AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.3.1 CHANGES OF STATE AND THE PARTICLE MODEL (PACK 2)

SCORE	PERCENTAGE
/131	%

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Q1.

(a) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

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

1–2

No relevant content

0

Indicative content

- measure mass
- use a top pan balance or scales

- part fill a measuring cylinder with water
- measure initial volume
- place object in water
- measure final volume
- volume of object = final volume − initial volume

- fill a displacement / eureka can with water
- water level with spout
- place object in water
- collect displaced water
- measuring cylinder used to determine volume of displaced water

- use of:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(b) all *y*-axis values correct (minimum of 3)

*allow **1** mark for two correct values*

2

all bars drawn to the correct height

*allow **1** mark for two correct bars*
allow ± ½ small square

2

(c) $\frac{(1120 - 960)}{2}$

ignore + and / or − signs

1

= 80 (kg/m^3)

*an answer of 160 scores **1** mark*

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1

*an answer of 80 scores **2** marks*

[12]

Q2.

(a) (use a) displacement / eureka can filled with water

1

collect the water that is displaced (by the stone)

1

measure volume of water with a measuring cylinder

1

or

(use a) measuring cylinder of water (1)

take a start and end level of the water (in the measuring cylinder) (1)

allow idea of measure how far water has risen from original level

calculate volume of water rise (1)

(b) Vernier callipers

1

(c) 11.2 (cm^3)

allow 11

1

(d) $\frac{56}{11.2}$

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

1

5(.0)(g/cm^3)

1

*an answer of 5(.0) scores **2** marks*

(e) haematite

1

[8]

Q3.

(a) ice
water
steam

*allow **1** mark for 1 or 2 correct answers*

2

(b) 1 kg of steam

1

(c) steam

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1

(d) ρ = 11 200 / 12.0

1

ρ = 933 (kg/m^3)

*an answer of 933 (kg/m^3) scores **2** marks*

1

(e) the internal energy of the iceberg increases

allow there is a temperature difference between ice and water / air

1

because

therefore

energy is transferred from the sea/water to the ice(berg)

1

[8]

Q4.

(a) (approximate same size particles as each other and as liquid and gas) touching

*do **not** accept particles that overlap*

1

regular arrangement (filling the square)

1

(b) condensing

1

(c) solid

1

(d) physical

1

(e) particles have more kinetic energy

1

particles move faster

1

(f) mass of the liquid

1

specific latent heat of vaporisation

1

(g) 2 × 4 200 × 80

1

672 000 (J)

*an answer of 672 000 (J) scores **2** marks*

1

[11]

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Q5.

(a) (similarity) same size / shape particles

1

(difference) further apart / fewer in same area

allow none / not many touching

1

(b) any **two** from:

- no movement shown
- atoms / molecules / ions / particles are not solid spheres
- no forces between the spheres
- only 2D

2

(c) • different forces between particles

allow substances have different types of bond

1

• (so) different amounts of energy required (to break forces)

1

(d) high(er) pressure (within fire extinguisher)

1

(e) liquid to gas

1

(f) (change from solid to liquid) 80 seconds

and

(change from liquid to gas) takes 550 seconds

1

(therefore) takes longer so more (thermal) energy is supplied (to change state)

1

(g) $1\,695\,000 = m \times 2.260 \times 10^6$

1

$$m = \frac{1\,695\,000}{2.260 \times 10^6}$$

1

0.75

*an answer of 0.75 scores **3** marks*

allow conversion of kJ to J

1

[13]

Q6.

(a) mass of oil

or

time the heater was turned on

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1

(b) 1 (°C)

1

(c) $\frac{470}{1630} \times 100$

28.8 (%)

1

or

$\frac{470}{2100} \times 100$

22.4 (%)

1

(d) insulate the beaker

or

add a lid

1

use a smaller heater

or

submerge heater fully in oil

1

(e) any **two** from:

- density / mass (of the metal)
- reactivity (of the metal)
- toxicity (of the metal)
- strength / hardness (of the metal)
- thermal conductivity (of the metal)
- corrosion resistance (of the metal)

2

[8]

Q7.

(a) **Level 3 (5–6 marks):**
A clear, logical explanation containing accurate ideas presented in the correct order with links between ideas.

Level 2 (3–4 marks):
Key ideas presented with some linked together to form a partial explanation.

Level 1 (1–2 marks):
Fragmented ideas, some may be relevant, insufficient links to form an explanation.

0 marks:
No relevant content.

