

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.5.6.2.2 NEWTON'S SECOND LAW (PACK 1)

SCORE

/89

PERCENTAGE

%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

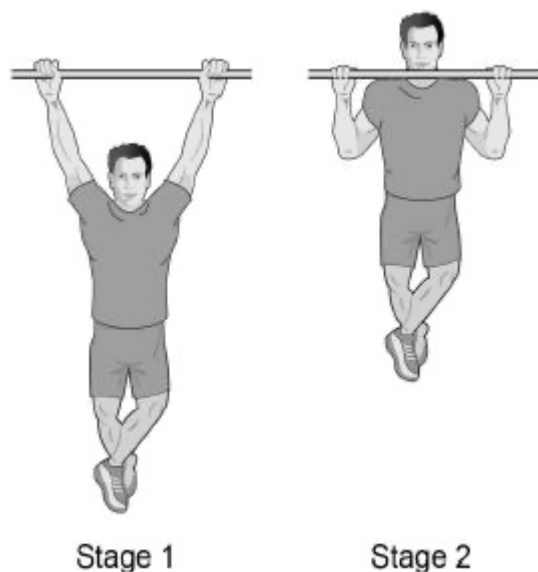
Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

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:

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

$$\text{Work done} = \underline{\hspace{2cm}} \text{ J}$$

(2)

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

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

$$\text{Work done} = \underline{\hspace{2cm}} \text{ J}$$

(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/s^2

Calculate the resultant force on the woman.

Use the equation:

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

$$\text{Force} = \underline{\hspace{2cm}} \text{ N}$$

(2)

(Total 8 marks)

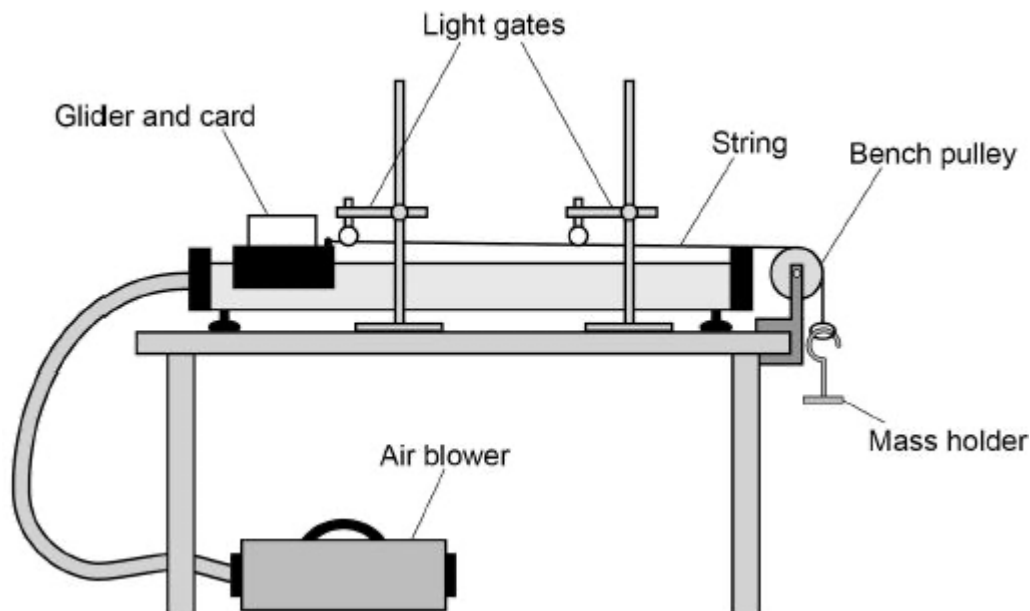
Q2.

A student investigated acceleration using gliders, an air track and light gates.

The air track reduces friction between the glider and the track to zero.

Figure 1 shows the apparatus.

Figure 1



The glider was released from rest and moved along the track.

The mass holder hit the ground before the card passed through the second light gate.

(a) Which **two** statements describe the effect this would have on the glider?

Tick **two** boxes.

Its acceleration would decrease to zero.

☐

Its acceleration would increase.

☐

The resultant force on it would decrease to zero.

☐

The resultant force on it would increase.

☐

Its speed would increase.

☐

(2)

(b) The mass holder should **not** hit the ground before the card passes through the second light gate.

Suggest **one** way that the student could stop this happening.

(1)

The student increased the resultant force acting on the glider by adding more masses to the mass holder.

She calculated the acceleration of the glider for each resultant force.

Each test was done three times.

Table 1 shows the results.

Table 1

Resultant force in N	Acceleration in m/s ²			Mean acceleration in m/s ²
	Test 1	Test 2	Test 3	
0.20	1.3	1.2	1.3	1.26667
0.39	2.6	2.5	2.6	2.6
0.59	3.8	3.8	3.9	3.8
0.78	5.1	5.1	5.1	5.1
0.98	6.4	7.2	6.4	6.7

- (c) The student made **two** mistakes in the mean acceleration column.

Identify the mistakes the student made.

Suggest how each mistake can be corrected.

Mistake _____

Correction _____

Mistake _____

Correction _____

(4)

- (d) Write a conclusion for this investigation.

Use the data in **Table 1**

(1)

- (e) The student used a constant resultant force to accelerate the glider.

