

Forces 7

Name: _____

Class: _____

Date: _____

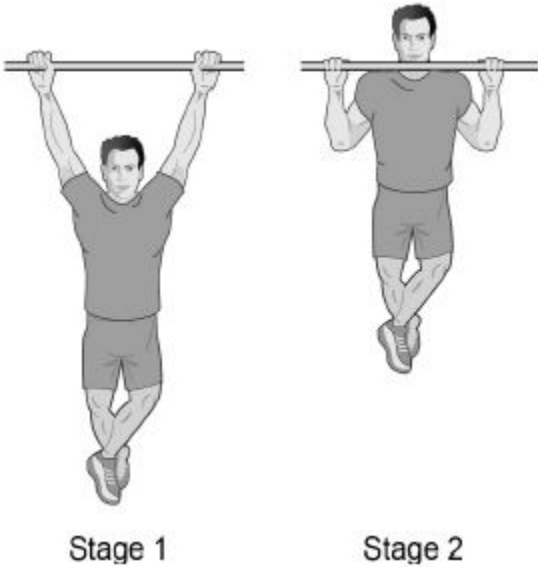
Time: **74 minutes**

Marks: **70 marks**

Comments:

1.

The diagram below shows a man doing two stages of a pull up. In both diagrams the man is stationary.



(a) Complete the sentence.

Choose the answers from the box.

equal to	less than	more than
-----------------	------------------	------------------

In stage 1 the downwards force of the man on the bar is _____
the upwards force of the bar on the man.

(1)

(b) The man has a mass of 85 kg

Gravitational field strength = 9.8 N/kg

Calculate the weight of the man.

Use the equation:

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

Weight = _____ N

(2)

- (c) The man raises his body a vertical distance of 0.63 m to go from stage 1 to stage 2

Calculate the work done by the man.

Use your answer to part **(b)**

Use the equation:

$$\text{work done} = \text{force} \times \text{distance}$$

$$\text{Work done} = \text{_____} \text{ J}$$

(2)

- (d) The man was **not** moving at stage 2

How much work is done by the man at stage 2?

$$\text{Work done} = \text{_____} \text{ J}$$

(1)

- (e) A woman uses the bar to do a pull up.

The woman has a mass of 62 kg

She accelerates at 11 m/s²

Calculate the resultant force on the woman.

Use the equation:

$$\text{force} = \text{mass} \times \text{acceleration}$$

$$\text{Force} = \text{_____} \text{ N}$$

(2)

(Total 8 marks)

2. (a) Which of these is a scalar quantity?

Tick **one** box.

displacement

distance

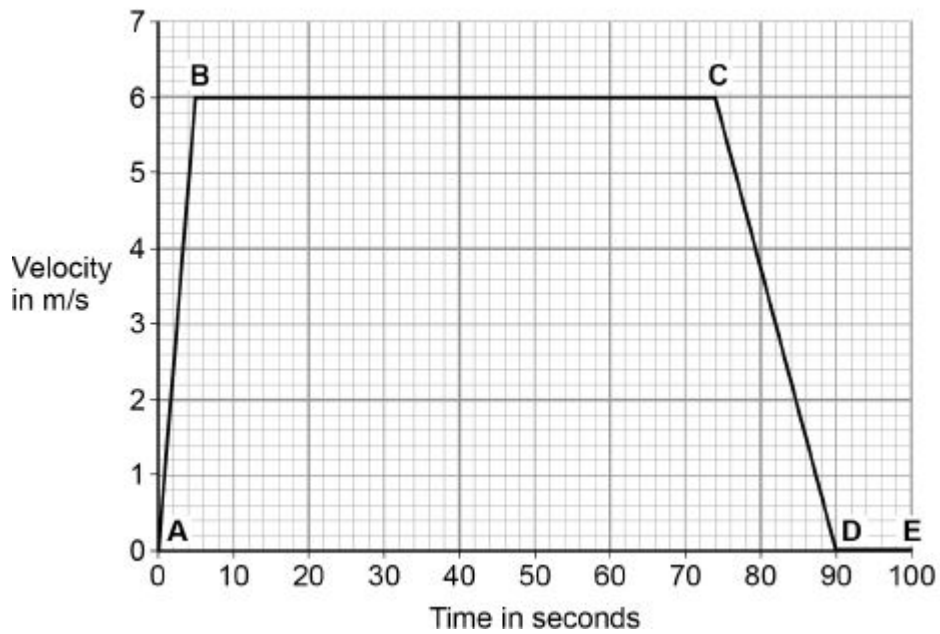
force

velocity

(1)

(b) A woman cycled along a straight flat road.

