Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Tuesday 12 May 2020

(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.
- **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 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 questions 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 ▶

1/1/1/1/1/1/1/1

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 only used with vector quantities?

☐ **A** J

☐ **B** m

☐ **C** N

☐ **D** W

(Total for Question 1 = 1 mark)

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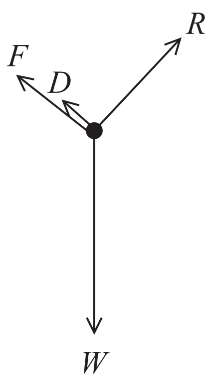
2 A box was placed at the top of a ramp and released.

The free-body force diagram for the box as it moved down the ramp at a constant velocity is shown.



D = air resistance

F = frictional force

R = normal contact force

W = weight of the box

Which two forces acting on the box have, according to Newton's third law, corresponding forces acting on the ramp?

☐ **A** *F* and *D*

☐ **B** *F* and R

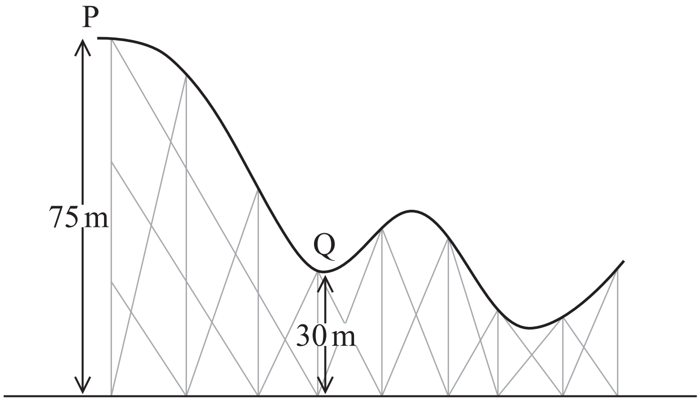
☐ **C** *W* and D

☐ **D** *W* and *R*

(Total for Question 2 = 1 mark)

P 6 2 5 9 1 R A 0 2 2 8

3 The diagram shows a roller coaster. A roller coaster car stops momentarily at P before descending towards Q.



Which of the following expressions could be used to determine the velocity of the roller coaster car at Q?

☒ **A** $\sqrt{75g} - \sqrt{30g}$

☒ **B** $\sqrt{150g} - \sqrt{60g}$

☒ **C** $\sqrt{45g}$

☒ **D** $\sqrt{90g}$

(Total for Question 3 = 1 mark)

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4 A car travels north with a velocity of $+50\,\text{m}\,\text{s}^{-1}$. While still travelling north, the car slows to a velocity of $+20\,\text{m}\,\text{s}^{-1}$.

Which of the following is the change of velocity of the car?

☒ **A** $+30\,\text{m}\,\text{s}^{-1}$

☒ **B** $-30\,\text{m}\,\text{s}^{-1}$

☒ **C** $+70\,\text{m}\,\text{s}^{-1}$

☒ **D** $-70\,\text{m}\,\text{s}^{-1}$

(Total for Question 4 = 1 mark)

