Name: _____

Forces and Motion

Questions

Date:

Time:

Total marks available:

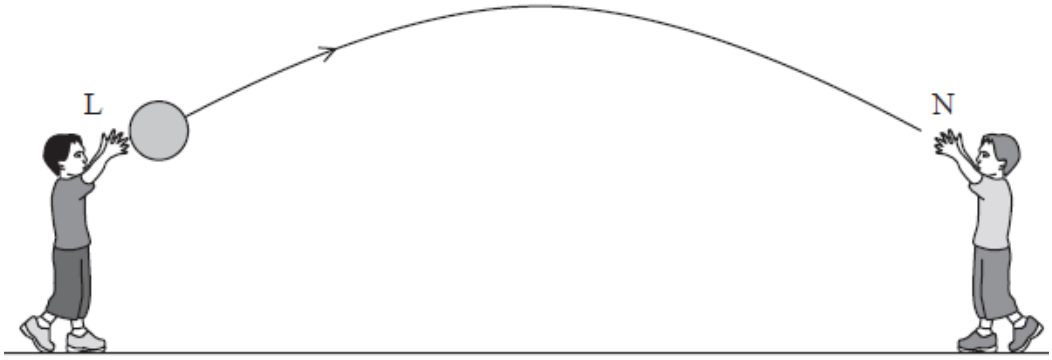
Total marks achieved: _____

Questions

Q1.

A ball is thrown from position L and caught at position N.

L and N are the same height above the ground. The trajectory of the ball is shown.



If vectors directed upwards are taken as positive, and air resistance is neglected then the acceleration of the ball at L is $-g$ and its speed is v.

Select the row of the table that correctly gives the acceleration and speed of the ball as it reaches N.

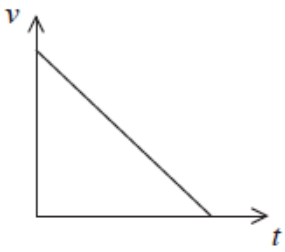
	Acceleration	Speed
☒ A	$-g$	v
☒ B	$-g$	$-v$
☒ C	g	v
☒ D	g	$-v$

(Total for question = 1 mark)

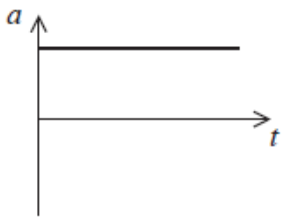
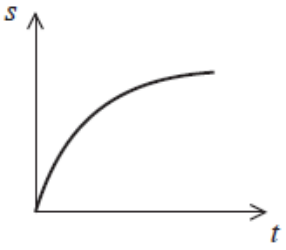
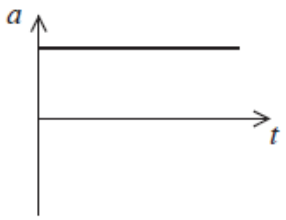
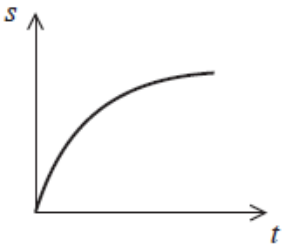
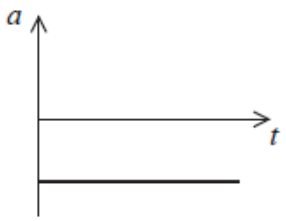
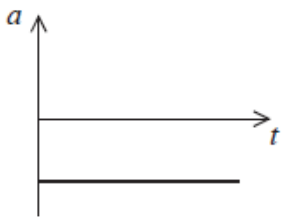
Q2.

A ball is rolled along a horizontal surface. Frictional forces slow the ball to rest.

The velocity-time graph for the ball is shown.

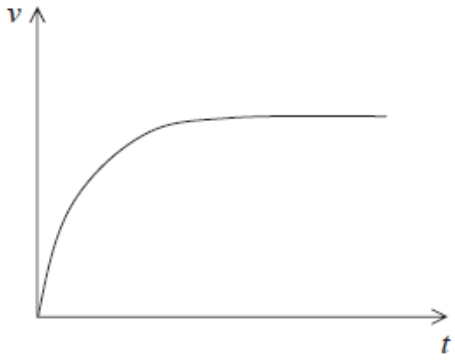


Select the row of the table that correctly gives the corresponding displacement-time and acceleration-time graphs for the ball.

	Displacement-time graph	Acceleration-time graph
☒ A		
☒ B		
☒ C		
☒ D		

(Total for question = 1 mark)

A sports class is studying cycling. They produce a video of a cyclist on a horizontal lawn.
The cyclist starts from rest.
They produce a sketch graph of the velocity v of the cyclist against time t.



Explain the shape of this graph and include a consideration of force as part of your answer.

(3)

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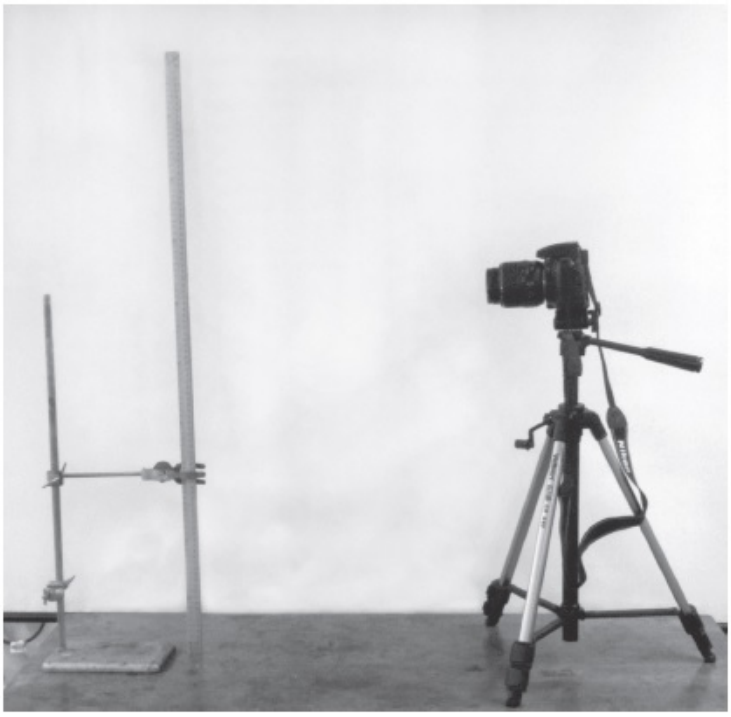
(Total for question = 3 marks)

Q4.

A student carries out an experiment to find the acceleration of free fall.



(a) In this experiment the student releases a small steel ball in front of a metre rule and uses a video camera to record its motion. The camera captures 30 images per second, which may be played back one image at a time.

(i) Explain how the acceleration of free fall could be determined using the recording.

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(ii) Describe a systematic error which could arise.

(1)

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(b) Describe one property of the steel ball that makes it suitable to use in this experiment and explain why this property makes it suitable.

(2)

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(c) Explain an advantage of using a video camera to take measurements for this experiment rather than using a stopwatch.

(2)

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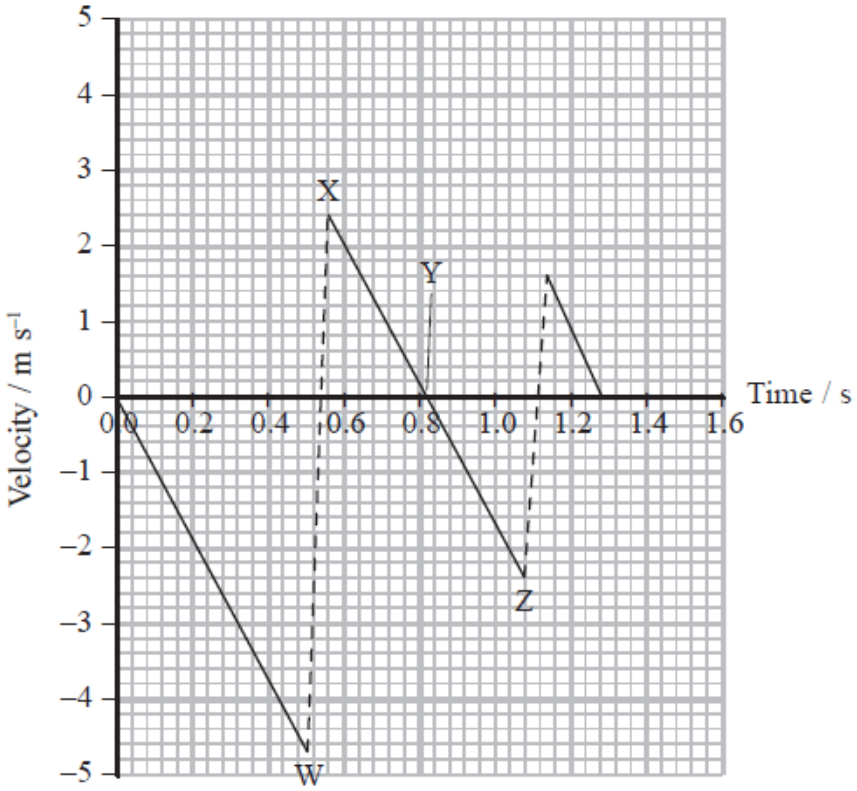
(Total for question = 9 marks)

Q5.

A basketball is dropped vertically onto the horizontal ground and bounces twice before being caught. The graph shows how the velocity of the basketball varies with time.



(a) Suggest why the downward sloping lines are all parallel.

(1)

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(b) (i) State the reason for the upwardly sloping dotted lines.

(1)

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(ii) Describe how the gradient of the dotted lines would change if the basketball was not fully inflated.

(1)

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(c) Calculate the initial height through which the basketball fell.

(2)

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Height = ...

(d) (i) Show that the kinetic energy of the basketball at X is about 1 J.

mass of ball = 0.4 kg

(2)

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(ii) Hence calculate the height of the basketball at Y.

(2)

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Height = ...

(e) The velocity of the basketball on impact at W is greater than the velocity on impact at Z.

State a reason for the difference in velocities at W and Z.

(1)

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(Total for question = 10 marks)

Q6.

A student investigated the physics of football.

(a) She used the equations of motion to model the behaviour of a ball when kicked at different angles to the horizontal. She predicted the height of the ball when it reached the goal, if the ball was kicked from the same place, with the same initial speed, at the same angle.

are shown in the table below.

Angle to the horizontal / °	Height of the ball when it reached the goal / m
10	–0.78
20	1.0
30	2.8
40	4.7

(i) State the significance of the negative value of height for an angle of 10°.

(1)

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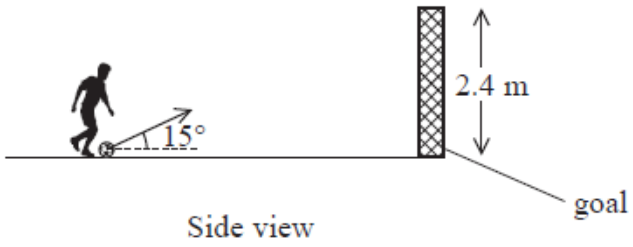
(ii) On the diagram below, sketch and label the predicted path of the ball for angles of 20° and 40°.

(2)

(b) (i) During a football match the ball is kicked towards the goal, at an angle of 15° to the horizontal, from a distance of 11 m as shown.



Side view

The ball has a diameter of 0.22 m and an initial speed of 26 m s^{-1}.

By means of a calculation, determine whether or not the ball will pass into the goal. You may ignore the effects of air resistance.

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(ii) Air resistance would cause an additional force on the ball.

Explain the effect this would have on the ball's motion.

(2)

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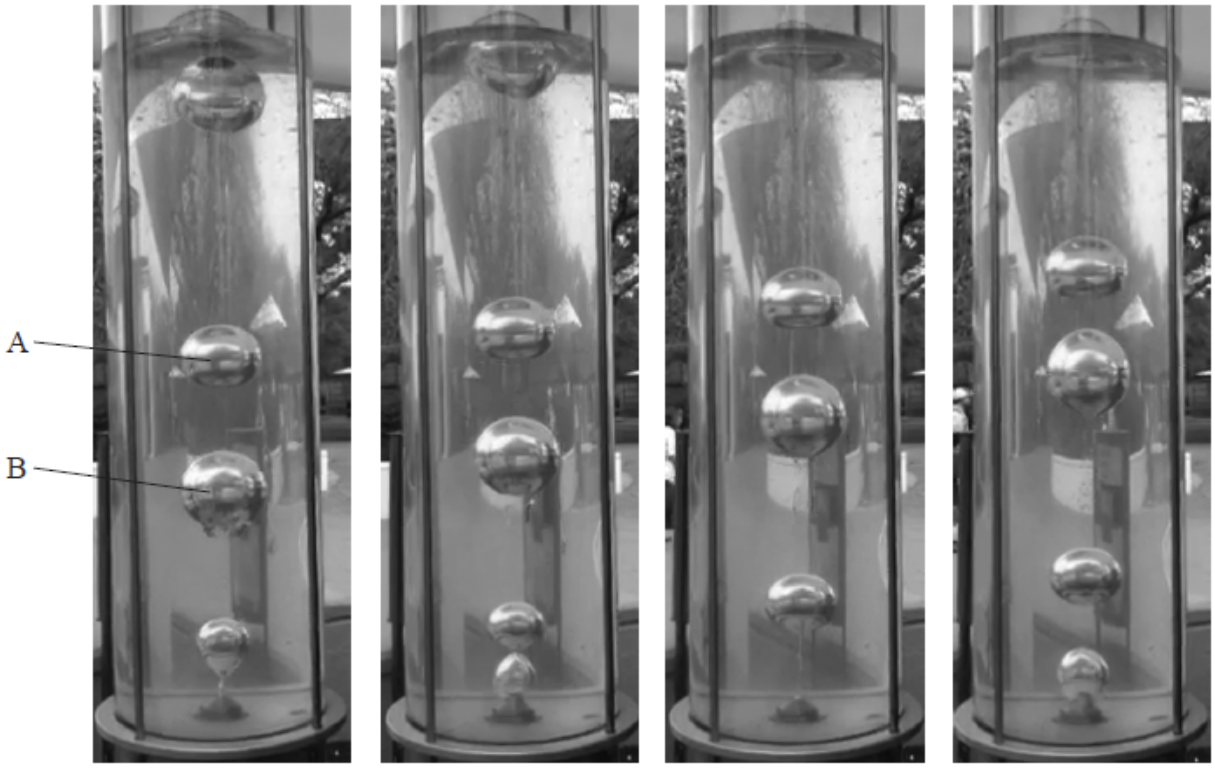
Q7.

