Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 1: Physics on the Go

Monday 20 May 2013 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6PH01/01

You must have:
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.*

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

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

Turn over ▶

P41632A

1/1/1/1/1/

P 4 1 6 3 2 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 pair of quantities does **not** contain a vector and a scalar?

☐ **A** acceleration and time

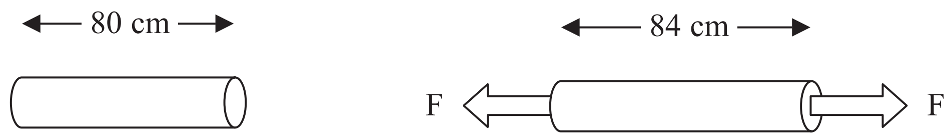
☐ **B** force and displacement

☐ **C** mass and acceleration

☐ **D** velocity and time

(Total for Question 1 = 1 mark)

2 A wire of length 80 cm has a force F applied. The new length of the wire is 84 cm.



The strain is given by

☐ **A** $\frac{4}{84}$

☐ **B** $\frac{4}{80}$

☐ **C** $\frac{80}{84}$

☐ **D** $\frac{84}{80}$

(Total for Question 2 = 1 mark)

3 Which of the following is a derived SI quantity?

☒ **A** force

☒ **B** length

☒ **C** second

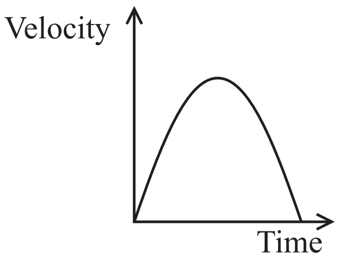
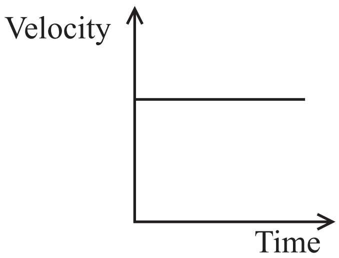
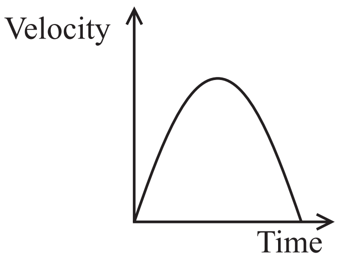
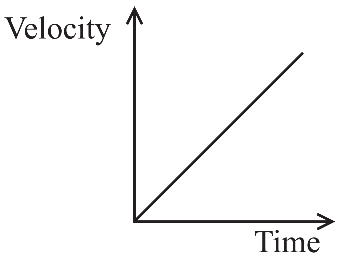
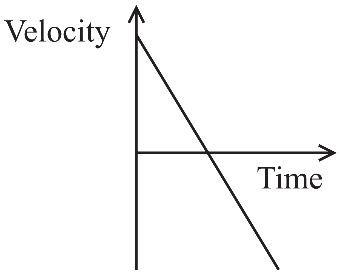
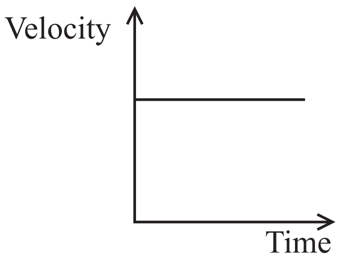
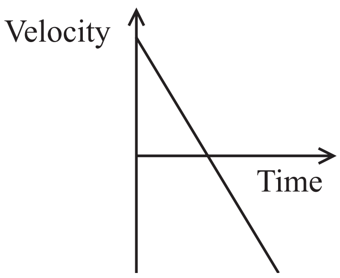
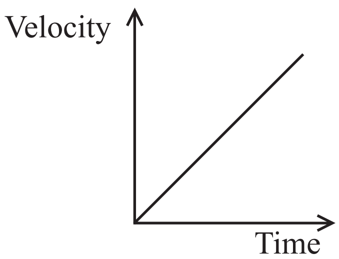
☒ **D** watt

(Total for Question 3 = 1 mark)

---

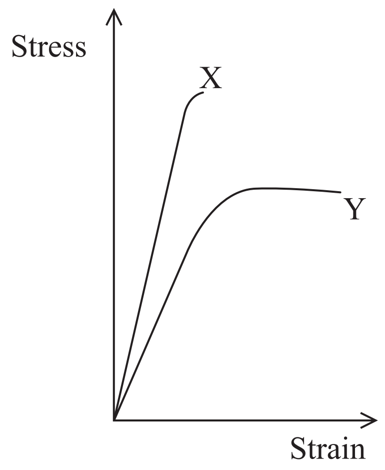
4 A projectile is launched at an angle of 45° to the horizontal.

Ignoring air resistance, which pair of graphs correctly shows how the vertical and horizontal components of velocity vary with time for the projectile until it lands?

	Vertical component	**Horizontal component**
☒ **A**		
☒ **B**		
☒ **C**		
☒ **D**		

(Total for Question 4 = 1 mark)

5 The graph shows stress against strain up to the breaking point for two materials X and Y.

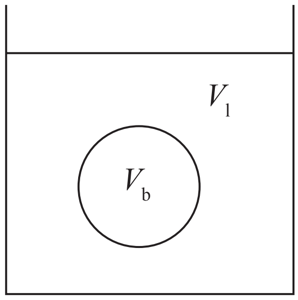


Which row in the table correctly identifies the behaviour of each material?

	X	**Y**
☒ **A**	brittle	ductile
☒ **B**	ductile	brittle
☒ **C**	ductile	hard
☒ **D**	brittle	hard

(Total for Question 5 = 1 mark)

6 A ball of volume V_b and density ρ_b is released in a volume V_l of liquid with density ρ_l.



The upthrust on the ball is given by

- ☒ **A** $V_b \rho_b g$
- ☒ **B** $V_b \rho_l g$
- ☒ **C** $V_l \rho_b g$
- ☒ **D** $V_l \rho_l g$

(Total for Question 6 = 1 mark)

---

7 A hanging basket of weight W is supported by three chains of equal length, each at an angle θ to the vertical.

The tension, T, in each chain is given by

- ☒ **A** $T = \dfrac{3W}{\cos\theta}$
- ☒ **B** $T = \dfrac{3W}{\sin\theta}$
- ☒ **C** $T = \dfrac{W}{3\cos\theta}$
- ☒ **D** $T = \dfrac{W}{3\sin\theta}$

(Total for Question 7 = 1 mark)

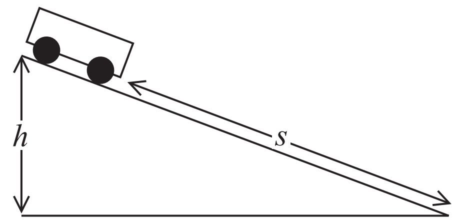
8 Which of the following descriptions of a material implies that it undergoes significant plastic deformation?

- ☒ **A** brittle
- ☒ **B** hard
- ☒ **C** malleable
- ☒ **D** stiff

(Total for Question 8 = 1 mark)

---

9 A trolley rolls down a slope from rest. The trolley moves through a vertical height h while rolling a distance s along the slope.



The maximum possible speed is given by

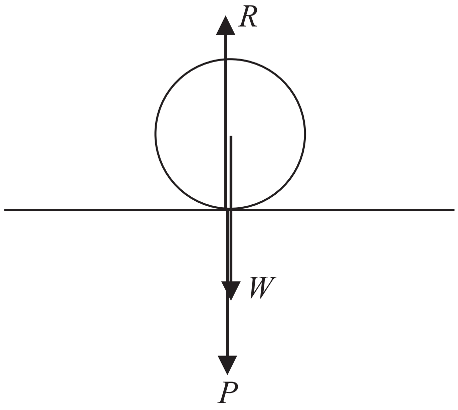
- ☒ **A** $2gs$
- ☒ **B** $2gh$
- ☒ **C** $\sqrt{(2gs)}$
- ☒ **D** $\sqrt{(2gh)}$

(Total for Question 9 = 1 mark)

---

10 An apple is at rest on the ground.

The diagram shows three forces of equal magnitude.



W = weight of apple

P = push of apple on ground

R = normal contact force of ground on apple

Which row in the table shows Newton's first and third laws being applied correctly.

	Newton's first law	Newton's third law
☒ **A**	$P = W$	$R = P$
☒ **B**	$R = P$	$W = R$
☒ **C**	$W = R$	$P = W$
☒ **D**	$W = R$	$R = P$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 Viscosity is sometimes given units of kg m^{-1} s^{-1} and sometimes Pa s.

Show that these are equivalent.

(2)

....

....

....

....

....

(Total for Question 11 = 2 marks)

12 (a) State what is meant by centre of gravity.

(1)

....

....

....

(b) The picture shows a snooker cue. It is made from wood of uniform density and takes the form of a rod with decreasing diameter towards one end.

(i) On the picture, mark the position of the centre of gravity of the snooker cue.

(1)

(ii) State a simple method to test if this is the correct position.

(1)

....

....

(Total for Question 12 = 3 marks)

13 Queues of cars often form behind cyclists on narrow, rural roads.

Sometimes cars that would normally travel at 65 km hour^{-1} may be limited to about 20 km hour^{-1} by a cyclist.

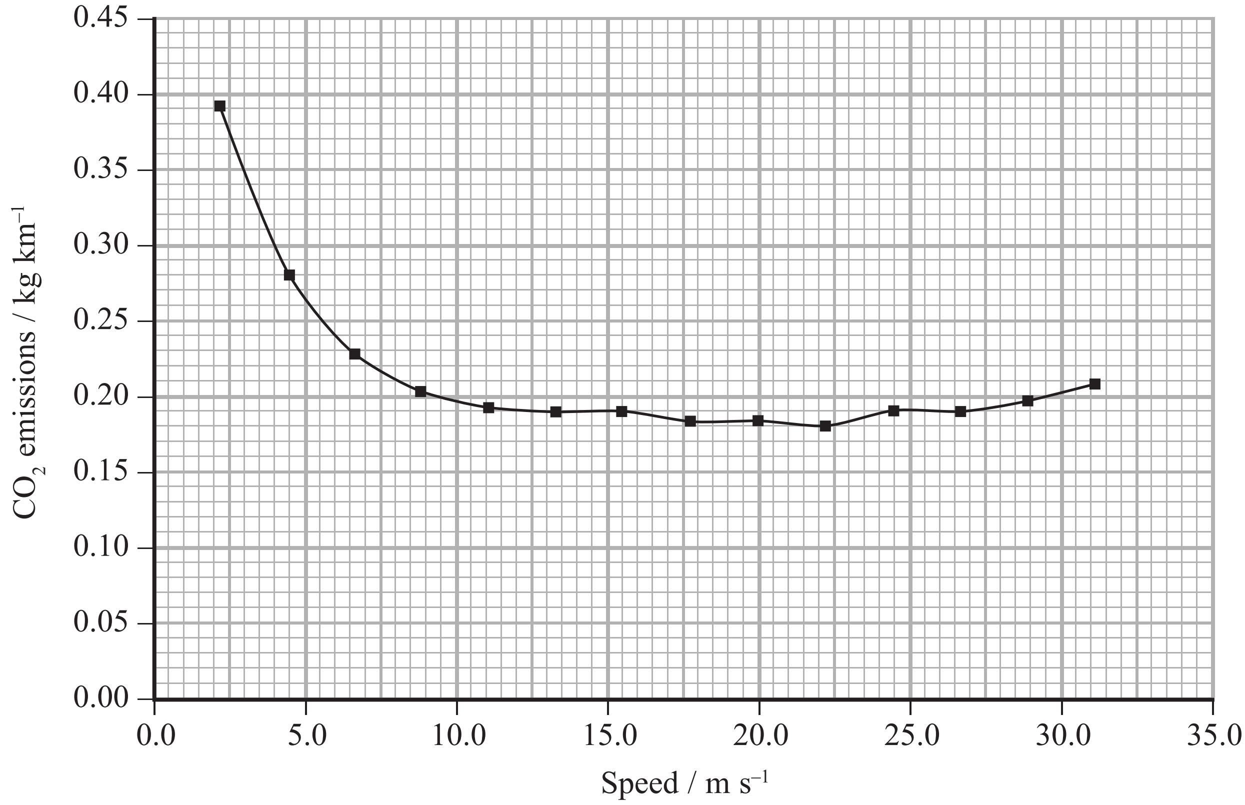
(a) Show that 65 km hour^{-1} is about 18 m s^{-1}.

(1)

....

....

(b) The graph shows the amount of carbon dioxide emitted per kilometre by a typical car at different speeds.



P 4 1 6 3 2 A 0 1 0 2 8

During a 10 minute journey a cyclist, travelling at 5 m s^{-1}, has an average of three cars queuing behind him. The cars would otherwise be travelling at 18 m s^{-1}. The cars emit more carbon dioxide because they are travelling slowly.

(i) Calculate the extra carbon dioxide emitted by the 3 cars due to travelling at this reduced speed for 10 minutes.

(4)

Extra carbon dioxide emitted = ...

(ii) If the cyclist had made the same journey in his car at 18 m s^{-1}, his car would have emitted 0.54 kg of carbon dioxide. Comment on the significance of this.

(1)

(Total for Question 13 = 6 marks)

14 The gravitational field strength on the Moon is about 1/6 of the gravitational field strength on the Earth.

(a) On the Moon, an astronaut dropped a golf ball. He later wrote "When I dropped the ball, it took about three seconds to land."

Show that the astronaut would need to be over 7 m tall for the ball to take 3 s to land.

(2)

....

....

....

....

(b) The astronaut hit the ball with a golf club. He wrote "The ball, which would have gone thirty to forty yards on the Earth, went over two hundred yards. The ball stayed up in the black sky for almost thirty seconds."

Assume an initial velocity of 18 m s^{-1} at 34° to the horizontal.

(i) Show that the astronaut's suggested time of flight of 30 s is over twice the actual value.

(3)

....

....

....

....

....

....

....

(ii) Show that the value given for the initial velocity leads to a value for the horizontal distance travelled by the ball in agreement with his stated value.

200 yards = 183 m

(3)

....

....

....

....

....

....

*(c) A projectile would have a greater range on the Moon than the Earth because of the lower gravitational field strength and because of the lack of an atmosphere.

Explain how each of these factors would increase the range of the projectile.

(3)

....

....

....

....

....

....

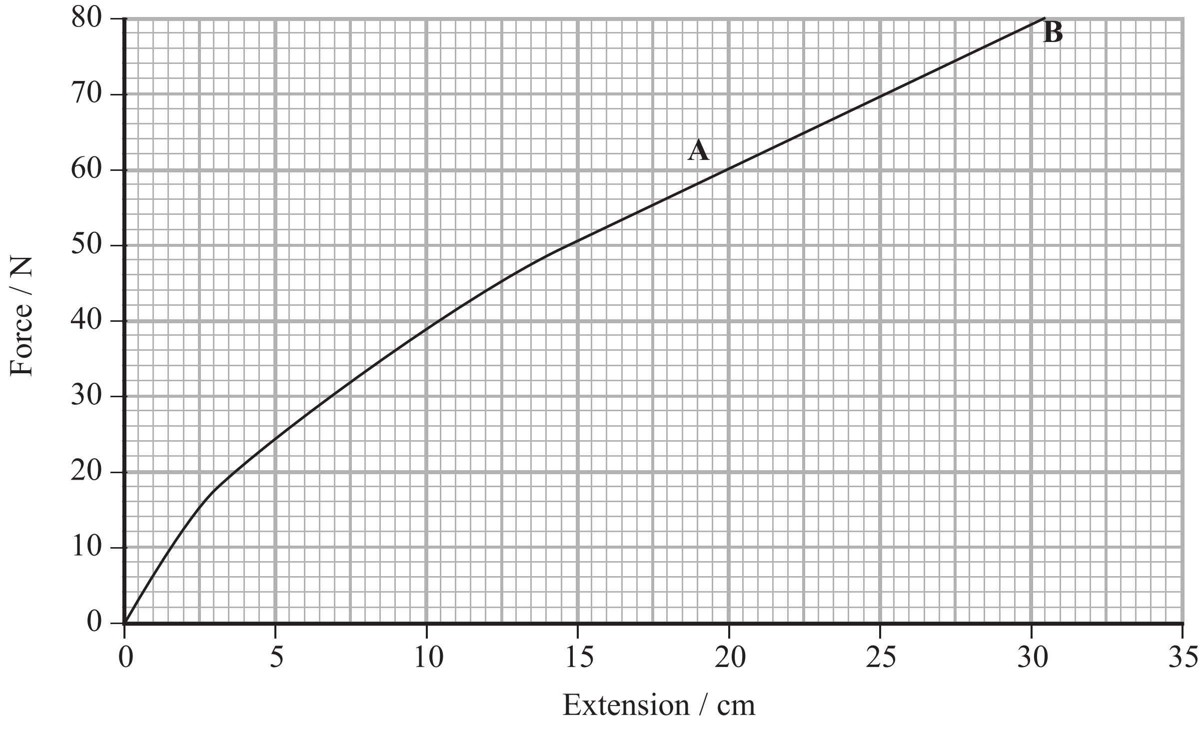
(Total for Question 14 = 11 marks)

BLANK PAGE

15 The photographs show an exercise device and someone using it. The device contains two rubber cords which are extended when the device is used.

A student investigates the properties of the device by hanging weights on it and measuring the extension.

The student obtains the following graph for her results.



Turn over ▶

(a) The student notices that her graph is a straight line between A and B and concludes that the device obeys Hooke's law.

Comment on this conclusion.

(2)

....

....

....

(b) (i) Describe how the student could use the graph to obtain an estimate of the total work done.

(2)

....

....

....

....

(ii) The student sets up a spreadsheet to investigate the work done in stretching the device each time a weight is added.

	A	B	C	D
1	Total stretching force / N	Extension / cm	Change in extension / m	Work done (force × change in extension) / J
2	0	0.0	0.000	0.00
3	10	1.6	0.016	0.16
4	20	3.5	0.019	0.38
5	30	7.0	0.035	1.05
6	40	10.5	0.035	1.40
7	50	14.5	0.040	2.00
8	60	20.0	0.055	3.30
9	70	25.2	0.052	3.64
10	80	30.5	0.053	4.24
11			Total work done	16.17

Explain why this spreadsheet results in an over-estimate for the total work done.

(2)

(c) The student eats a packet of crisps and then uses the exercise device. The energy content in a packet of crisps is 540 kJ. During exercise this energy is converted and 25% of it is transferred to mechanical work.

The student extends the device fully 15 times in 1 minute. An accurate value for the work done in fully extending the device is 14.7 J.

Calculate the time it would take the student, working at this rate, to transfer 25% of the energy from the crisps to mechanical work.

(3)

Time = ...

(d) Explain whether more or less work would be done applying the same maximum total stretching force to a similar exercise device with rubber cords of twice the cross-sectional area.

(2)

(Total for Question 15 = 11 marks)

16 The 'Stealth' roller coaster at the Thorpe Park theme park is advertised as reaching 135 km hour^{-1} from rest in 2.3 seconds.

Most roller coasters are driven slowly up to the top of a slope at the start of the ride. However the carriages on 'Stealth' are initially accelerated horizontally from rest at ground level by a hydraulic launch system, before rising to the top of the first slope.

(a) (i) Calculate the average acceleration of the carriages.

135 km hour^{-1} = 37.5 m s^{-1}

(2)

....

....

....

....

Average acceleration = ...

(ii) Calculate the minimum average power which must be developed by the launch system.

mass of carriages and passengers = 10 000 kg

(3)

....

....

....

....

....

Minimum average power = ...

(iii) Suggest why the power in (ii) is a minimum value.

(1)

....

....

....

....

*(b) The force required to launch 'Stealth' is not always the same. The ride is monitored and the data from preceding launches is used to calculate the required force.

If the mass of the passengers for a particular ride is significantly more than for preceding launches, this can lead to 'rollback'. This is when the carriages do not quite reach the top of the first slope and return backwards to the start.

Explain why 'rollback' would occur in this situation.

(3)

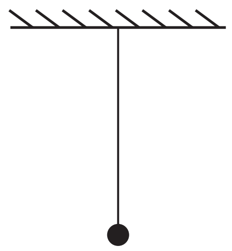
(c) Suggest why roller coasters may have a greater acceleration when the lubricating oil between the moving parts has had time to warm up.

(2)

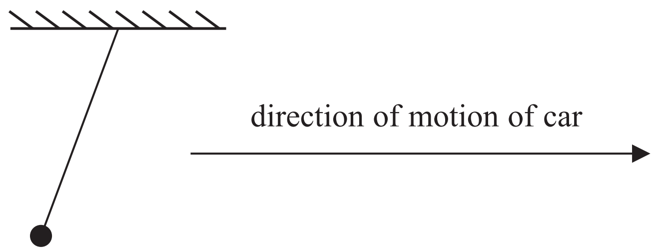
(Total for Question 16 = 11 marks)

17 Many hand held devices such as smartphones and tablet computers contain accelerometers. These allow changes in orientation of the device to be tracked.

A student models a simple accelerometer by attaching a small mass on a string to the roof of a car.



When the car starts moving, the string is seen to change position as shown below.



(a) (i) Complete a free body force diagram for the mass when the car starts moving.

(2)

(ii) Draw a vector diagram, in the space below, to show how the resultant force on the mass is produced.

(2)

(iii) When the string is at 7° to the vertical, show that the acceleration of the car is about 1 m s^{-2}.

(2)

....

....

....

(b) Sketch the positions of the mass and string when the car is moving in the same direction and is:

(i) moving with constant velocity,

(ii) undergoing a much greater acceleration than in (a)(iii),

(iii) decelerating.

(3)

(i) moving with constant velocity,

(ii) undergoing a much greater acceleration than in (a)(iii),

(iii) decelerating.

(c) Explain why the string would **not** become horizontal, however great the acceleration.

(2)

....

....

....

(d) Suggest why many devices contain 3 accelerometers, arranged at right angles to each other.

(1)

....

....

....

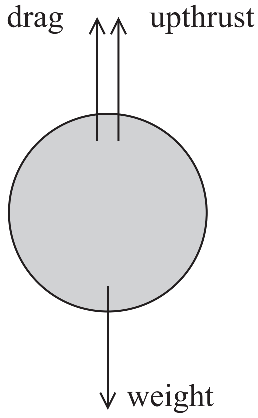
(Total for Question 17 = 12 marks)

18 The Greek philosopher Aristotle (4th Century BC) stated that heavy objects fall more quickly than lighter objects.

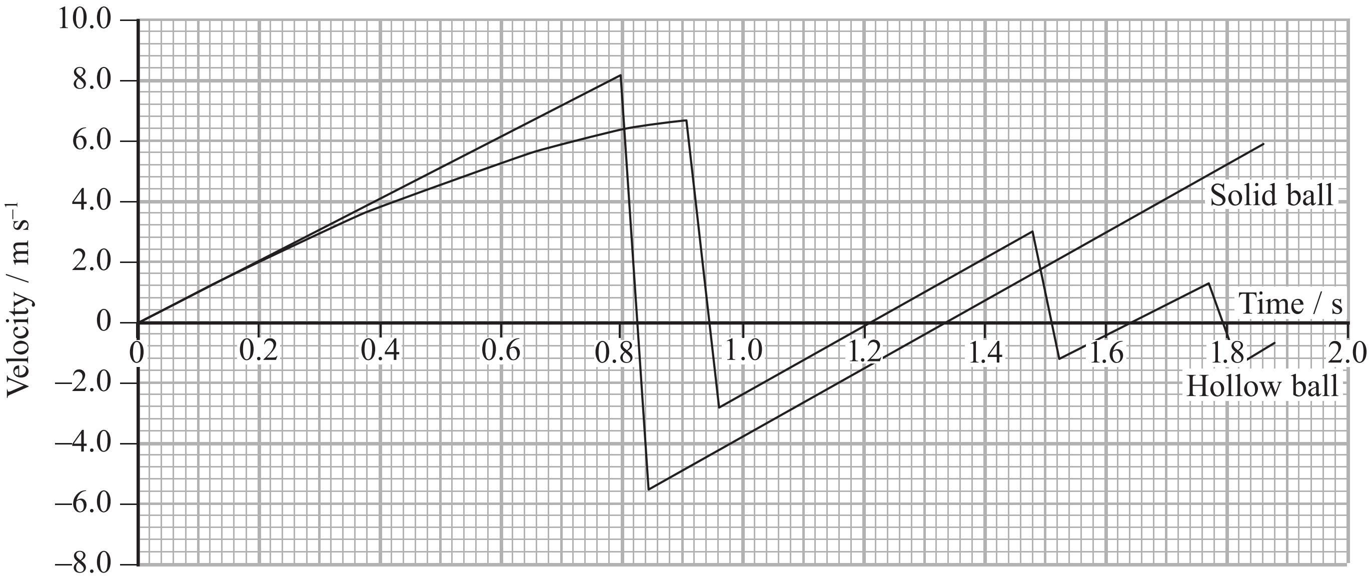
In the 17th Century Galileo reported that a cannon ball and a much smaller musket ball, dropped at the same time, reached the ground together.

