AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.6.1.5 ACCELERATION (PACK 3)

SCORE	PERCENTAGE
/189	%

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.

(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)

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

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

STEMUP.CO.UK

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]

Q2.

(a) 1.5 m/s

1

(b) 6.0 m/s

1

(c) **C** = 3.8 (s) **and D** = 8.6 (s)

1

(t =) 4.8 (s)

*allow correct subtraction of incorrect values given for **C** and / or **D***

1

(d) straight line from **E** to *x*-axis

1

finishing at 14 s

1

(e) C−D

1

(f) C−D

1

(g) distance travelled

1

(h) (resultant) force = mass × acceleration

allow F = m a

1

(i) $a = \frac{11.6}{3.2}$

1

= 3.625 (m/s^2)

STEMUP.CO.UK

allow 3.6 (m/s^2) or 3.63 (m/s^2)

1

*an answer of 3.6 / 3.625 / 3.63 (m/s^2) scores **2** marks*

[12]

Q3.

(a) air resistance

allow drag
ignore wind resistance

1

(b) B−C

1

(c) (velocity =) 12.2 (m/s)

1

(momentum =) 94.8 × 12.2

1

(momentum =) 1160 (kg m/s)

allow an answer that rounds to 1160 (kg m/s)
*an answer of 1147 / 1150 scores **2** marks*

1

*an answer of 1160 (kg m/s) scores **3** marks*

(d) tangent drawn at 12 s

1

correct readings of Δv and Δt from tangent

1

$$(\text{acceleration}) = \frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}$$

1

−2.4 (m/s^2)

allow value in range −2.2 to −2.6 (m/s^2)
allow a correctly calculated answer from $-\frac{\textit{their value of } \Delta v}{\textit{their value of } \Delta t}$

1

m/s^2

allow m/s/s

1

(e) straight line (with gradient of 1.6) from origin to 6 s, 9.6 m/s

*allow **1** mark for a straight line below A−B with a positive gradient from origin to 6 s*

2

(f) (calculation of distance travelled by first athlete)

STEMUP.CO.UK

(2.2 × 12.2) = 26.84 (m)

1

(0.5 × 3.8 × 12.2) = 23.18 (m)

1

*an answer of 50.02 (m) scores **2** marks*

(calculation of distance travelled by second athlete)

(0.5 × 9.6 × 6 =) 28.8 (m)

*allow ecf from part **(e)***

allow ($9.6^2 - 0 = 2 \times 1.6 \times s$ =) 28.8 (m)

1

(calculate difference) = 21.22 (m)

allow their distance for athlete 1 minus their distance for athlete 2

1

*an answer of 21.22 (m) scores **4** marks*

[16]

Q4.

(a) (in circular motion) the direction is (constantly) changing

1

(so) velocity is (constantly) changing

1

(and) acceleration is rate of change of velocity

allow

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

1

(b) $$s = \frac{2.6^2 - 1.4^2}{2 \times 0.31}$$

1

(c) $$0.72 = \frac{190}{P_{input}}$$

allow $$\frac{72}{100} = \frac{190}{P_{input}}$$

1

$$P_{input} = \frac{190}{0.72}$$

1

P_{input} = 264 (W)

allow an answer that rounds to 264 (W)

1

264 = 36 × I

STEMUP.CO.UK

allow their calculated
$P_{input} = 36 \times I$

1

I = 7.33 (A)

1

I = 29 (A)

allow an answer that rounds to 29 (A)
allow their value for I × 4 correctly calculated

1

*an answer of 29 (A) scores **6** marks*

(d) old theory suggests Moon rocks would be different from Earth rocks

1

(but) new evidence shows they are similar

this mark is dependent on scoring the first mark

1

*allow **1** mark for new evidence (from studying Moon rocks) could not be explained by the old theory*

[12]

Q5.

(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

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

STEMUP.CO.UK

1

(h) force = 58 × 24.5

allow ecf from (f)

1

force = 1421

1

Newtons

allow N

1

[13]

Q6.

(a) distance = 2.4 m/s × 4.5 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) $v^2 – u^2 = 2as$

$1.5^2 (– 0^2) = 2 × a × 2$

1

STEMUP.CO.UK

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

1

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

*an answer of 0.56(25) (m/s^2) scores **3** marks*

1

[13]

Q7.

(a) between **A** and **B** (the elastic store decreases and) the kinetic and gravitational stores increase

1

between **B** and **C** the kinetic store decreases and the gravitational store increases

1

the internal energy store of the surroundings increases

*allow **either***

some energy is dissipated to the surroundings

or

some energy is dissipated as heat / sound

1

(b) the weight and air resistance are equal and opposite

1

so the resultant force is zero

1

(c) $25\ 000 = ½ \times 125 \times e^2$

1

$$e^2 = \frac{2 \times 25000}{125}$$

1

$$e = \sqrt{\frac{2 \times 25000}{125}}$$

1

$e = 20$ (m)

*an answer of 20 (m) scores **4** marks*

1

(d) acceleration = (–)9.8(m/s^2)

1

$0^2 – 26^2 = 2 \times (–9.8) \times s$

1

$$s = \frac{–26^2}{2 \times (–9.8)}$$

1

STEMUP.CO.UK

s = 34 (m)

allow any correct rounding of 34.489...
*an answer of 34 (m) scores **4** marks*

1

[13]

Q8.

(a) vector

1

direction

must be in this order

1

(b) 42 (km)

1

210 (minutes)

1

(c) moving at constant speed

1

(d) **A** to **B**

1

(e) the gradient / line is the steepest (in this section)

1

(f) straight line from origin

1

finishing at 42 km **and** 120 minutes (2 hours)

allow ecf from part (b)

1

(g) 1.5 (m/s)

1

(h) $\frac{1.5}{60}$

allow ecf from part (g)

1

0.025

*an answer of 0.025 scores **2** marks*

1

m/s^2

1

(i) **B**

1

[14]

Q9.

STEMUP.CO.UK

(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:



*scores **2** marks*

1

(f) −855 = 950 .× a

ignore sign

1

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

1

STEMUP.CO.UK

$a = -0.9\ (m/s^2)$

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]

Q10.

(a) so that there wasn't any extra force

1

(b) 8 (degrees)

allow a range 7–9 (degrees)

1

(c) increase the height of the block or move the block to the right

or

move the block to the right

allow any other safe suggestion for increasing the angle

1

(d) two correct pairs of values taken from graph

1

values substituted into:

$$\text{gradient} = \frac{\text{change in y}}{\text{change in x}}$$

1

correctly calculated value

*an answer of 0.64 (m/s^2) gains **3** marks*

allow full credit for correct use of a single pair of values taken anywhere from the straight line

1

(e) total distance travelled

1

(f) compare the data from the tests (for the same angle)

1

STEMUP.CO.UK

to see if the results are similar

1

(g) GPE = 0.75 × 9.8 × 0.34

1

GPE = 2.499 (J)

*an answer of 2.499 (J) or rounded to 2.5 (J) scores **2** marks*

1

[11]

Q11.

(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

(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]

Q12.

(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 = Δ v/t with incorrect values from graph*

allow ms^{-2}

1

STEMUP.CO.UK

(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

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]

Q13.

(a) velocity is a vector (so has both magnitude and direction)

1

direction is changing (and so velocity is changing)

1

if velocity is changing, there is an acceleration

1

STEMUP.CO.UK

(b) as radius increases, force required decreases

allow converse statements for all marking points

1

as speed increases, force required increases

1

at greater speeds, change in force for same change in speed is greater

allow force proportional to square of speed

1

(c) a conductor carrying a current in magnetic field has a force exerted on it (by the motor effect)

1

(so) force on opposite sides in opposite directions (so the coil turns)

allow current in opposite directions

1

as coil turns, commutator reverses direction of current relative to coil (so rotation can continue)

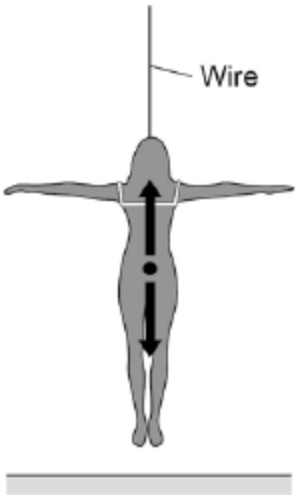
allow current / force directions in terms of arrows on the diagram (force directions do not have to be correct from Fleming's LHR to illustrate the point)

1

[9]

Q14.

(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)

STEMUP.CO.UK

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 × acceleration
accept F = ma

1

accept equation correctly rearranged for a

(g) 25 = 65 × a

1

a = 25 / 65

1

a = 0.38(4615…) (m / s^2)

1

*allow 0.38 (m / s^2) with no working for **3** marks*

[12]

Q15.

(a) acceleration = change in velocity / time taken
allow a = Δv / t

1

(b) $= \frac{(3 - 5)}{6}$

1

–0.33 (m / s^2)

1

*allow 0.33 m / s^2 with no working shown for **2** marks*

(c) force = mass × 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

STEMUP.CO.UK

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]

STEMUP.CO.UK

Q1.

(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.

Q2.

(a) 57% of students were able to recall the typical mean speed for a person walking.

(b) 33% of students knew this with a greater number of students answering in terms of the typical mean speed for a person cycling being 4.5 m/s.

(c) 55% of students were able to determine the figures of 3.8 (s) and 8.6 (s) from the graph. Those who did not appreciate the scale used generally answered 3.9 (m).

Most realised that they had to subtract values determined for C and D (though a few did add) to determine the time taken.

