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mock papers 1

SECTION A

1 The table shows some physical quantities. Which row correctly identifies scalar and vector quantities?

		Scalar	Vector
☒	**A**	distance	acceleration
☒	**B**	time	speed
☒	**C**	velocity	force
☒	**D**	work	power

(Total for Question 1 = 1 mark)

---

2 A cyclist travelling at a speed of 4.2 m s^{-1} accelerates at 1.1 m s^{-2}. In a time of 7.4 s the distance travelled is

☒ **A** 30 m

☒ **B** 35 m

☒ **C** 61 m

☒ **D** 91 m

(Total for Question 2 = 1 mark)

---

3 Which of these units is the same as the newton?

☒ **A** kg m s^{-1}

☒ **B** kg m s^{-2}

☒ **C** kg m^2 s^{-2}

☒ **D** kg m^2 s^{-3}

(Total for Question 3 = 1 mark)

---

4 A student is asked to determine the output of a motor as it lifts an object. He measures the height through which the object is raised, the time taken and the weight of the object.

To find the power he must calculate

☒ **A** height × weight × time

☒ **B** $\frac{\text{height} \times \text{weight}}{\text{time}}$

☒ **C** $\frac{\text{time} \times \text{weight}}{\text{height}}$

☒ **D** $\frac{\text{weight}}{\text{height} \times \text{time}}$

(Total for Question 4 = 1 mark)

5 A football is kicked at a speed of 12 m s^{-1} at an angle of 35° to the horizontal. The horizontal component of its velocity, in m s^{-1}, is given by

☒ **A** 12 cos 35°

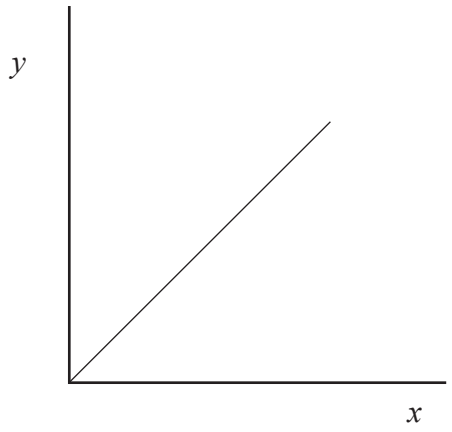
☒ **B** 12 sin 35°

☒ **C** $\frac{12}{\cos 35°}$

☒ **D** $\frac{12}{\sin 35°}$

(Total for Question 5 = 1 mark)

6 The diagram shows a graph plotted using the results from an experiment in which a metal wire was stretched.



The gradient of the graph equals the Young modulus of the metal.

Which row gives the correct labels for the axis?

		y	*x*
☒	**A**	extension	force
☒	**B**	force	extension
☒	**C**	strain	stress
☒	**D**	stress	strain

(Total for Question 6 = 1 mark)

7 A pigeon of mass 0.45 kg is flying with kinetic energy 58 J.
Its speed is

☒ **A** 8.0 m s^{-1}

☒ **B** 11 m s^{-1}

☒ **C** 16 m s^{-1}

☒ **D** 22 m s^{-1}

(Total for Question 7 = 1 mark)

8 A ball bearing is dropped through a liquid and its terminal velocity measured.
The experiment is repeated at a different temperature.

Which row could correctly describe this second experiment?

		Temperature	Viscosity	Terminal velocity
☒	**A**	lower	greater	faster
☒	**B**	lower	greater	slower
☒	**C**	higher	greater	slower
☒	**D**	higher	smaller	slower

(Total for Question 8 = 1 mark)

9 Velocity can be found from the

☒ **A** area under a displacement-time graph

☒ **B** area under a force-time graph

☒ **C** gradient of a displacement-time graph

☒ **D** gradient of an acceleration-time graph

(Total for Question 9 = 1 mark)

10 A freely falling object on Earth has a speed of 5.0 m s^{-1}.

After falling a further 20 m its speed is

☒ **A** 15 m s^{-1}

☒ **B** 20 m s^{-1}

☒ **C** 25 m s^{-1}

☒ **D** 45 m s^{-1}

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

11 The Saturn V rocket used in NASA's space programme had a mass of 3.04×10^6 kg.
It took off vertically with a thrust force of 3.40×10^7 N.

(a) Show that the resultant force on the rocket is about 4×10^6 N.

(3)

.....

.....

.....

(b) Calculate the initial acceleration.

(2)

.....

.....

Initial acceleration = ...

(c) After 150 s the rocket reached a speed of 2390 m s^{-1}.

Calculate its average acceleration.

(2)

.....

.....

.....

Average acceleration = ...

(d) Suggest why the initial acceleration and average acceleration are different.

(1)

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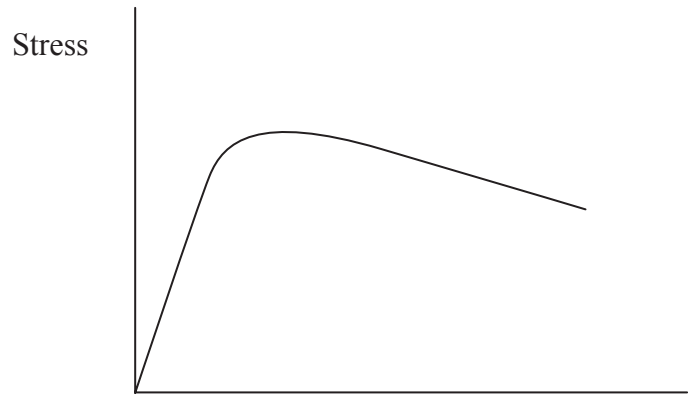
.....

(Total for Question 11 = 8 marks)

12 The graph shows how stress varies with strain for a given material.



(a) Explain what is meant by each of the following terms

(3)

limit of proportionality (L)

.....

.....

tensile strength

.....

.....

yield point (Y)

.....

.....

(b) Using crosses and the letters shown above, mark the 'limit of proportionality' (L) and the 'yield point' (Y) on the graph.

(2)

(Total for Question 12 = 5 marks)

13 When a ball moves through air, the airflow is laminar around the front of the ball and turbulent behind it.

(a) State what is meant by

(2)

laminar flow

.....

.....

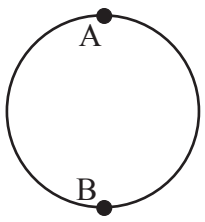
turbulent flow

.....

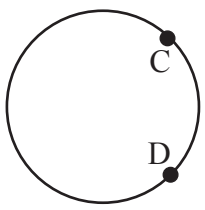
.....

(b) The diagram shows a ball for which the airflow becomes turbulent beyond points A and B. Add to the diagram to show the airflow around the ball. The ball is moving to the left.

(2)



(c) It is suggested that 'dimples' on a golf ball decrease the area over which there is turbulent flow so it is only produced beyond points C and D.



Explain how decreasing the area over which there is turbulent flow would increase the range of a golf ball.

(2)

.....

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.....

(Total for Question 13 = 6 marks)

14 (a) What is meant by Newton's first law of motion?

(2)

.....

.....

(b) Newton's third law identifies pairs of forces.

(i) State **two** ways in which the forces in a pair are identical.

(2)

.....

.....

.....

(ii) State **two** ways in which the forces in a pair differ.

(2)

.....

.....

.....

(iii) One of the forces acting on a car can be described as follows:

'The Earth exerts a downward gravitational force of 12 000 N on the car'.

Describe its Newton's third law pair force.

(2)

.....

.....

(Total for Question 14 = 8 marks)

*** 15** You are asked to determine the acceleration of free fall at the surface of the Earth, g, using a free fall method in the laboratory.

(a) Describe the apparatus you would use, the measurements you would take and explain how you would use them to determine g.

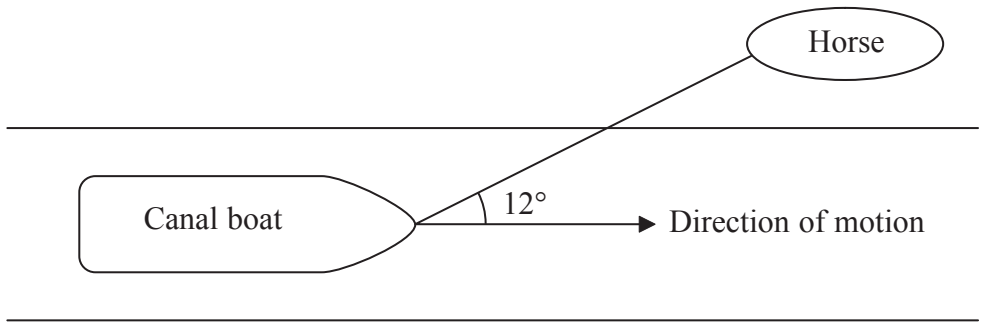
(6)

(b) Give **one** precaution you would take to ensure the accuracy of your measurements.

(1)

(Total for Question 15 = 7 marks)

16



A horse is pulling a canal boat using a rope at 12° to the direction of motion of the boat. The tension in the rope is 1150 N.

(a) The canal boat is moving at a steady speed. Calculate the resistive force opposing the boat's forward motion.

(2)

.....

.....

Force = ...

(b) Calculate the work done on the boat by the horse when the canal boat is towed 500 m along the canal.

(2)

.....

.....

Work = ...

(c) Explain why using a longer rope could allow the horse to do the same work while producing a lower tension in the rope.

(2)

.....

.....

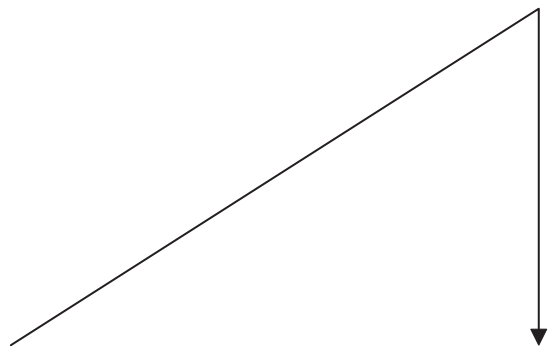
.....

(Total for Question 16 = 6 marks)

***17** In the fifteenth century, an explanation of projectile motion went as follows:

When you throw an object you give it a force called impetus. It moves in a straight line until the impetus is used up. Then the object falls vertically to the ground.

The diagram shows the path described.



(a) Correct the diagram to show the path followed by a projectile according to modern observations. Assume it has the same initial direction.

(1)

(b) Explain why a projectile follows the path you have drawn. Your answer should include reference to horizontal velocity.

(3)

(c) When a toy balloon is hit quickly up at an angle, it appears to follow a path similar to the one described by the fifteenth century explanation.

Explain why the balloon follows this path.

(3)

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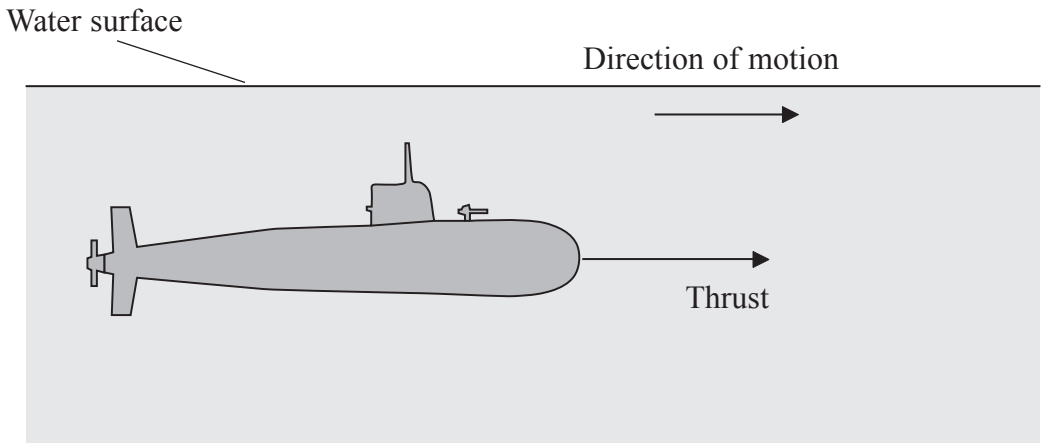
(Total for Question 17 = 7 marks)

***18** The diagram shows a submarine and one of the forces acting on it. The submarine moves at a constant depth and speed in the direction shown.



(a) Add labelled arrows to show the other **three** forces on the submarine.

(2)

(b) State **two** equations that show the relationship between the forces acting on the submarine.

(2)

(c) The submarine has a volume of 7100 m^3.
Show that the weight of the submarine is about 7×10^7 N.

Density of sea water = 1030 kg m^{-3}

(2)

(d) The submarine can control its depth by changing its weight. This is done by adjusting the amount of water held in ballast tanks.

As the submarine dives to greater depths the increased pressure of the surrounding water produces a compressive strain.

(i) Explain what is meant by compressive strain.

(1)

.....

.....

.....

.....

(ii) This decreases the volume of the submarine. Explain the action that should be taken to maintain a constant depth as the volume of the submarine is decreased.

(2)

.....

.....

.....

.....

(iii) The submarine is made from steel. Suggest why a material, such as fibreglass, which has a much smaller Young modulus than steel would be unsuitable at greater depths.

