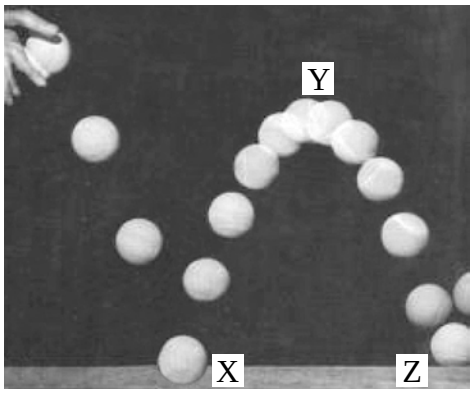
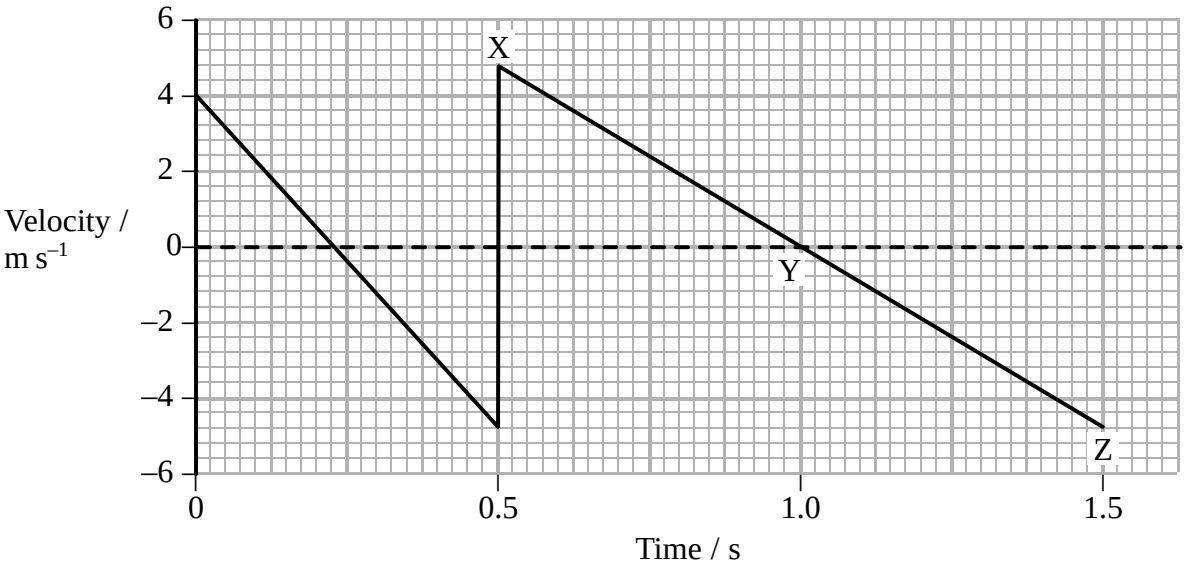
1 The photograph shows a sequence of images of a bouncing tennis ball.



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)

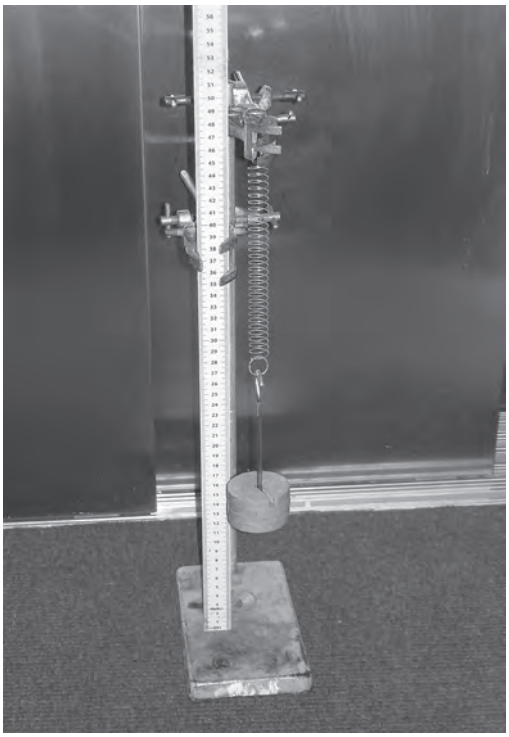
Error 1

Error 2

(Total for Question = 6 marks)

2 A student uses a mass hanging on a spring to investigate the motion of a lift travelling between two floors.

The photograph shows the apparatus used which is placed in the lift.