The student changed the mass of the glider and calculated the new acceleration.

She repeated this for different masses of the glider, keeping the resultant force constant.

The results are shown in **Table 2**

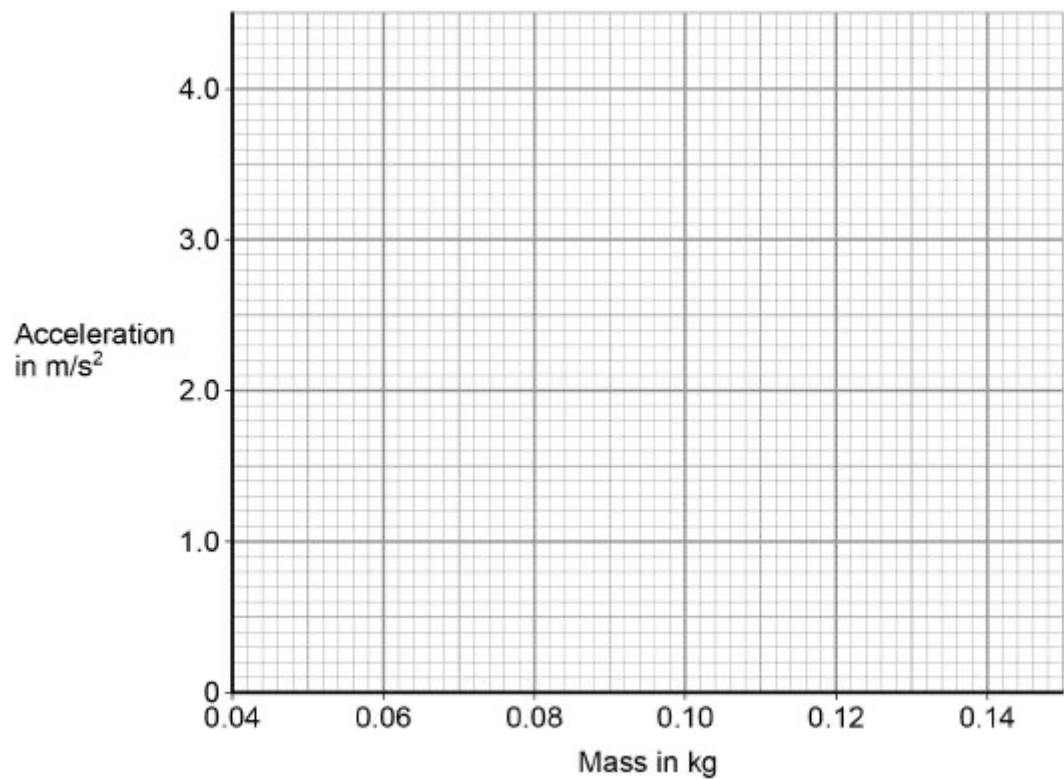
Table 2

Mass of the glider in kg	Acceleration in m/s ²
0.060	3.5
0.080	2.6
0.10	2.0
0.12	1.7
0.14	1.4

Plot the results on **Figure 2**

Draw a line of best fit.

Figure 2



(3)

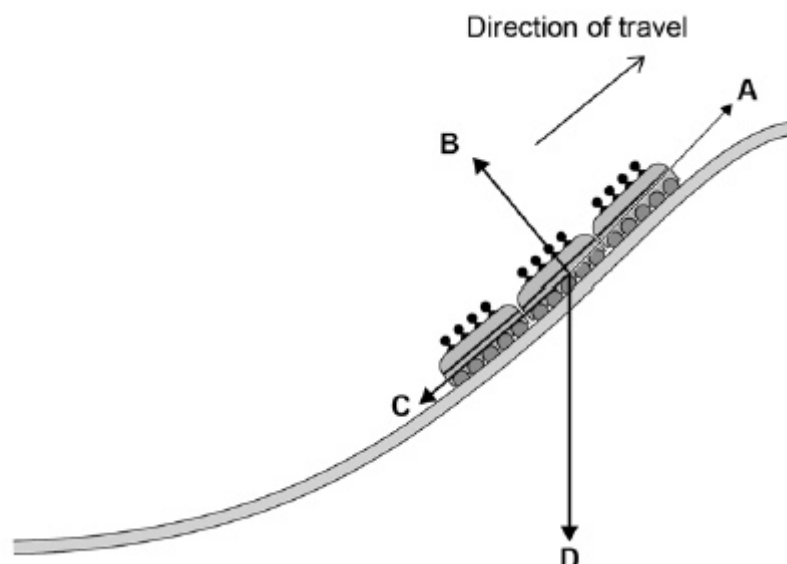
(f) Describe the relationship between mass and acceleration.

(1)

Q3.

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?

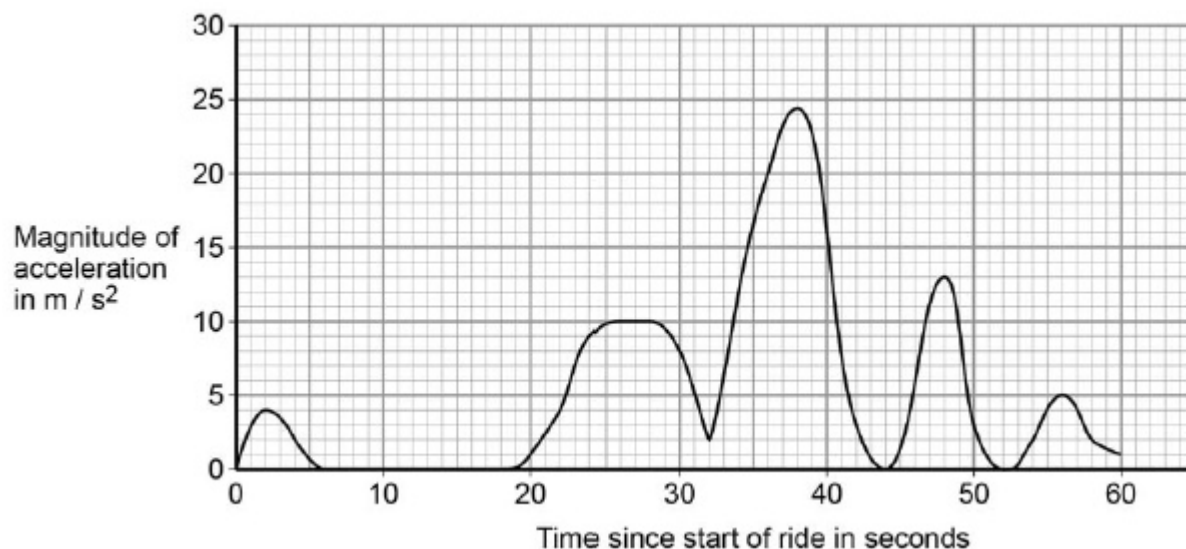
Tick **one** box.

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**.

Acceleration = _____ m/s²

(1)

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

Acceleration due to gravity = 9.8 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.

Maximum force = _____ Unit _____

(3)

(Total 13 marks)

Q4.

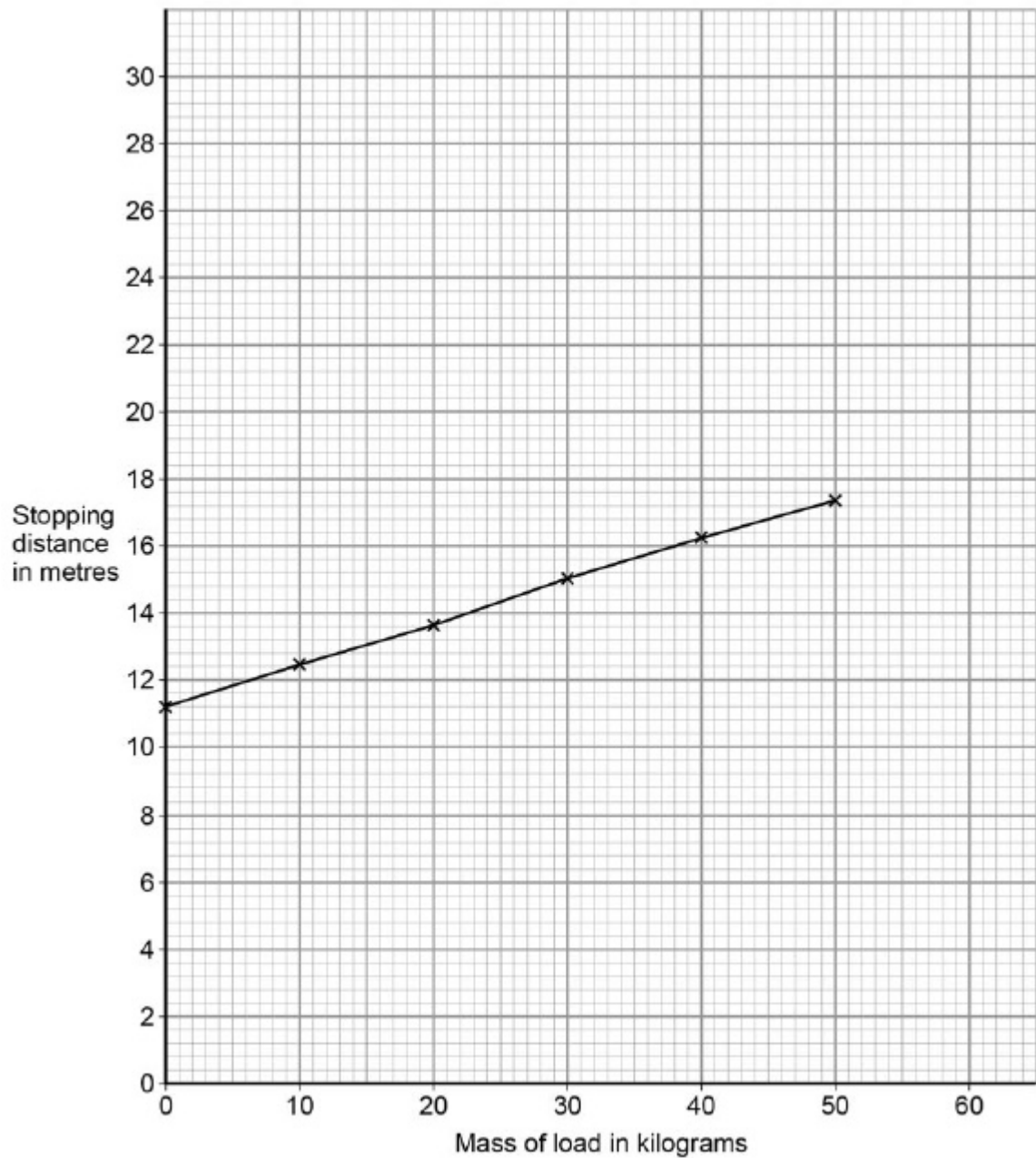
Figure 1 shows a cyclist with a trailer attached to his bike.