The graph below shows how the woman's velocity changed with time.



Which part of the graph shows the woman moving at constant velocity?

Tick **one** box.

BC

CD

DE

(1)

(c) Which part of the graph shows the woman stationary?

BC CD DE

(1)

Between points **A** and **B** the woman was accelerating.

(d) Use the graph above to determine the total time for which she was accelerating.

Time = _____ s

(1)

(e) Use the graph above to determine her increase in velocity between points **A** and **B**.

Increase in velocity = _____ m/s

(1)

(f) Calculate her acceleration between points **A** and **B**.

Use the equation:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Acceleration = _____ m/s²

(2)

(g) Estimate how a typical cycling speed of 6 m/s compares with a typical walking speed.

Tick **one** box.

about twice as fast

about four times faster

about eight times faster

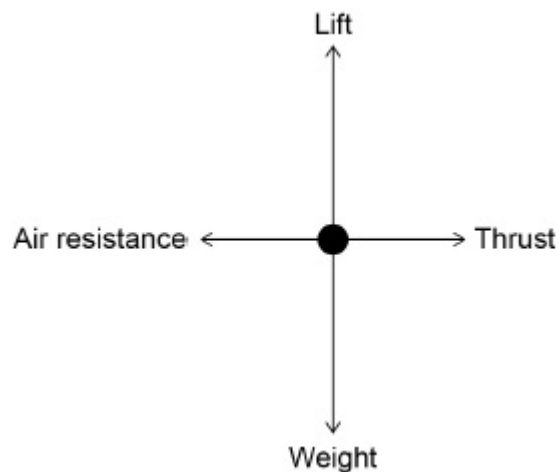
(1)

(Total 8 marks)

3.

Below is a free body diagram for an aeroplane flying at a constant speed and at a constant height.

The speed of the aeroplane is much greater than the speed at which the aeroplane lands.



(a) Explain how the forces need to change so the aeroplane can land.

(4)

(b) Skater **A** travels with a velocity of 3.2 m/s and has a momentum of 200 kg m/s

Calculate the mass of Skater **A**.

Mass = _____ kg

(3)

(c) Skater **A** bumps into another skater, Skater **B**. Skater **B** is stationary.

The skaters move off together in a straight line.

Explain what happens to the velocity of each of the skaters.

Use the idea of conservation of momentum.

(3)

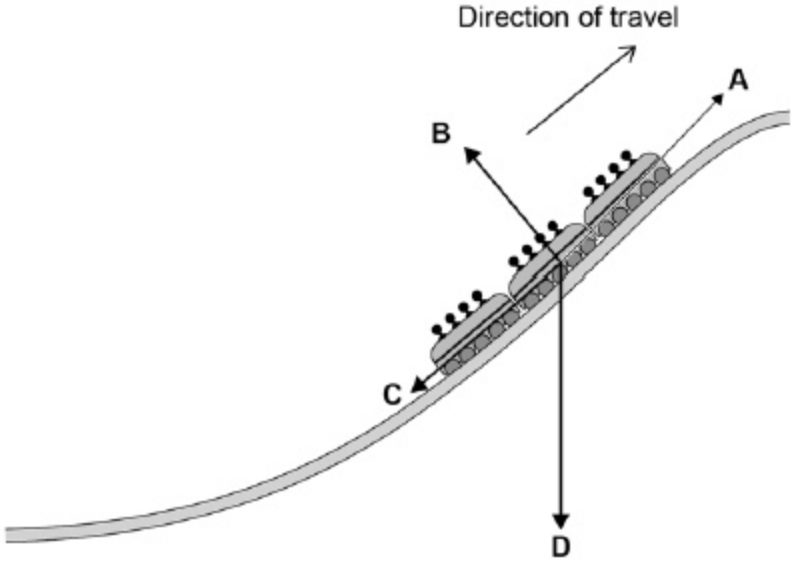
(Total 7 marks)

5.