(2)

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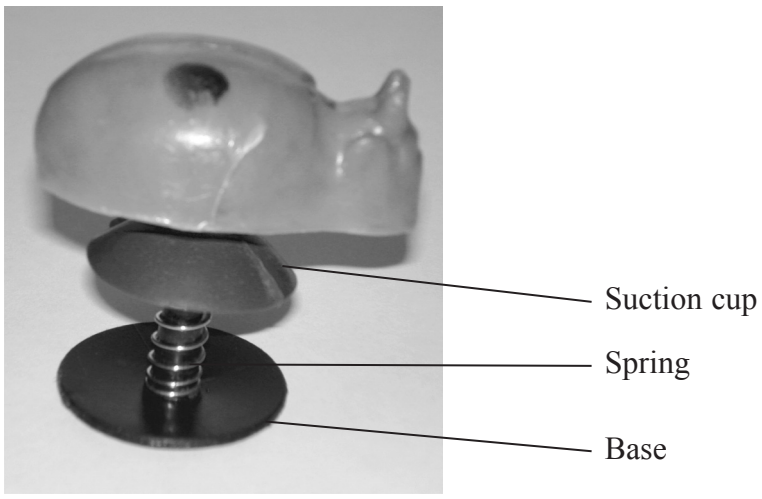
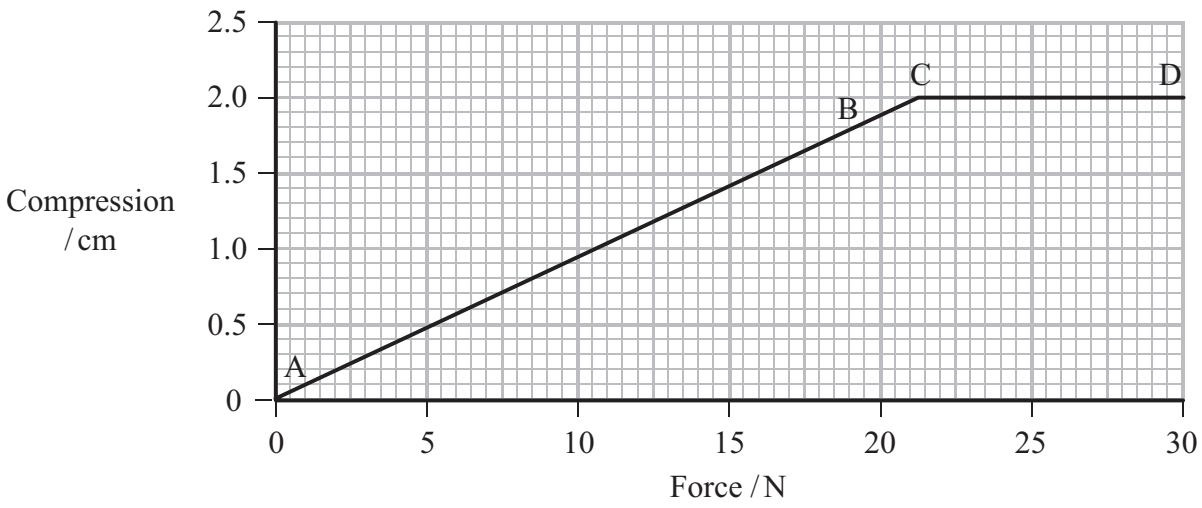
(Total for Question 18 = 11 marks)

19 The picture shows a jumping toy on which a student carries out some experiments.



The top of the toy is pushed down, compressing the spring. The suction cup adheres to the base and holds the toy down. After a short time, the suction cup leaves the base, causing the toy to jump.

A compression–force graph is obtained for the spring in the toy.



(a) (i) Explain the shape of section AB of the graph.

(1)

.....

.....

(ii) Explain why section CD of the graph is horizontal.

(1)

.....

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.....

(b) Show that the stiffness of the spring is about 1000 N m^{-1}.

(2)

.....

.....

.....

(c) As the suction cup is about to leave the base the compression of the spring is 0.018 m.

(i) Calculate the energy stored in the spring at this stage.

(2)

.....

.....

.....

Energy stored = ...

(ii) Calculate the maximum possible height reached by the toy.

Mass of toy = 7.3×10^{-3} kg

(2)

.....

.....

.....

Height = ...

(iii) State an assumption made in your calculation.

(1)

.....

.....

(d) The student uses a camera to video the movement of the toy in front of a metre rule. The video is then used to find the maximum height reached by the toy.

(i) Explain the advantage of using the video camera over making observations just by eye.

(2)

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.....

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.....

.....

(ii) The student repeats this procedure several times and records the following data:

0.45 m, 0.44 m, 0.36 m, 0.46 m, 0.45 m.

mean maximum height = 0.45 m

Why is the student justified in using 0.45 m as the mean?

(1)

.....

.....

(Total for Question 19 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

mock papers 2

SECTION A

1 Which set of quantities is all scalar?

☒ **A** acceleration, displacement, velocity

☒ **B** energy, mass, power

☒ **C** extension, force, gravitational potential energy

☒ **D** weight, kinetic energy, work

(Total for Question 1 = 1 mark)

---

2 A material is described as ‘not easy to scratch or indent’.

The material is best described as

☒ **A** hard

☒ **B** plastic

☒ **C** stiff

☒ **D** tough

(Total for Question 2 = 1 mark)

---

3 A force of 24 N and a force of 15 N act at right angles to each other.

The size of their resultant force is

☒ **A** 15.8 N

☒ **B** 24.3 N

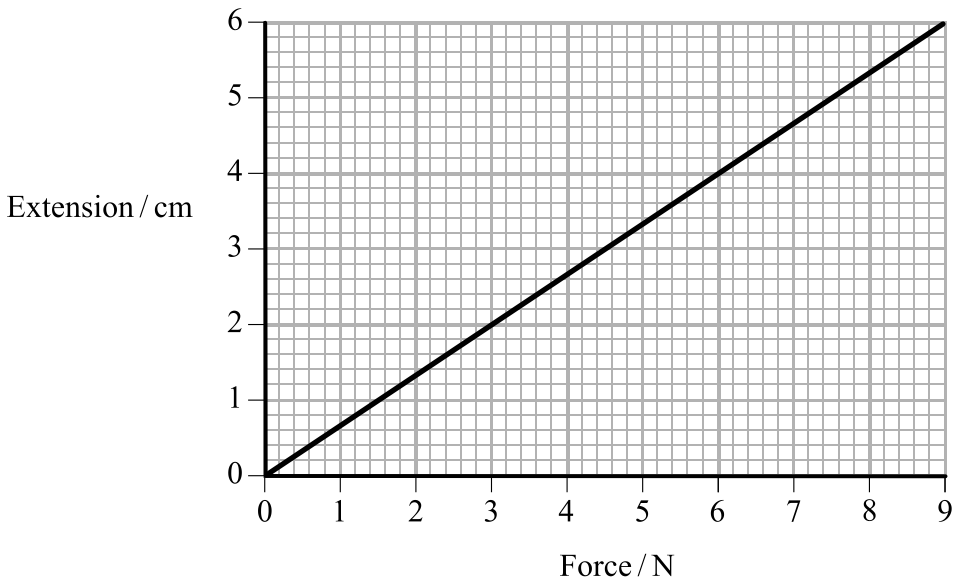
☒ **C** 28.3 N

☒ **D** 39.0 N

(Total for Question 3 = 1 mark)

Use the following graph to answer Questions 4 and 5.

The graph shows how extension varies with applied force for a spring.



4 The stiffness of the spring in $N\,m^{-1}$ is

- ☒ **A** 1.5
- ☒ **B** 54
- ☒ **C** 67
- ☒ **D** 150

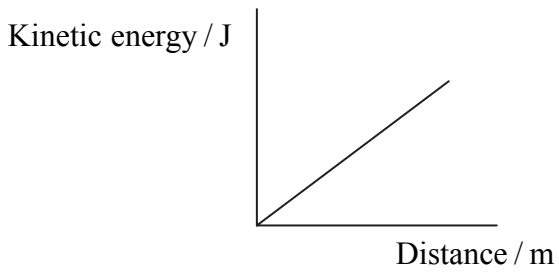
(Total for Question 4 = 1 mark)

5 The energy stored in the spring when it is extended by 6.0 cm is

- ☒ **A** 0.27 J
- ☒ **B** 0.54 J
- ☒ **C** 54 J
- ☒ **D** 108 J

(Total for Question 5 = 1 mark)

6 The graph shows how kinetic energy varies with distance for a train accelerating from a station.



The quantity represented by the gradient of the graph is

☒ **A** acceleration

☒ **B** force

☒ **C** power

☒ **D** velocity

(Total for Question 6 = 1 mark)

---

7 A car of known mass has a constant acceleration. The resultant force acting on the car can be found by applying

☒ **A** Newton's first law

☒ **B** Newton's second law

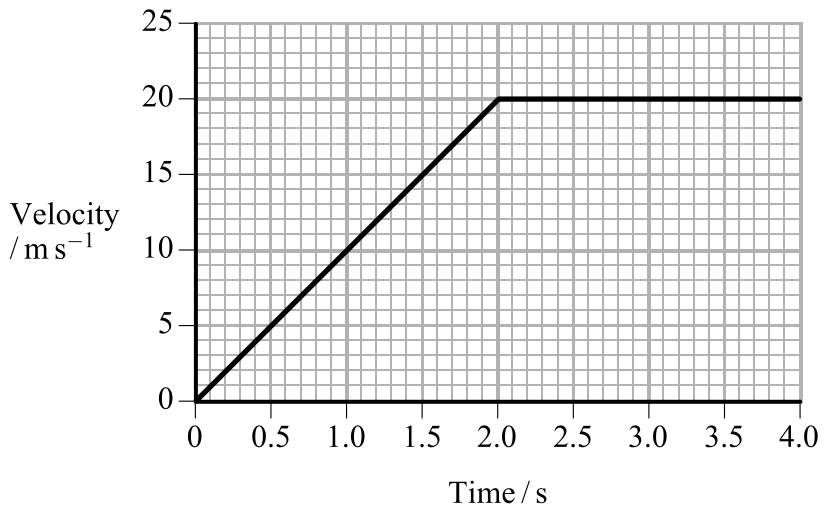
☒ **C** Newton's third law

☒ **D** Stokes's law

(Total for Question 7 = 1 mark)

Use the following graph to answer Questions 8 and 9.

8 The graph shows how velocity varies with time for an object.



The total distance travelled by the object in 4 s is

☒ **A** 20 m

☒ **B** 40 m

☒ **C** 60 m

☒ **D** 80 m

(Total for Question 8 = 1 mark)

9 The acceleration at 3 s is

☒ **A** 10 m s^{-2}

☒ **B** 7 m s^{-2}

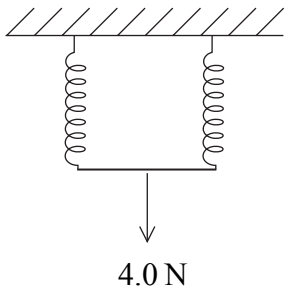
☒ **C** 5 m s^{-2}

☒ **D** 0 m s^{-2}

(Total for Question 9 = 1 mark)

10 A spring extends by 10 cm when a force of 8.0 N is applied. The limit of proportionality is not exceeded.

Two of these springs are arranged side by side and a force of 4.0 N is applied.



The extension for this arrangement of springs is

☒ **A** 2.5 cm

☒ **B** 5.0 cm

☒ **C** 10 cm

☒ **D** 20 cm

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

***11** (a) Explain the difference between scalar and vector quantities.

(1)

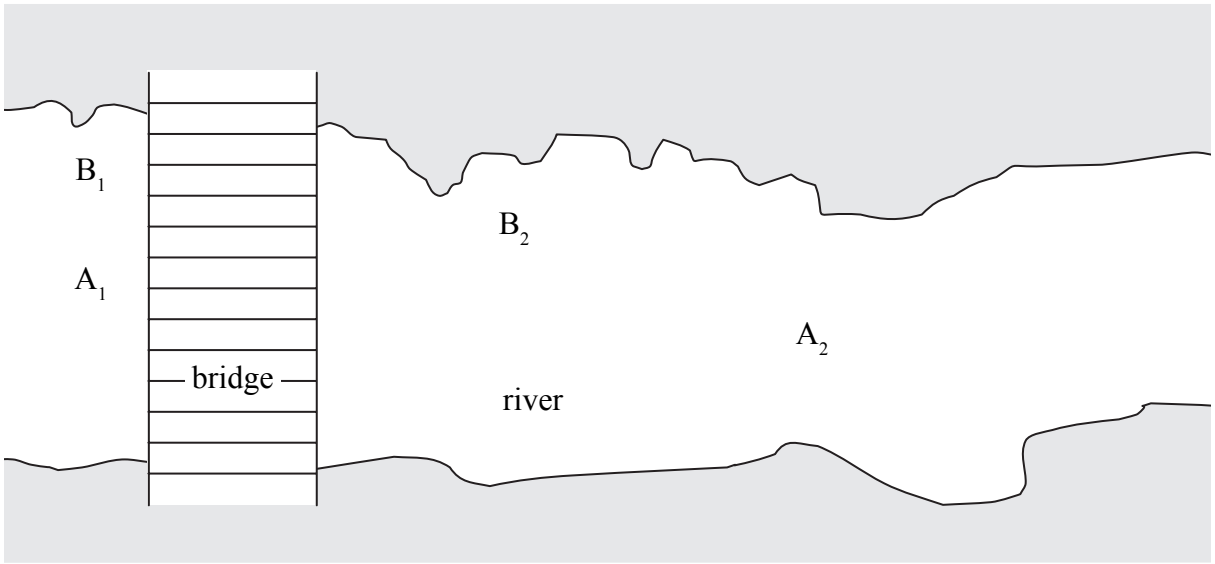
(b) When asked to run one complete lap around a track, a student says, "However fast I run, my average velocity for the lap will be zero".

Comment on his statement.

(3)

(Total for Question 11 = 4 marks)

12 In the game of Poohsticks, sticks are dropped into a river from one side of a bridge to see which reaches the other side first.



A stick is dropped into the centre of the river at A_1 and moves at a steady speed to A_2, winning the game.

Another stick is dropped into the river near its edge at B_1, and ends up swirling around at B_2.

(a) Add to the diagram to show the water flow at A_2 and at B_2.

(2)

(b) Name and describe the type of water flow at A_2 and at B_2.

(4)

A_2 .....

