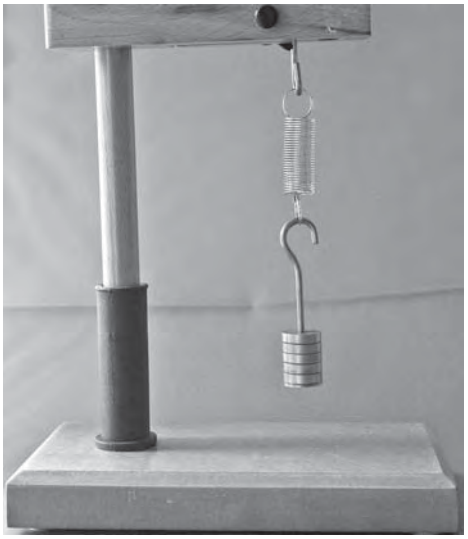
1 A student investigates whether a spring obeys Hooke's law.

She uses the apparatus shown in the photograph.



(a) Which additional measuring instrument does the student need for the investigation?

(1)

(b) Explain how the student can investigate whether the spring obeys Hooke's law.

(5)

(Total for Question 1 = 6 marks)

2 An underground train enters a station.

(a) The mass of the train and its passengers is 250 000 kg.

The total kinetic energy is 18 MJ.

(i) State the relationship between kinetic energy (KE), mass and velocity.

(1)

(ii) Calculate the velocity of the train as it enters the station.

(3)

velocity = ... m/s

(iii) The driver applies the brakes to stop the train.

State what happens to the kinetic energy of the train.

(1)

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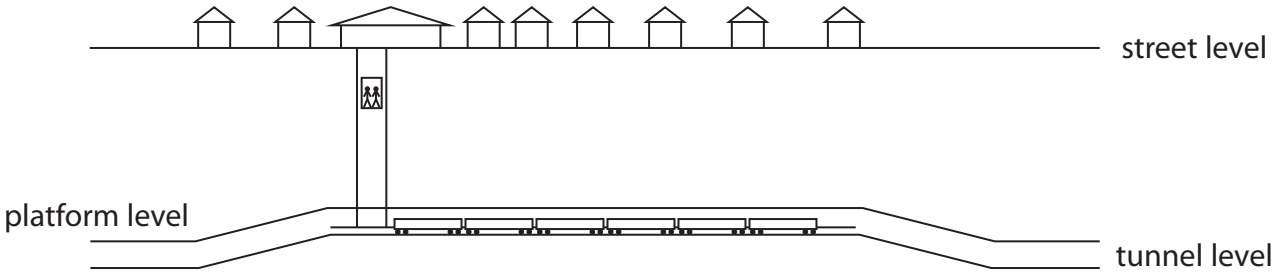
(b) The diagram shows a section through the station.



(i) The passengers who use the station are carried from platform level to street level in a lift.

Explain why these passengers gain gravitational potential energy in the lift, even when they are below ground.

(2)

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(ii) The tunnel is designed so that the trains go up a slope as they enter the station and go down a slope as they leave.

The driver uses brakes to stop the train in the station and a motor to make the train move away.

Explain how the sloping parts of the tunnel affect the amount of work that needs to be done on the train by the brakes and by the motor.