Figure 1 shows a rollercoaster train as it is pulled up a slope on the track.

The arrows, A, B, C and D, represent the forces acting on the rollercoaster train.

Figure 1



(a) Give **two** ways that the force arrows show that forces are vector quantities.

- 1. _____
- 2. _____

(2)

(b) Which arrow shows the weight of the rollercoaster train?

Tick **one** box.

A B C D

(1)

(c) Which arrow shows the normal contact force?

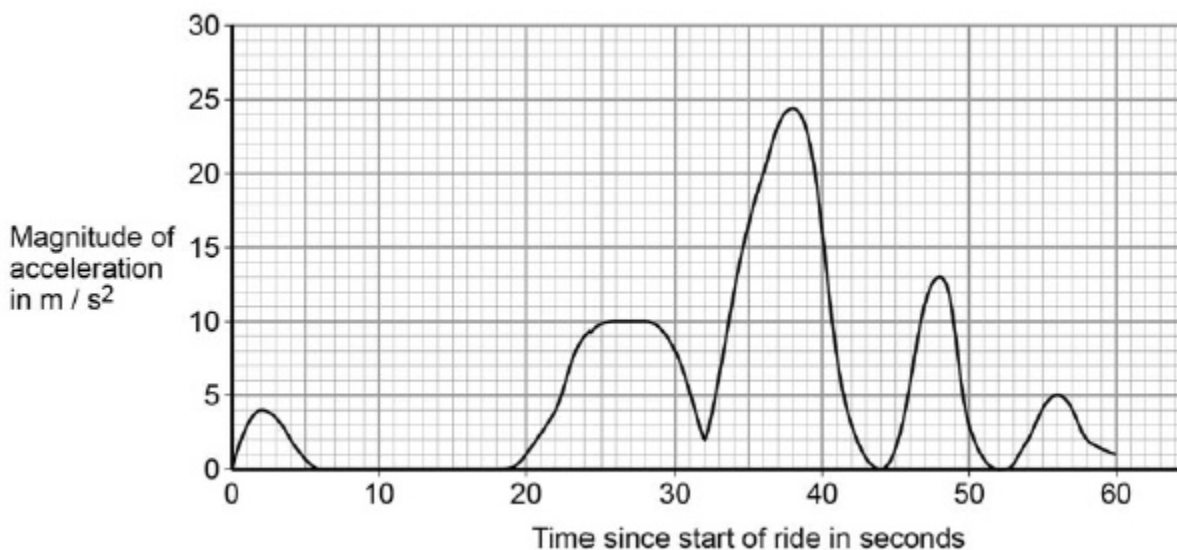
Tick **one** box.

A B C D

(1)

Figure 2 shows the magnitude of the acceleration of the rollercoaster train during the ride.

Figure 2



(d) Why has a line graph been drawn instead of a bar chart?

Tick **one** box.

Acceleration is a control variable.

Both variables are continuous.

Line graphs are easier to read.

Time is a categoric variable.

(1)

(e) What conclusion can be made from **Figure 2** about the motion of the rollercoaster train between 10 and 15 seconds?

Tick **one** box.

It is moving at a constant velocity.

Its velocity is decreasing.

Its velocity is increasing.

(1)

(f) What is the maximum acceleration of the rollercoaster train?

Use **Figure 2**.

$$\text{Acceleration} = \text{_____} \text{ m/s}^2$$

(1)

(g) The maximum safe acceleration for most people is 5 times the acceleration due to gravity.

$$\text{Acceleration due to gravity} = 9.8 \text{ m/s}^2$$

Explain whether the acceleration of this rollercoaster train is safe for most people

(3)

(h) One of the passengers on the rollercoaster train has a mass of 58 kg

Calculate the maximum force experienced by the passenger during the ride.

