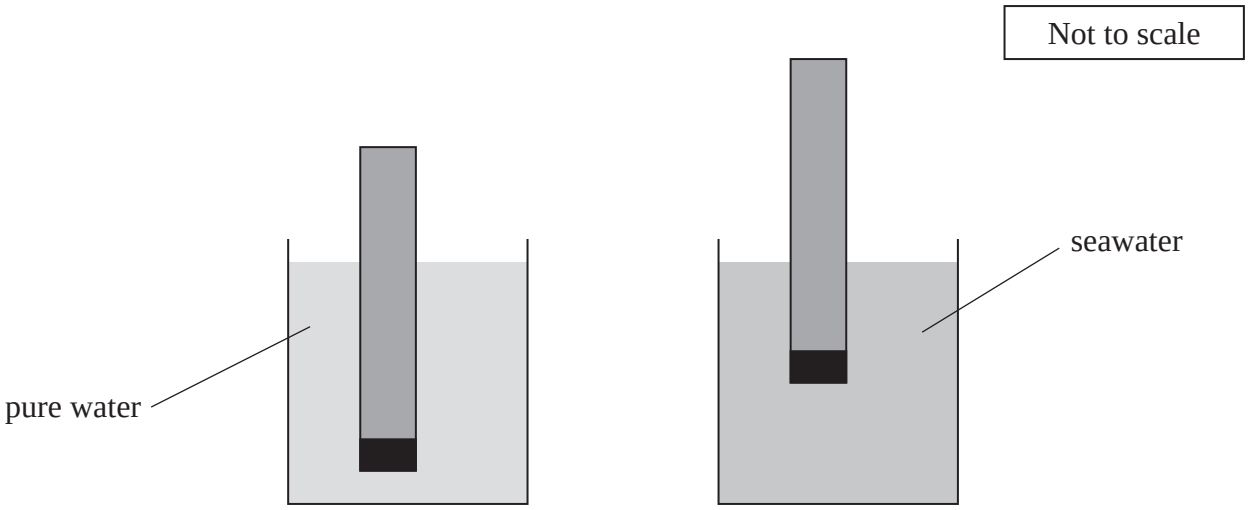
(2)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The student placed the hydrometer in a sample of seawater.

Seawater is more dense than pure water.

At equilibrium, the vertical position of the hydrometer was higher in the seawater than in the pure water, as shown.



(i) Explain why the vertical position of the hydrometer was higher in the seawater than in the pure water.

(3)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) Calculate the change in the vertical position of the hydrometer when moved from pure water into seawater.

weight of hydrometer = 0.324 N
density of pure water = 997 kg m^{-3}
density of seawater = 1025 kg m^{-3}
x = 1.23 cm

(5)

Change in vertical position = ...

(Total for Question 16 = 10 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

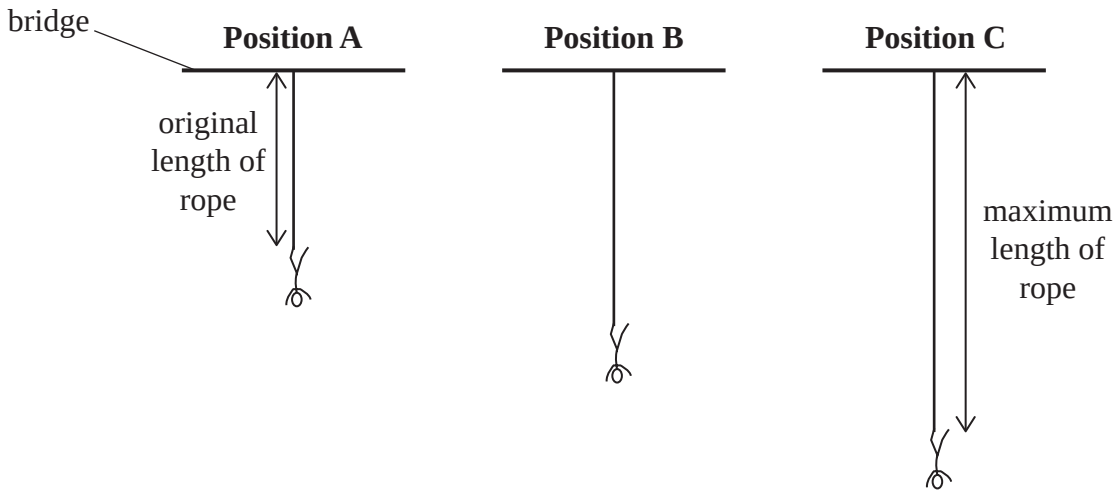
DO NOT WRITE IN THIS AREA

BLANK PAGE

17 A student is about to do a bungee jump from a high bridge. The student is attached to the bridge by an elastic rope.

The student jumps from the bridge and initially accelerates. The diagrams show the student at three different positions during the bungee jump.

At **Position A** the distance fallen by the student is equal to the original length of the rope.
At **Position B** the student is in equilibrium.
At **Position C** the rope has maximum extension.



*(a) Explain how the acceleration of the student changes as she moves from **Position A** to **Position C**.
Assume that air resistance is negligible.

(6)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The bridge is above a river. The student will reach the river if the rope stretches to a total length of 35 m during the bungee jump.

The student has a mass of 65 kg.

The original length of the rope is 17 m.

The rope behaves like a spring with stiffness constant 250 $N\,m^{-1}$.

Deduce whether the student will reach the river during the bungee jump.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 17 = 10 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

18 Some spiders form silk in long, thin threads to catch flying insects.

The Darwin's bark spider can produce very long threads. A scientist investigated the properties of these threads.