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Indicative content

- current in the wire causes heating
- increases temperature of the metal wires / ice

Solid

- arrangement of particles is regular
- particles vibrate about a fixed position

Melting

- internal energy of the ice increases, increasing the temperature to melting point
- so (as the temperature increases) particles vibrate faster
- eventually particles vibrate fast enough to break free from the (strong) bonds
- therefore the arrangement of particles becomes irregular

Liquid

- arrangement of particles is irregular
- particles movement (translational) is random

6

(b) The current in the heating element

1

The mass of ice

1

(c) latent heat of fusion

1

45 / 120 = 0.375

1

0.38

*allow 0.38 with no working shown for **2** marks*
*allow 0.375 with no working shown for **1** mark*

1

[11]

Q8.

(a) random

accept in all directions

1

description must be of random motion

(b) heating increases the temperature of the gas

1

temperature is proportional to kinetic energy

1

if kinetic energy increases speed increases

1

(c) energy is needed to change the state of the water

1

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to break the bonds

1

(d) $1000 = m / 2.5 \times 10^{-5}$

1

$m = 2.5 \times 10^{-5} \times 1000$

1

$m = 0.025$ (kg)

1

$E = 0.025 \times 2\,260\,000$

1

$E = 56\,500$ (J)

1

*allow 56 500 (J) without working shown for **5** marks*
***0** marks awarded for $E = m \times L$*

(e) any **four** from:

- because the water is preheated) the change in temperature of the water is less
- so less energy is used to heat the water ($E=mc\Delta\theta$)
- therefore they (condensing boilers) are more efficient
- so less energy is wasted
- less gas is burned to heat the same amount of water
- less waste gas (CO_2) is produced by the boiler **or** (because less gas is used) they are cheaper to run / save money

4

[15]

Q9.

(a) density = mass / volume

1

(b) any **two** from:

- no forces shown between spheres
- atoms / molecules / ions are not solid spheres
- not all the same size.

2

(c) at higher temperatures particles have more kinetic energy

1

(so) the (average) speed of the particles increases

1

(so there are) more frequent collisions with the wall of the container

1

which apply a greater force on wall of container (so pressure rises)

1

[7]

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Q10.

(a) most alpha particles went straight through, suggesting lots of empty space

1

a few alpha particles bounced back, suggesting small central nucleus

1

with all the positive charge

1

the plum pudding model does not explain the results because it shows the whole atom as a ball of positive charge with no empty space

1

(b) the figures show that the radius of an atom is 10 000 times bigger than the nucleus

1

consistent with the nuclear model, which says that the atom has a tiny nucleus at the centre of the atom

1

(c) all hydrogen atoms have just one proton (in the nucleus)

1

some hydrogen atoms also have one neutron

1

protons and neutrons have the same relative mass so mass number of these atoms is 2

1

(d) neutrons are not attracted or repelled by a positive nucleus

1

so the neutrons would all pass through the foil

1

[11]

Q18.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

0 marks
No creditworthy response

Level 1 (1 – 2 marks)
At least **one** relevant statement is made

Level 2 (3 – 4 marks)
Relevant statements are made about two of the states
or
a relevant statement is made about each state

Level 3 (5 – 6 marks)
Relevant statements are made about each of the three states

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Examples of the Physics points made in the response:

ignore statements about the states of matter

*a description without mention of particles, but clearly about particles, can gain **max** 4 marks*

solids:

- arranged in a regular pattern
  allow closely / tightly packed / compact
- particles vibrate about fixed points
  allow cannot move freely / around
- particles have low energy.

liquids:

- pattern is irregular
  allow close together
- particles are not fixed in place **or** can move freely / around
- particles have more energy than solids and / or less energy than gases.

gases:

- particles are in a random pattern
  allow far apart
- particles move (about) freely / randomly
  allow move fast(er)
- particles have high energy.

[6]

Q19.

(a) condensation

1

(b) larger (exposed) surface area

1

(so) water can evaporate faster
or
(so) more water (molecules) can escape
allow more water can evaporate

1

[3]

Q20.

(a) balls are far apart from each other

1

balls move randomly

1

(b) solid

1

gas

1

[4]

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Q21.