Use the equation:

$$\text{force} = \text{mass} \times \text{acceleration}$$

Give the unit.

$$\text{Maximum force} = \text{_____} \text{ Unit } \text{_____}$$

(3)

(Total 13 marks)

6.

Figure 1 shows an electric wheelchair.

Figure 1



(a) The wheelchair moves at a constant speed of 2.4 m/s for 4.5 seconds.

Calculate the distance moved by the wheelchair.

Use the equation:

$$\text{distance} = \text{speed} \times \text{time}$$

Distance = _____ m

(2)

(b) What could be a reason for the speed of the wheelchair decreasing?

Tick **one** box.

It started going downhill.

It started going uphill.

Its store of kinetic energy increased.

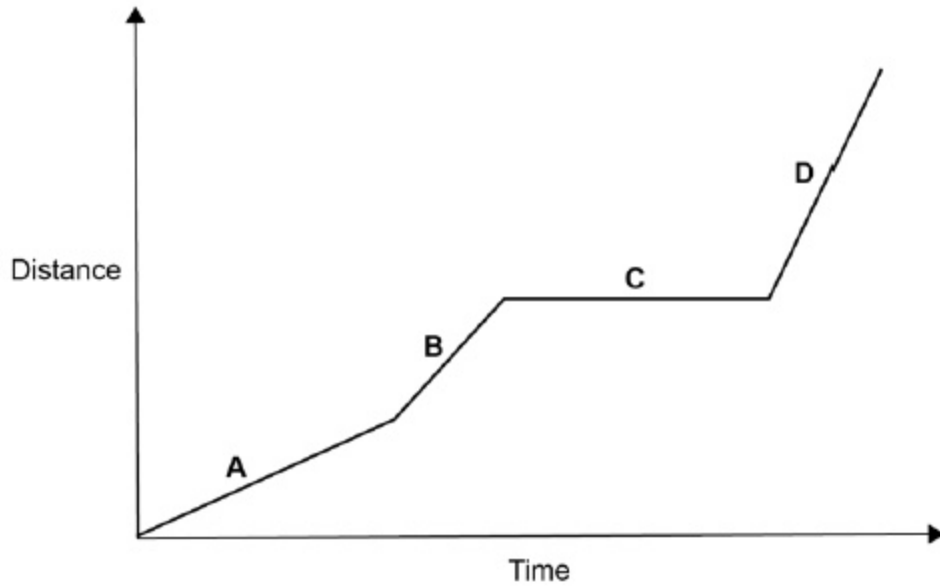
It used more power from its battery.

(1)

A student measured how the distance travelled by the wheelchair changed over time.

Figure 2 shows a sketch-graph of the results.

Figure 2



(c) In which section of the graph, **A**, **B**, **C**, or **D**, did the wheelchair travel fastest?

Give the reason for your answer.

Section _____

Reason _____

(2)

(d) The student used a data logger with a distance sensor to record the data.

Give **two** advantages of using a data logger rather than using a stopclock and tape measure.