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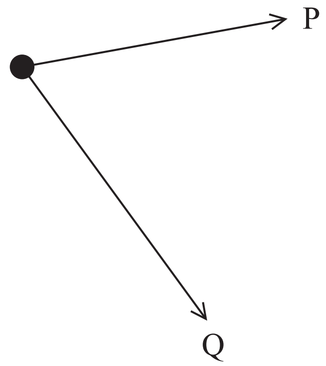
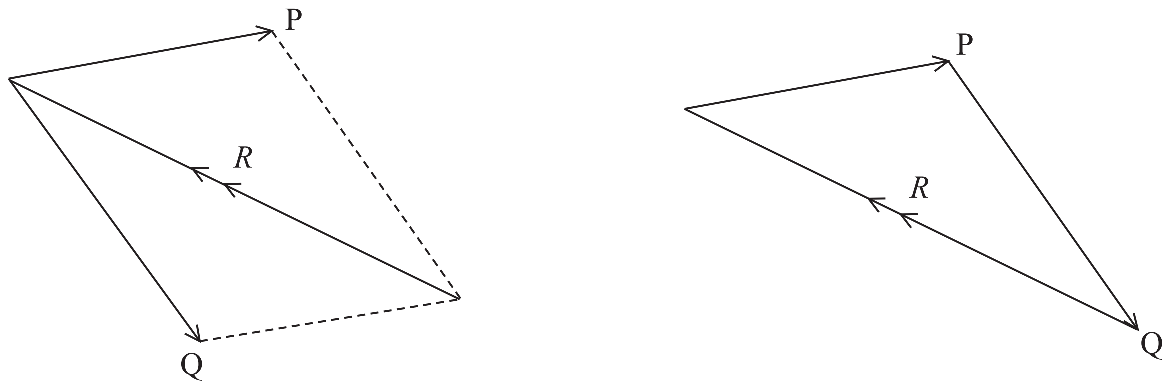
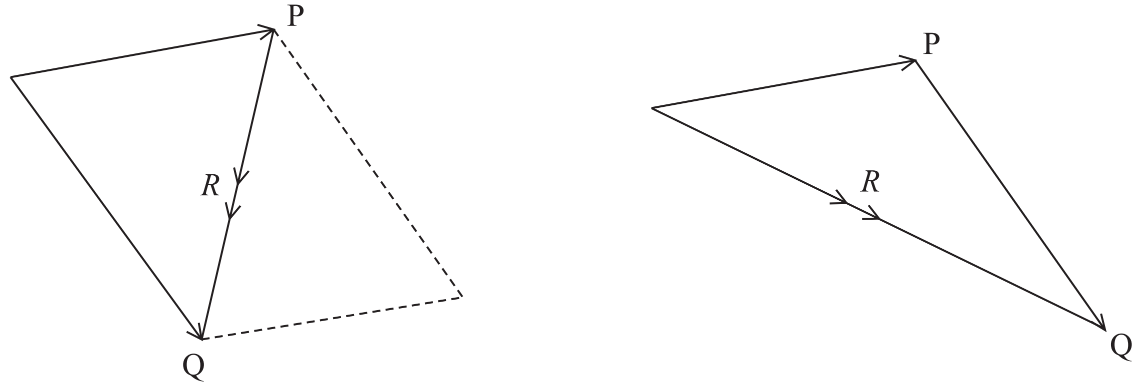
5 Two forces P and Q act on an object as shown.



Which of the following is a correctly drawn, scaled, vector diagram for the resultant *R* of forces P and Q?





☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 5 = 1 mark)

6 A lamp with an efficiency of 0.68 usefully transfers 120 J of energy.

Which of the following can be used to determine E, the energy supplied to the lamp?

- ☒ **A** $E = 0.68 \times 120 \times 100$
- ☒ **B** $E = 0.68 \times 120$
- ☒ **C** $E = \dfrac{120}{0.68} \times 100$
- ☒ **D** $E = \dfrac{120}{0.68}$

(Total for Question 6 = 1 mark)

7 A student used a falling sphere to determine the acceleration of free-fall g. The sphere was released from rest.

Which two quantities would require the fewest measurements to be taken in order to determine g?

- ☒ **A** displacement and initial velocity
- ☒ **B** displacement and time
- ☒ **C** final velocity and displacement
- ☒ **D** final velocity and time

(Total for Question 7 = 1 mark)

8 A stress σ is applied across the ends of a wire of cross-sectional area A.

Work W is done to extend the wire by Δx.

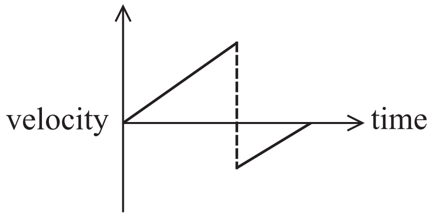
Which of the following could be used to determine W?

- ☒ **A** $W = \dfrac{1}{2} \times \dfrac{\sigma}{A} \times \Delta x$
- ☒ **B** $W = \dfrac{1}{2} \times \dfrac{\sigma}{A} \times \Delta x^2$
- ☒ **C** $W = \dfrac{1}{2} \times \sigma \times A \times \Delta x$
- ☒ **D** $W = \dfrac{1}{2} \times \sigma \times A \times \Delta x^2$

(Total for Question 8 = 1 mark)

Questions 9 and 10 refer to the information below.