.....

B_2 .....

.....

(Total for Question 12 = 6 marks)

13 (a) Explain the meanings of the terms brittle and ductile.
Sketch stress-strain graphs and use them to illustrate your answer.

(4)

Brittle .....

.....

.....

.....

.....

.....

.....

Ductile .....

.....

.....

.....

.....

.....

.....

.....

(b) Give an example of a ductile material and a situation where its ductile behaviour is desirable.

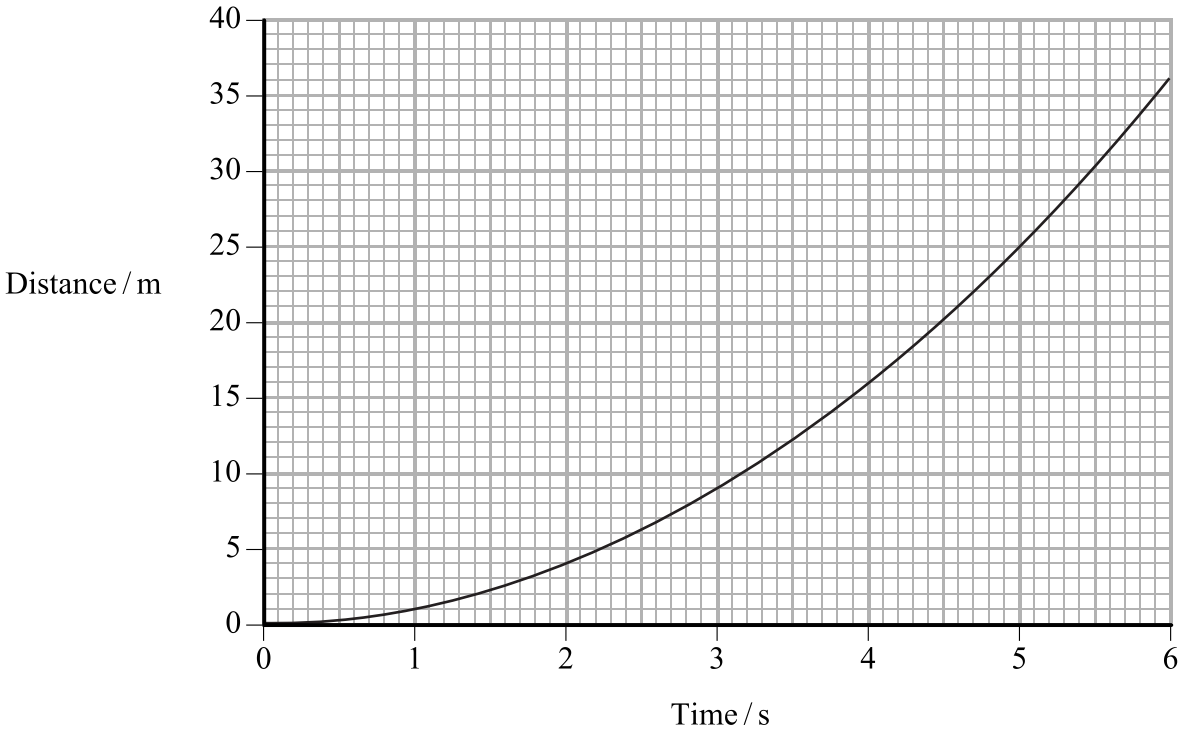
(2)

.....

.....

(Total for Question 13 = 6 marks)

14 The graph shows how displacement varies with time for an object which starts from rest with constant acceleration.



(a) Use the distance-time graph to determine the speed of the object at a time of 4.0 s.

(3)

.....

.....

.....

Speed = ...

(b) Calculate the acceleration.

(2)

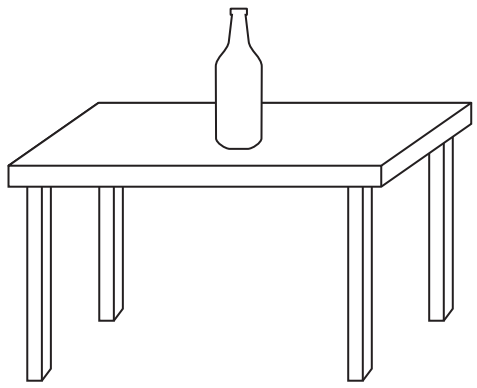
.....

.....

Acceleration = ...

(Total for Question 14 = 5 marks)

15 A student is asked to provide an explanation of why a bottle on a table remains stationary.



(a) Complete a free-body force diagram for the bottle.

(2)

(b) The student writes the following incorrect explanation.

The force of gravity pulls the bottle down.
The bottle pushes down on the table, so by Newton's first law,
the table pushes up with an equal and opposite force.
According to Newton's third law, if the forces are balanced,
nothing can move.

The student's explanation contains errors.

Rewrite the student's explanation correctly.

(3)

(Total for Question 15 = 5 marks)

16 In 2008 a new energy scheme opened on the Scottish island of Eigg. The scheme uses solar, hydroelectric and wind energy. There are also stand-by diesel generators.

(a) In a feasibility study, the following information was collected about one possible hydroelectric site:

mean rate of water flow into turbine = 0.13 $m^3 s^{-1}$
change in height of water = 30 m.

(i) Show that the power available to the turbine is about 40 kW.

density of water = 1000 kg m^{-3}

(3)

.....

.....

.....

.....

(ii) The study suggests a typical output for the turbine might be only 6 kW. Suggest a reason for this inefficiency.

(1)

.....

.....

.....

(b) Publicity for the scheme states:

> "The whole project involves one 100 kW hydroelectric system, two smaller 6 kW hydroelectric systems, a 24 kW wind farm and a 10 kW solar energy system. There are also two 80 kW diesel generators on stand-by."

(i) Calculate the maximum energy output from the solar energy system for a period of six hours.

(2)

Maximum energy output = ...

(ii) Discuss the suitability of the output of the stand-by diesel generators.

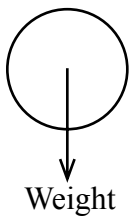
(2)

(Total for Question 16 = 8 marks)

17 A science centre houses a display with tall, transparent tubes of different liquids. Visitors can pump air into the bottom of the tubes to create bubbles that rise to the top at different steady speeds.

(a) (i) Add labelled arrows to the diagram to show the other two forces acting on a bubble as it rises through a liquid.

(2)



(ii) With reference to the forces on the bubble, explain why the bubble initially accelerates and then reaches a steady upwards speed.

(4)

.....

.....

.....

.....

.....

.....

(iii) Write an expression which relates these forces for a bubble moving at a steady upwards speed.

(1)

.....

.....

(b) If the weight of the air in the bubble is ignored, the steady upwards speed is given by

$$v = \frac{2\rho r^2 g}{9\eta}$$

Where ρ is the density of liquid, r is the radius of the sphere and η is the coefficient of viscosity of the liquid.

(i) Explain why it is reasonable to ignore the weight of the air.

(2)

(ii) Explain what happens to the speeds of the observed bubbles if the temperature of the liquid increases.

(2)

(iii) It is possible to create a small bubble followed by a larger bubble.

Use the expression to explain why the larger bubble catches up with the smaller one.

(1)

(Total for Question 17 = 12 marks)

18 Champagne bottles are often opened by 'firing' the cork out of the bottle. The world record for the horizontal distance travelled by a fired cork is 53 m.

The high pressure inside the bottle produces an average force of 150 N on the cork as it leaves the bottle. This force acts on the cork over a distance of 2.5×10^{-2} m.

(a) Show that the work done on the cork is about 4 J.

(2)

.....

.....

(b) Calculate the maximum speed at which the cork could leave the bottle.

mass of cork = 7.5×10^{-3} kg

(2)

.....

.....

.....

Speed = ...

(c) The cork is fired from ground level at an angle of 40° to the horizontal with a speed of 32 m s^{-1}.

(i) Show that the vertical component of the velocity is about 20 m s^{-1}.

(1)

(ii) Calculate the horizontal distance travelled by the cork through the air.

(5)

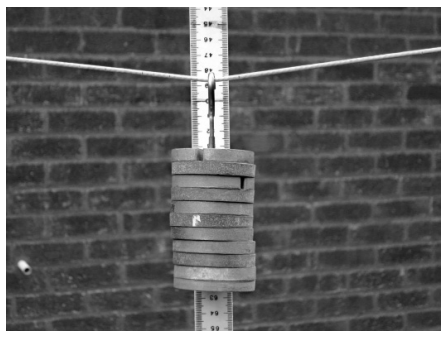
Distance = ...

(d) Suggest an explanation for the difference between your calculated value and the world record distance.

(2)

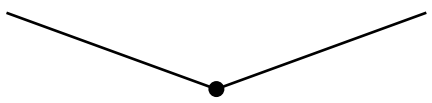
(Total for Question 18 = 12 marks)

19 A washing line has a negligible mass and is initially horizontal. A student investigates the effect of hanging masses from the midpoint of the washing line.



(a) Add to the diagram to show the forces acting at the midpoint of the line when a mass is hung from its midpoint.

(2)



(b) A mass of 1.10 kg is hung from the midpoint of the line.

(i) Show that the downward vertical force on the line is about 11 N.

(1)

.....

.....

.....

(ii) This force pulls the midpoint down a distance of 48.5 cm.

Show that the line is at an angle of about 84° to the vertical.

length of washing line when horizontal = 9.600 m

(2)

.....

.....

.....

(iii) Show that the tension in the line is less than 60 N.

(2)

(iv) The washing line stretches so that the total length of the line is now 9.847 m.

Calculate the strain for the line.

(2)

Strain = ...

(c) Calculate the value of the Young modulus for the line material.

cross-sectional area of the line = $6.6 \times 10^{-6}\,m^2$

(3)

Young modulus = ...

(Total for Question 19 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

mock papers 3

SECTION A

1 Which of the following is a scalar quantity?

☒ **A** displacement

☒ **B** force

☒ **C** time

☒ **D** velocity

(Total for Question 1 = 1 mark)

---

2 A substance which can undergo a large plastic deformation without cracking can be described as

☒ **A** brittle

☒ **B** hard

☒ **C** malleable

☒ **D** stiff

(Total for Question 2 = 1 mark)

---

3 A bus is travelling at a speed of 9.0 m s^{-1}. It then accelerates at a rate of 0.75 m s^{-2} for a time of 8.0 s. What is its final speed?

☒ **A** 6.0 m s^{-1}

☒ **B** 15 m s^{-1}

☒ **C** 17 m s^{-1}

☒ **D** 21 m s^{-1}

(Total for Question 3 = 1 mark)

---

4 Which of the following is not a SI base quantity?

☒ **A** force

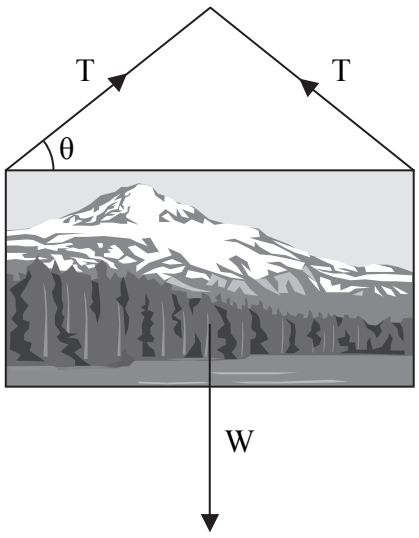
☒ **B** length

☒ **C** mass

☒ **D** time

(Total for Question 4 = 1 mark)

5 The diagram shows the forces acting on a picture, of weight W, suspended by a cord.
The tension in the cord is T.



Which of the following expressions shows the correct relationship between W and T?

☒ **A** $W = 2\ T \cos \theta$

☒ **B** $W = T \cos \theta$

☒ **C** $W = T \sin \theta$

☒ **D** $W = 2\ T \sin \theta$

(Total for Question 5 = 1 mark)

6 A person weighing 100 N stands on some bathroom scales in a lift. If the scales show a reading of 110 N, which answer could describe the motion of the lift?

☒ **A** Moving downwards and decelerating.

☒ **B** Moving downwards with a constant velocity.

☒ **C** Moving upwards and decelerating.

☒ **D** Moving upwards with a constant velocity.

(Total for Question 6 = 1 mark)

---

7 A spring extends by 9 cm when a force of 6 N is applied. The limit of proportionality is not exceeded.

Another identical spring is joined end to end with this spring and a force of 4 N is applied.

The extension for the pair of springs is

☒ **A** 3 cm

☒ **B** 6 cm

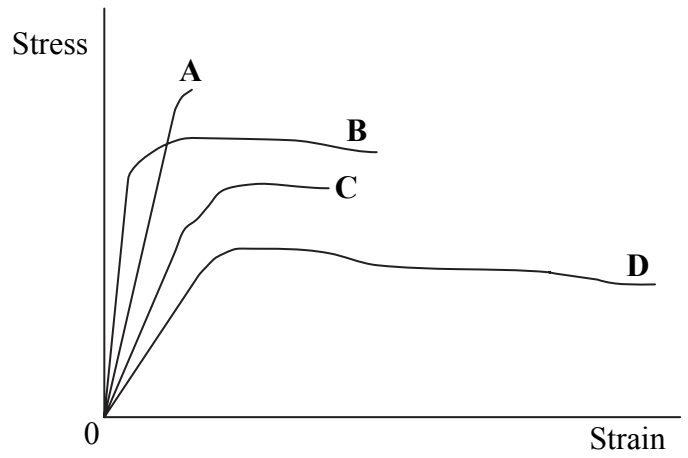
☒ **C** 12 cm

☒ **D** 18 cm

(Total for Question 7 = 1 mark)

Use the graph below for questions 8 and 9.

The graph shows stress–strain curves for samples of four different materials.