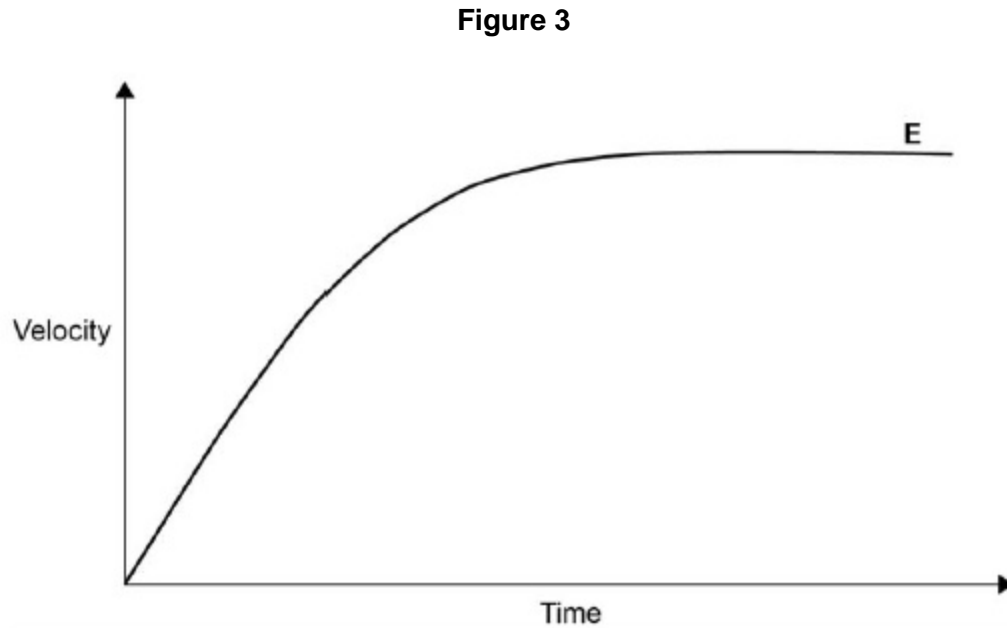
1. _____

2. _____

(2)

The velocity of the wheelchair changes as it accelerates to its top speed.

Figure 3 shows a sketch-graph of the changes.



(e) The forward force on the wheelchair is constant as it accelerates on flat ground.

Which force reduces the acceleration?

Tick **one** box.

Air resistance

Magnetism

Tension

Weight

(1)

(f) Explain the acceleration of the wheelchair at point **E** on **Figure 3**.

(2)

(g) The wheelchair starts from rest.

It accelerates at a constant rate until it has a speed of 1.5 m/s

The wheelchair travels a distance of 2.0 m while it is accelerating.

Calculate the acceleration of the wheelchair.

Using the Physics Equations Sheet.

Acceleration = _____ m/s²

(3)

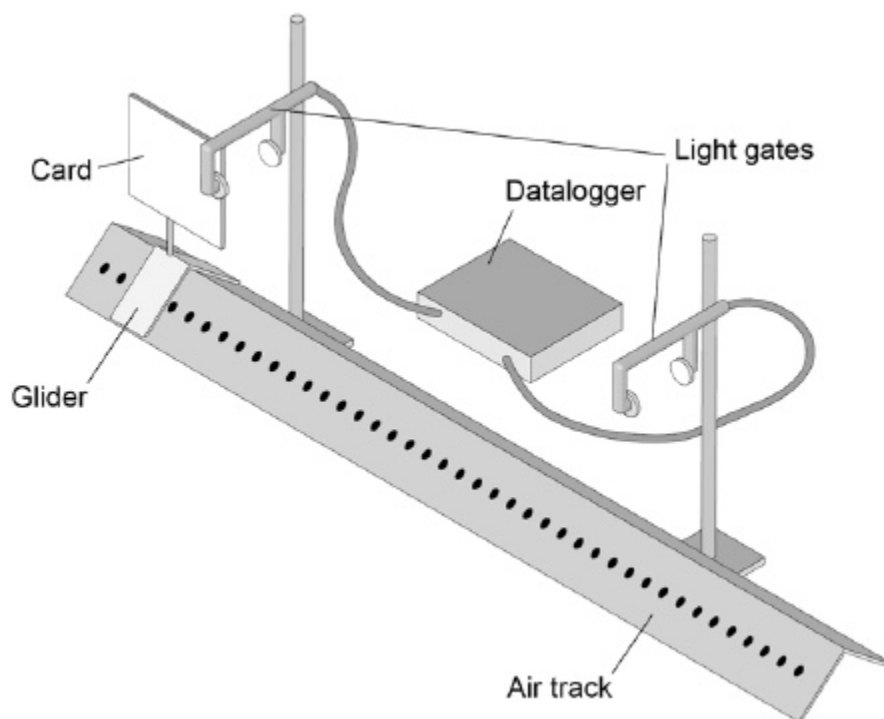
(Total 13 marks)

7.

A student investigated the motion of a glider on an air track.

Figure 1 shows the apparatus.

Figure 1



(a) The speed of the glider is the same at both ends of the air track.

What is the tendency for objects to continue at the same speed in the same direction called?

(1)

(b) The glider has a mass of 0.14 kg and a velocity of 17 cm/s

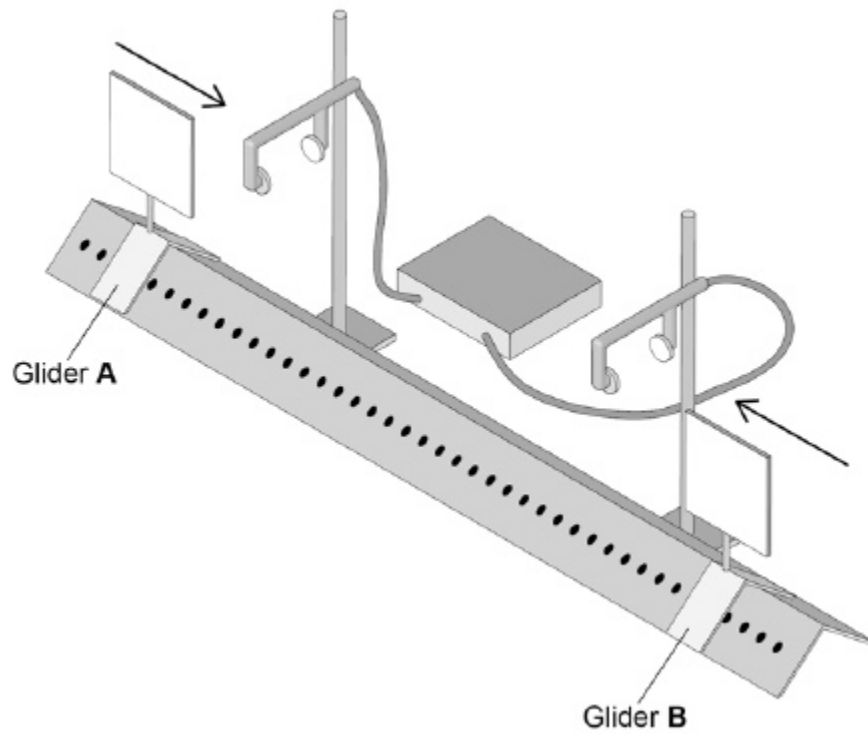
Calculate the momentum of the glider.

Momentum = _____ kg m/s

(3)

(c) **Figure 2** shows two identical gliders travelling at the same speed in opposite directions.

Figure 2



The gliders collide and stick together.

Explain what happens to the momentum and speed of the gliders.

(4)

(d) The light gate on the air track shown in **Figure 3** aims a beam of light at a sensor.

A datalogger calculates the speed of the glider.

The datalogger divides the length of card by the time for which the card breaks the beam of light.

Figure 3

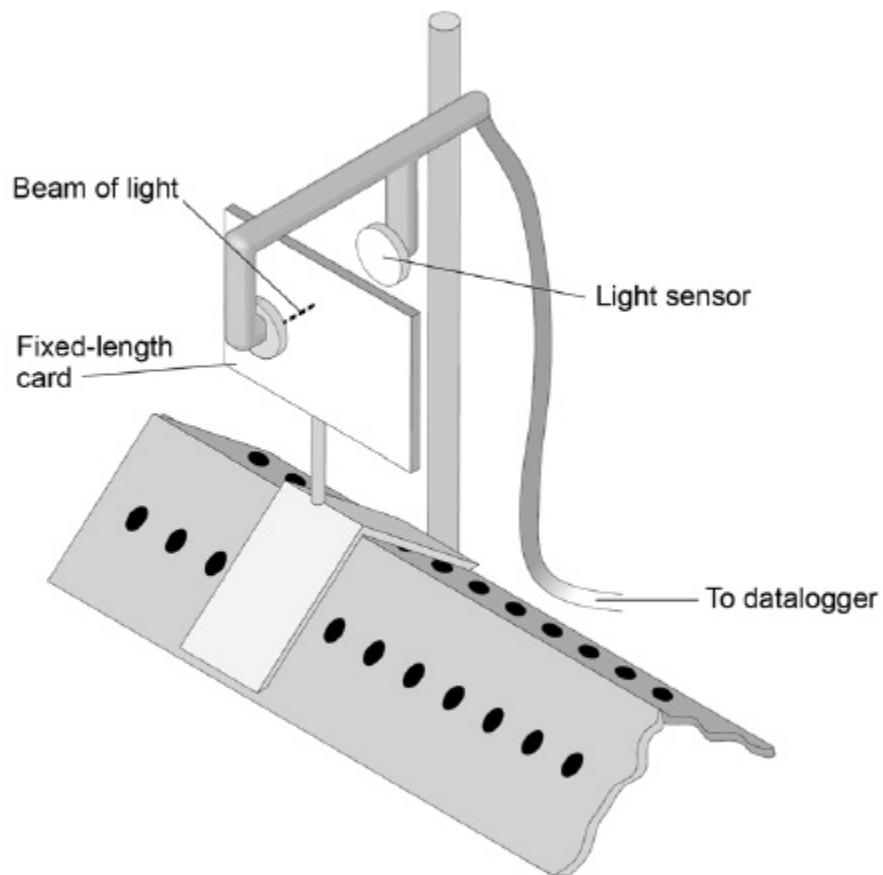
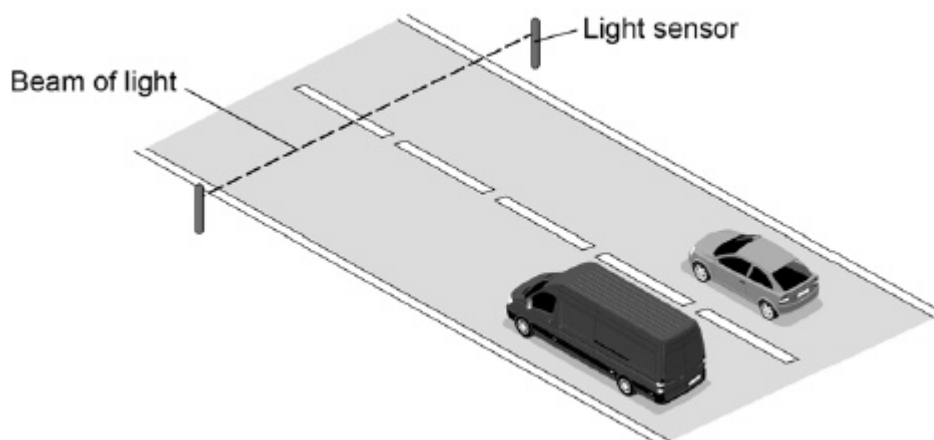


Figure 4 shows two vehicles on a road.

Figure 4



The beam of light and light sensor shown in **Figure 4** are not suitable for determining the speed of vehicles on the road.

Give **two** reasons why they are **not** suitable.

Give an explanation for each reason.

Reason 1 _____

Explanation _____

Reason 2 _____

Explanation _____

(4)
(Total 12 marks)

Mark schemes

- 1.** (a) equal to 1
- (b) weight = 85×9.8 1
- weight = 833 (N)
allow weight = 830 (N) 1
an answer of 833 (N) or 830 (N) scores 2 marks
- (c) work done = 833×0.63
allow their calculated value from part (b) $\times 0.63$ 1
- work done = 525 (J)
allow an answer that is consistent with their calculated value from part (b) 1
an answer that rounds to 525 (J) scores 2 marks
- (d) work done = 0 (J) 1
- (e) force = 62×11 1
- force = 682 (N)
allow force = 680 (N) 1
an answer of 682 (N) or 680 (N) scores 2 marks
- [8]**
- 2.** (a) distance 1
- (b) BC 1
- (c) DE 1
- (d) 5.0 (s)
allow 5 (s) 1
- (e) 6.0 (m/s)
allow 6 (m/s) 1

(f) 6.0 / 5.0

allow ecf from parts (d) and (e)

1

= 1.2 (m/s²)

1

an answer of 1.2 scores 2 marks

(g) about four times faster

1

[8]

3.