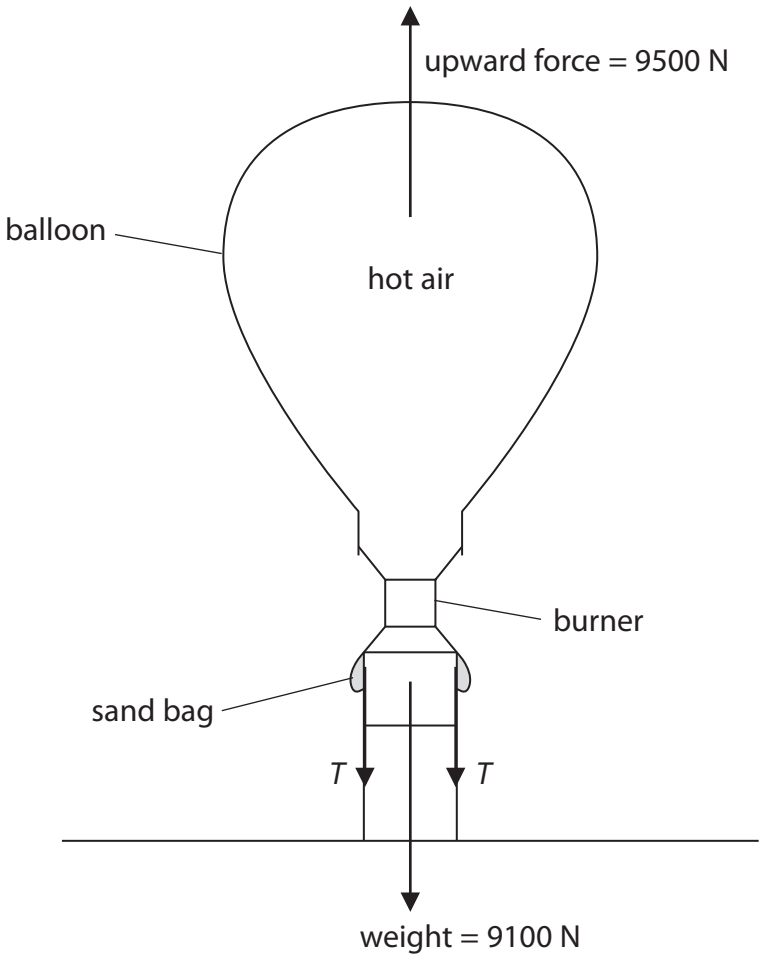
(4)

(Total for Question 2 = 11 marks)

3 A hot-air balloon is tied to the ground by two ropes.

The diagram shows the forces acting on the balloon.

The tension *T* in each rope is 200 N.



The ropes are untied and the balloon starts to move upwards.

(a) State the value of the force acting downwards on the balloon immediately after the ropes are untied and before the balloon starts moving.

(1)

force downwards = ... N

(b) (i) State the relationship between unbalanced force, mass and acceleration.

(1)

(ii) The balloon has a total mass of 910 kg.

The initial unbalanced force on the balloon is 400 N upwards.

Calculate the initial acceleration.

(2)

initial acceleration = ... m/s^2

(c) Explain how the upward acceleration of the balloon changes during the first few seconds of its flight.

(3)

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(d) While the balloon is still accelerating, the pilot controls the balloon by pouring some sand from the bags.

Explain how this affects the upward acceleration of the balloon.

(2)

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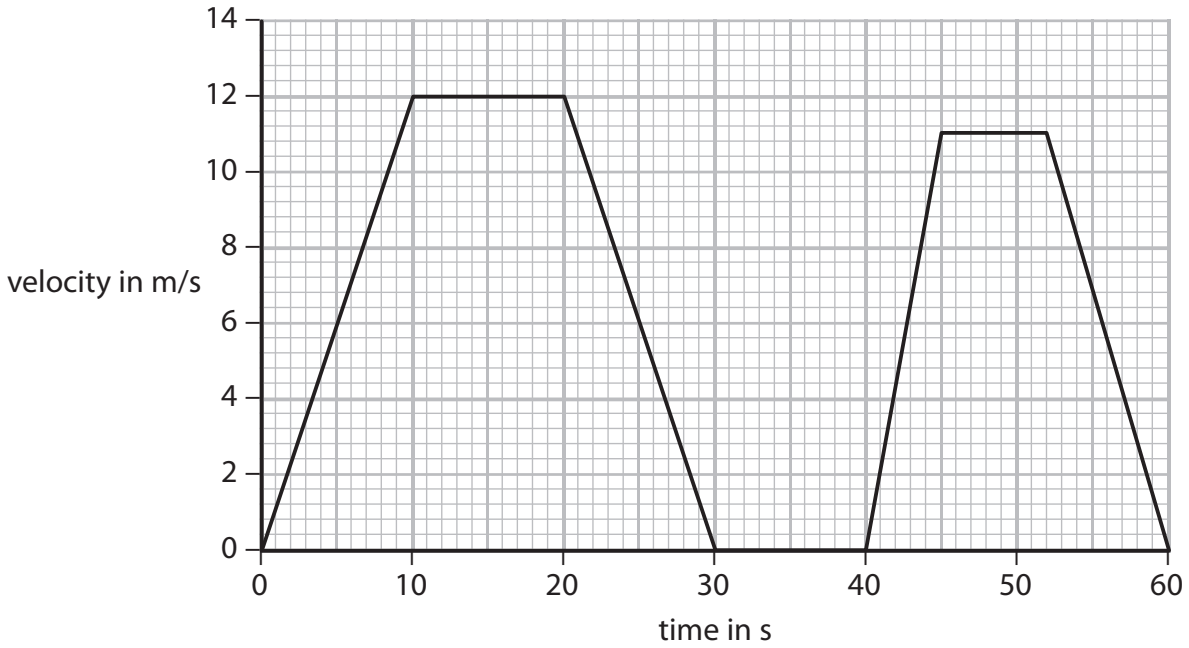
(Total for Question 3 = 9 marks)

4 A bus travels along a straight road.

The graph shows how the velocity of the bus changes during a short journey.



(a) (i) State the velocity of the bus after 25 s.

(1)

velocity = ... m/s

(ii) How long is the bus stationary during its journey?

(1)

time = ... s

(b) (i) State the equation linking acceleration, change in velocity and time taken.

(1)

(ii) Calculate the acceleration of the bus during the first 10 seconds.

Give the unit.

(3)

acceleration = ... unit .....

(c) (i) State the equation linking average speed, distance moved and time taken.

(1)

(ii) The bus moves a total distance of 390 m during the journey.

Calculate the average speed of the bus.

(2)

average speed = ... m/s

(d) The bus travels further in the first 30 seconds of its journey than it does during the last 30 seconds.

Explain how the graph shows this.

(2)

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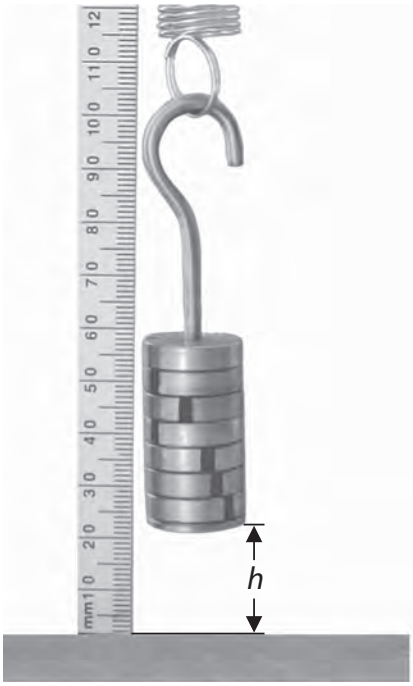
(Total for Question 4 = 11 marks)

5 A student uses this apparatus to investigate forces stretching a spring.

She uses a ruler to measure the vertical distance *h* between the bottom of the mass hanger and the base of the stand.



(a) Suggest two ways that the student can measure distance *h* more accurately.

(2)

1 .....

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2 .....

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(b) The student continues her investigation by loading the spring with different masses.

The table shows her results.

Mass in g	Force in N	Distance *h* in cm
20	0.2	4.6
40	0.4	3.9
60	0.6	3.1
80	0.8	2.3
100	1.0	1.6
120	1.2	0.9

(i) Name the dependent variable in this investigation.

(1)

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(ii) Explain how the force values in the table are calculated.