8 Which material has the greatest strength?

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

(Total for Question 8 = 1 mark)

---

9 Which material has the greatest value for the Young modulus?

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

(Total for Question 9 = 1 mark)

---

10 The acceleration of free fall on a particular planet is 8.0 m s^{-2}. An object is dropped from a height and hits the ground after 1.5 s. From what height was it dropped?

☒ **A** 6.0 m

☒ **B** 9.0 m

☒ **C** 11 m

☒ **D** 12 m

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

11 A brochure states that a particular type of wood is “extremely tough and does not become brittle over time”.

(a) Describe what is meant by the following terms

(2)

tough

.....

.....

brittle

.....

.....

(b) A cricket bat made of wood is found to have a dent after striking a cricket ball.

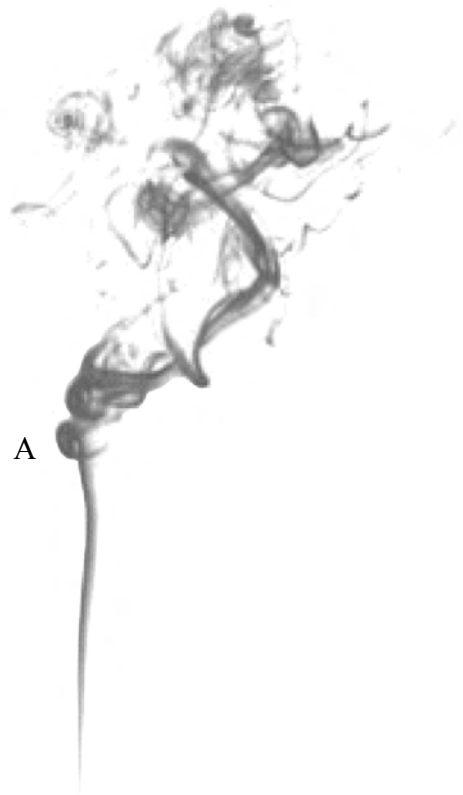
State the type of behaviour shown by the material of the cricket bat.

(1)

.....

(Total for Question 11 = 3 marks)

12 The photograph shows some smoke rising.



At A, the type of fluid flow changes.

Label the type of fluid flow below and above A and describe each of them.

Below A .....

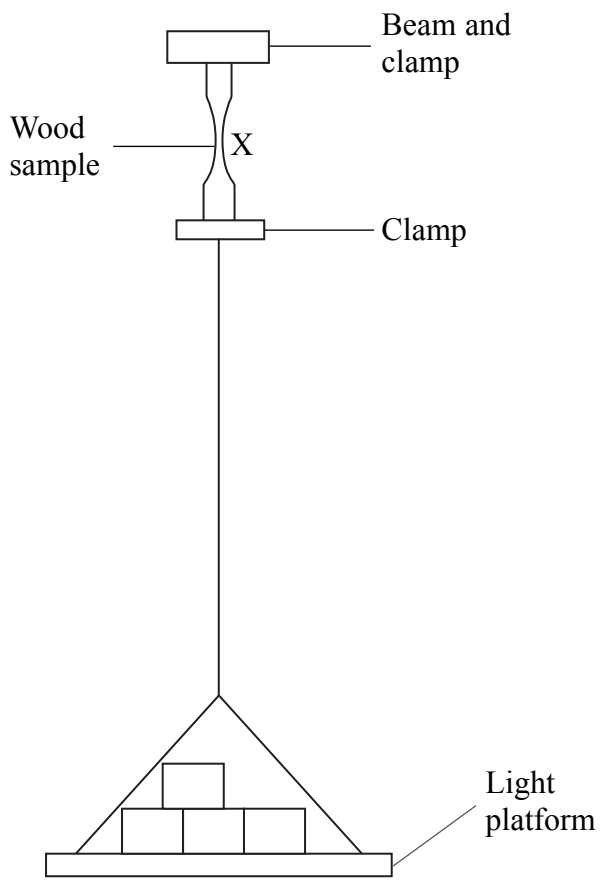
.....

Above A.....

.....

(Total for Question 12 = 4 marks)

13 A sample of wood is tested using the following arrangement.



The wood sample is clamped securely to a supporting beam. A light platform is suspended from the wood sample using another clamp.

The dimensions of the wood sample at X are known. Masses of 2 kg are added to the platform during the testing process.

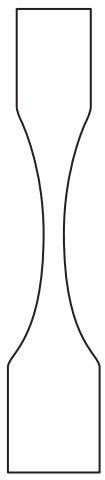
(a) The wood sample breaks at X when the total suspended mass is 84 kg. The cross-sectional area at X is 1.3×10^{-5} m^2.

Show that the ultimate tensile strength is about 6×10^7 Pa.

(3)

(b) Explain why this method of testing may produce a larger value than the true ultimate tensile strength.

(2)



(c) Explain why the wood sample used for this test has the shape shown.

(2)

(d) Samples of wood of the same type are not entirely uniform. What should be done to ensure reliable results are obtained when carrying out this test?

(1)

(Total for Question 13 = 8 marks)

14 One account of the origin of the term *horsepower* is as follows.

In the eighteenth century, James Watt manufactured steam engines. He needed a way to demonstrate the benefits of these compared to the horses they replaced. He did some calculations based on horses walking in circles to turn a mill wheel.

Watt observed that a horse could turn the wheel 144 times in one hour. The horse travelled in a circle of radius 3.7 m and exerted a force of 800 N.

(a) Show that the work done by the horse in turning the wheel through one revolution was about 20 000 J.

(3)

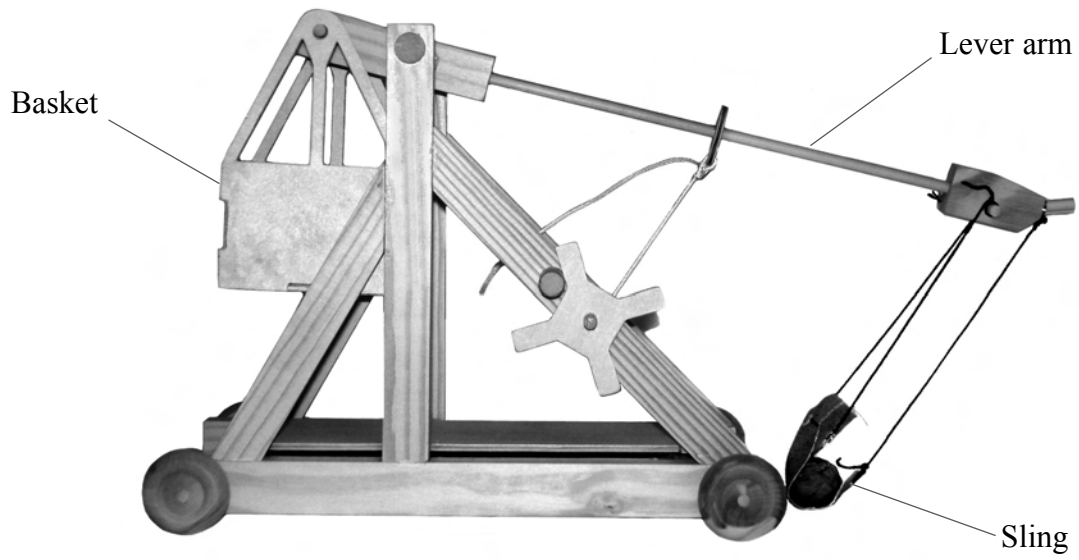
(b) Calculate the average power of the horse in SI units.

(3)

Average power = ...

(Total for Question 14 = 6 marks)

***15** The photograph shows a model of 'Warwolf', a siege engine used in the thirteenth century. It was used to attack castles by firing missiles from a sling.



To operate this model, coins are placed in the basket and a small projectile is placed in the sling. When the basket is released, it falls quickly, swinging the lever arm up and shooting the projectile from the sling.

(a) On one occasion the mass of coins placed in the basket is 0.41 kg. The basket falls through a vertical distance of 7.0 cm.

Calculate the maximum amount of energy available to launch the projectile.

(2)

.....

.....

.....

.....

Energy = ...

(b) An energy conversion calculation predicts a projectile speed of 16 m s^{-1}. The projectile is observed to fly out of the sling at an angle of 40° to the horizontal.

Resolve this velocity into horizontal and vertical components.

(3)

.....

.....

.....

.....

.....

Horizontal component = ...

Vertical component = ...

(c) The predicted range is 27 m. When measured, the range is found to be only 8 m.

Air resistance and friction in the machine are possible reasons for the difference.

Without further calculation, explain another reason why the projectile does not go as far as predicted.

(2)

.....

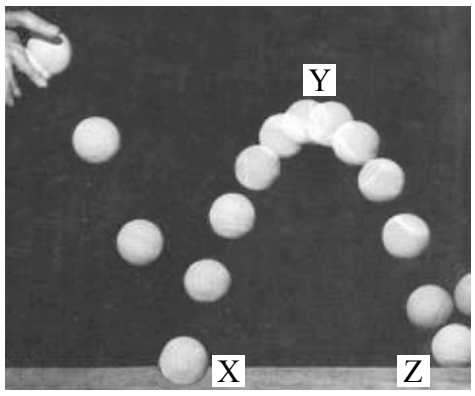
.....

.....

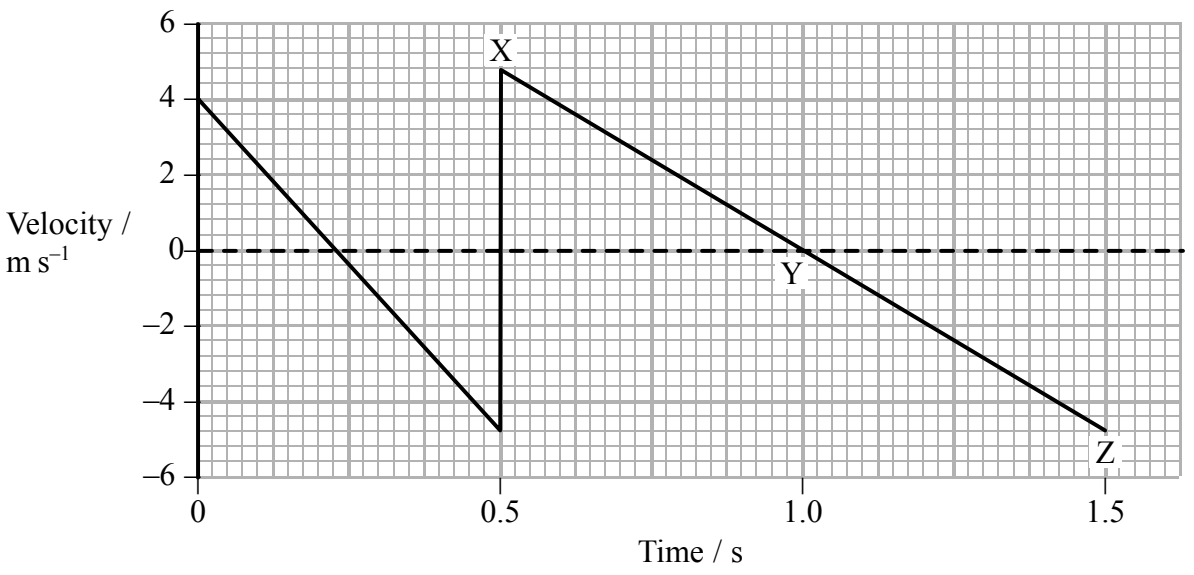
.....

(Total for Question 15 = 7 marks)

***16** The photograph shows a sequence of images of a bouncing tennis ball.



A student plots the following graph and claims that it shows the vertical motion of the ball in the photograph.



(a) Without carrying out any calculations describe how the following can be found from the graph

(2)

(i) the vertical distance travelled by the ball between 0.5 s and 1.0 s

.....

(ii) the acceleration at Y.

.....

(b) The graph contains several errors in its representation of the motion of the ball.

Explain two of these errors.

(4)

Error 1

.....

.....

.....

.....

Error 2

.....

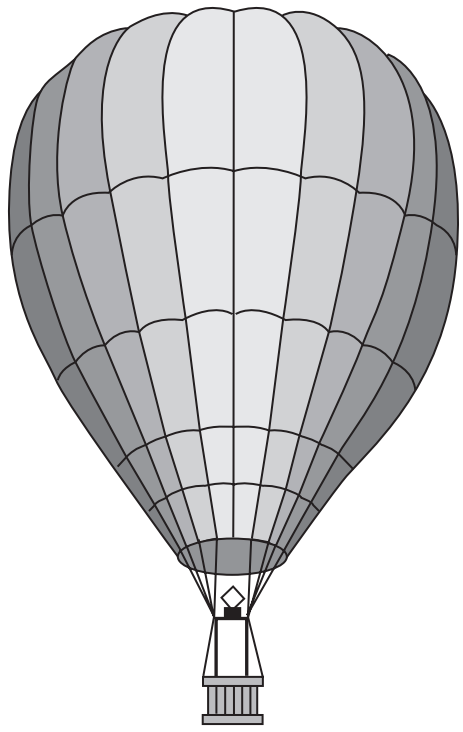
.....

.....

.....

(Total for Question 16 = 6 marks)

17 A hot air balloon consists of an 'envelope' containing hot air, with a wicker basket suspended from it. The balloon flies because the heated air in the envelope is less dense than the surrounding air.



(a) The total volume of the hot air balloon is 2830 m^3. The total weight of the balloon, including the hot air in the envelope, is 33 100 N. The density of the surrounding air is 1.20 kg m^{-3}.

(i) Show that the resultant upward force on the balloon at the moment it is released is about 200 N.

(3)

.....

.....

.....

(ii) Calculate the initial upward acceleration of the balloon. The mass of the balloon is 3370 kg.

(2)

.....

.....

.....

Acceleration = ...

(iii) The balloon is rising through air of viscosity 1.8×10^{-5} kg m^{-1} s^{-1}, at a speed of 2.0 m s^{-1}.

The effect of viscous drag on the balloon is negligible provided the air flow around the balloon is laminar.

Justify the statement in bold with the aid of a calculation. You may treat the whole balloon as a single sphere of radius 8.8 m.

(3)

.....

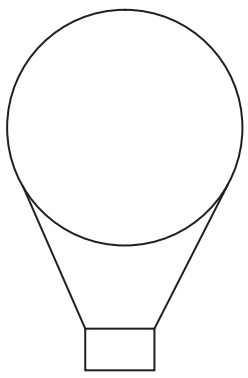
.....

.....

.....

(b) Add labelled arrows to the diagram below to show the forces acting on a vertically ascending balloon.

(2)



(c) As the balloon rises the density of the surrounding air decreases. Explain why this density change limits the height to which the balloon will rise.

(2)

.....

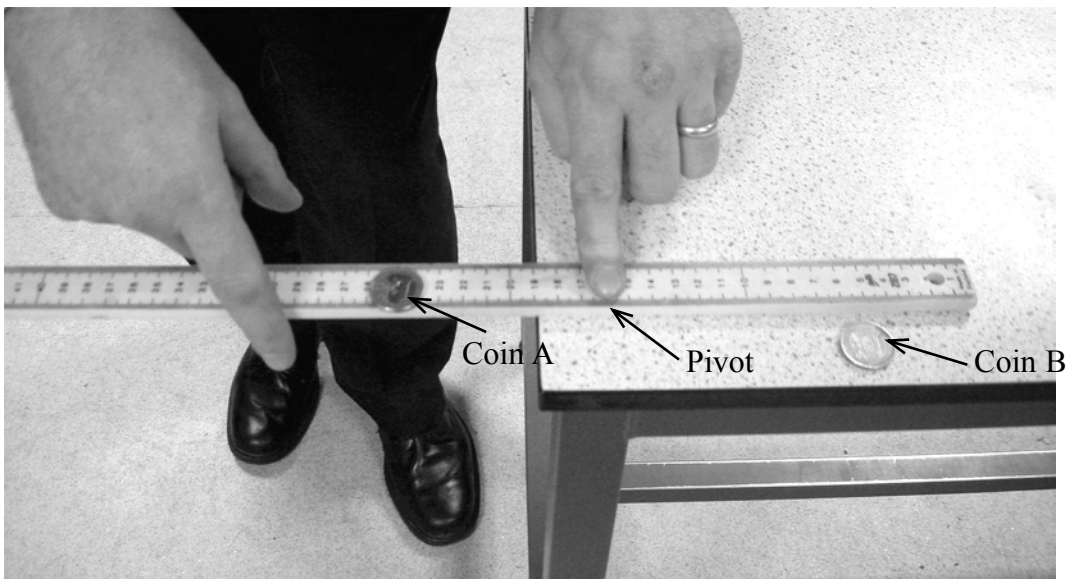
.....

.....

.....

(Total for Question 17 = 12 marks)

18 The photograph shows a physics teacher carrying out a demonstration related to vertical motion.



A coin, A, is placed on top of the smooth ruler and another coin, B, is placed on the table.
One hand is acting as a pivot. The other hand gives the ruler a sharp horizontal tap.

Coin A falls vertically to the ground while coin B is pushed horizontally off the table.
Both coins are heard to strike the floor at the same instant.

(a) Use Newton's first law to explain why the coin A has no horizontal motion.

(2)

.....

.....

.....

.....

(b) Explain how this demonstration shows the independence of vertical and horizontal motion.

(2)

.....

.....

.....

.....

(c) The table is 0.85 m high.

Show that the coin on the ruler strikes the ground with a speed of about 4 m s^{-1}.

(2)

.....

.....

.....

(d) After 0.42 s the second coin lands at a horizontal distance of 1.1 m from the table.

Calculate the velocity at which the coin strikes the ground.

(5)

.....

.....

.....

.....

.....

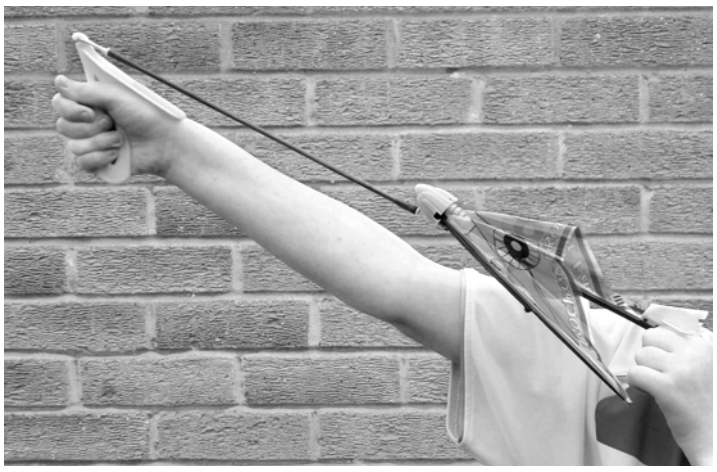
.....

Magnitude of velocity = ...

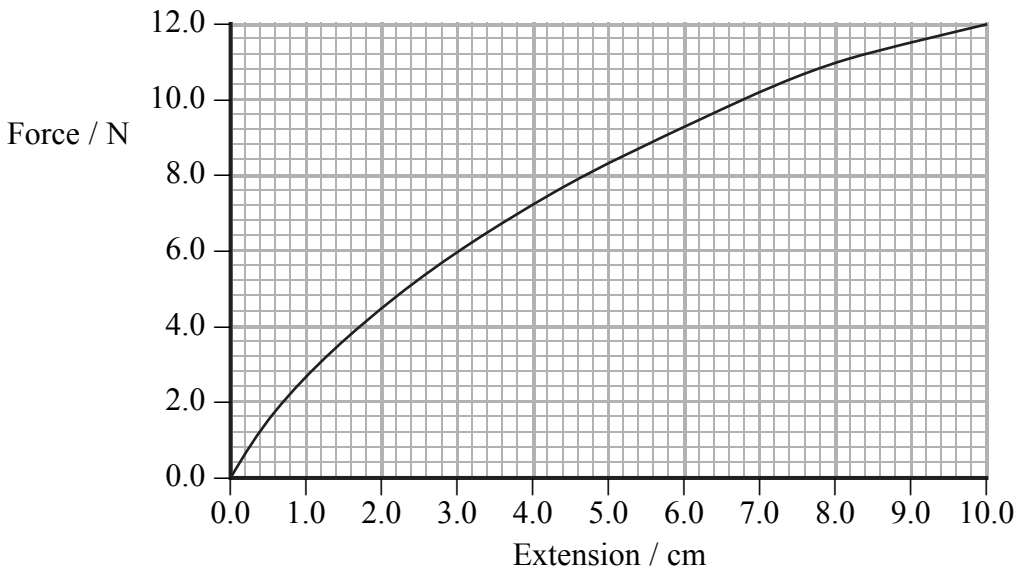
Angle of velocity to horizontal = ...

(Total for Question 18 = 11 marks)

***19** The photograph shows a long rubber band being used to launch a model aeroplane.



The following graph shows force against extension for the rubber band.



(a) Explain whether the rubber band obeys Hooke's law.

(2)

(b) Use the graph to show that the elastic strain energy stored in the rubber band when it has an extension of 10.0 cm is less than 0.8 J.

(3)

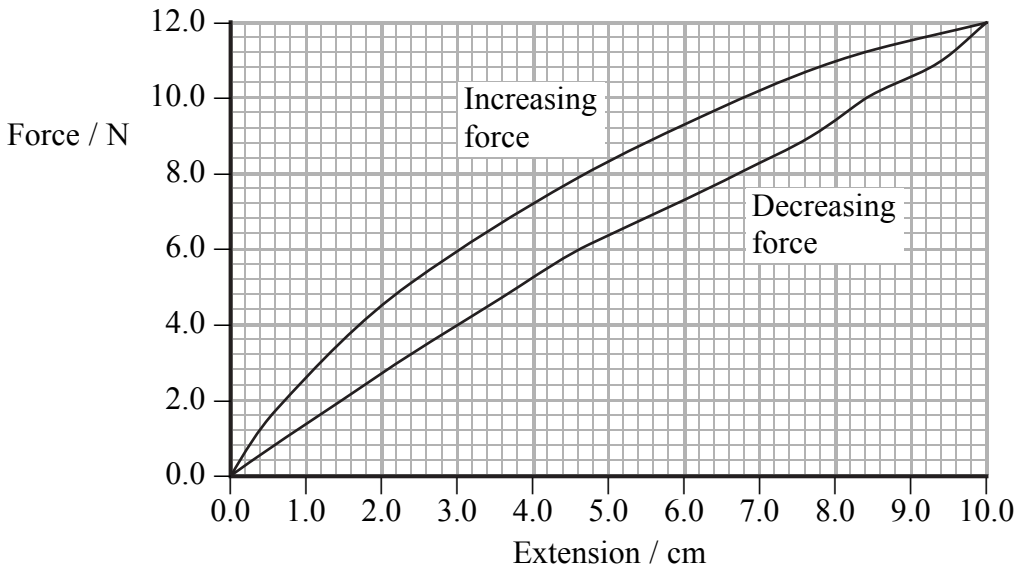
(c) The rubber band is extended by 10.0 cm before being released to launch the aeroplane. Calculate the maximum possible initial speed of the aeroplane.

Mass of aeroplane = 0.027 kg

(3)

Speed = ...

(d) The following graph shows two lines. Measurements were obtained by increasing the force on the band to 12 N and then decreasing the force.



(i) Describe the energy transfers taking place when the force on the band is increased and then decreased.

(2)

(ii) The maximum speed of the aeroplane will be less than that calculated in (c).
Without further calculation use the graph to explain this.

(3)

.....

.....

.....

.....

.....

(Total for Question 19 = 13 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

mock papers 4

SECTION A

1 Distance travelled can be found from the

☒ **A** area under a velocity-time graph

☒ **B** area under an acceleration-time graph

☒ **C** gradient of a force-time graph

☒ **D** gradient of a velocity-time graph

(Total for Question 1 = 1 mark)

---

2 Which of the following is a scalar quantity?

☒ **A** acceleration

☒ **B** displacement

☒ **C** force

☒ **D** work

(Total for Question 2 = 1 mark)

---

3 A car pulls a trailer of weight 2500 N with a force of 20 N for a distance of 8 km along a horizontal road.

How much work is done by the car in pulling the trailer?

☒ **A** 160 J

☒ **B** 20 000 J

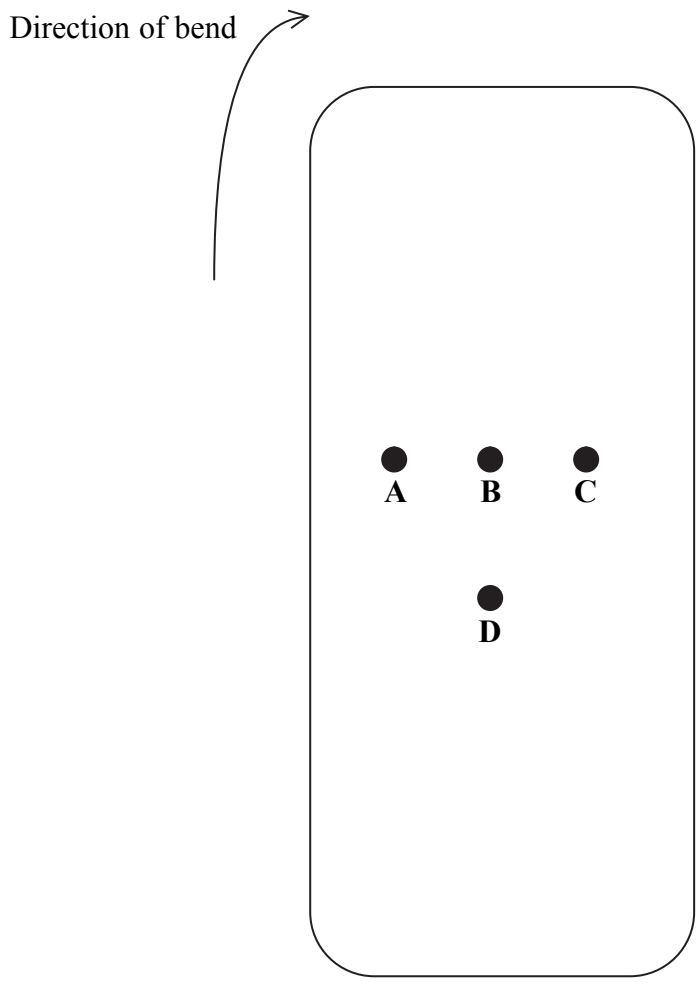
☒ **C** 160 000 J

☒ **D** 20 000 000 J

(Total for Question 3 = 1 mark)

---

4 A person is standing at point C in a train carriage travelling round a sharp bend to the right. The person jumps up. Nearest which marked point is the person most likely to land?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

5 Which of the following units could be used for power?

☒ **A** kg m s^{-2}

☒ **B** kg m^2 s^{-2}

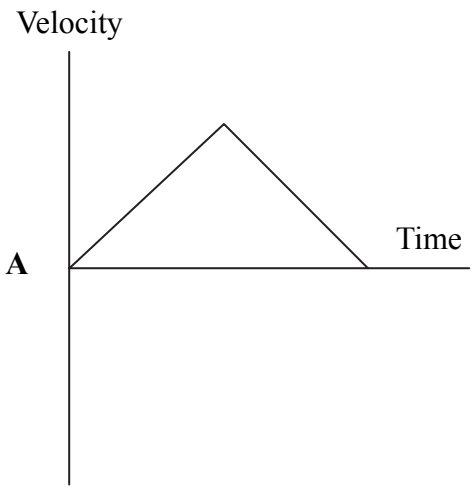
☒ **C** kg m^2 s^{-3}

☒ **D** kg^2 m^2 s^{-3}

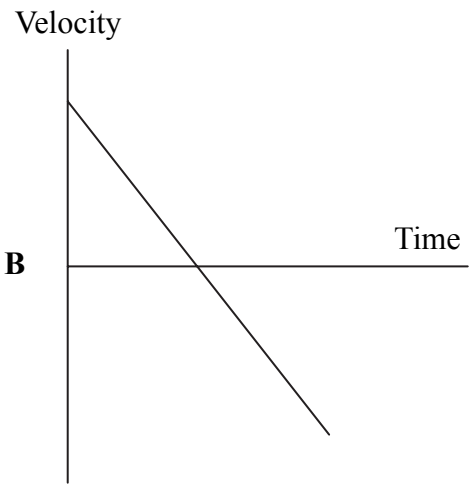
(Total for Question 5 = 1 mark)

6 A ball is thrown straight up in the air and caught when it comes down. Which graph best shows the velocity of the ball from the moment it is released until just before it is caught?

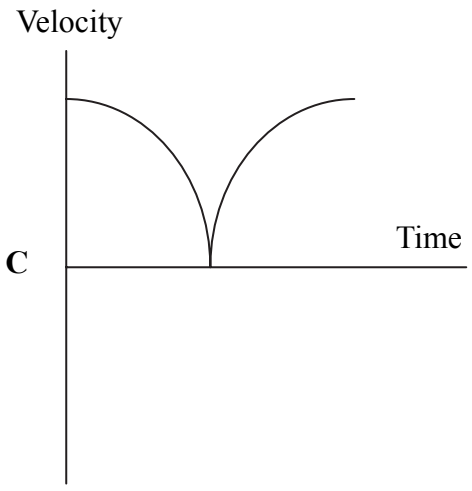
A



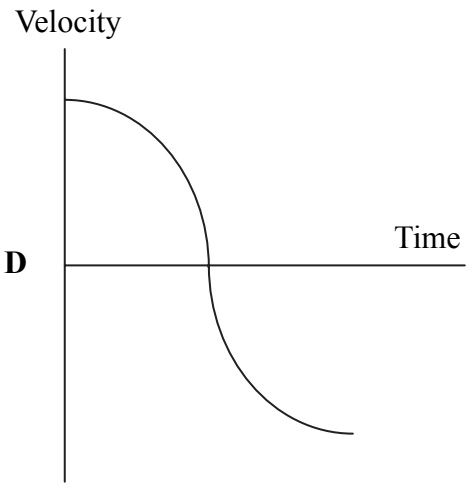
B



C



D



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for Question 6 = 1 mark)

7 A building has 5 floors. The windows on successive floors are separated by the same vertical distance. A brick is dropped from a window on each floor at the same time. The bricks should hit the ground at

☒ **A** decreasing time intervals

☒ **B** equal time intervals

☒ **C** increasing time intervals

☒ **D** the same time

(Total for Question 7 = 1 mark)

8 All ductile materials are also

☒ **A** brittle

☒ **B** hard

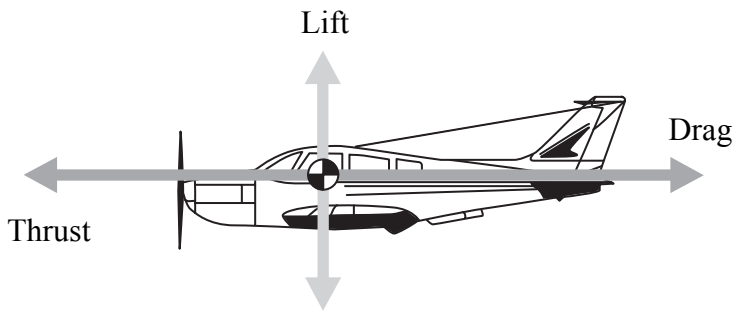
☒ **C** malleable

☒ **D** stiff

(Total for Question 8 = 1 mark)

Use the diagram below for questions 9 and 10.

The diagram shows four forces acting on an aeroplane.



9 Which of the following shows the correct two relationships if the aeroplane is climbing at a constant velocity?

		Relationship 1	Relationship 2
☒	**A**	lift > weight	thrust > drag
☒	**B**	lift > weight	thrust = drag
☒	**C**	lift = weight	thrust > drag
☒	**D**	lift = weight	thrust = drag

(Total for Question 9 = 1 mark)

10 The aeroplane is now flown at a constant altitude but an increasing speed.

Which of the following pairs of forces will have the same magnitude?

☒ **A** drag and weight

☒ **B** drag and thrust

☒ **C** lift and drag

☒ **D** lift and weight

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

11 The diagram shows part of the upper surface of an aeroplane wing.

Direction of motion
of the wing

At point A the air flow changes from laminar to turbulent.

Complete the diagram to show the airflow before and after point A.

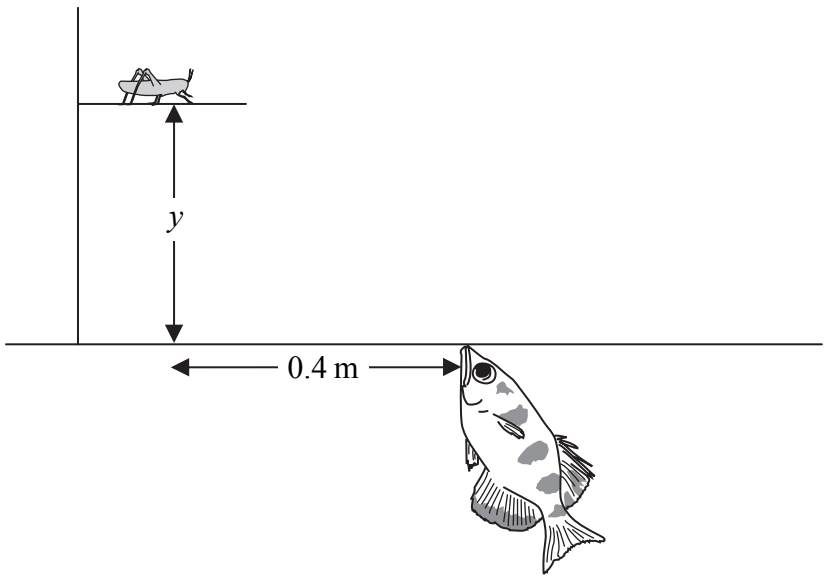
(Total for Question 11 = 2 marks)

***12** Explain the difference between elastic deformation and plastic deformation. Use the behaviour of the same material or object to illustrate both types of deformation.

(Total for Question 12 = 4 marks)

13 Archer fish spit water droplets at insects from the surface of the water.

(a) The Archer fish spits a droplet of water with a velocity of 3.5 m s^{-1} at an angle of 70° to the horizontal, aiming for an insect on a branch above the surface of the water. The horizontal distance to the insect is 0.4 m.



(i) Show that the initial horizontal component of velocity for the droplet is about 1 m s^{-1}.

(2)

(ii) Calculate the vertical distance, y, to the insect if the droplet hits the insect.

(5)

Distance = ...

(b) Sketch the path of the water droplet on the diagram above.

(1)

(Total for Question 13 = 8 marks)

14 One method used to find the viscosity of a liquid is to measure the terminal velocity of a solid spherical object falling through it.

In such an experiment the following data are provided:

weight of sphere = 4.8×10^{-3} N
radius of sphere = 2.5×10^{-3} m
volume of sphere = 6.5×10^{-8} m^3
density of liquid = 1300 kg m^{-3}

(a) Show that the upthrust is about 8×10^{-4} N.

(2)

(b) The terminal velocity is found to be 4.6×10^{-2} m s^{-1}. Use this value to show that the viscosity of the liquid is about 2 kg m^{-1} s^{-1}.

(3)

(c) The students carrying out this experiment wish to repeat it on another day using the same equipment. State another relevant variable that needs to be controlled to make this a fair test.

(1)

(Total for Question 14 = 6 marks)

15 The photograph shows the top of an inspection cover for a drain.

(a) The cover is marked ‘ductile’. It is made from ductile iron, which was invented in 1943. It replaced the previous form of cast iron, which was more brittle.

Explain the meaning of the following terms:

(2)

Ductile .....

.....

Brittle .....

.....

(b) The cover is also marked ‘35 kN’. This refers to the load it must be able to support.

Calculate the mass that would produce this load.

(2)

.....

Mass = ...

(Total for Question 15 = 4 marks)

Turn over ▶

16 There has been a proposal to build a train tunnel underneath the Atlantic Ocean from England to America. The suggestion is that in the future the trip of 5000 km could take as little as one hour.

Assume that half the time is spent accelerating uniformly and the other half is spent decelerating uniformly with the same magnitude as the acceleration.

(a) Show that the acceleration would be about 2 m s^{-2}.

(2)

(b) Calculate the maximum speed.

(2)

Speed = ...

(c) Calculate the resultant force required to decelerate the train.

mass of train = 4.5×10^5 kg

(2)

Force = ...

(Total for Question 16 = 6 marks)

17 A kite is held by a string and flies because of lift produced by the flow of air.

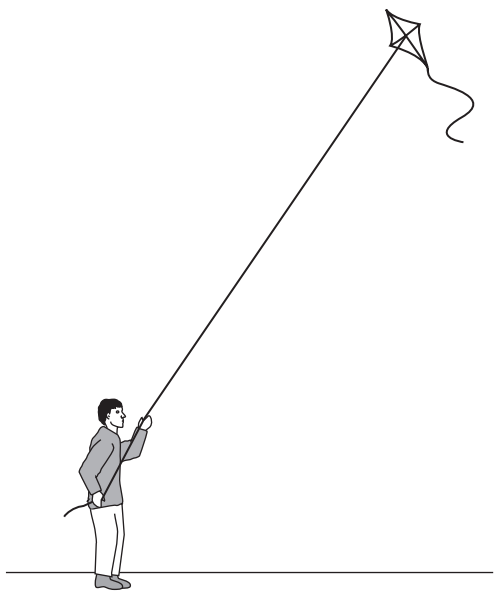


Figure 1

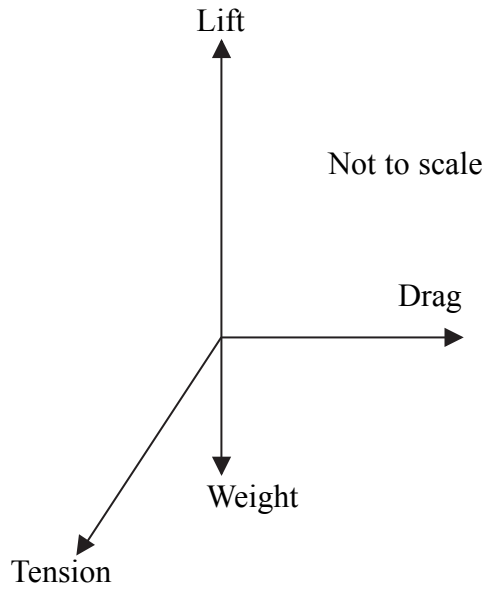


Figure 2

Figure 2 shows a free-body force diagram for the kite.

(a) Sketch a labelled vector diagram to show that the four forces are in equilibrium.

(1)

(b) The lift is 4.3 N, the drag is 6.0 N and the weight is 0.44 N.

Calculate the tension in the string. State its magnitude and direction from the horizontal.

(4)

Magnitude of tension = ...

Direction of tension from the horizontal = ...

(c) (i) The wind speed decreases so the girl flying this kite walks into the wind at a constant speed of 2.0 m s^{-1} to maintain the forces shown. Calculate the work done by the girl as she walks 25 m.

(2)

Work done = ...

(ii) Calculate the rate at which work is done by the girl.

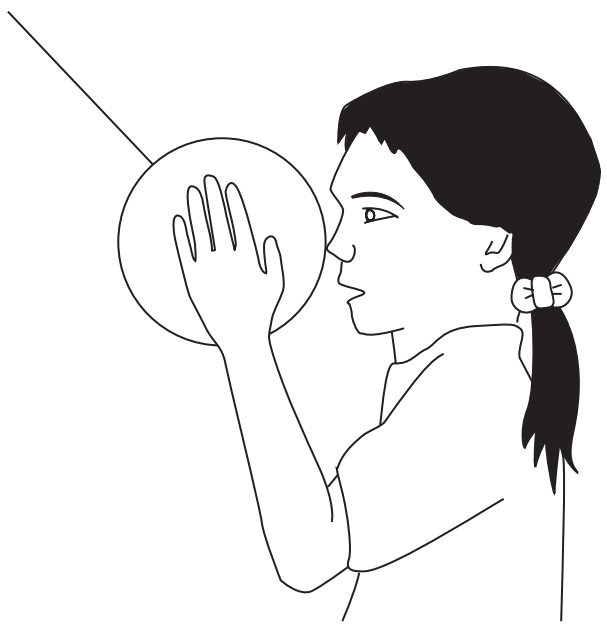
(2)

Rate at which work is done = ...

(Total for Question 17 = 9 marks)

***18** In a demonstration of energy transfer, a large pendulum is made by suspending a 7.0 kg bowling ball on a long piece of wire.

A student is invited to pull the ball back until it just touches her nose and then to release it and stand perfectly still while waiting for the ball to return.



The following instructions are given:

> Do not push the ball – just release it.
> Do not move your face before the ball returns.

(a) Explain this demonstration and the need for these instructions.

(6)

(b) The bowling ball is raised through a vertical distance of 1.5 m.

(i) Calculate the gravitational potential energy gained by the ball.

(2)

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.....

Gravitational potential energy = ...

(ii) Calculate the speed of the ball at the bottom of its swing.

(2)

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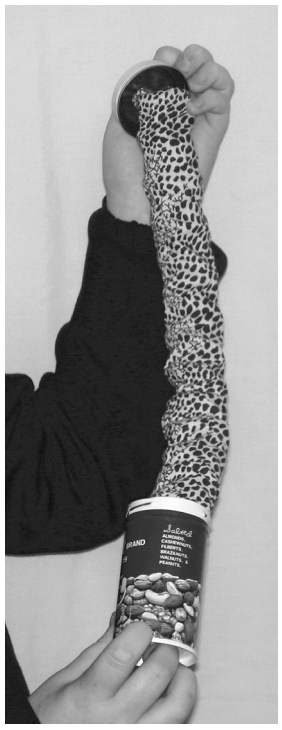
Speed = ...

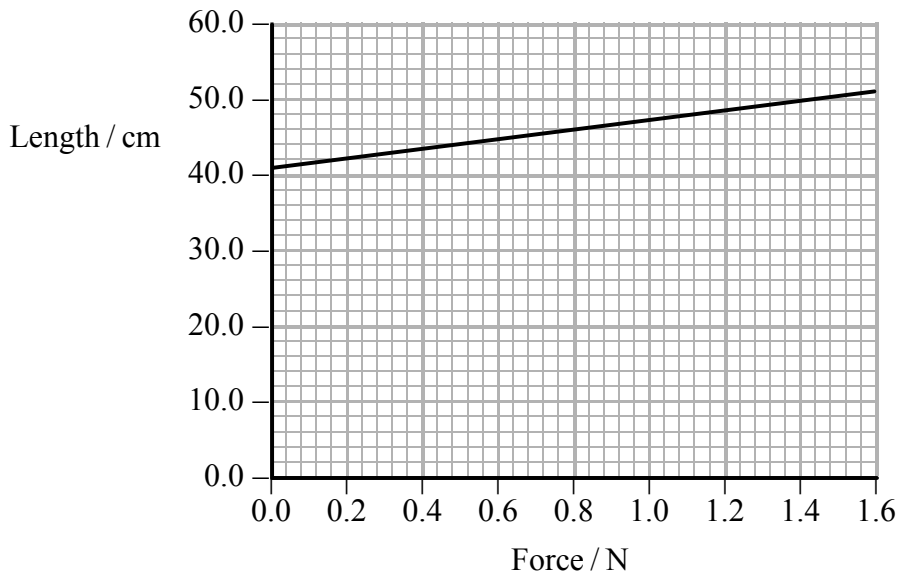
(Total for Question 18 = 10 marks)

***19** The photograph shows a tin bought from a joke shop. When the lid is removed, a long spring, covered in fabric to resemble a snake, flies out of the tin.



The spring on its own is shown here.

The graph shows length against force for the spring.



(a) Explain whether the spring obeys Hooke's law.

(2)

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(b) Show that the spring constant k of the spring is about 20 N m^{-1}.

(3)

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k = ...

(c) The original length of the spring is 41.0 cm and the length of the tin is 9.0 cm.

(i) Calculate the force that must be applied to the spring to get it into the tin.

(2)

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Force = ...

(ii) Calculate the energy stored in the spring when it is compressed to fit into the tin.

(2)

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Energy = ...

(d) In fact the bottom of the tin contains a device that makes a squeak when the spring is released, making the internal length of the tin less than 9.0 cm.

Explain the effect this has on the speed at which the spring leaves the tin.

(3)

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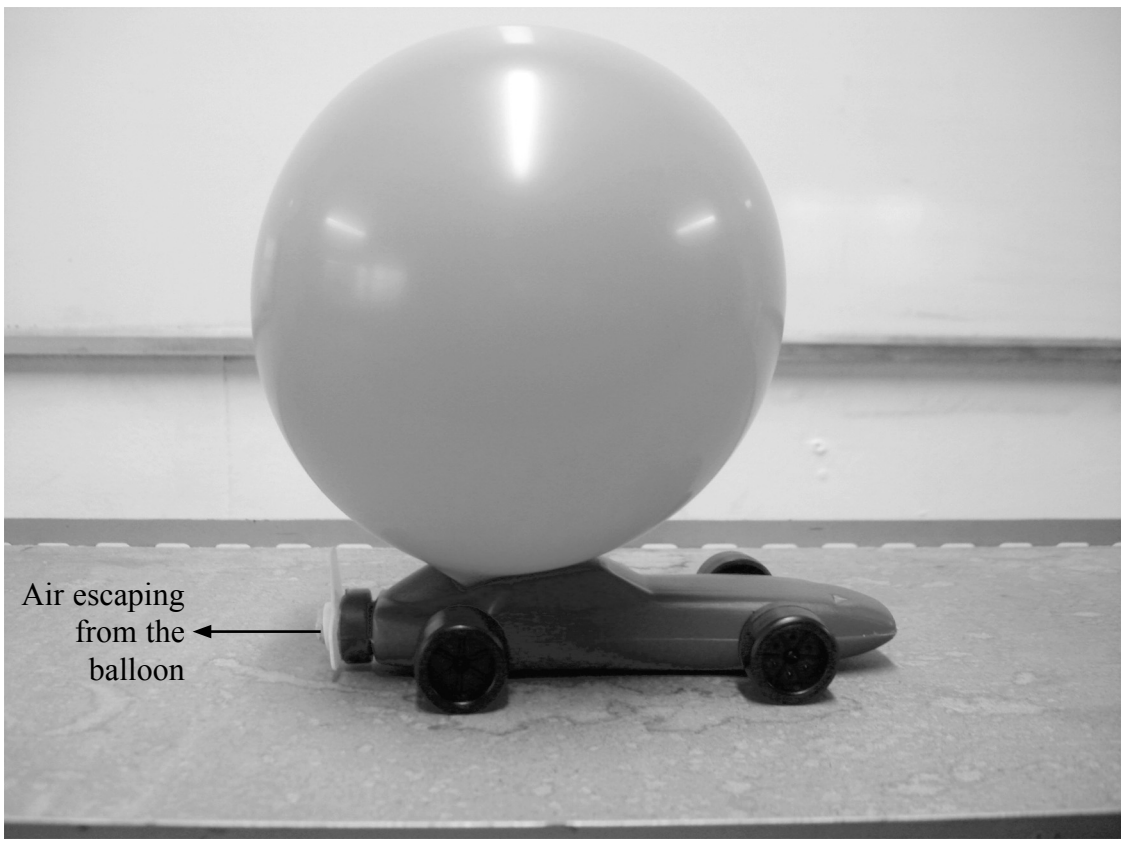
(Total for Question 19 = 12 marks)

20 The photograph shows a toy car driven by air from a deflating balloon.

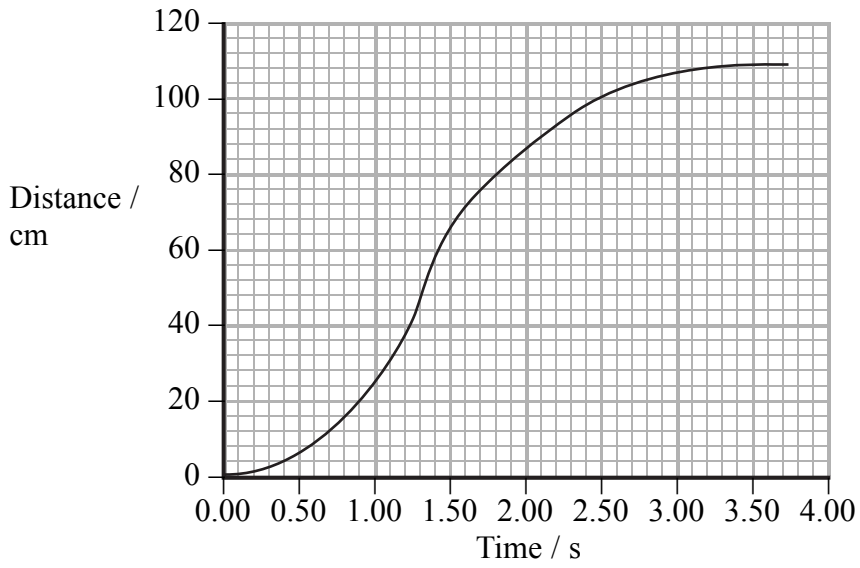


When the air in the inflated balloon is released, the car starts to move forwards.

(a) Use Newton's first and third laws of motion to explain why the air coming out of the balloon causes this.

(3)

(b) The following distance-time graph is obtained for the car.



(i) Show that the maximum speed reached is between 100 and 150 cm s^{-1}.

(3)

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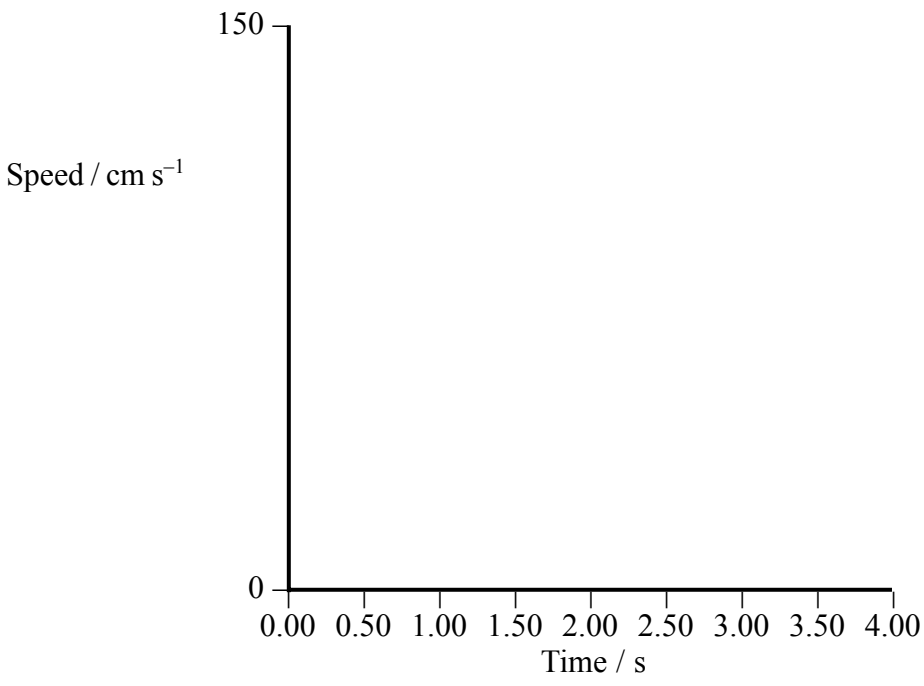
(ii) Sketch the shape of the corresponding speed-time graph on the axes below.

(3)



(Total for Question 20 = 9 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

mock papers 5

SECTION A

1 Acceleration can be found from the

☒ **A** area under a distance-time graph.

☒ **B** area under a velocity-time graph.

☒ **C** gradient of a distance-time graph.

☒ **D** gradient of a velocity-time graph.

(Total for Question 1 = 1 mark)

---

2 Which table is correct for scalar and vector quantities?

☒ **A**

	has magnitude	has a direction
scalar	✓	✓
vector	✗	✓

☒ **B**

	has magnitude	has a direction
scalar	✗	✓
vector	✓	✓

☒ **C**

	has magnitude	has a direction
scalar	✓	✗
vector	✓	✓

☒ **D**

	has magnitude	has a direction
scalar	✓	✓
vector	✓	✗

(Total for Question 2 = 1 mark)

---

3 Which of the following is **not** a unit of energy?

☒ **A** $N\ s^{-1}$

☒ **B** kW h

☒ **C** N m

☒ **D** W s

(Total for Question 3 = 1 mark)

Use the following information to answer Questions 4 and 5.

A body is acted on by a vertical force of 18 N and a horizontal force of 32 N.

4 The angle to the horizontal of the resultant force is given by

☒ **A** $\cos^{-1}(18/32)$

☒ **B** $\tan^{-1}(18/32)$

☒ **C** $\sin^{-1}(32/18)$

☒ **D** $\tan^{-1}(32/18)$

(Total for Question 4 = 1 mark)

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5 The magnitude of the resultant force in N is

☒ **A** $32 + 18$

☒ **B** $32^2 + 18^2$

☒ **C** $\sqrt{32+18}$

☒ **D** $\sqrt{32^2+18^2}$

(Total for Question 5 = 1 mark)

---

6 Which of the following statements is true for the two forces in a Newton's third law pair?

☒ **A** They have different magnitudes and act in different directions.

☒ **B** They act in different directions on the same body.

☒ **C** They have the same magnitude and are different types of force.

☒ **D** They are the same type of force and act on different bodies.

(Total for Question 6 = 1 mark)

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7 A ball is dropped from rest from a building 35.0 m high.

If air resistance is neglected the ball hits the ground with a speed of

☒ **A** 8.4 m s^{-1}

☒ **B** 13.1 m s^{-1}

☒ **C** 18.5 m s^{-1}

☒ **D** 26.2 m s^{-1}

(Total for Question 7 = 1 mark)

---

8 A physics book gives this definition:

A material which shows a large plastic deformation under compression.

This is the definition for

☒ **A** ductile

☒ **B** hard

☒ **C** malleable

☒ **D** stiff

(Total for Question 8 = 1 mark)

---

9 A ball bearing is released in a measuring cylinder filled with oil. To increase the time taken for the ball bearing to reach the bottom, which one of the following would have to increase?

☒ **A** the temperature of the oil

☒ **B** the viscosity of the oil

☒ **C** the gravitational field strength

☒ **D** the density of the ball bearing

(Total for Question 9 = 1 mark)

10 Which of the following is a vector quantity?

☒ **A** distance

☒ **B** force

☒ **C** speed

☒ **D** work

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

***11** During a lesson on Newton's laws of motion, a student says, "We don't really need to bother with Newton's first law because it is included in his second law".

State Newton's first two laws of motion and explain how Newton's second law includes the first law.