Figure 1



- (a) Describe how Newton's Third Law applies to the forces between the bike and the trailer.
-
-
-
-
- (2)
- (b) A student investigated how the stopping distance of the bike was affected by the mass of the load.
- The same person rode the same bike throughout the investigation.
- Give **two** other variables which the student should have controlled.
1. _____
-
2. _____
-
- (2)
- (c) **Figure 2** shows the results of the investigation.

Figure 2



Draw a line on **Figure 2** to show how the stopping distance would be different if a heavier cyclist rode the bike.

(1)

- (d) At one time in the investigation the cyclist was distracted.

The distraction increased the stopping distance of the bike but did **not** affect the braking distance.

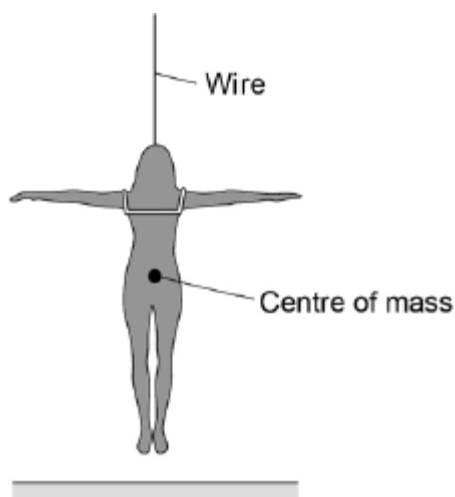
Explain why the stopping distance increased.

(3)
(Total 8 marks)

Q5.

An actor is attached to a wire so that she can hang above the stage.

Look at the figure below.



- (a) On The figure above draw two arrows to show the forces acting on the actor.

(2)

- (b) Which **two** forces are acting on the actor?

Tick **two** boxes.

Air resistance force

☐

Electrostatic force

☐

Gravitational force

☐

Magnetic force

☐

Tension force

☐

(2)

- (c) The actor hangs above the stage in a stationary position.

What is the resultant force on the actor?

Resultant force = _____ N

(1)

- (d) The actor has a mass of 70 kg.

Gravitational field strength = 9.8 N / kg

Use the following equation to calculate the weight of the actor.

Weight = mass $\times$ gravitational field strength

Give your answer to 2 significant figures.

Weight of actor = _____ N

(2)

- (e) A motor pulls vertically upwards on the wire with a force of 720 N.

Calculate the resultant force on the actor.

Resultant force = _____ N

(1)

- (f) Another actor has a mass of 65 kg.

This actor is attached to the wire and the motor pulls her vertically upwards.

The resultant force on the actor is 25 N.

Write down the equation that links acceleration, mass and resultant force.

Equation _____

(1)

- (g) Calculate the acceleration of the actor.

Acceleration of actor = _____ m / s²

(3)

(Total 12 marks)

Q6.

Four students tested their reaction times using a computer program.

When a green light appeared on the screen the students had to press a key.

Table 1 shows their results.

Table 1

Student	Reaction time in s			Mean reaction time in s
	Test 1	Test 2	Test 3	
Boy 1	0.28	0.27	0.26	0.27
Boy 2	0.28	0.47	0.22	0.29
Girl 1	0.31	0.29	0.27	0.29
Girl 2	0.32	0.30	0.29	0.30

- (a) What is meant by 'reaction time' in this experiment?

(1)

- (b) Boy 2 had an anomalous result in **Test 2**.

Suggest a reason why.

(1)

- (c) Give **one** conclusion that can be made from the results in **Table 1**.

(1)

- (d) Suggest further evidence that you could collect to support your conclusion.

(1)

- (e) Reaction time is important at the start of a race.

Table 2 shows the time taken by a boy to run different distances.

Table 2

Distance in m	Time in s
---------------	-----------

100	12.74
200	25.63
800	139.46

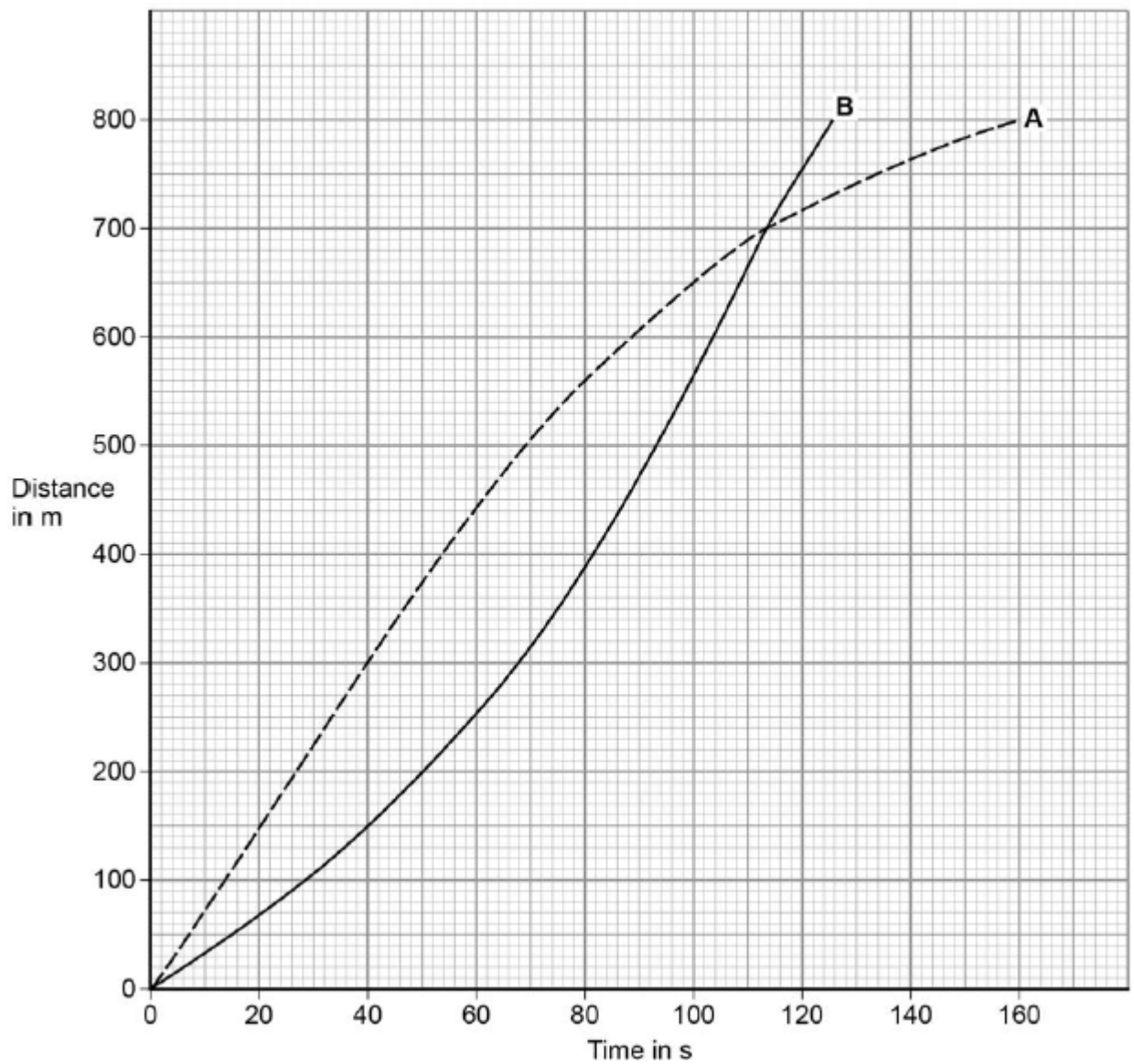
Reaction time is more important in a 100 m race than in an 800 m race.

Explain why.

(2)

- (f) Two girls, **A** and **B**, ran an 800 m race.

The figure below shows how the distance changed with time.



Compare the motion of runners **A** and **B**.

Include data from the figure above.

(6)

- (g) Use above **Figure** to determine Girl **B**'s speed at 60 s.

Show how you use the graph to obtain your answer.

Speed = _____ m / s

(3)

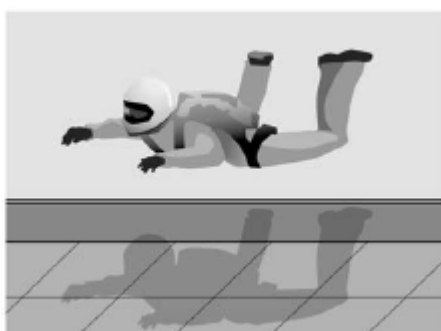
(Total 15 marks)

Q7.

Figure 1 shows a skydiver training in an indoor wind tunnel.

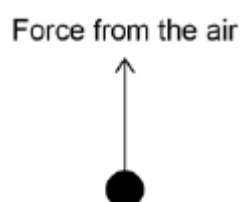
Large fans below the skydiver blow air upwards.

Figure 1



- (a) The skydiver is in a stationary position.

Complete the free body diagram for the skydiver.



(2)

- (b) The skydiver now straightens his legs to increase his surface area.

This causes the skydiver to accelerate upwards.

Explain why straightening his legs cause the skydiver to accelerate upwards.

(2)

- (c) A small aeroplane used for skydiving moves along a runway.

The aeroplane accelerates at 2 m / s^2 from a velocity of 8 m / s .

After a distance of 209 m it reaches its take-off velocity.

Calculate the take-off velocity of the aeroplane.

Take-off velocity = _____ m / s

(3)

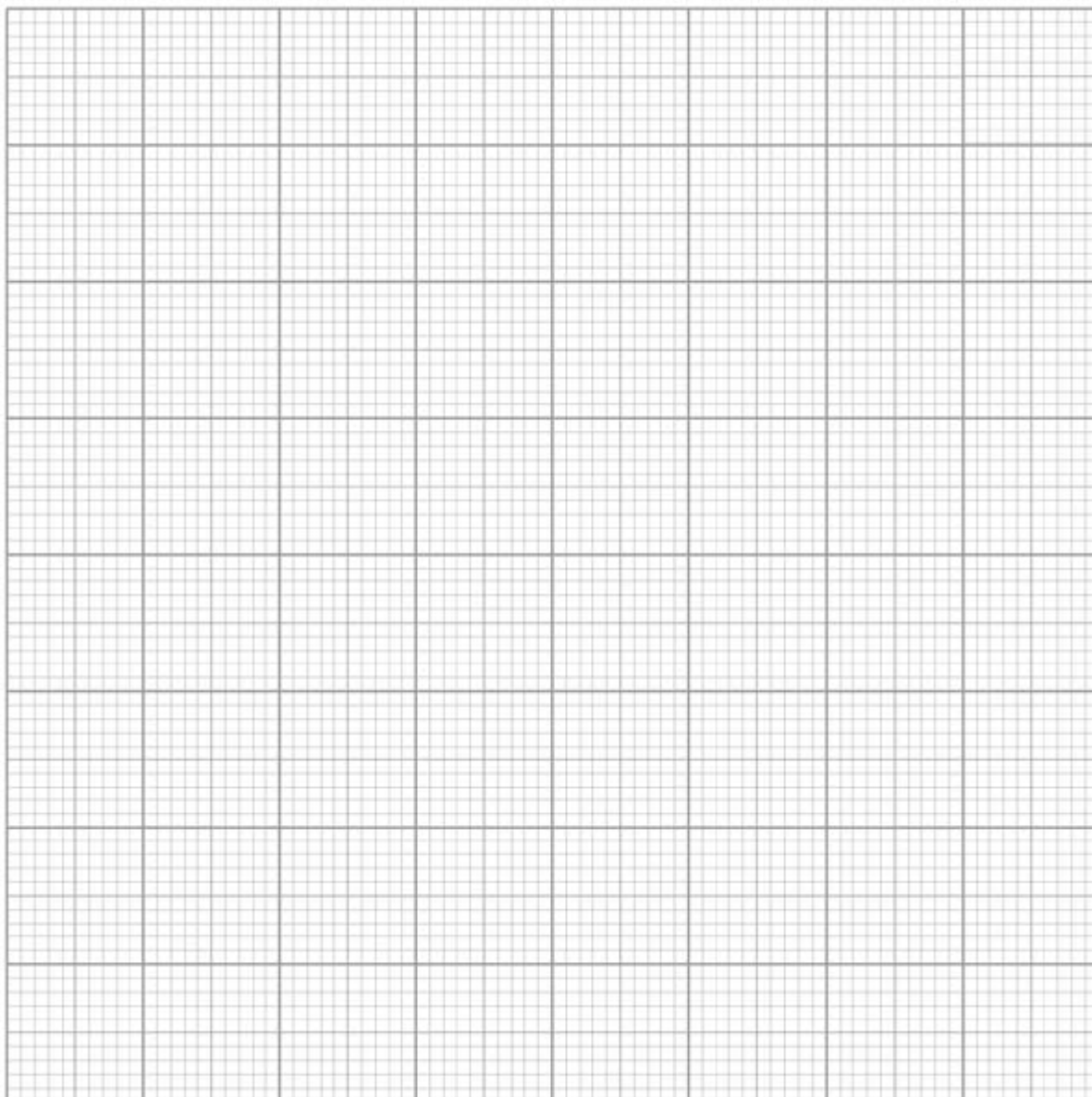
- (d) A skydiver jumps from an aeroplane.

There is a resultant vertical force of 300 N on the skydiver.

There is a horizontal force from the wind of 60 N.

Draw a vector diagram on **Figure 2** to determine the magnitude and direction of the resultant force on the skydiver.

Figure 2



Magnitude of resultant force = _____ N
(5)
(Total 12 marks)

Q8.

The figure below shows an ice skater standing on the ice.



Mass
70 kg

- (a) Write down the equation that links acceleration, change in velocity and time.

(1)

- (b) As the skater pushes away across the ice there is a small frictional force.

After pushing, the skater starts to move with a velocity of 5 m / s.

He slows to 3 m / s in 6 seconds.

Calculate the acceleration of the skater.

Acceleration = _____ m / s²
(2)

- (c) Write down the equation that links acceleration, force and mass.

(1)

- (d) Friction reduces the speed of the skater.

Calculate the frictional force acting on the skater to slow him down.

Frictional force = _____ N
(2)

- (e) The skater stands still on the ice.

He throws his bag to a friend.

As he throws his bag forwards, the skater moves backwards across the ice.

Use the idea of conservation of momentum to explain why he moves backwards.

(4)

(Total 10 marks)

Mark schemes

Q1.

- (a) equal to 1
- (b) $\text{weight} = 85 \times 9.8$ 1
- $\text{weight} = 833 \text{ (N)}$
- allow weight = 830 (N)* 1
- an answer of 833 (N) or 830 (N) scores 2 marks*
- (c) $\text{work done} = 833 \times 0.63$
- allow their calculated value from part (b) $\times 0.63$* 1
- $\text{work done} = 525 \text{ (J)}$
- 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) $\text{work done} = 0 \text{ (J)}$ 1
- (e) $\text{force} = 62 \times 11$ 1
- $\text{force} = 682 \text{ (N)}$
- allow force = 680 (N)* 1
- an answer of 682 (N) or 680 (N) scores 2 marks*
- [8]**

Q2.

- (a) its acceleration would decrease to zero 1
- the resultant force on it would decrease to zero 1
- (b) any **one** from:
- move the second light gate closer to the first
 - shorten the string length
- allow use a taller table* 1
- (c) $1.26667 \text{ (m/s}^2\text{)}$ (is wrong)
- allow (mean value calculated at) 0.20 (N)* 1
- give value to 2 significant figures

allow give value to 1 decimal place
allow 1.3 (m/s²)

1

6.7 (m/s²) (is wrong)

allow (mean value calculated at) 0.98 (N)
allow test 2 for 0.98 (N) or 7.2 is an anomaly

1

discard the anomalous result and recalculate the mean

allow repeat the anomalous test result and
re-calculate the mean
allow 6.4 (m/s²)

1

each mistake and its correction may be given in
any order

(d) (resultant) force is directly proportional to acceleration

allow the larger the (resultant) force, the greater
the acceleration

allow positive correlation between (resultant)
force and acceleration

allow mass / weight (of the holder) for (resultant)
force

1

(e) all points correctly plotted within ½ small square

allow 1 mark for 3 or 4 points correctly plotted

2

curved line of best fit

1

(f) inversely proportional

allow as mass increases, acceleration decreases

1

[12]

Q3.

(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/s ²)	1
(g)	5 g = 49 (m/s ²)	1
	49 m/s ² > 24.5 m/s ²	1
	so the ride is safe	
	<i>allow ecf from (f) (ie if their answer to (f) was greater than 49, then the ride is unsafe)</i>	1
(h)	force = 58 × 24.5	
	<i>allow ecf from (f)</i>	1
	force = 1421	1
	Newtons	
	<i>allow N</i>	1
		[13]

Q4.

(a)	the forces of the bike on the trailer and the trailer on the bike are equal in size	
	<i>allow the force of tension acts on the bike and the trailer</i>	1
	and opposite in direction	1
(b)	any two from:	
	• the same trailer should be used	
	• the weather conditions should be the same	
	<i>allow a description of this, eg the wind should be the same</i>	
	• the same road (surface) should be used	
	• the same gradient road should be used	
	• the same speed should be used	
	• the cyclist should be at the same level of alertness throughout the experiment	
	<i>allow a description of a cause of this eg the cyclist should not drink coffee between experiments</i>	2
(c)	straight line drawn above the original line, sloping upwards	1
(d)	the cyclist's reaction time increased	1
	so the thinking distance increased	1

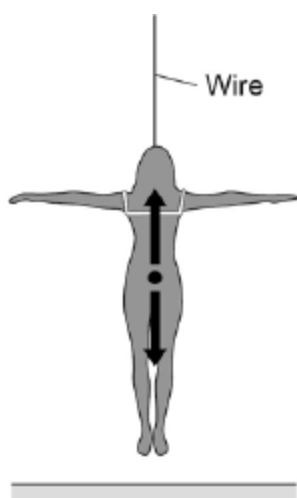
stopping distance is thinking distance plus braking distance

1

[8]

Q5.

(a)



arrow pointing vertically upwards

1

arrow pointing vertically downwards

1

(b) Gravitational force

if more than **two** boxes ticked apply list principle

1

Tension force

1

(c) 0 (N)

1

(d) weight = 70×9.8 (= 686)

1

weight = 690 (N)

1

allow 690 (N) with no working shown for **2** marks

allow 686 (N) with no working shown for **1** mark

(e) 34 (N) / 30 (N)

allow ecf from 05.4 correctly calculated

1

(f) resultant force = mass $\times$ acceleration

accept $F = ma$

1

accept equation correctly rearranged for a

(g) $25 = 65 \times a$

1

$a = 25 / 65$

$$a = 0.38(4615\dots) \text{ (m / s}^2\text{)}$$

allow 0.38 (m / s²) with no working for 3 marks

[12]

Q6.

- (a) the time it took from seeing the green light to pressing a key

1

- (b) he could have been distracted

1

- (c) boys have a shorter reaction time than girls

or

reaction time improves with practice

1

- (d) collect more data / larger sample size

must link to response in 1.3

or

take more repeat readings per person

1

- (e) reaction time will have less effect (as distance increases)

1

because it is a smaller proportion of the total race time

1

- (f) **Level 3 (5–6 marks):**

A coherent description of the race, which uses data from the graph, including discussion of the meanings of the changing gradient of both of the lines.

Level 2 (3–4 marks):

Multiple pieces of data taken from the graphs used to evidence a comparison between the runners. Likely to include discussion of the meaning of the (changing) gradient of one of the lines. Answer not coherently structured.

Level 1 (1–2 marks):

Some data taken from the graph, but may be limited to one aspect or simple readings.
Lack of coherence in answer.

0 marks:

No relevant content.

Indicative content

- A starts at constant speed *for 440 m / 60 s*
- A then slows down *from 60 s*

- the gradient for B is lower at the start so B starts at a slower speed
- the gradient for B increases so B accelerates
- B overtook A at 700 m / 114 s
- B has a greater top speed because the maximum gradient is greater
- B won the race in 126 s / beat A by 34 s

6

(g) tangent drawn at 60s

1

data obtained using correct information

1

5.5(m / s)

accept answer in range 5.3 to 5.7

1

[15]

Q7.

(a) arrow of equal size pointing vertically downwards
judged by eye

1

labelled 'weight'

1

(b) the upwards force is greater than the downwards force

1

because air resistance increases

1

(c) $v^2 = (2 \times 2 \times 209) + 8^2$

1

$$v = \sqrt{900}$$

1

$$v = 30 \text{ (m / s)}$$

1

allow 30 (m / s) without working shown for 3 calculation marks

(d) vertical force (300 N) drawn with a suitable scale

1

horizontal force (60 N) drawn to the same scale

1

resultant force drawn in correct direction

1

value of resultant in the range 304 N – 308 N

1

[11]

Q8.

- (a) acceleration = change in velocity / time taken
allow $a = \Delta v / t$ 1
- (b) $= \frac{(3 - 5)}{6}$ 1
- $-0.33 \text{ (m / s}^2\text{)}$ 1
- allow 0.33 m / s^2 with no working shown for 2 marks*
- (c) force = mass $\times$ acceleration
allow $F = m a$ 1
- (d) 70×0.33
allow ecf from 4.3 1
- 23.1 (N)
allow 23.1 with no working shown for 2 marks 1
- (e) before throwing the bag the momentum of the skater and bag is zero 1
- when it is thrown the bag has momentum forwards 1
- because momentum before = momentum after 1
- the skater has equal backwards momentum so will move backwards 1
- [10]

Examiner reports

Q1.

- (a) Only 21% identified the downwards force of the man on the bar as being equal to the upwards force of the bar on the man. Many believed it to be more than.
- (b) Nearly 90% of students were able to substitute the correct numbers into the given equation and calculate the correct value of weight.
- (c) 68% took their answer from part **(b)** and multiplied by 0.63 m to obtain the correct answer for work done. Many incorrect answers were given when students used $9.8 \text{ N/kg} \times 0.63 \text{ m}$ and a significant minority multiplied the part **(b)** by 0.32 m.
- (d) Just over 40% demonstrated they understood that when the man was not moving the work done would be 0 J. Many put in their calculated values from other parts of the question.
- (e) 85% gained two marks with most students able to substitute the correct numbers into the equation given.

Q2.

Foundation

- (a) 25% of students gained both marks with a further 30% scoring one mark. The most common incorrect responses were where students thought acceleration and the resultant force would increase.
- (b) Only 19% scored this mark, with many suggesting that altering the weight/mass on the holder would solve the problem. Others suggested that catching the holder before it hit the ground would be sufficient.

Most correct responses came from raising the table, with fewer suggesting shortening the string.

- (c) Over 50% of students scored at least two marks, with a further 19% gaining three or four marks. Most were able to identify the mean calculated at 0.20 N as having too many significant figures and correctly suggesting that this should be rounded to 1 decimal place.

The anomalous reading of 7.2 m/s^2 was less commonly spotted and few stated what to do about it.

- (d) 54% of students were able to identify a correct pattern between the variables in order to make a conclusion. Those that failed to score often referred to 'faster' or 'quicker' acceleration.
- (e) 28% scored all 3 marks. The quality of the plotting was generally good, but lines of best fit were often mistakenly given as straight lines giving rise to 53% gaining 2 marks.

Those that struggled to plot points found the second, fourth and fifth points the most difficult. A minority of students used large 'blobs' rather than crosses to plot points resulting in these points going out of tolerance.

Where a curve was drawn these were generally of a creditworthy standard although some did have a 'feathered' appearance with multiple lines.

- (f) Just under 50% of students gained the mark, but few stated the relationship as being inversely proportional, rather stating that as mass increases acceleration decreases.

Common errors were to refer to "slower" acceleration. There were a number of answers which were insufficient, for example "negative correlation".

Higher

- (a) This was generally well answered with nearly 40% scoring both marks. The most common incorrect responses were that acceleration and the resultant force would increase.
- (b) Many students did not realise that it was distance that was important and a significant number spoke of needing to have less weight so that the glider moved more slowly. About 40% scored this mark. Correct responses of raising the table and shortening the string were given fairly equally.
- (c) Many students were not clear about how means were calculated and spoke of the mode being used instead at 0.59 N. There was widespread misunderstanding about accuracy with many stating that the more decimal places, the more accurate a result.

There were many references to recurring decimals. Those who scored in this question often did so by the 'decimal point' route rather than the 'significant figure' route.

Nearly 40% scored 2 marks, with a fairly even spread between those who identified one error and corrected it, or for identifying the 2 errors but not adequately describing how they would correct them.

- (d) This was well done with over 80% scoring the mark, but common errors were to refer to 'faster' or 'quicker' acceleration. A few made reference to the investigation not being a fair test.
- (e) 46% scored all 3 marks. The quality of the plotting was generally good, but lines of best fit were often mistakenly given as straight lines, 50% gaining 2 marks. Where a curve was drawn these were generally of a credit worthy standard.
- (f) This was well done, with 73% gaining the mark, but a common error was to refer to "slower" acceleration. There were a number of answers which were insufficient, for example "negative correlation".