1 In each of the following questions a description of a graph is given.

Insert the correct labels for the axes on the dotted lines in Fig. 1.1 to Fig. 1.4.

The first one has been completed for you.

The area under the graph shown in Fig. 1.1 is equal to the elastic potential energy of a spring.

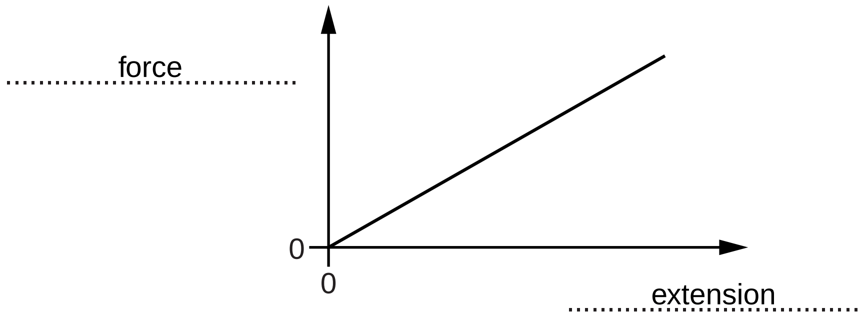

Fig. 1.1

(a) The area under the graph shown in Fig. 1.2 is equal to the displacement of a ball.

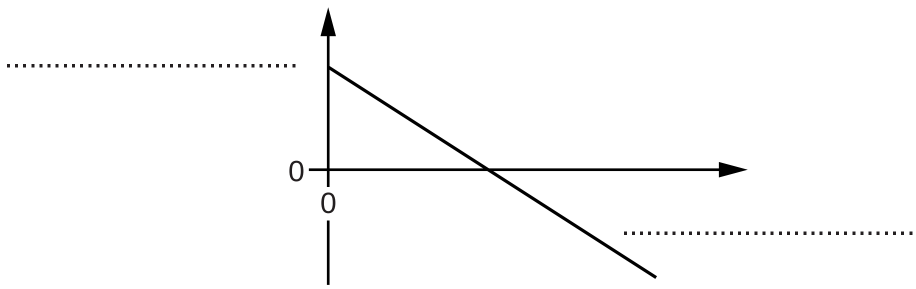

Fig. 1.2

[1]

(b) The gradient of the graph shown in Fig. 1.3 is the Young modulus of a material.

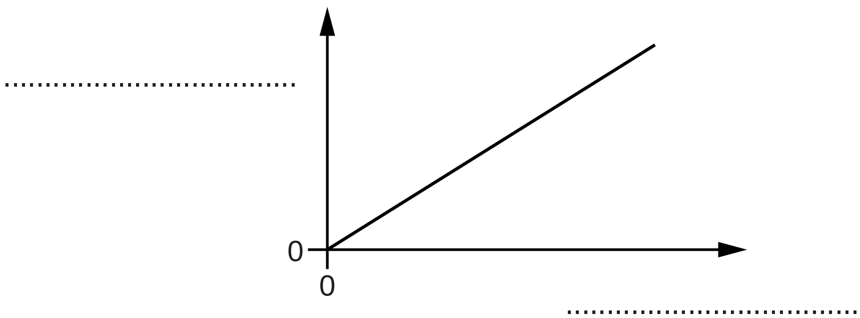

Fig. 1.3

[1]

(c) The gradient of the graph shown in Fig. 1.4 is the force constant of a wire.

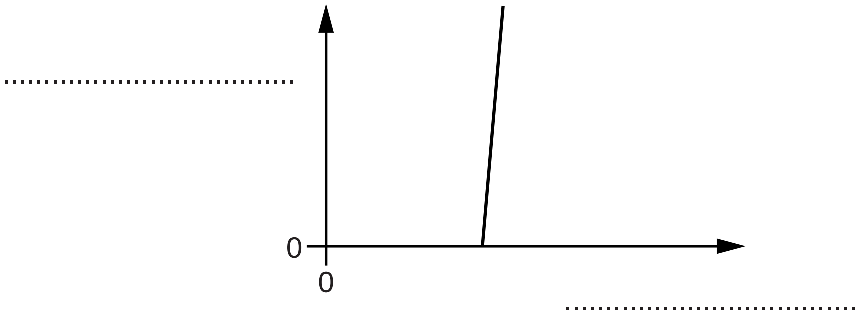

Fig. 1.4

[1]

2 **(a)** Define *velocity*.

....

.... **[1]**

(b) The mass of an ostrich is 130 kg. It can run at a maximum speed of 70 kilometres per hour.

(i) Calculate the maximum kinetic energy of the ostrich when it is running.

kinetic energy = ... J **[3]**

(ii) Scientists have recently found fossils of a prehistoric bird known as Mononykus. Fig. 1.1 shows what the Mononykus would have looked like.

Fig. 1.1

According to a student, the Mononykus looks similar to our modern day ostrich. The length, height and width of the Mononykus were all **half** that of an ostrich.
Estimate the mass of the Mononykus. Explain your reasoning.

....

....

....

.... **[2]**

[Total: 6]

3 **(a)** Fig. 4.1 shows the path of a tennis ball after bouncing on the ground at **A** and hitting a vertical wall at **B**.

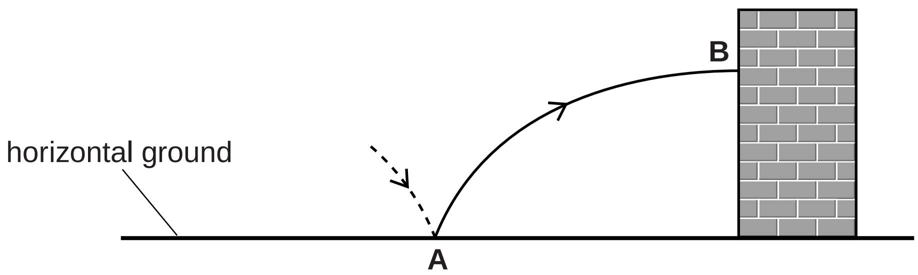

Fig. 4.1

The ball is travelling horizontally as it hits the wall at **B**. Air resistance has negligible effect on the motion of the ball.

(i) Explain why the horizontal component of the velocity of the ball remains constant as it moves from **A** to **B**.

....

.... **[1]**

(ii) The ball loses some of its kinetic energy when it hits the wall at **B**. It leaves the wall horizontally.

1 On Fig. 4.1, sketch the path of the ball between bouncing at the wall and hitting the ground.

2 Explain how the time taken for the ball to travel from **A** to **B** compares with the time it takes to travel from **B** to the ground.

....

....

....
[3]

(b) A student is given a metre rule, a stopwatch and a tennis ball.
Explain how this equipment can be used to determine an **approximate** value for the acceleration *g* of free fall.

....

....

....

....

....

....

.... **[3]**

(c) Fig. 4.2 shows a tennis ball moving up a smooth ramp at time $t = 0$.

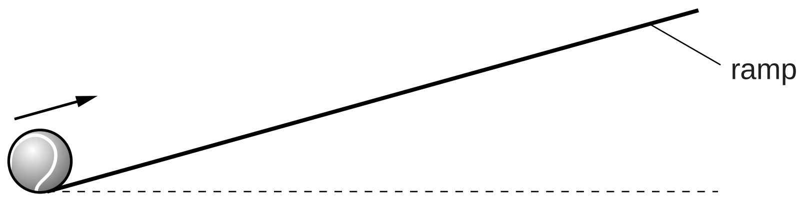

Fig. 4.2

Fig. 4.3 shows a graph of velocity v against time t for this ball.

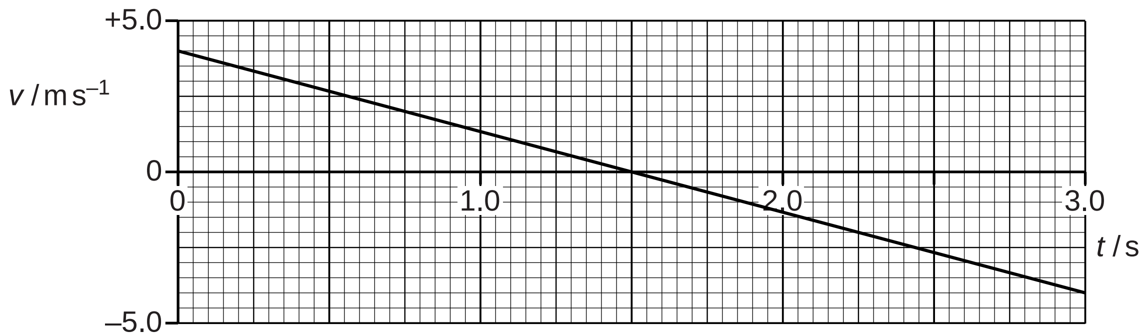

Fig. 4.3

(i) Describe, without calculation, the motion of the ball between $t = 0$ and $t = 3.0$ s.

....

....

....

....

.... **[3]**

(ii) Calculate the maximum distance D travelled by the ball up the ramp.

D = ... m **[2]**

[Total: 12]

4 **(a)** The areas under the graphs below are physical quantities.

(i) Fig. 1.1 shows a force against extension graph for a rubber band.

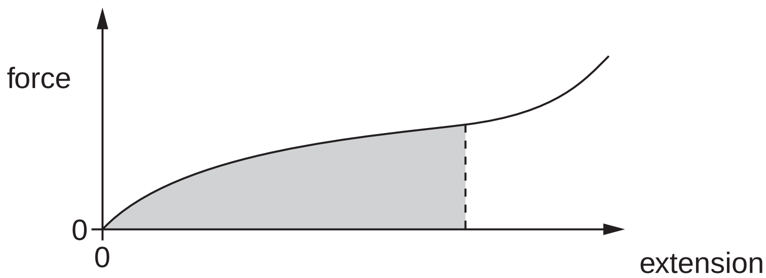

Fig. 1.1

State the quantity represented by the area under the force against extension graph.

.... **[1]**

(ii) Fig. 1.2 shows the velocity against time graph for an accelerating car.

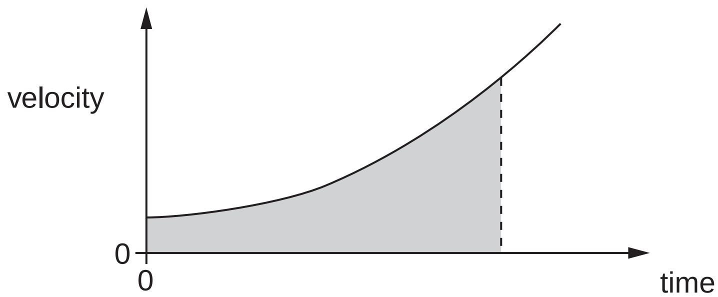

Fig. 1.2

State the quantity represented by the area under the velocity against time graph.

.... **[1]**

(b) State two quantities in physics that have the **same** unit of newton metre (N m).

quantity 1 .... **[1]**

quantity 2 .... **[1]**

[Total: 4]

5 (a) According to Aristotle (384 – 322 B.C.)

'heavier objects fall faster than lighter ones'.

Explain how one experiment carried out by Galileo (1564 – 1642) overturned Aristotle's ideas of motion.

....

....

....

....

....

.... **[3]**

(b) Fig. 2.1 shows an arrangement used in the laboratory to determine the acceleration *g* of free fall.

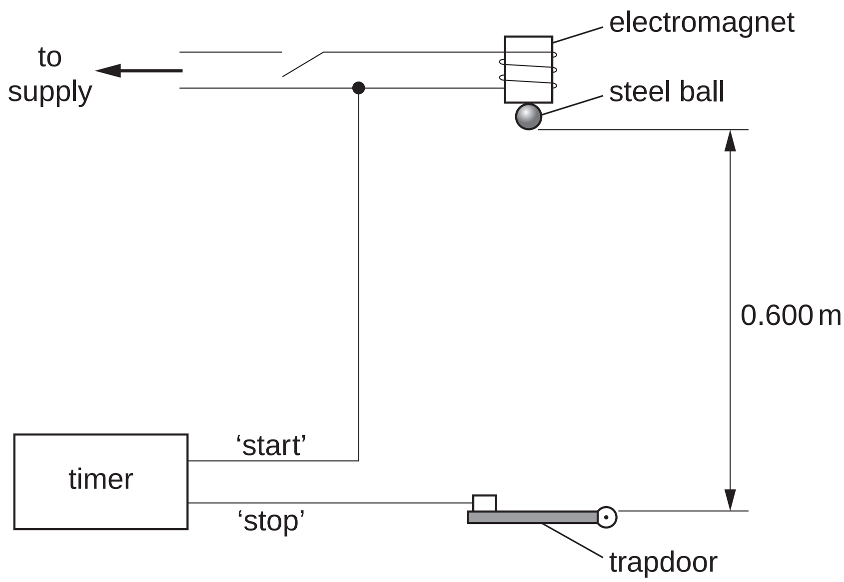

Fig. 2.1

The steel ball is held at rest by an electromagnet. When the electromagnet is switched off, the electronic timer is started and the ball falls. The timer is stopped when the ball opens the trapdoor. The distance between the bottom of the ball and the top of the trapdoor is 0.600 m. The timer records a time of fall of 0.356 s.

(i) Show that the value for the acceleration g of free fall obtained from this experiment is $9.47\,m\,s^{-2}$.

[2]

(ii) State **one** reason why the experimental value in **(i)** is less than $9.81\,m\,s^{-2}$.

....

....

.... **[1]**

(iii) On Fig. 2.2 sketch a graph to show the variation of the vertical distance s fallen by the ball with time t.

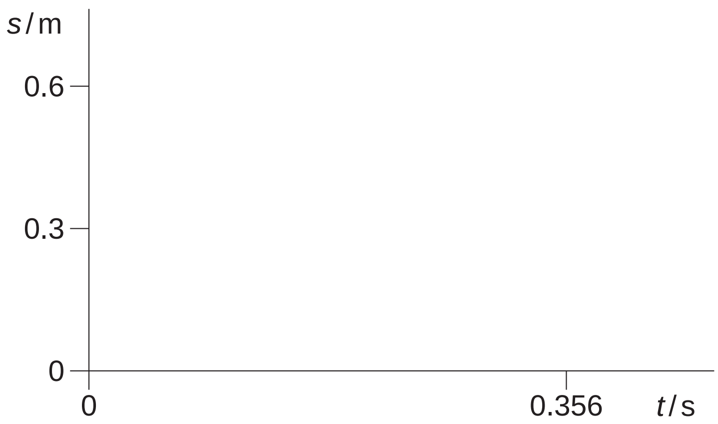

Fig. 2.2

[1]

[Total: 7]

6 **(a)** State a similarity and a difference between *distance* and *displacement*.

(i) similarity: ....

.... **[1]**

(ii) difference: ....

.... **[1]**

(b) Fig. 1.1 shows two airports **A** and **C**.

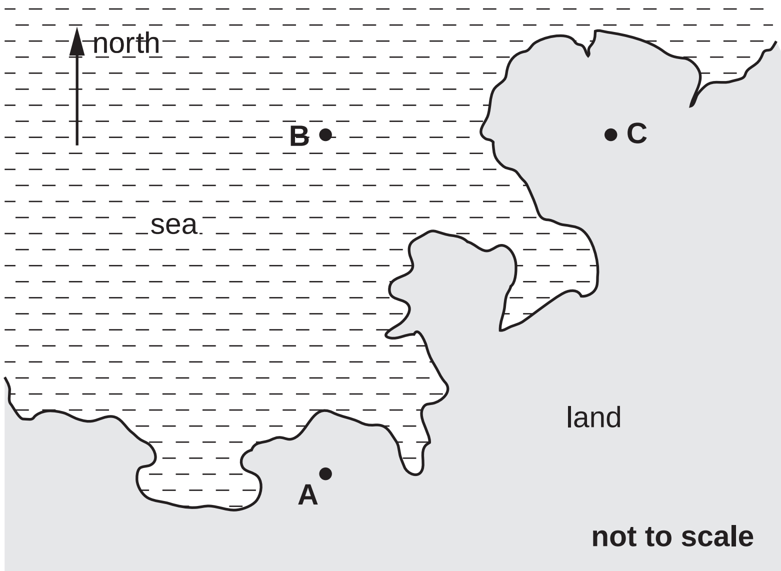

Fig. 1.1

An aircraft flies due north from **A** for a distance of 360 km (3.6×10^5 m) to point **B**. Its average speed between **A** and **B** is 170 m s^{-1}. At **B** the aircraft is forced to change course and flies due east for a distance of 100 km to arrive at **C**.

(i) Calculate the time of the journey from **A** to **B**.

time = ... s **[1]**

(ii) Draw a labelled displacement vector triangle below. Use it to determine the magnitude of the displacement in km of the aircraft at **C** from **A**.

displacement = ... km **[3]**

[Total: 6]

7 Fig. 2.1 shows a graph of velocity against time for an object travelling in a straight line.

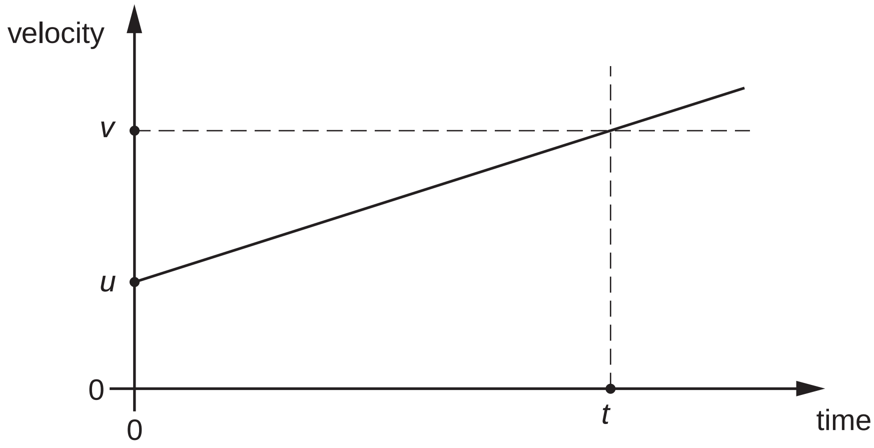

Fig. 2.1

The object has a constant acceleration *a*. In a time *t* its velocity increases from *u* to *v*.

(a) Describe how the graph of Fig. 2.1 can be used to determine

(i) the acceleration *a* of the object

In your answer, you should use appropriate technical terms, spelled correctly.

....

.... **[1]**

(ii) the displacement *s* of the object.

....

.... **[1]**

(b) Use the graph of Fig. 2.1 to show that the displacement *s* of the object is given by the equation:

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

[2]

(c) In order to estimate the acceleration *g* of free fall, a student drops a large stone from a tall building. The height of the building is known to be 32 m. Using a stopwatch, the time taken for the stone to fall to the ground is 2.8 s.

(i) Use this information to determine the acceleration of free fall.

acceleration = ... $m\,s^{-2}$ **[2]**

(ii) One possible reason why your answer to **(c)(i)** is smaller than the accepted value of $9.81\,m\,s^{-2}$ is the reaction time of the student. State another reason why the answer is smaller than $9.81\,m\,s^{-2}$.

....

.... **[1]**

[Total: 7]