(5)

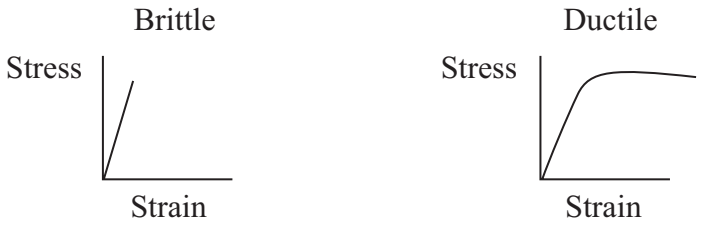
(Total for Question 11 = 5 marks)

***12** Explain why the wire used when measuring the Young Modulus of copper in a school laboratory is long and thin.

(5)

(Total for Question 12 = 5 marks)

13 The graphs show the behaviour of brittle and ductile materials.



(a) Use the graphs to help you describe brittle and ductile behaviour.

(2)

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(b) In 2006, three Chinese vases, dating from the 17th Century, were smashed when a man fell down the stairs at the Fitzwilliam Museum in Cambridge. The vases were made of porcelain.

A restoration expert put the vases back together. She said, "It wasn't a difficult job. The museum collected all the pieces and they fitted back together perfectly."

Explain why it was possible to fit the pieces back together perfectly.

(2)

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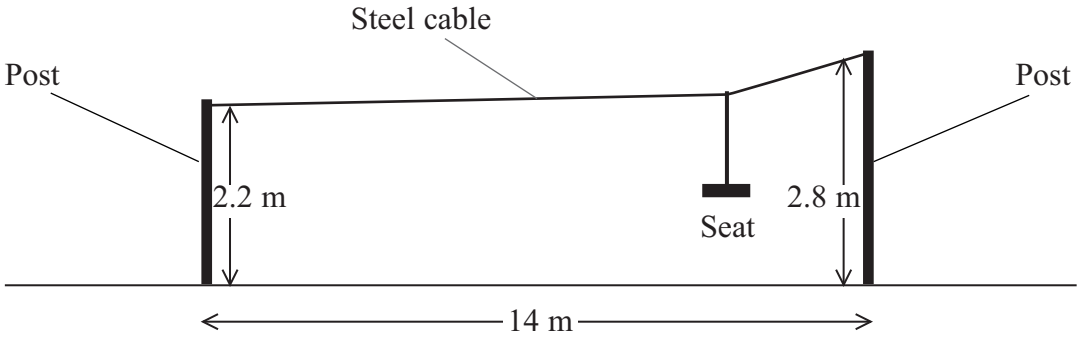
(Total for Question 13 = 4 marks)

14 A playground ride consists of a steel cable running at an angle between two posts of unequal height as shown in the diagram.



A child sits on the seat which moves on runners along the cable from the high end to the lower end.

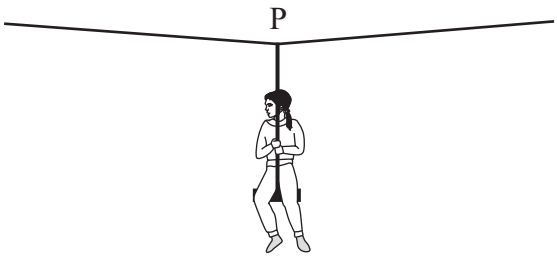
(a) (i) Show that her maximum possible speed when she arrives at the lower post is about 3 m s^{-1}.

(4)

(ii) State an assumption that you have made.

(1)

(b) The diagram below shows the child at a point P where both sides of the cable make an angle of 2° to the horizontal.



(i) Add labelled arrows to the diagram to show the forces acting on the cable at the point P.

(2)

(ii) The total mass of the child and seat is 40 kg.

Show that the tension in the cable is about 6000 N.

(3)

(Total for Question 14 = 10 marks)

15 (a) (i) A small solid particle is falling through water. Add labelled arrows to the diagram below to show the forces acting on the particle.

(3)

(ii) Explain the condition for the particle to fall at its terminal velocity.

(2)

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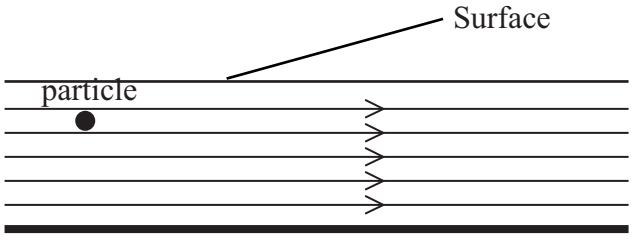
(b) Flowing water can be used to move solid particles from one place to another.

(i) The diagram below shows water moving horizontally with a laminar flow.

Add to the diagram to show the path of the particle falling through this water flow.

(1)



(ii) Complete the diagram below to show water moving with turbulent flow.

(1)

(iii) Describe the difference between laminar and turbulent flow.

(1)

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(iv) Suggest why turbulent flow may be used to move small solid particles.

(1)

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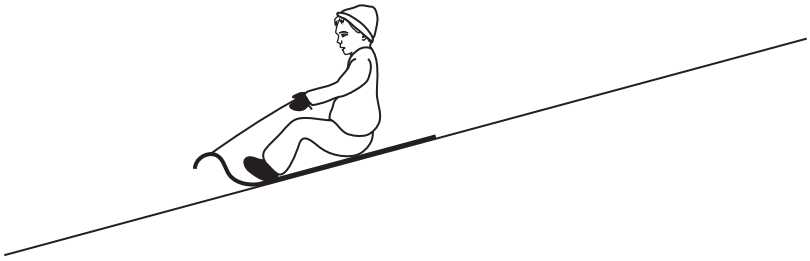
(Total for Question 15 = 9 marks)

16 (a) A child is going down a snowy hill on a sledge.



Complete, in the space below, a free-body force diagram for the child and sledge.
Treat the child and sledge as a single body object.

(2)

(b) The child and sledge are pulled across level ground by an adult.

(i) They are pulled 11 m from rest in 4.9 s.

Show that the average acceleration is about 1 m s^{-2}.

(2)

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(ii) The child and sledge have a combined mass of 40 kg.

Calculate the average resultant force on the child and sledge.

(2)

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.....

Average resultant force = ...

(c) The force applied by the adult is 200 N at an angle of 20° to the horizontal.

(i) Calculate the average resistive force acting while the sledge is being pulled.

(2)

Average resistive force = ...

(ii) Calculate the average power developed by the adult in pulling the sledge 11 m.

(3)

Average power = ...

(Total for Question 16 = 11 marks)

17 The photograph shows what happens when soft mint sweets are dropped into a bottle containing a fizzy drink. There is a sudden release of gas which forces a long stream of fluid out of the bottle.

A student decides to calculate the amount of kinetic energy transferred to the fluid in this process. In one experiment, the student places the bottle at an angle of 50° to the horizontal, adds the sweets and measures the maximum horizontal distance travelled by the fluid. The student then calculates that the fluid left the bottle at a speed of 7.5 m s^{-1}.

(a) (i) Show that the initial horizontal component of the fluid's velocity is about 5 m s^{-1}.

(1)

.....

.....

(ii) Show that the initial vertical component of the fluid's velocity is about 6 m s^{-1}.

(1)

.....

.....

(iii) Use these values to calculate the maximum horizontal distance travelled by the fluid. Assume the fluid leaves the bottle at ground level.

(4)

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.....

Maximum distance = ...

(b) (i) Calculate the total amount of kinetic energy transferred to the fluid.

total mass of bottle, contents and sweets before the experiment = 2.24 kg
total mass of bottle, contents and sweets after the experiment = 0.79 kg

(2)

Kinetic energy = ...

(ii) Give a reason why your value of kinetic energy might be higher than the true value.

(1)

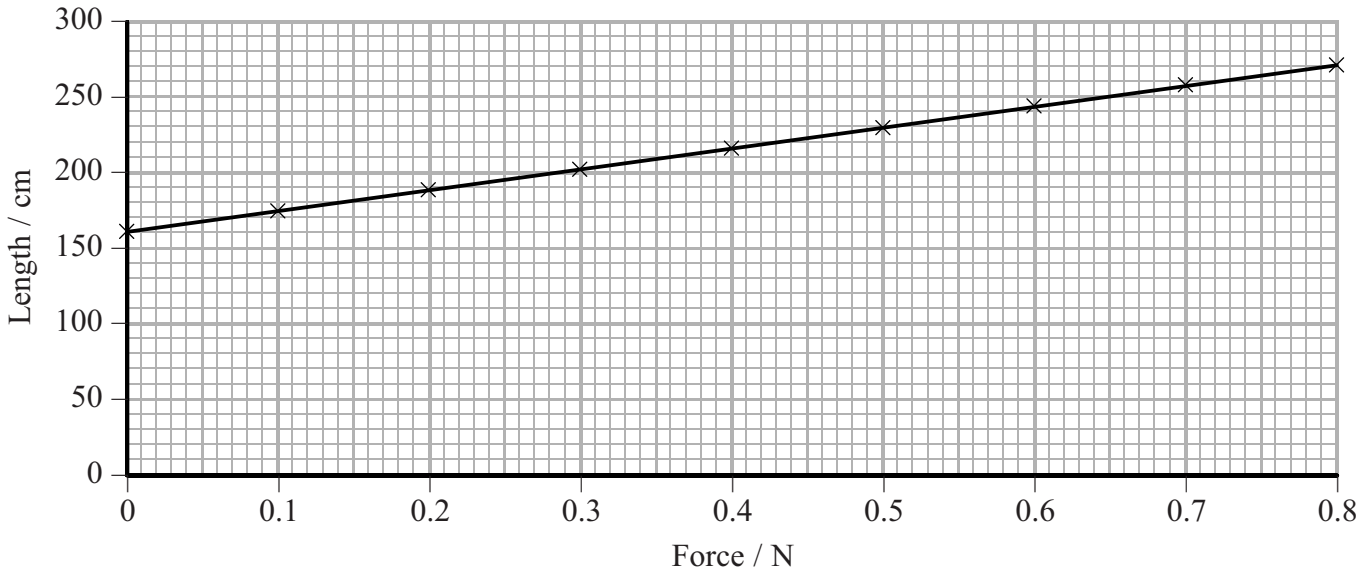
(iii) Explain why your value of kinetic energy might be lower than the true value.

(2)

(Total for Question 17 = 11 marks)

18 A Slinky is a long spring made of metal. One end of a Slinky is fixed to the ceiling. The force acting on the Slinky was varied by hanging weights from the other end.

The graph shows the results.



(a) (i) Explain whether the results follow Hooke's law.

(2)

(ii) Show that the stiffness of the Slinky is about 0.7 N m^{-1}.

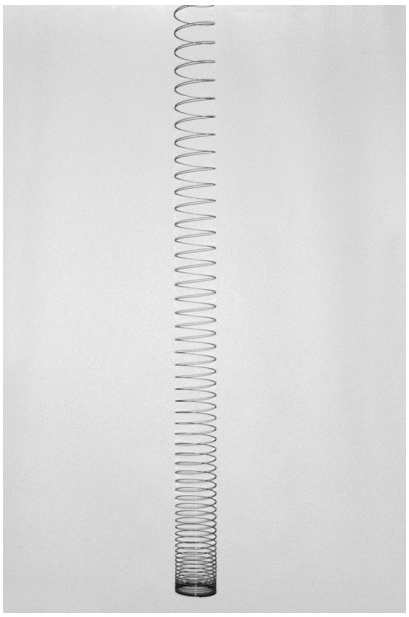
(3)

(iii) Calculate the elastic strain energy stored in the Slinky when the applied force is 0.70 N.

(3)

Elastic strain energy = ...

(b) The photograph shows part of the Slinky hanging from a person's hand.



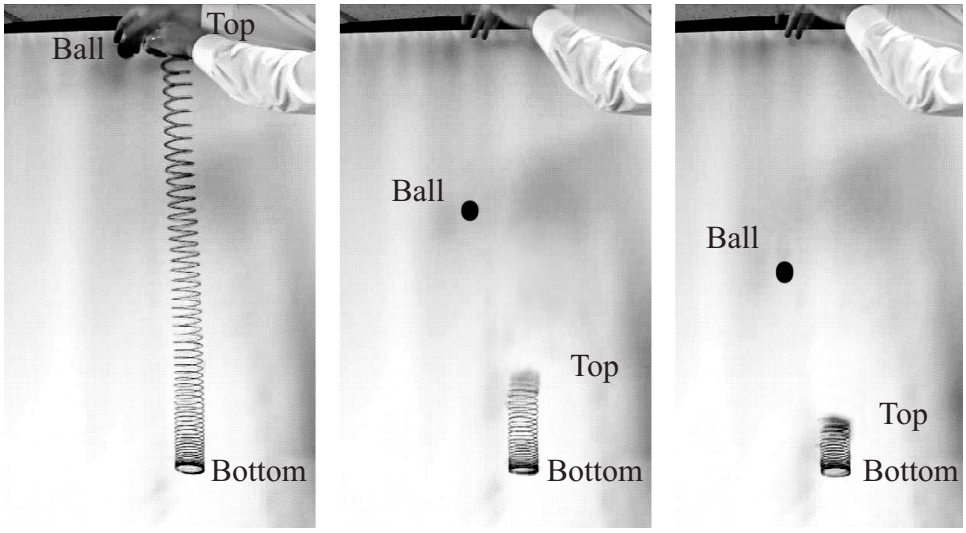
(i) Explain why the coils are extended more at the top than the bottom.

(2)

(ii) Mark and label the approximate position of the centre of gravity of the Slinky on the photograph above.

(1)

(iii) A ball is dropped from the same height, and at the same time, as the top of the Slinky is released. The three photographs below show what happens.



*(1) By considering the forces acting on the top coils of the Slinky, explain why they fall faster than the ball.

(3)

(2) Suggest why the bottom coils remain in the same position in the three photographs.

(1)

(Total for Question 18 = 15 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS