AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.5.3 FORCES AND ELASTICITY (PACK 1)

SCORE	PERCENTAGE
/90	%

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Q1.

(a) D

allow 20 (N)
allow fourth (newtonmeter)

1

needs the greatest force to extend the spring the same amount

reason only scores if correct newtonmeter selected

1

(b) zero (error)

allow systematic (error)

1

any **one** from:

- record the value and subtract from readings taken

  allow subtract 1 from all readings)

- adjust the newtonmeter to zero

1

(c) $4.5 \times 10^{-2} = 0.5 \times 400 \times e^2$

this mark may be awarded if the standard form value is incorrectly converted

1

$$e = \sqrt{\frac{4.5 \times 10^{-2}}{0.5 \times 400}}$$

this mark may be awarded if the standard form value is incorrectly converted

allow $e^2 = \frac{4.5 \times 10^{-2}}{0.5 \times 400}$

1

e = 0.015 (m)

this answer only

1

2.0 = 400 × e

1

e = 0.005 (m)

this answer only

1

0.015 + 0.005 = 0.02 (m)

allow their initial extension + their additional extension correctly calculated

1

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or

$4.5 \times 10^{-2} = 0.5 \times 400 \times e^2$ (1)

this mark may be awarded if the standard form value is incorrectly converted

$e = \sqrt{\frac{4.5 \times 10^{-2}}{0.5 \times 400}}$ (1)

this mark may be awarded if the standard form value is incorrectly converted

allow $e^2 = \frac{4.5 \times 10^{-2}}{0.5 \times 400}$

e = 0.015 (m) (1)

this answer only

F = 400 × 0.015

F = 6 (N) (1)

allow an answer of 400 × their calculated value of e

total force = 6 + 2

8 = 400 × e (1)

allow an answer that is consistent with their calculated value of e

e = 0.02 (m) (1)

*an answer of 0.02 (m) gains **6** marks*

[10]

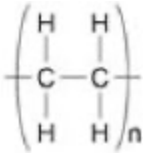
Q2.

(a) five single bonds inside the brackets (1 C−C bond and 4 C−H bonds)

1

two single bonds extending from the carbons

*allow **2** marks for an answer of:*



1

(b) HD (poly(ethene) polymer chains) have no side chains

allow LD (poly(ethene) polymer chains) have side chains
ignore cross links

1

chains are closer together in HD (poly(ethene) than LD poly(ethene))

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1

(c) **Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

3–4

Level 1: The method would not necessarily lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- suspend a poly(ethene) strip / bag
- (use a ruler) to measure length or to locate starting position
- add (known) mass / weight to the strip / bag or pull with a newtonmeter
- determine extension
- repeat using different forces (by adding further masses / weights **or** pulling harder)
- control variables: size / thickness of strip
- repeat and calculate a mean

(d) any **two** from:

- both have increasing extension with increasing force
- both extend non-linearly
- HD poly(ethene) has a smaller extension (than LD poly(ethene)) for a given force

  allow LD poly(ethene) stretches more for a given force
  allow correct readings of extension for a given force for both polymers

- HD poly(ethene) has a smaller maximum extension (than LD poly(ethene))

  allow HD poly(ethene) breaks at a greater (maximum) force
  ignore references to strong / weak

2

(e) $\frac{85}{100} \times 8.0$ (billion)

or

6.8 (billion)

allow $\frac{15}{100} \times 8.0$ *(billion)*

1

(8 billion − 6.8 billion =)
1.2 billion
or
1200 000 000
or
1.2×10^9

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*allow **1** mark for an answer consistent with an incorrect conversion of billion*

1

*an answer of 1.2 billion scores **2** marks*

*an answer of 1.2 scores **1** mark*

(f) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

similarities

- both made from crude oil
- crude oil is a finite resource
- production and transport of both cause emissions of carbon dioxide
- carbon dioxide contributes to global warming
- both can be disposed of in the same ways

disadvantages of disposable bags

- each disposable bag generates more waste (than one bag for life)
- each disposable bag generates approximately 2.5 times more waste **or** 0.25 g more waste (than one bag for life)
- if 6 disposable bags used they generate approximately 15 times more waste **or** 2.35 g more waste (than one bag for life)
- if 6 disposable bags used it causes more CO_2 to be emitted (than one bag for life)
- if 6 disposable bags used 2.7 g more CO_2 emitted **or** approximately 1.4 times more (than one bag for life)

advantages of disposable bags

- a disposable bag causes less CO_2 to be emitted (than one bag for life)
- a disposable bag emits 5.3 g less CO_2 (than one bag for life)
- if disposable bags used more than once less CO_2 emitted (than one bag for life)
- if bag for life is used fewer than 5 times, it results in more CO_2 being emitted (than one disposable bag)
- disposable bags extend less as made from HD poly(ethene)

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Q3.

(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

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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

s = 34 (m)

allow any correct rounding of 34.489...

*an answer of 34 (m) scores **4** marks*

1

[13]

Q4.

(a) any **two** from:

- length of coils increased
- increased gap between coils
- spring has become longer
- spring has become thinner

2

(b) **B** and **C**

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either order

1

(c) weight = mass × gravitational field strength

allow W = m g

1

(d) 5.5 (N)

allow any value in the range 5.0 to 5.8 (N)

1

up to that point force and extension are (directly) proportional

allow the line starts to curve

1

(e) use smaller intervals (for applied force)

allow any value for interval between 0.1 N and 0.2 N

1

between a total applied force of 5 to 6 Newtons

1

(f) force = spring constant × extension

1

(g) 0.064 m

1

18 × 0.064

1

= 1.152 (N)

*an answer of 1.152 (N) scores **3** marks*

allow 115.2 (N)

1

[12]

Q5.

(a) 5.5 (N)

1

(b) The spring gets shorter

1

(c) **Level 2 (3–4 marks):**
A detailed and coherent description of the experiment. The response provides a logical sequence.

Level 1 (1–2 marks):
Simple description of the experiment with some steps missing. The response may not be in a logical sequence and may not lead to the collection of valid results.

0 marks:
No relevant content.

Indicative content

- set up a clamp stand with a clamp and hang a spring on it

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- use another clamp and boss to fix a half metre rule alongside the spring
- record the metre rule reading that is level with the bottom of the spring
- hang a weight from the bottom of the spring
- record the new reading on the rule and the extension on the spring
- remove the weight and check the length of the spring
- repeat by adding more weights and record the readings on the rule

4

(d) Use a pointer from the spring to measure the length.

1

Make sure the spring is stationary before measuring length.

1

(e) Extension is directly proportional to force

*if more than **one** box ticked apply list principle*

1

(f) 0.5 (N)

1

(g) 0.100 m

*if more than **one** box ticked apply list principle*

1

(h) $0.5 \times 20 \times (0.050)^2$

1

= 0.025 (J)

1

*allow 0.025 (J) with no working for **2** marks*

[13]

Q6.

(a) force = spring constant × extension

accept f = ke

1

(b) extension is directly proportional to the force applied

1

because it is straight line through the origin

1

(c) test a greater range of load

or

test more springs

1

(d) work done is equal to elastic potential energy

1

as long as the spring does not go past the limit of proportionality

1

(e) line extending with a greater gradient than existing line

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1

a stiffer spring has a greater spring constant (*k*)

1

k = F / e

1

(f) the spring will be deformed

accept not gone back to original shape

1

because it has passed the elastic limit

1

[11]

Q7.

(a)

	contact	non-contact
Electrostatic		✓
Friction	✓	
Gravity		✓

one mark for each correct tick

3

(b) Velocity

1

Displacement

1

(c) Use a pointer from the spring to measure the length

1

(d) 25 g = 0.025 kg

1

weight = 0.025 × 9.8

1

= 0.25 (N)

1

*allow 0.25 with no working shown for **3** marks*

(e) Extension is directly proportional to force

1

(f) 1.125 (N)

allow values between 1.12 and 1.15

1

(g) elastic potential energy = 0.5 × 13.5 × $(0.12)^2$

1

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= 0.097 (J)

*allow 0.097 with no working shown for **2** marks*

1

[13]

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Q1.

(a) Nearly 70% identified the correct newtonmeter but very few stated that it was the extension being the same for all of the newtonmeters that was the key factor.

(b) Fewer than 10% could correctly identify the type of error, with many giving descriptions rather than stating zero error or systematic error. Terms used incorrectly with some frequency included human error.

Over 50% were then able to say how the error could be corrected. Some suggested that the newtonmeter might just be 'sticky' and need to be pulled down and released which, whilst showing practical experience, would not be a solution in all cases.

(c) Whilst only just over 5% gained all 6 marks, correct solutions, when seen, were clear and well set out. A significant number, nearly 17%, calculated the initial extension, but did not complete the calculation to determine the total extension.

Those managing to do the second part of the question opted in about equal numbers for each of the two expected methods.

Typical errors in the first part included not finding the square root of the answer for the extension and in dividing by 2 twice.

A few candidates realised there were two parts but worked out incorrect values. They were able to gain the final mark by adding the two incorrect extensions correctly.

Q2.

Foundation

(a) Around one quarter of students did not attempt this question.

Of those who did, very few, around 1%, were able to draw the correct diagram. Some scored 1 mark, usually for the five single bonds within the bracket.

The most common incorrect diagram was just a repeat of the structure of ethene which had been given in the question. The significance of the ‘n’ was not understood by some students − some answers showed a pattern of ‘n’s around the outside of the bracket.

(b) Around 8% of students gained both marks. Many students, around 50%, gained one mark, usually for pointing out that the LD poly(ethene) has side chains, whereas HD does not.

Despite the fact that both the polymer chains and the side chains were labelled, many students chose to ignore these terms to talk about ‘wiggly lines’ and ‘a cracked appearance’.

(c) More than 40% of students did not attempt this question.

Of those who did attempt it, some did not describe a method, merely stating that poly(ethene) extends when a force is applied.

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Of those who attempted to describe a method, many failed to score more than two of the four marks available because their account lacked detail and would not lead to a valid outcome. In many cases, this was because ‘see how much it stretches’ was stated with no detail as to how this would be done. In other cases, there was no indication that more than one force would be applied to the poly(ethene).

There were quite a few references to pulling the polythene and examining it under a microscope. A small number of students described the extension of a spring experiment, with no mention of poly(ethene) at all.

(d) Around 10% of students gained one mark for this question, with a very small number gaining both marks. The answers tended to be very imprecise, such as ‘HD needs a greater force than LD’ and ‘LD has a greater extension than HD’.

Many students stated that one extended faster than the other; as no time values were given, this is incorrect.

(e) Around 18% of students scored two marks for this question, with a further 20% gaining one mark. Some worked out 85% of 8 billion, and quoted this as their answer, failing to subtract this from the original 8 billion.

A commonly seen error was dividing by 0.85 instead of multiplying.

Another common error was to put an incorrect number of zeros for billion (instead of just leaving it as ‘billion’). Another common error was an inability to perform the percentage calculation correctly. To work out 85% of 8 billion, many students worked out 10% of 8 billion, and then 1%, then added 8 lots of 10% to five lots of 1%. Coupled with a large number of zeros, this method had the potential for errors to arise.

(f) More than 20% of students did not answer this, the last question on the paper. Most students who wrote something made a good attempt at this 'evaluation' question based on LCAs. Many students were able to point out that bags for life were better from the point of view of 'waste'. A simple comparison for CO_2 emissions on a 'per bag' basis was also given by many. Few students processed the data for CO_2 emissions to show that on a 'per use' basis, bags for life were more environmentally desirable. Some students misinterpreted the word 'emitted' and referred to the use of CO_2 during the production and transport of the bags. Few students did calculations when comparing the data.

