AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.6.3 FORCES AND BRAKING (PACK 1)

SCORE	PERCENTAGE
/124	%

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Q1.

(a) thinking distance stays the same

1

braking distance increases

1

(b) reaction time is increased by using a mobile phone

1

hand-held mobile phones increase the thinking distance more than hands-free phone

allow thinking distance is increased by using a mobile phone

1

by 4 m more than the hands-free phone

1

*allow **2** marks for a hand-held mobile phone doubles the increase of the thinking distance*

so overall stopping distance increases

1

[6]

Q2.

(a) either:
7.5 (m) **and** 12.3 (m) from the graph
or
15 (m/s) × 0.32 (s) using speed

allow 7.5 (m) and between 12.2 (m) and 12.4 (m)

1

extra distance = 4.8 (m)

1

*an answer between 4.7 (m) and 4.9 (m) scores **2** marks*

(b) there is a decrease in kinetic energy of the car

allow work is done by friction (on the brakes)

1

so this (causes) the internal / thermal energy store of the brakes to increase

1

(c) $19^2 - u^2 = 2 \times 2 \times 84$

1

$u^2 = 19^2 - (2 \times 2 \times 84)$

1

u = 5 (m/s)

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$$u = \sqrt{19^2 - (2 \times 2 \times 84)}$$

1

an answer of 5 (m/s) scores 3 marks

(d) **Level 3:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

5–6

Level 2: Scientifically relevant facts, events or processes are identified and their relevance is clear. The account is not fully accurate.

3–4

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–2

No relevant content

0

Indicative content

- use of drugs, alcohol, tiredness and distractions would increase the thinking distance
- thinking distance increases with speed
- thinking distance is directly proportional to speed
- use of drugs, alcohol, tiredness and distractions would increase the gradient of thinking distance

- poor brakes, poor tyres, wet / icy roads and mass would increase the braking distance
- braking distance increases with speed
- braking distance increases at an increasing (accept greater) rate (with speed)
- poor brakes, poor tyres, wet / icy roads and mass would increase the gradient of braking distance
- braking distance is directly proportional to speed squared

- stopping distance = thinking distance + braking distance
- factors that increase thinking and / or braking distance would increase the gradient of stopping distance
- stopping distance increases at an increasing (accept greater) rate (with speed)

[13]

Q3.

(a) any **two** from:

- alcohol
- drugs

allow named drugs

- tiredness
- distraction

allow named distractions

allow caffeine
allow age

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ignore drinking unqualified

2

(b) any **one** from:

- speed of vehicle
- condition of tyres
- condition of brakes
- condition of road surface
- water / ice / snow on road
- braking force

allow mass of vehicle

1

(c) (s =) 13 × 0.6

1

= 7.8 (m)

1

*an answer of 7.8 (m) scores **2** marks*

(d) 21.8 (m)

*allow ecf from part **(c)***

1

(e) the greater the braking distance

1

(f) brakes overheat

allow damage to brakes

1

car goes out of control

allow skidding
allow damage to car or occupants

1

[9]

Q4.

(a) the forces of the bike on the trailer and the trailer on the bike are equal in size

allow the force of tension acts on the bike and the trailer

1

and opposite in direction

1

(b) any **two** from:

- the same trailer should be used
- the weather conditions should be the same

allow a description of this, eg the wind should be the same

- 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

allow a description of a cause of this eg the cyclist should not drink coffee between experiments

2

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(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) vector

1

direction

must be in this order

1

(b) 42 km **and** 210 minutes

1

(c) draw a tangent

1

at 20 minutes

1

measure the gradient of the tangent

1

(d) 1.5 m/s

1

180 (s)

1

$$\frac{1.5}{180}$$

1

0.00833 (m/s^2)

*an answer of 0.00833 (m/s^2) scores **4** marks*
*an answer of 0.0083333 (m/s^2) scores **3** marks*
*an answer of 0.500 (m/s^2) scores **3** marks*
*an answer of 0.5 (m/s^2) scores **2** marks*

1

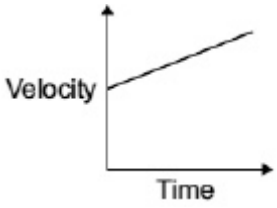
(e) axes labelled and velocity intercept on y-axis