The velocity-time graph for the motion of a ball is shown.

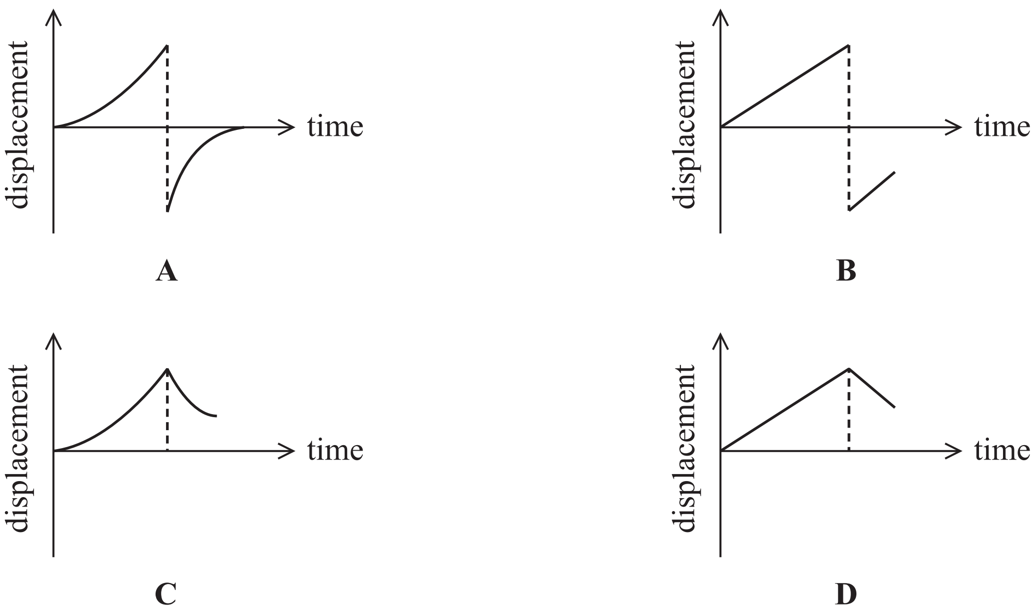


9 Which of the following correctly describes the motion of the ball?

- ☒ **A** The ball is dropped and rebounds to its original position.
- ☒ **B** The ball is dropped and rebounds to a lower position.
- ☒ **C** The ball is thrown upwards and is caught at its original position.
- ☒ **D** The ball is thrown upwards and is caught at a higher position.

(Total for Question 9 = 1 mark)

10 Which of the following graphs of displacement against time could represent the motion of the ball?



- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions.

11 Every litre of fuel used in a car engine releases 32 MJ of energy. During one journey the car used 65 litres of fuel. The car journey lasted 8 hours.

(a) Show that the average power input to the engine was about 70 kW.

(2)

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(b) The car travelled a total distance of 730 km during the journey.

The average force of the engine was 2.1 kN.

Show that the average power output of the engine was about 50 kW.

(3)

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(c) Determine the efficiency of the engine.

(2)

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Efficiency of engine = ...

(Total for Question 11 = 7 marks)

12 The photograph shows a person riding a unicycle. The unicycle moves at a constant speed on a horizontal surface. The vertical forces *R* and *W* act as shown.

The magnitude of each force is represented by the length of the arrow on the photograph.

(a) Assess whether forces *R* and *W* are a Newton's third law pair of forces.

(3)

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(b) Explain the motion of the unicycle. Your answer should make reference to all of the forces acting on the unicycle.

(2)

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(Total for Question 12 = 5 marks)

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13 A uniform, horizontal flagpole is connected by a hinge to a wall at position O.
An aluminium wire connects the pole to the wall at A, as shown.