The scientist applied forces to stretch threads of spider silk.

(a) The stress in one thread was 4.3 MPa. The radius of the thread was 1.9×10^{-6} m.

Calculate the force applied to the thread.

(3)

Force = ...

(b) The scientist investigated a thread of length 25.0 m.

Determine the length of this thread when stretched to its limit of proportionality.

Young modulus of spider silk = 8.70 GPa
stress at limit of proportionality = 300 MPa

(4)

Length at limit of proportionality = ...

DO NOT WRITE IN THIS AREA

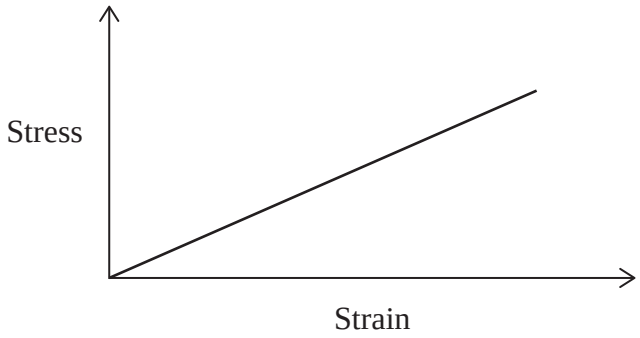
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) The table shows some properties of spider silk and a type of steel.

Material	Young modulus / GPa	Stress at limit of proportionality / MPa
Spider silk	8.70	300
Steel	200	350

(i) The sketch graph shows the stress-strain relationship for the spider silk up to its limit of proportionality.



Add a line to the sketch graph to show the stress-strain relationship for the steel up to its limit of proportionality.

(2)

(ii) A sample of the steel has the same shape, length and cross-sectional area as a sample of the spider silk.

Each sample is stretched to its limit of proportionality.

Explain which sample has the greater elastic strain energy.

(3)

.....

.....

.....

.....

.....

.....

(Total for Question 18 = 12 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

19 A deep-sea diver is a person who swims at great depths below the surface of the sea.

(a) To help a deep-sea diver move downwards quickly, spherical masses are attached to the diver.

During a dive, one mass became unattached and fell to the bottom of the sea.

(i) State the conditions for Stokes' law to apply.

(2)

.....

.....

.....

.....

(ii) The mass accelerated to terminal velocity as it fell to the bottom of the sea.

At terminal velocity, the mass fell 25 m in a time of 0.36 s.

There was a difference of 4.6 N between the weight of the mass and the upthrust on the mass.

The spherical mass has a volume of 45 cm^3.

Deduce whether Stokes' law applied as the mass fell through the water.

$\eta_{water} = 1.2 \times 10^{-3}$ Pa s

(5)

.....

.....

.....

.....

.....

.....

.....

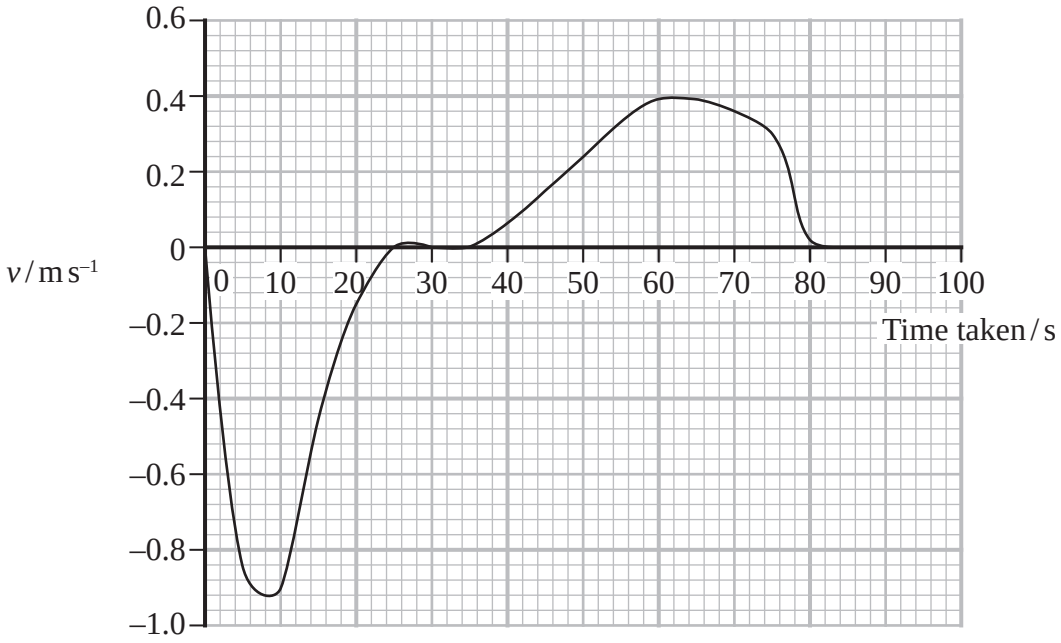
.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The graph shows how the vertical velocity v of the diver varied during a dive.



(i) The diver was at the surface of the sea at 0 s.

Explain how the graph could be used to show that the diver reached the surface of the sea again at 82 s.

(2)

.....

.....

.....

.....

(ii) Determine the vertical acceleration of the diver at 70 seconds.

(3)

.....

.....

.....

Acceleration = ...

(Total for Question 19 = 12 marks)

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

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

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

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

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

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

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE