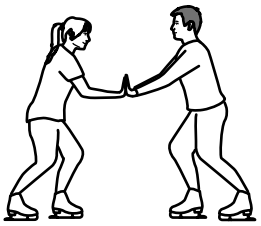
1 Nina and Matt like to ice skate.

Nina and Matt start from rest and hold each other's hands.

Then they push each other and move apart.

Look at the diagrams below.

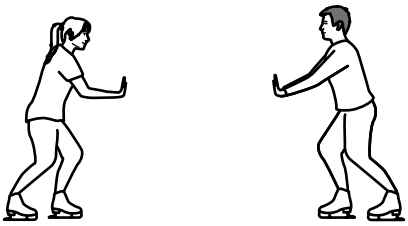
before



Nina
mass = 60 kg
velocity = 0 m/s

Matt
mass = 100 kg
velocity = 0 m/s

after



Nina
mass = 60 kg
velocity = −5 m/s

Matt
mass = 100 kg
velocity = 3 m/s

Explain why Nina and Matt move apart at different velocities.

Use the data and ideas about forces and momentum in your answer.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 6]

2 **(a** Quantities in science can be **vector** or **scalar**.

There are differences between vector and scalar quantities.

Look at the list.

mass **momentum** **speed**

Put each quantity in the correct column in the table.

Vector	S

[2]

(b) A skydiver drops vertically from a plane with a starting velocity of 0 m/s.

Calculate his speed after 7 s.

Assume his acceleration during this time is 8.0 m/s^2.

Put a (ring) around the correct answer.

15 m/s **m/s** **m/s** **m/s** **[1]**

(c) He now opens his parachute and decelerates steadily.

After 6 s his speed is 4 m/s.

Calculate the distance he falls during these 6 s.

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answer ..... m **[2]**

[Total: 5]

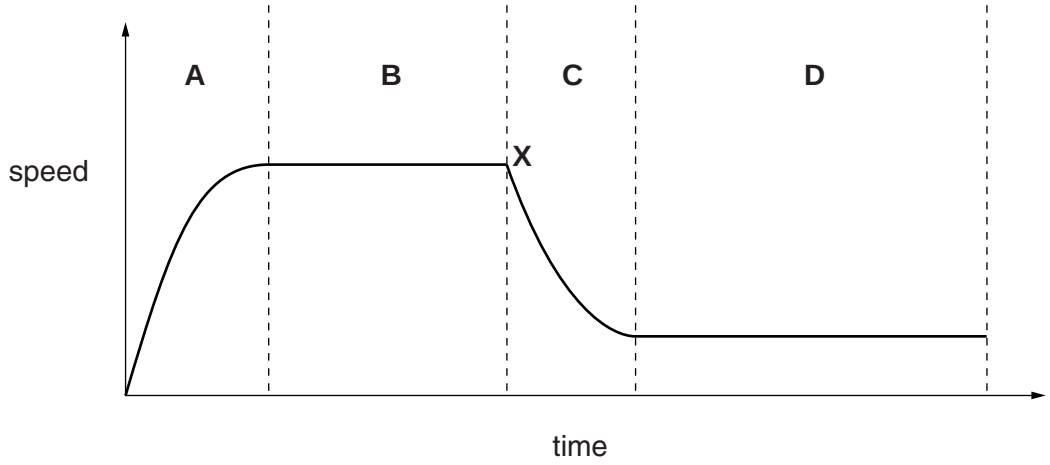
3 Susie is a skydiver.

Look at the graph.

It shows her speed after she has jumped from an aeroplane.

There are four sections of the graph, labelled **A**, **B**, **C** and **D**.

Susie opened her parachute at point **X** shown on the graph.



(a) Write about the forces acting on Susie during her descent to explain the different speeds she travels at.

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..... **[4]**

(b) Susie practises her landings by jumping from a low platform.

She is attached to straps which act like a parachute.

A Susie **standing still** on platform.

B Susie is **exactly half way** down.

C Susie is **on** the ground.

Look at the statements about Susie's energy as she does her practice fall.

Put a tick (✓) in the box beside any correct statement and a cross (✗) beside any incorrect statement.

The first one has been done for you.

At **A** all of Susie's energy is GPE.	✓
Between **A** and **B** Susie gains **both** GPE and KE.	
Between **A** and **B** Susie gains **only** KE.	
At **B** her KE is **exactly** half her GPE at **A**.	
Just before touching the ground at **C** Susie has her maximum KE.	
On the ground at **C** Susie has zero KE.	
On the ground at **C** Susie has her maximum GPE.	

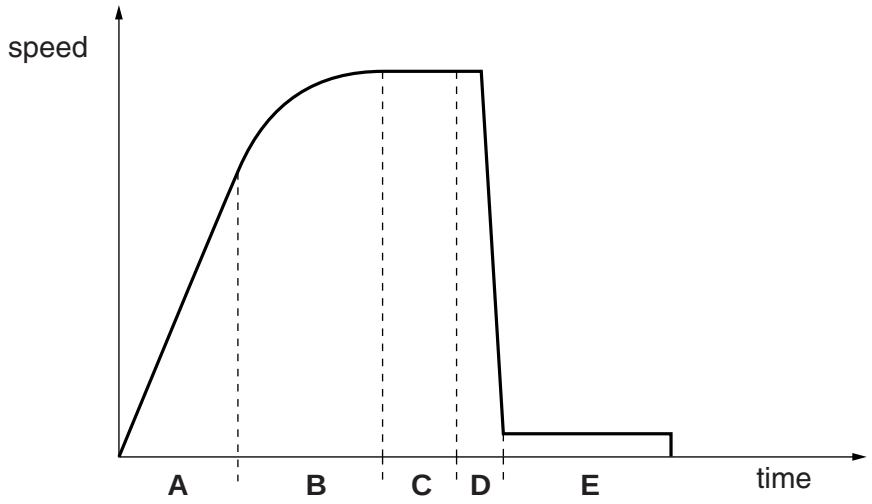
[3]

[Total: 7]

4 Alex is a sky-diver.

He jumps out of an aeroplane, and sky-dives before opening his parachute.

Look at the graph of Alex's speed as he falls.



As he falls there are two forces acting on Alex

- weight
- drag.

(a) In part **A** of the graph his speed **increases**.

Explain why.

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

(b) Part **C** of the graph shows Alex travelling at terminal speed **before** his parachute opens.

Explain why terminal speed is reached.

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

(c) In part **D** the parachute opens and the speed reduces very **quickly**.

Explain why.

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

(d) Part **E** of the graph shows the terminal speed **after** the parachute opens.

Explain why the open parachute causes Alex to have a **lower** terminal speed than in part **C** of the graph.

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..... **[2]**

(e) The parachute is used again. This time it is used with a much **heavier** person.

His fall is different to Alex's.

Part **E** of the graph has a higher speed.

Explain why.

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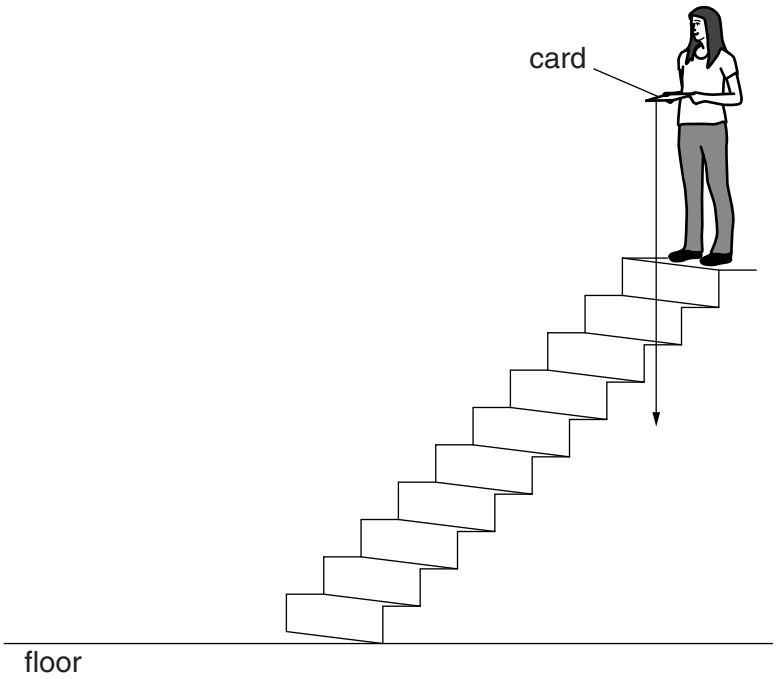
..... **[2]**

[Total: 7]

5 Molly is investigating falling objects in a science lesson.

She drops a piece of thin card from the top of a staircase and measures the time it takes to fall to the floor. She then changes its shape and repeats the test.



Look at Molly's results.

thin card	shape of card that was dropped	description	mass in grams	time to fall in seconds
A		thin card sheet area exposed to air during fall = 1200 cm^2	5.0	5.2
B		thin card sheet folded in half area exposed to air during fall = 600 cm^2	5.0	3.8
C		card crushed into a ball shape area exposed to air during fall = 150 cm^2	5.0	1.2

Put a tick (✓) in the box beside each correct statement.

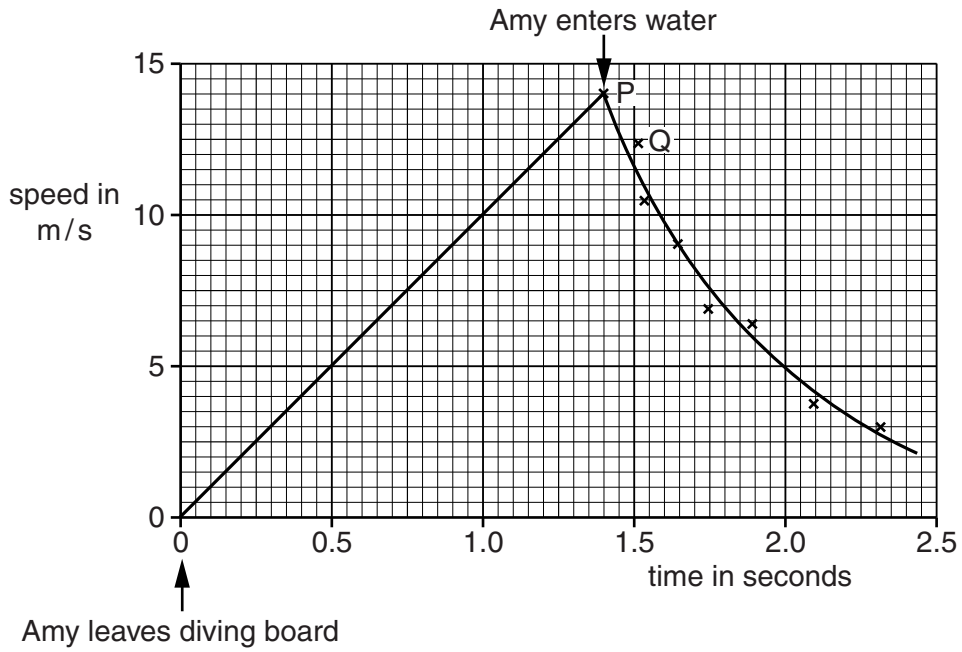
statement	
all sheets of paper have the same drag force when accelerating	
the weight of each sheet = the drag force when they fall at terminal speed	
the time to fall is directly proportional to the exposed area	
drag on **A** > drag on **B** > drag on **C** when falling	
at terminal speed the loss of GPE increases the thermal energy of the surrounding air particles	

[2]

[Total: 2]

6 Amy dives from the high diving board at a swimming pool.

Look at the graph of her motion.