An exhibit at a science museum requires the observer to use a pump to create a bubble in a

column of liquid. The bubbles then rise through the liquid.

The following photographs were taken at 0.33 s intervals.



Photograph 1
time = 0

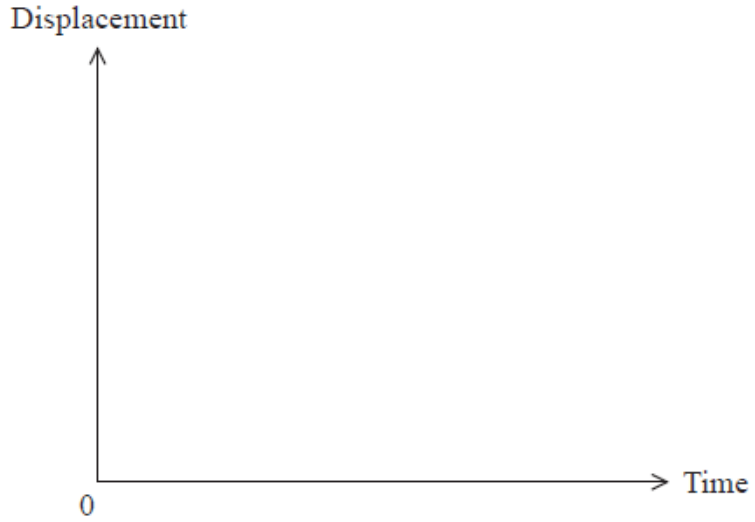
Photograph 2

Photograph 3

Photograph 4

(i) Sketch on the axes below two labelled lines to show how the displacements of the smaller bubble A and the larger bubble B vary with time over the four images.

(2)



(ii) The photographs are at a scale of 1 to 12. By using measurements from the photographs, calculate the speed of bubble B between photographs 2 and 3.

(4)

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Speed of bubble B = ...

Q8.

Kite surfing is the sport of riding on a small surfboard, propelled forwards across water by a large kite. The surfer holds onto a bar that is attached to the lines. As the air moves over the kite an upwards and forwards force is produced, causing a tension in the lines of the kite.

Consider the board and the surfer to be a single object and the lines of the kite to be equivalent to a single line.

(a) (i) Complete the free body diagram for the forces acting on the surfer at the instant he starts to move along the water.

(2)

(ii) At maximum speed, the angle of the kite to the horizontal is 40° and the total tension in the lines is 1100 N

Show that the horizontal force from the kite on the surfer is about 800 N.

(2)

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(iii) By considering the vertical forces acting on the surfer, explain why the mass of the surfer must be at least 72kg.

(3)

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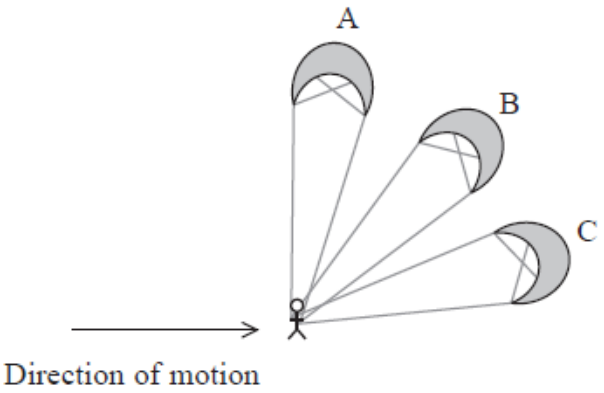
*(b) The diagram shows three positions of the kite when pulling the surfer along.



State and explain which position of the kite would supply the most power to the surfer. Assume that the tension in the kite lines is the same in each position.

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(Total for question = 11 marks)

Q9.

An exhibit in a science museum requires the observer to use a pump to create air bubbles in a column of liquid. The bubbles then rise through the liquid.

(i) Complete the free-body force diagram for a bubble as it rises through the liquid.

(3)

*(ii) It is observed that larger bubbles reach the top of the column of liquid in less time than smaller bubbles.

By considering the forces acting on a bubble as it rises, explain this observation.

(3)

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