1

straight line with increasing gradient

an answer of:

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*scores **2** marks*

1

(f) −855 = 950 .× a

ignore sign

1

$a = \frac{-855}{950}$

1

a = −0.9 (m/s^2)

1

$0^2 - 5.2^2 = 2 .\times (-0.9) .\times s$

($v^2-u^2 = 2as$)

for this mark, sign of a must be opposite to sign of u, ie allow:

$0^2-(-5.2)^2 = 2 .\times 0.9 .\times s$

1

$s = \frac{-27.04}{-1.8}$

ignore signs

1

s = 15.0 (m)

*an answer of 15.0 (m) scores **6** marks*

allow credit for use of a correct alternative method

1

[18]

Q6.

(a) 0 (N)

1

(b) F = 850 × 0.8

1

F = 680 (N)

*an answer of 680 (N) scores **2** marks*

1

(c) 12 × 0.18

1

= 2.16 (m)

*an answer of 2.16 (m) scores **2** marks*

1

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(d) distance increases with speed

1

thinking distance increases linearly

*allow thinking distance is directly proportional to speed for first **2** marks*

1

braking / stopping distance increases at an increasing rate

allow braking distance is proportional to square of speed

1

[8]

Q7.

(a) a = 12/20

1

= 0.6

1

m/s2

*an answer of 0.6 scores **2** marks*

*if first **2** marks not awarded, allow **1** mark for an attempt to determine a = ∆ v/t with incorrect values from graph*

allow ms^{-2}

1

(b) (first calculate area under graph) 20s: 0.5 × 20 × 12 = 120 (m)

1

next 25s: 25 × 12 = 300 (m)

1

final 6s: 0.5 × 6 × 12 = 36 (m)

1

total: 120 + 300 + 36 = 456 (m)

*an answer of 456 (m) scores **4** marks*

1

(c) $258 = \frac{1}{2}\ 45\ 300 \times e^2$

1

$$e = \sqrt{\frac{2 \times 258}{45\ 300}}$$

1

= 0.107 (m)

*an answer of 0.107 (m) scores **3** marks*

allow 0.11, 0.106727...

1

(d) stopping distances lower on asphalt than concrete (for all tread depths)

1

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as tread depth increases, stopping distance decreases

1

below a certain tread depth, stopping distance increases much faster

if values quoted, expect to see

4 mm for asphalt and 2.5 mm for concrete

1

(e) stopping distance also includes thinking distance

allow stopping distance = thinking distance + braking distance

1

braking distance can never be zero

1

[15]

Q8.

(a) C

1

(b) 2040 / 120

1

17 (m / s)

1

*allow 17 (m / s) with no working shown for **2** marks*

(c) the thinking distance and the braking distance combined

accept 36 m

1

(d) thinking distance increases

1

braking distance stays the same

1

[6]

Q9.

(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 06.3

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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

[12]

Q10.

(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

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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]

Q11.

(a) 3.3×10^2 m / s

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation of the shape of the graph and what it says about the motion of the car between each point is given. Values from the graph are

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clearly referred
in a logical and consistent way.

Level 1 (1–2 marks):
An attempt at an explanation of the motion of the car is given, which may be incomplete
or not in a logical sequence. Values from the graph may not be referred to or referred to incorrectly.

0 marks:
No relevant content.

Indicative content

- between **A** and **B** car is moving from origin
- the gradient of the line shows it's moving at a constant speed
- speed between these points is 250 / 20 = 12.5 m / s
- between **B** and **C** car is stationary / not moving
- because between these points the graph is flat
- showing that the car's speed is 0 m / s
- between **C** and **D** car is moving further from origin
- at a constant speed
- speed is 250 / 20 = 12.5 m / s
- movement between these points is the same as at **A–B**
- because the gradient is the same
- between **D** and **E** moves towards origin
- at a constant speed
- speed is 500 / 30 = 16.7 m / s
- gradient between **D** and **E** shows that car moves faster **or** at a greater speed than between any other points

4

(c) kinetic energy = 0.5 × mass × (speed)^2

allow $E_k = ½ mv^2$

1

(d) ½ × 1 650 × 30^2

1

= 742.5 (kJ)

answer must be in kJ for mark

1

*allow 742.5 with no working shown for **2** marks*

(e) **Level 3 (5–6 marks):**
A detailed and coherent explanation is given of why the man may not be able to stop in time, clearly and logically linking factors that could affect the braking in the situation given

Level 2 (3–4 marks):
An explanation is given, with an attempt at linking factors affecting braking distance to
the situation given. Links made between factors and explanation may not be complete
and the logic may be unclear.