(a) Calculate the height of the diving board above the water.

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answer ..... m **[2]**

(b) (i) John thinks that he can find Amy's deceleration just after she enters the water by using points **P** and **Q** on the graph.

Elaine thinks it is better to find Amy's deceleration just after she enters the water by using the gradient of the graph at point P.

Explain why Elaine's method is better than John's to find the deceleration.

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..... **[2]**

(ii) Amy has a mass of 60 kg.
Amy's deceleration as she enters the water is 20 m/s^2.
Calculate the decelerating force on Amy just as she enters the water.

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answer ..... N **[1]**

7 Emma drops a rock from the top of a cliff.

(a) The rock has a mass of 0.5 kg.

As the rock falls it loses potential energy and gains kinetic energy.

The rock is travelling at a speed of 15 m/s just before it hits the ground.

Calculate the distance the rock falls.

Take the value of g to be 10 N/kg.

Ignore the effect of air resistance.

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answer ..... metres **[3]**

(b) Emma drops another rock.

This rock has a mass of 1.0 kg.

The rock hits the ground at the same speed.

Explain why.

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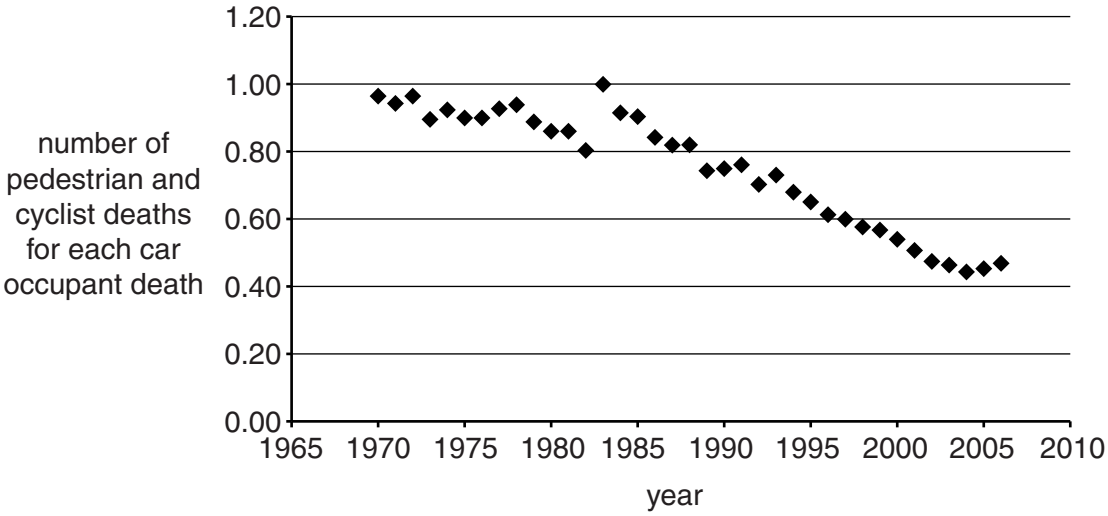
..... **[1]**

[Total: 4]

8 Dave and Fred are discussing issues about road safety.

(a) Look at the graph.

It shows data about the risks to road users.



Dave thinks these data show that cycling has become safer since 1970, and that fewer cyclists die in accidents.

(i) Explain how the graph partly supports Dave's view.

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

(ii) Fred is less confident about what the data shows and feels he needs more information.

Suggest what other information about the data Fred needs to be more convinced.

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(b) Cars and their occupants have **momentum** when moving.

Seatbelts **stretch** in a crash.

Use these ideas to explain how seatbelts reduce injury in a crash.

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..... **[2]**

[Total: 5]