(a) thrust decreases

allow air resistance or drag increases

ignore air resistance decreases as speed decreases

1

so there is a resultant force in opposite direction

allow so air resistance or drag is greater than thrust

1

lift must decrease (because weight stays the same)

1

so there is a resultant downwards force

allow so weight is greater than lift

the last two marking points cannot be awarded if there is a reference to the weight increasing

1

(b)

an answer of 300 000 (kg) scores 5 marks

$$a = \frac{(10-80)}{28}$$

allow $a = \frac{(80-10)}{28}$

1

$$a = (-)2.5 \text{ (m/s}^2\text{)}$$

a valid equation must have been used to calculate a to score subsequent marks

1

$$(-) 750\,000 = m \times (-)2.5$$

allow a correct substitution using their calculated value of a

1

$$m = \frac{(-)750\,000}{(-)2.5}$$

allow a correct rearrangement using their calculated value of a

1

$$m = 300\,000 \text{ (kg)}$$

allow a correct calculation using their calculated value of a

1

[9]

4.

(a) momentum = mass \times velocity

allow $p = mv$

1

(b) $200 = m \times 3.2$

1

$$m = \frac{200}{3.2}$$

1

$$m = 63 \text{ (kg)}$$

allow 62.5 (kg)

1

an answer of 63 (kg) scores 3 marks

(c) (total) momentum before (collision) = (total) momentum after (collision) 1

either

momentum of skater A decreases and momentum of skater B increases

allow (total) momentum is shared between skater A and skater B

1

velocity of skater A decreases and velocity of Skater B increases

1

or

momentum of skater A decreases and so velocity of skater A decreases (1)

momentum of skater B increases and so velocity of skater B increases (1)

[7]

5.

(a) the arrows have different lengths

allow forces can have different sizes

1

the arrows point in different directions

allow forces can have different directions

1

(b) **D**

1

(c) **B**

1

(d) both variables are continuous

1

(e) it is moving at a constant velocity

1

(f) 24.5 (m/s²)

1

(g) 5 g = 49 (m/s²)

1

49 m/s² > 24.5 m/s²

1

so the ride is safe

allow ecf from (f) (ie if their answer to (f) was greater than 49, then the ride is unsafe)

1

(h) force = 58×24.5

allow ecf from (f)

1

force = 1421

1

Newtons

allow N

1

[13]

6.

(a) distance = $2.4 \text{ m/s} \times 4.5 \text{ s}$

1

distance = 10.8 (m)

an answer of 10.8 m scores 2 marks

1

(b) It started going uphill.

1

(c) **D**

1

the line has the largest gradient

allow it is steepest

allow it travels the furthest distance in the shortest amount of time

1

(d) any **two** from:

- the data logger records time more accurately
- the data logger can take readings more frequently
- there is less chance for human error when using a data logger
- the data logger automatically records data

allow the converse of each argument, eg there is a human reaction time error when using a stopclock

2

(e) air resistance

1

(f) acceleration is zero

1

because the resultant force is zero

allow because the forward force equals the air resistance

there is too much air resistance is insufficient

1

(g) $v^2 - u^2 = 2as$
 $1.5^2 - 0^2 = 2 \times a \times 2$

1

$$a = \frac{1.5^2}{2 \times 2}$$

1

$a = 0.56(25) \text{ m/s}^2$

an answer of 0.56(25) (m/s²) scores 3 marks

1

[13]

7.

(a) inertia

1

(b) $17 \text{ cm/s} = 0.17 \text{ m/s}$

1

$P = mv = 0.14 \times 0.17$

1

$= 0.024 \text{ (kg m/s)}$

an answer of 0.024 (kg m/s) scores 3 marks

1

(c) the total momentum before the collision is zero

1

and momentum is conserved

1

so the total momentum after the collision is zero

1

so the speed after the collision is zero

1

(d) more than one car may pass through a beam at a time

allow a description of this eg cars overtaking, cars passing in opposite directions etc

1

(so) the light gate could not accurately measure the time for one car to pass

1

the length of each car would be unknown

allow cars come in different lengths.

1

(so) speed could not be calculated without the length

ignore references to the data logger

1

[12]