(a) The weight of the mass hanging on the spring is 3.90 N.

It produces an extension of 12.2 cm.

Show that the spring constant is about 30 N m ^{1}.

(2)

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(b) The lift takes 7.0 s to travel between floors, starting and ending at rest.

The student makes a video of the apparatus and constructs the following table from the observations made. The student notes three phases of the motion.

Phase of motion	Duration of phase / s	Average extension of spring / cm	Average acceleration / m s ^{2}
Start	2.0	12.7	0.4
Middle	3.0	12.2	0.0
End	2.0	11.7	0.4

(i) Show that the spring exerts a force of about 4 N on the mass during the start phase.

(2)

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(ii) Show how the average acceleration during the start phase is calculated.

mass hanging on spring 0.40 kg

(2)

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(iii) Use the values in the table to calculate the speed at the end of the start phase.

(2)

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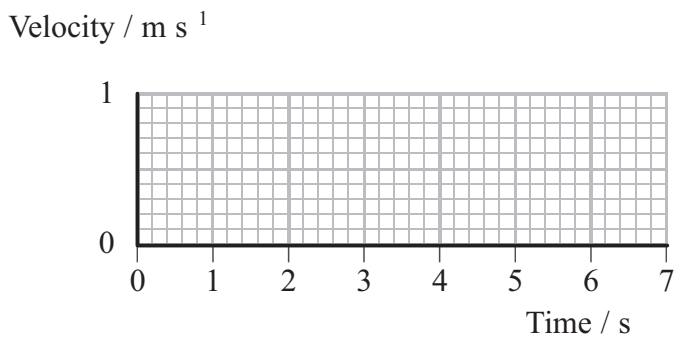
Speed .....

(iv) Complete the graph to show the motion of the lift.

(2)



(v) Use your graph to find the distance travelled between the floors.

(2)

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Distance .....

(vi) Explain how the data for the average extension of the spring shows that the lift is moving upwards.

(2)

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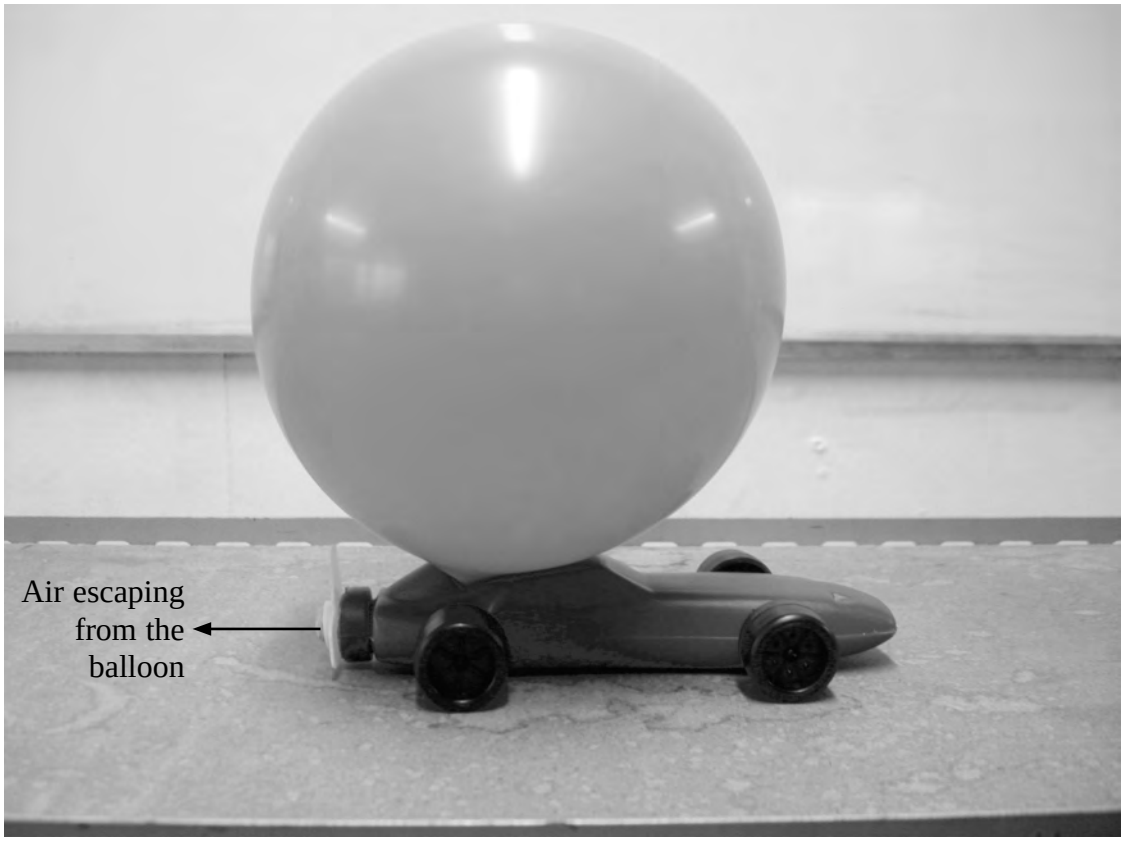
(Total for Question 14 marks)

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

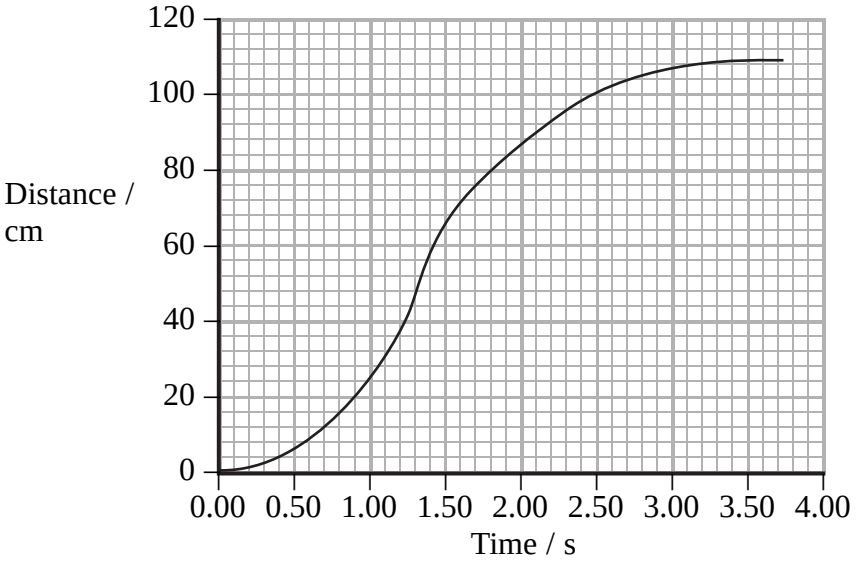


When the air in the inflated balloon is released, the car starts to move forwards.

(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.

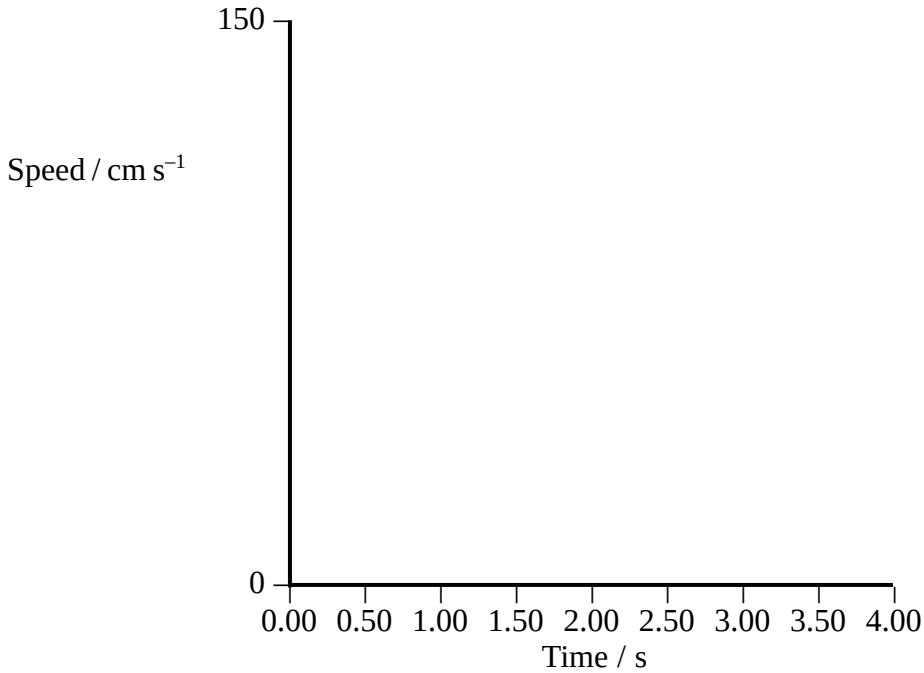


(i) Show that the maximum speed reached is between 100 and 150 cm s^{-1}.

(3)

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

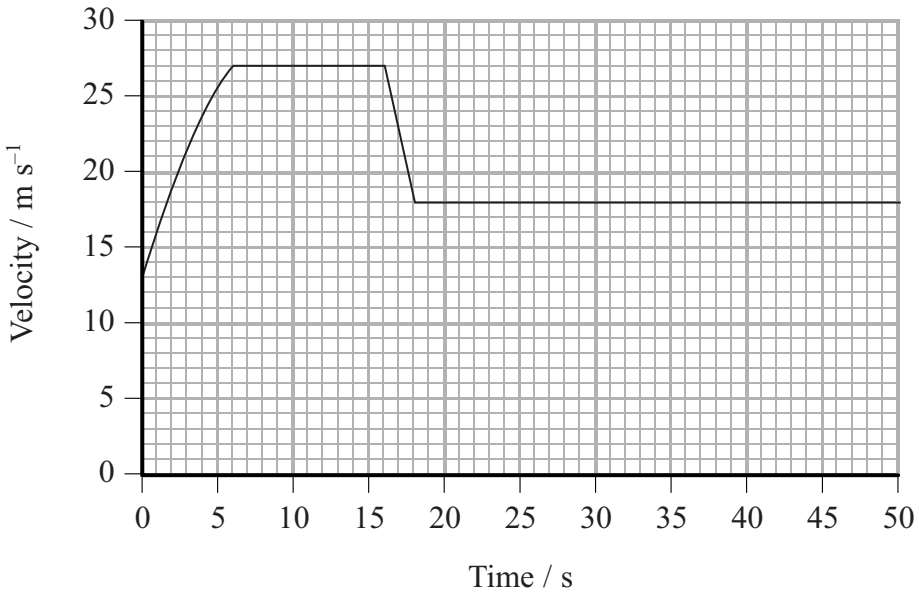
(3)



(Total for Question = 9 marks)

4 The speeds of cars travelling through roadworks on major roads are often monitored by 'average speed check' cameras. This is done by timing a car between two cameras a large distance apart.

The graph shows how the velocity of a car varies with time as it passes between two average speed check cameras. The car passes the cameras at time t 0 s and t 50 s.



A constant driving force is applied to the car for the first 6 s. At time t 16 s the driver realises the car is travelling too fast for the 22 m s ^{1} speed limit (50 miles per hour) and applies the brakes until time t 18 s.

(a) Calculate the acceleration at time t 3 s.

(3)

Acceleration .....

(b) Describe and explain the shape of the line in the first 6 s.

(4)

(c) Describe the resultant force on the car between times t 6 s and t 16 s.

(1)

(d) Show that the average speed of the car does not exceed the average speed limit of 22 m s ^{1}.

(4)

(Total for Question 12 marks)