A Level 2 answer (three or four marks) involved comparing the two types of carrier bag qualitatively, e.g. ‘more waste is generated from the production of one disposable bag compared with a bag for life’ and addressing both waste and carbon dioxide. Around 40 % of students fell into this category.

A few students (around 4%) achieved Level 3 (five or six marks) for going a step further and involving calculations such as ‘around two and a half times as much waste is generated from the production of one disposable bag compared with a bag for life’. In addition, both waste and carbon dioxide had to be addressed quantitatively. Also, a judgement needed to be made, either saying which type of bag was better, with reasons why, or giving the pros and cons of both types of bag.

Students whose answers were Level 1 standard (one or two marks) tended to discuss only one aspect of the information given, or to ignore the information altogether and write something from their own knowledge. Answers which merely stated the given information without any comparisons did not gain credit.

Higher

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(a) Around 7% of students did not attempt this question. Very few students were able to draw the correct diagram. Some scored one mark, either for the five single bonds within the bracket or for the two single bonds extending outwards from the two carbons.

The most common incorrect diagram was just a repeat of the structure of ethene which had been given in the question. Another incorrect answer was to ignore the monomer diagram and to draw out a structure, usually of an alkane, or an alkane-type structure but with carbon-carbon double bonds.

(b) Most students attempted this question, with around one quarter gaining both marks. A further 50% gained one mark, usually for pointing out that the LD poly(ethene) had side chains, whereas HD did not. A number of students also picked up on the difference between the polymer chains but commented about the difference in number rather than their proximity.

Despite the fact that both the polymer chains and the side chains were labelled, a minority of students chose to ignore these terms to talk about ‘wiggly lines’ and ‘cracks’.

(c) The question asked was to describe a method to investigate how the extension of poly(ethene) changes with the force applied. A number of students did not take on board that the command word was ‘describe’ but attempted to explain (a different command word) why poly(ethene) extends.

Many students who did describe a method failed to score more than two of the four marks available because their account lacked detail and would not lead to a valid outcome. In many cases, this was because ‘measure the extension’ was stated with no detail as to how this would be done. In other cases, there was no indication that more than one force would be applied to the poly(ethene).

A small number of students described the extension of a spring experiment, with no mention of poly(ethene) at all.

(d) Fewer than 2% of students scored both marks, although a further quarter gained one of the marks, often for stating that for both types of poly(ethene) the extension increases as the force increases.

Other answers tended to be too vague, such as ‘LD’s extension is greater than HD’. Answers which gained credit qualified such an answer with ‘…for a given force’ or quoted a value for force and compared the values of the two extensions.

Some students stated that one extended faster than the other; as no time values were given, this is incorrect.

(e) Around half of students scored two marks for this. Of those who did not gain both marks, some worked out 85% of 8 billion, and quoted this as their answer, failing to subtract it from the original 8 billion.

Another common error was to put an incorrect number of zeros for billion (instead of just leaving it as ‘billion’).

Some students made mathematical mistakes in performing the percentage calculation. To work out 85% of 8 billion, many students worked out 10% of 8 billion, and then 1%, then added 8 lots of 10% to five lots of 1%. Coupled with a large number of zeros, this method had the potential for errors to arise.

(f) Many students made a good attempt at this 'evaluation' question based on LCAs.

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A Level 2 answer (three or four marks) involved comparing the two types of carrier bag qualitatively, e.g. ‘more waste is generated from the production of one disposable bag compared with a bag for life’ and addressing both waste and carbon dioxide. Around 60% of students fell into this category.

Some students (around 14 %) achieved Level 3 (five or six marks) for going a step further and involving calculations such as ‘around two and a half times as much waste is generated from the production of one disposable bag compared with a bag for life’. In addition both waste and carbon dioxide had to be addressed quantitatively. Also, a judgement needed to be made, either saying which type of bag was better, with reasons why, or giving the pros and cons of both types of bag.

Students whose answers were Level 1 standard (one or two marks) tended to discuss only one aspect of the information given, or to ignore the information altogether and write something from their own knowledge.

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