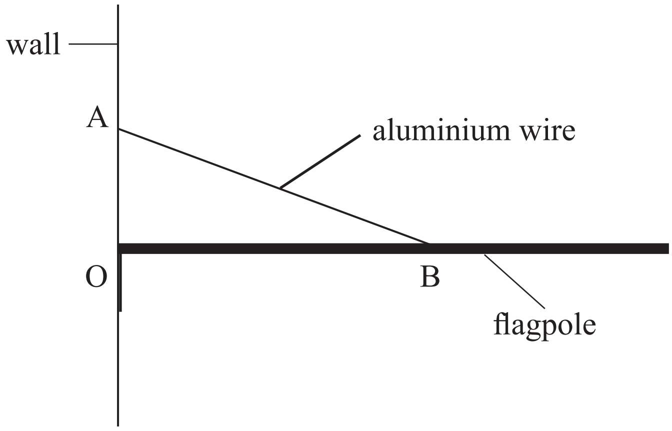
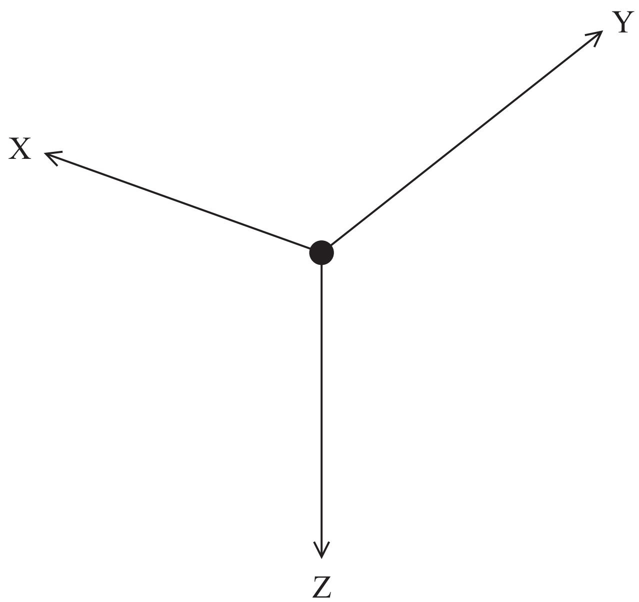


Diagram not to scale

(a) A free-body force diagram for the flagpole is shown below.

Identify the forces X, Y and Z.

(3)



X ....

Y ....

Z ....

(b) The aluminium wire will break if the tension in the wire exceeds 350 N.

The wire is attached to the flagpole at B, 0.8 m from the wall.

The wire is at an angle of 20° to the flagpole.

Assess whether the wire will break. You should use the principle of moments, taking moments about O.

length of flagpole = 1.2 m

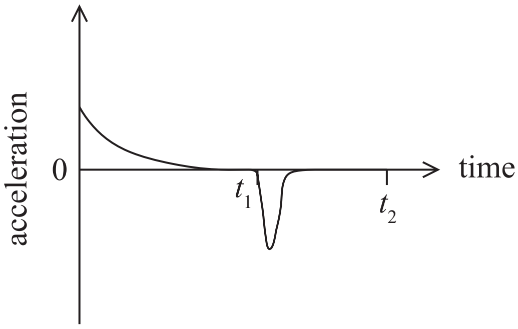
mass of flagpole and flag = 15 kg

(3)

(Total for Question 13 = 6 marks)

***14** A skydiver jumps from an aeroplane and accelerates until she reaches terminal velocity. At a time t_1, she opens a parachute and a second, lower terminal velocity is reached before landing safely at time t_2.

The acceleration-time graph for the motion of the skydiver is shown.



Explain the shape of the graph. You should refer to the forces acting on the skydiver.