A student carries out an experiment, dropping two balls of the same size at the same time. One of the balls is hollow and the other is solid.

The diagram shows the forces acting on each ball as it falls.



The velocity-time graph shows the motion of the two balls from the time they are dropped.



(a) State how the graphs show that neither ball reaches terminal velocity.

(1)

....

....

....

(b) (i) By drawing a tangent to the graph, show that the acceleration of the hollow ball at time $t = 0.60$ s is about 7 ms^{-2}.

(2)

(ii) Show that the resultant force on the hollow ball at $t = 0.60$ s is about 0.02 N.

mass of hollow ball = 2.4 g

(2)

(iii) Show that the drag force on the hollow ball at $t = 0.60$ s is about 0.01 N. You may neglect upthrust.

(2)

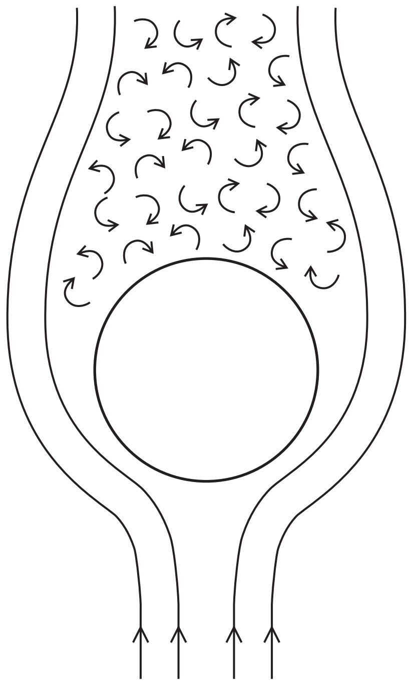
(iv) Demonstrate that the Stokes' law force is **not** sufficient to produce this drag force.

radius of hollow ball = 2.0 cm

viscosity of air = 1.8×10^{-5} Pa s

(2)

(c) The diagram shows the air flow around the hollow ball as it falls.



(i) Add labels to show laminar flow and turbulent flow.

(1)

(ii) Suggest why the drag is much greater than the Stokes' law force.

(1)

....

....

....

....

(d) Without further calculation, use the graph to describe the motion of the solid ball.

(3)

....

....

....

....

....

....

....

....

(Total for Question 18 = 14 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$	
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8} \text{ m s}^{-1}$	

Unit 1

Mechanics

Kinematic equations of motion

$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$
$$g = F/m$$
$$W = mg$$

Work and energy

$$\Delta W = F\Delta s$$
$$E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_{grav} = mg\Delta h$$

Materials

Stokes' law $F = 6\pi\eta rv$

Hooke's law $F = k\Delta x$

Density $\rho = m/V$

Pressure $p = F/A$

Young modulus $E = \sigma/\varepsilon$ where
Stress $\sigma = F/A$
Strain $\varepsilon = \Delta x/x$

Elastic strain energy $E_{el} = \tfrac{1}{2}F\Delta x$

BLANK PAGE

BLANK PAGE