(d) 35% of students did not attempt this question. Of those that did, most students were able to achieve one mark usually for finishing the line at 14 seconds, often just by continuing the line from D to E. 29% of students achieved two marks. A few students

STEMUP.CO.UK

drew the lines freehand, which were often not credited due to the number of 'wobbles'.

(e) 58% of students were able to interpret the graph and determine the region in which the athlete was moving at constant velocity.

(f) Although the majority of students were able to interpret the graph and determine the region in which the athlete was moving at constant velocity, fewer then realised that the resultant force when travelling at constant velocity would be zero. 35% of students were able to do this.

(g) The correct answer was the most popular response, with 42% of students selecting 'distance travelled'.

(h) 25% of students were able to correctly recall the equation. A variety of incorrect answers were seen with arranging the terms incorrectly, or subtracting one term. A significant number of students answered in terms of $v^2 - u^2 = 2as$, despite force and mass being in the question.

(i) 72% of students answered correctly achieving both marks. However, some students rounded their response to 3.62 rather than 3.63.

Q3.

(a) Most correct answers gave air resistance, though drag was also credited. Incorrect responses included friction, gravity, wind, wind resistance, resistance, types of energy and acceleration.

(b) 86% of students were able to interpret the graph correctly.

(c) 23% of students achieved all three marks. Some students were not able to correctly apply the scale and incorrectly read the value for the velocity for the graph. The only incorrect velocity value which was credited when used in marking points two and three was 12.1 m/s. Many students incorrectly used the time of 6 s given in the question as the velocity.

(d) To access the first four marking points, students had to draw a tangent. 4% of students who had the necessary mathematical skills were able to achieve full marks. A significant number used the co-ordinates of the point on the graph, whilst others made a triangle out of the deceleration part of the graph and tried to work from the *x* and *y* readings despite there being a curve on the third side. The unit mark was scored by the majority of students. Relatively few did not attempt this question.

(e) 38% of students realised that the acceleration value given led to a velocity of 9.6 m/s after six seconds and then correctly drew the line to obtain two marks. Others who didn't use the acceleration value given drew their line to a velocity of 1.6 m/s or 12.2 m/s.

Some students drew a vertical line upwards from six seconds until it reached the other athlete's 'steady speed' section at 12.2 m/s.

(f) Those students who knew that the area under the graph represented distance were often then able to go on and achieve four marks. Others who gained some marks found it easier to calculate the area of the triangle for the distance travelled by the second athlete, rather than calculating the area of the trapezium for the first athlete. Few used the equation for the area of a trapezium, more usually splitting the trapezium into a rectangle and triangle.

STEMUP.CO.UK

For the calculation of the distance travelled by the second athlete an error carried forward was allowed from their answer to part **(e)**. Some tried to use the equation $v^2 - u^2 = 2as$ for both athletes, without appreciating that this could only be used for the second athlete.

Many tried to use d = s × t gaining an overall answer of 15.6 m. They were awarded marking point four if they had clearly indicated they had calculated the distance travelled for both athletes. Others just subtracted the two velocities after six seconds.

Q4.

(a) Over 11% of students made no attempt to answer this question and more than three quarters scored no marks.

Few students realised that this question was linked to the vector nature of velocity and acceleration. Indeed, several students stated that the question was incorrect because the moon could not be accelerating because it was moving at constant speed.

Students who attempted an incorrect explanation attributed the acceleration to a variety of causes − global warming, astronauts landing on the moon and the earth's changing magnetic field were fairly common answers.

Students who scored marks for this question usually cited the constant change in direction of the moon, linking this to a change in velocity, but omitting the link between velocity and acceleration.

(b) Around half of students chose the correct response to the calculation. The next most popular choice was the final box, which was similar to the correct one, but with '2' as a multiplier. The other two responses were equally chosen.

(c) Around 3% of students performed this complex calculation correctly to gain all six marks. Some students attempted calculations, but it was often difficult to follow the line of reasoning. Strings of figures, apparently randomly multiplied or divided, were often seen, with no attempt to explain what was being worked out. It would benefit students to explain, just with a word or two, what they think they are working out. Some students attempted to deal with all stages of this multi-stage calculation in one equation − such answers seldom scored any marks.

Of those whose working was clear enough to follow, the most frequent mistake was working out the input power as 72% of the output power, ending up with a smaller value for the input power than the output. However, such answers could go on to gain up to three of the marks by using the P = IV equation and/or multiplying by four.

(d) In order to gain marks, students needed to refer to the old theory and what it would suggest about the composition of Moon rocks compared to Earth rocks. Very few answers made reference to the old theory, so very few students gained marks.

Many answers stated that if the Moon rocks had a similar composition to Earth rocks, it was likely that they originated from the same place − this is what was stated in the question so there was no credit for repeating it.

There was evidence that a number of students had mis-read or failed to understand the question, as they referred to the Giant Impact Hypothesis as being incorrect because the Earth would have been destroyed in a collision.

STEMUP.CO.UK