(6)

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(Total for Question 14 = 6 marks)

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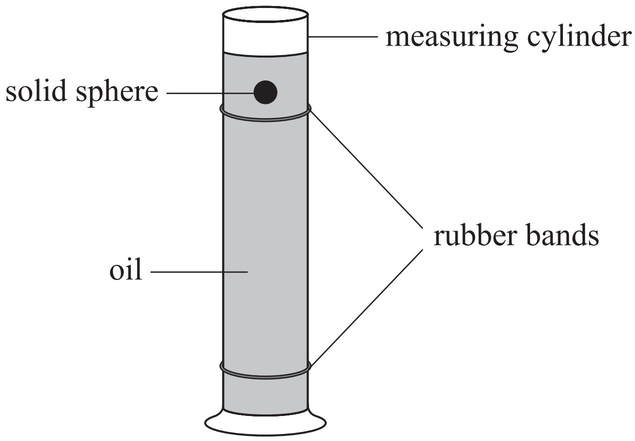
P 6 2 5 9 1 R A 0 1 3 2 8

15 A student carried out an experiment to determine the viscosity of a sample of oil contained in a large measuring cylinder.

A small solid sphere was released just above the surface of the oil and the terminal velocity of the sphere was determined.



(a) Two rubber bands were placed around the cylinder as shown. When the sphere passed the top band a timer was started. The timer was stopped when the sphere passed the bottom band.

(i) Explain why the top rubber band should be placed a short distance below the surface of the oil.

(2)

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(ii) Another student suggested using an additional rubber band halfway between the top and bottom rubber bands.

Discuss the benefit of adding the third rubber band.

(2)

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(b) The student used the following equation to determine the viscosity η of the oil.

$$\frac{4}{3}\pi r^3 \rho_s g = \frac{4}{3}\pi r^3 \rho_o g + 6\pi r \eta v$$

Where

ρ_s = density of the solid sphere

ρ_o = density of the oil

r = radius of the sphere

v = terminal velocity of the sphere

(i) Which quantity is represented by $\frac{4}{3}\pi r^3 \rho_s g$?

(1)

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(ii) Which quantity is represented by $\frac{4}{3}\pi r^3 \rho_o g$?

(1)

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(iii) Which quantity is represented by $6\pi r \eta v$?

(1)

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(iv) The accepted value for the viscosity of the oil used in this experiment is 41 mPa s at 24 °C.

The student obtained a value of 36 mPa s.

Suggest a possible reason for the student obtaining a lower value for the viscosity than the accepted value.

(1)

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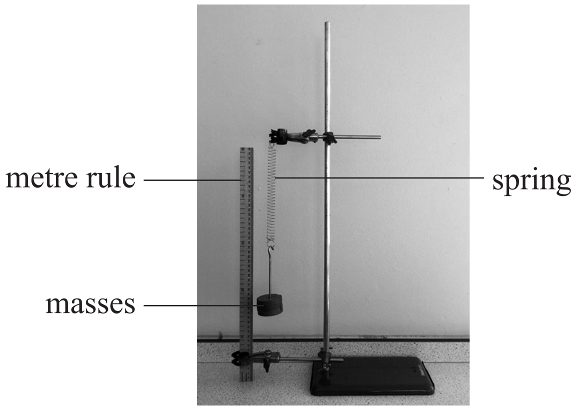
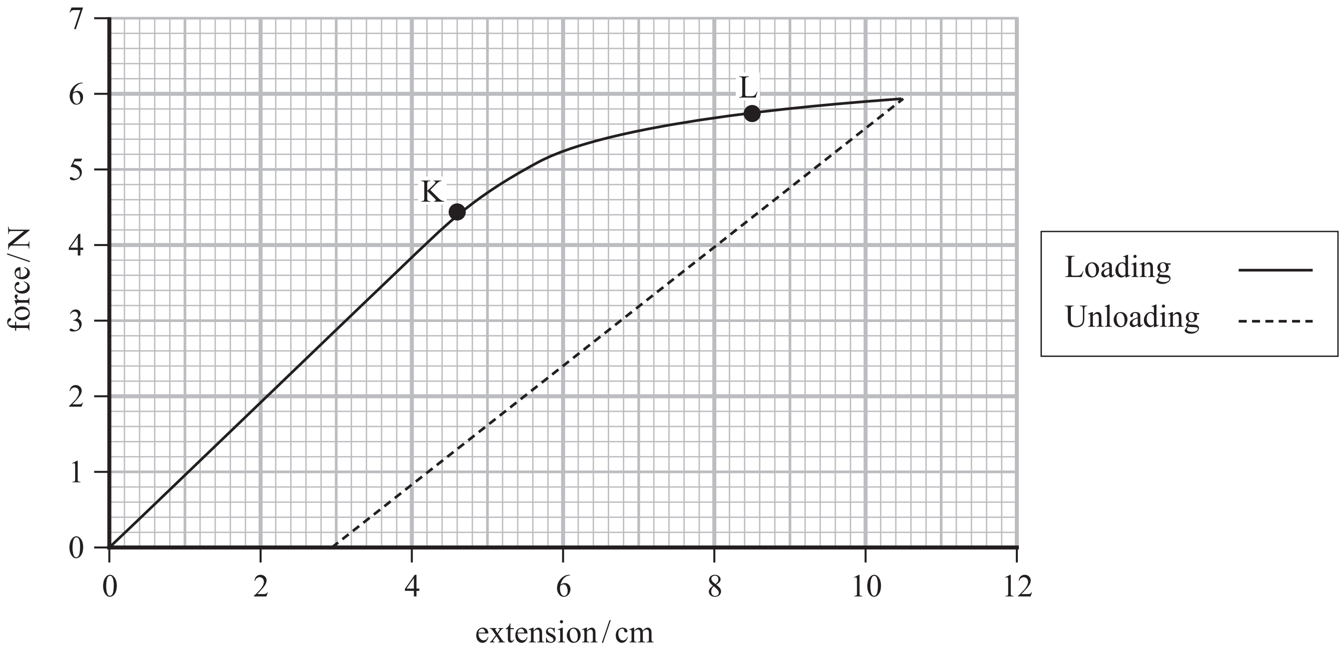
(Total for Question 15 = 8 marks)

16 A student used the equipment shown to investigate the behaviour of a spring.



The student recorded the position of the spring on the metre rule for increasing loads. He plotted the graph shown for the loading and unloading of the spring.



(a) The student continued to increase the load until the spring exceeded the elastic limit at point L.

(i) State the significance of point K.

(1)

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(ii) Explain the significance of point L.

(2)

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(iii) The graph for the unloading of the spring is also shown on the axes.

Suggest why the unloading graph has a different gradient to the loading graph.

(1)

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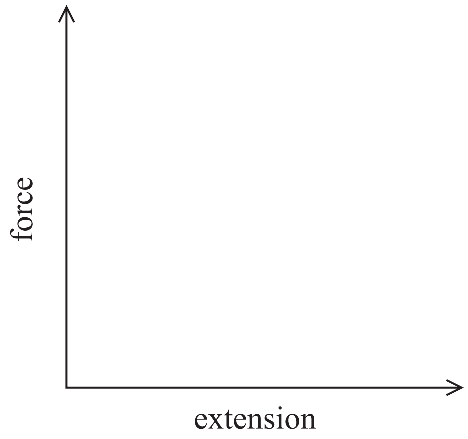
(b) A second student repeated the investigation but forgot to subtract the original length of the spring from his measurements.

Sketch, on the axes below, the shape of the graph he would obtain for the loading of the spring.

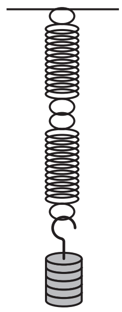
(1)



P 6 2 5 9 1 R A 0 1 7 2 8

Turn over

(c) A third student repeated the investigation using two new springs connected in series as shown.



The springs were identical to the spring used in the original investigation.

Explain why the spring constant for this arrangement of the springs would be half that for one spring.

(4)

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(Total for Question 16 = 9 marks)

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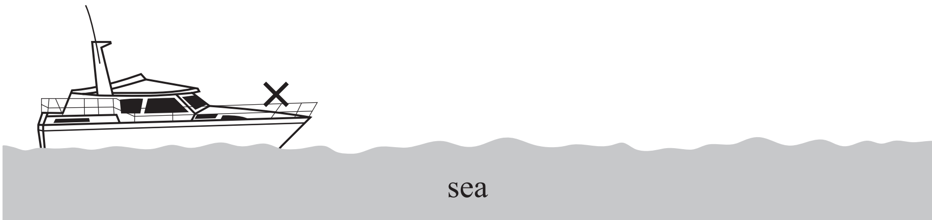
17 A distress flare may be launched from a boat, to signal for help.

(a) A flare was launched from a stationary boat at an angle of 30° to the horizontal.

(i) The flare was launched to the right from the launch position marked × on the boat in the diagram below.

Complete the diagram to show the path taken by the flare before it hit the sea.

(1)



(ii) The maximum height of the flare above the launch position was 42 m.

Show that the flare was launched at a speed of about 60 m s^{-1}.

(3)

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(iii) The flare was visible from a maximum distance of 8 km. A rescue boat was 8.2 km from the boat in distress.

Determine whether the flare travelled a sufficient distance to be visible from the rescue boat. You should assume that the flare was launched in the direction of the rescue boat.

(4)

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(b) State one assumption you made in (a)(iii).

(1)

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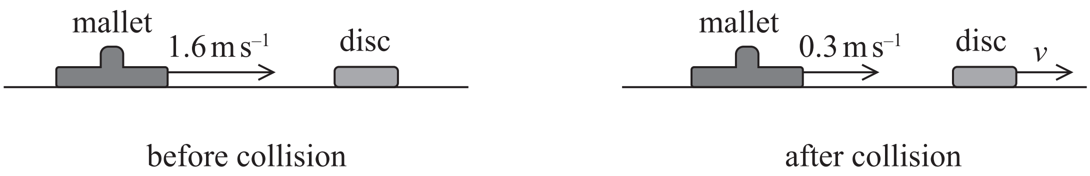
(Total for Question 17 = 9 marks)

18 A game is played where each player must use a 'mallet' to hit a disc across a table into the opponent's goal.

One player accidentally lets go of a mallet. The mallet travels at a speed of $1.6\,\mathrm{m\,s^{-1}}$ and collides with a stationary disc.

After the collision, the mallet continues in the same direction at a lower speed of $0.3\,\mathrm{m\,s^{-1}}$. The disc moves in the same direction as the mallet with a velocity v, as shown.



(a) Calculate a value for v.
Assume that frictional forces are negligible.

mass of disc = 0.035 kg
mass of mallet = 0.17 kg

(3)

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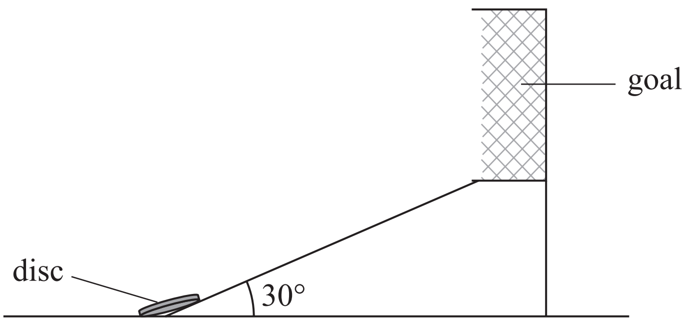
v = ...

(b) To reach the goal, the disc must move up a ramp which is at an angle of 30° to the horizontal.



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The velocity of the disc at the bottom of the ramp is $5.0\,m\,s^{-1}$. The disc moves up the ramp and work is done by the disc against the frictional force. The disc moves a distance of 6.5 cm up the ramp before moving back down.

Determine the frictional force acting on the disc.

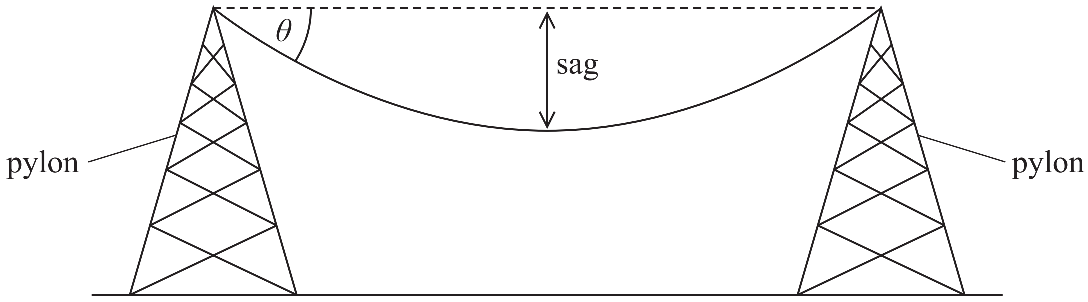
(6)

Frictional force = ...

(Total for Question 18 = 9 marks)

19 The transmission of electricity over long distances requires a conducting cable that is suitable to hang from supporting towers called pylons.

The vertical distance from the line of support to the lowest point on the wire is called the sag. Due to the high voltages involved, the cable must maintain a minimum distance from the ground.



(a) The temperature and the tension in the cable affect the sag.

(i) Suggest one further factor that may increase the sag of a cable.

(1)

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(ii) A cable of mass M is at an angle θ to the horizontal.

Explain why the tension in the cable decreases as the sag increases.

(3)

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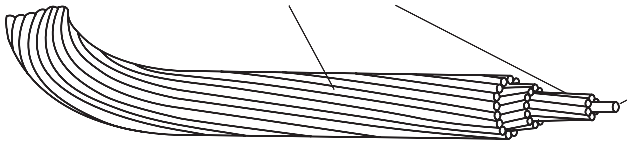
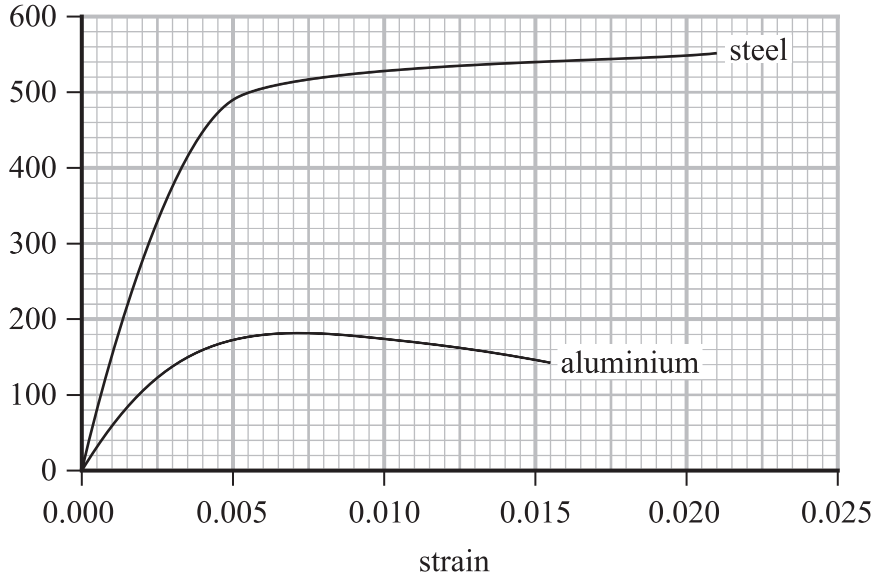
(b) A type of conducting cable used in overhead power lines is ACSR. This cable has a steel core surrounded by strands of aluminium cable of the same diameter.



Stress-strain graphs for samples of steel and aluminium typically used in each strand of the cable are shown.



(i) Show that the Young modulus of steel is about 2×10^{11} Pa.

(2)

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(ii) The pylons are positioned every 270 m.

Show that the stress in a strand of steel is about 70 MPa.

(2)

cross-sectional area of one strand = $2.3 \times 10^{-6}\,m^2$
tension per m for steel = $0.62\,N\,m^{-1}$

(iii) ACSR cables consist of a steel core surrounded by strands of aluminium cable.

The extension produced, due to the tension, for each strand of aluminium is 0.95 m.

Comment on why ACSR cables consist of both a steel core and strands of aluminium cable. You should include a calculation as part of your answer.

(3)

(Total for Question 19 = 11 marks)

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

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List of data, formulae and relationships

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

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

$$E_\mathrm{k} = \frac{1}{2}mv^2$$

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

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

$$F = k\Delta x$$

Elastic strain energy

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

Young modulus

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

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

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

P 6 2 5 9 1 R A 0 2 7 2 8

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P 6 2 5 9 1 R A 0 2 8 2 8