(2)

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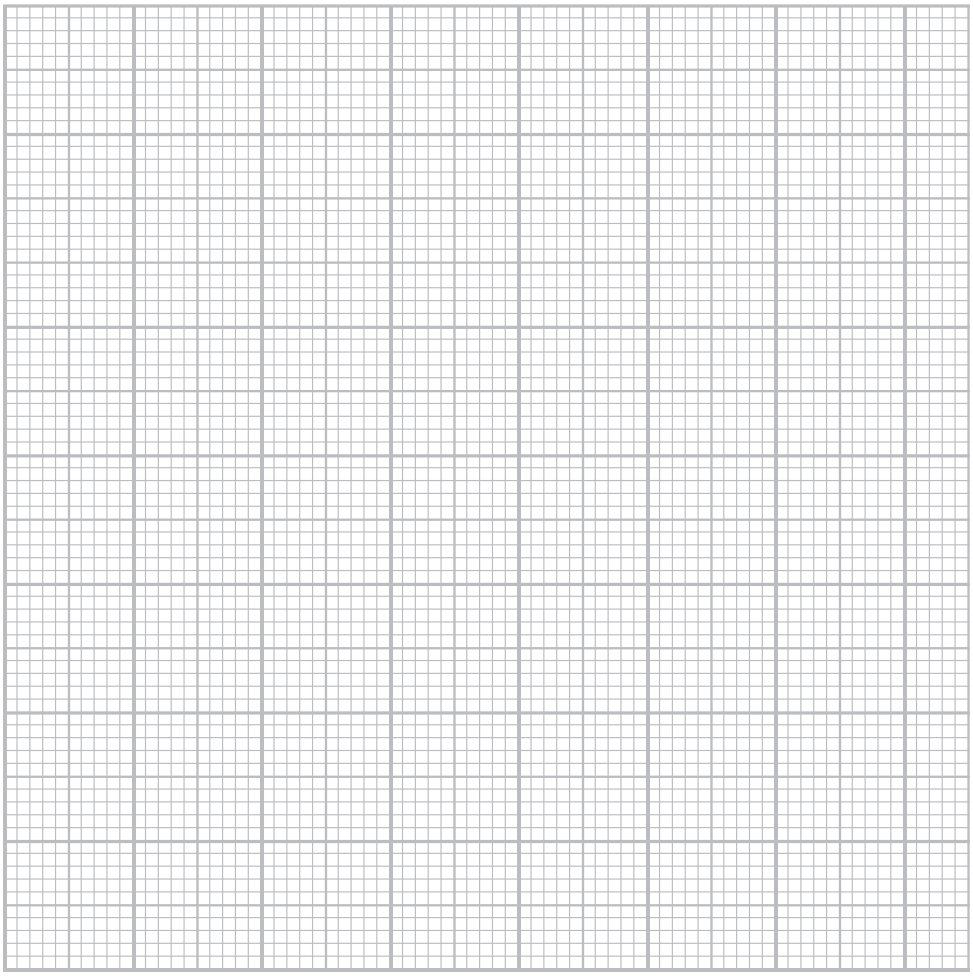
(iii) Plot a graph of distance *h* against force, and draw the line of best fit.



(iv) Use your graph to find the force for which *h* is zero.

(2)

force = ... N

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

(2)

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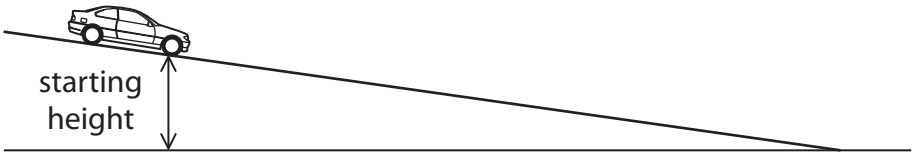
(Total for Question 5 = 14 marks)

6 A student investigates the speed of different toy cars as they roll down a slope.



(a) The student makes this prediction.

'The more weight a toy car has the faster it will roll down the slope.'

(i) What is the independent variable in the student's prediction?

(1)

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(ii) What is the dependent variable in the student's prediction?

(1)

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(b) State two factors that the student should keep constant in his investigation.

(2)

1 .....

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2 .....

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(c) Put ticks (✓) in the boxes to show which pieces of apparatus the student needs for his investigation.

One has been done for you.

(2)

battery	
joulemeter	
micrometer	
newtonmeter	
ruler	✓
stopwatch	
thermometer	

(d) Describe what the student should do to test his prediction that the more weight the toy car has, the faster it will roll down the slope.

(5)

(Total for Question 6 = 11 marks)