Level 1 (1–2 marks):
Simple relevant statements made about factors affecting braking, but no attempt to link

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to explanations of how they are relevant in the situation given

0 marks:
No relevant content.

Indicative content

- overall stopping distance related to thinking distance and braking distance
- factors affecting thinking distance:
  - driver could be distracted
  - driver could be tired
  - driver could be on medication that affects thinking (eg make drowsy)
  - driver could have drunk alcohol
  - mean that reaction time will be longer so will not brake as quickly
- factors that affect braking distance:
  - condition of car (eg worn brakes means can't stop as quickly, wear on tyres reduces friction with road)
  - speed car is travelling (faster means more kinetic energy)
  - condition of the road (eg the road is wet so friction between tyres and road reduced)

6

[14]

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Q1.

(a) Only 11% scored both marks with a further 29% gaining one mark. There was a persistent misinterpretation that because the brakes were poor, the driver would have to start his/her thinking time earlier, giving a larger thinking distance. Many referred to time rather than distance. Those that did score were more likely to recognise that the braking distance would increase.

(b) Less than 2% gained three or four marks with a further 37% gaining one or two marks. Most students attempted this question but many gave weak responses using their knowledge of mobile phone operation for texting etc.

Few referred to “thinking distance”, “reaction time” or “stopping distance” and many did not use the data in the table to answer the question.

Q2.

(a) About 30% gained both marks, with fewer than 1% gaining just one mark. There was widespread misreading of the graph, in some cases misreading the scale but in a very large proportion there was little attempt to read between the grid lines.

Those who were successful adopted one of three routes: reading the distance off the graph between the given times; finding the time interval from the data given and reading that off the graph from the origin; using the data from the graph along with distance = speed x time to find the extra distance.

(b) This was not answered well, with many students simply talking about heat energy, and many of those who referred to kinetic energy talking about kinetic energy in the brakes.

Many students overcomplicated their responses to this question. Over three quarters of students gained no marks.

(c) This calculation was fairly well done with just over 42% gaining full marks. There were not many able to score compensation marks and so 40% scored zero.

The major problem was the inability to rearrange the equation, and substitution marks were rare as students were trying to substitute into an incorrect equation. A significant minority divided rather than subtracted when moving v^2 from one side of the equation to the other.

(d) Many students did not grasp that a specific requirement of the question was to include factors that would affect the gradient and only a minority talked about the gradient being altered by factors rather than simply describing the graphs presented.

Lower attaining students described the graphs, often saying that “everyone has stopped by 112 km/h” as this was seen as an end point. Many mentioned factors that would affect each of the distances but the factors were not always attributed to the correct distance. A significant number of students cited factors that affected the stopping distance in their own right.

Fewer than 6% of responses achieved level three.

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Q3.

(a) 77% of students were able to give at least one correct suggestion for factors that might affect the thinking distance; usually the consumption of alcohol or distractions such as the use of a mobile phone. ‘Drinking’ by itself was insufficient for a mark as it needed to be linked to alcohol.

(b) 56% of students could suggest an appropriate factor that would affect the braking distance. Some were confused between braking distance and overall stopping distance, and were therefore suggesting factors that might affect the thinking distance.

(c) 83% of students were able to correctly calculate the thinking distance to be 7.8 m.

(d) 14% of students realised that the overall stopping distance was equal to thinking distance plus braking distance. A very common response was to subtract 7.8 m from 14 m.

(e) 53% of the students knew that a greater speed would result in a greater braking distance. Common incorrect responses were to say that a greater speed resulted in a slower braking distance or would take longer to brake but without reference to the distance.

(f) Most students realised that applying a large braking force could cause damage to the car or injury to the occupants. Few students made any reference to the effect on the brakes. 9% of students achieved full marks.

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