(a) energy transferred from athlete / skin / body to water / sweat

allow water / sweat heated by athlete

1

(so) more energetic (water / sweat) particles escape (from the liquid)

accept particles with higher speeds escape (from the liquid)

1

water / sweat <u>evaporates</u>

accept particles escape from the (surface of the) liquid

1

(which) lowers the <u>average</u> energy of (remaining) water / sweat particles

allow reference to the total energy of the liquid reducing

allow lowers the athlete's <u>temperature</u>

ignore cool down

1

(b) any **three** from:

accept IR / radiation / heat / infrared / energy throughout

- the blanket traps air
- air is an insulator

  accept for 2 marks trapped air reduces conduction / convection
- space blanket reflects infrared radiation (back to the body)

  ignore incident solar radiation

  ignore reflects light

  ignore bounces off
- space blanket is a poor emitter / radiator of infrared radiation

  *do **not** accept does not emit infrared radiation*

3

[7]

Q22.

(a) (liquid C)

no mark awarded for stating liquid C

no marks awarded if liquid A or B chosen

(causes) biggest temperature decrease

allow cools quicker / the quickest

1

(because it) evaporates quickest

allow evaporates quicker

allow most / more evaporated

ignore references to boiling

1

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(b) all of the liquid has evaporated

accept no net energy transfer

allow it was dry

1

(c) particles with most energy / highest speed evaporate

allow hottest particles

1

these particles escape from the (surface of the) liquid

accept overcoming the attractive forces (between particles)

1

decreasing mean energy of particles (left in liquid)

allow some reference to the total energy of the liquid reducing

1

which lowers the temperature

ignore cool down

1

[7]

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Q1.

Foundation

(a) This levels of response question had three tiers. When students are asked to describe a plan or method, their answer must contain all of the key steps in a logical sequence and lead to a valid outcome. This practical is one of the required practicals on the specification, so a displacement technique should have been described by students but this was not always the case. To achieve a level 3 response students should state:

- the variables are to be measured
- the measuring instruments to be used
- how the measurement is to be made
- how the gathered data is to be processed.

Some students described the method without stating that the volume of the displaced water would equal the volume of the object. Measuring cylinders did not always get a mention with a significant number assuming that beakers would give an accurate enough measurement. Whilst some described how the object needed lowering carefully into the water to avoid splashes and excess spillage, others would have obtained very inaccurate measurements by collecting what overflowed from buckets and bowls. Some went no further than the volume measurement which was occasionally described as the density. 'Weighing' the object to get the mass, often without a mention of a balance or scales, was common.

There were some methods described which would not work, such as measuring dimensions, timing falls, or checking for sinking and floating. Some students described melting, smashing and breaking the object.

Very few students we able to write an answer which would lead to a valid outcome, with key steps identified and logically sequenced. Just over a third of students scored zero.

(b) 57% of the students scored at least 2 marks with 39% gaining full marks but 17% did not score on this question and 5% made no attempt. There were some good answers putting 0, 250, 500 etc. on the y axis and accurate plotting of the three bars required.
Some students put too many values on the *y*-axis making it difficult to judge if they were correct and giving more chance of getting one or more of the values wrong.

(c) Only a small minority of students scored both marks and over two-thirds scored zero. It was possible to get the correct answer of 80 in a variety of ways and students did so but the concept of uncertainty seemed to be poorly understood.

Higher

(a) This levels of response question had three tiers. When students are asked to describe a plan or method, their answer must contain all of the key steps in a logical sequence and lead to a valid outcome. This practical is one of the Required Practical Activities on the specification, so a displacement technique should have been described but this was not always the case. To achieve a level 3 response students should state:

- the variables to be measured
- the measuring instruments to be used

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- how the measurement is to be made
- how the data gathered is to be processed.

Some students described the method without stating that the volume of the displaced water would equal the volume of the object. Measuring cylinders did not always get a mention with a significant number assuming that beakers would give an accurate enough measurement. Whilst some described how the object needed lowering carefully into the water to avoid splashes and excess spillage, others would have obtained very inaccurate measurements by collecting what overflowed from buckets and bowls. Some went no further than the volume measurement which was occasionally described as the density. 'Weighing' the object to get the mass, often without a mention of a balance or scales, was common.

There were some methods described which would not work, such as measuring dimensions, timing falls, or checking for sinking and floating. Some students described melting, smashing and breaking the object.

25% of students we able to write an answer which would lead to a valid outcome with key steps identified and logically sequenced and were judged to have written a level 3 response. A further quarter of students achieved a level 2 mark. Level 1 was awarded to 30%. A significant minority scored zero or did not attempt the question.

(b) 67% of the students scored full marks. There were good answers putting 0, 250, 500 etc. on the *y*-axis and accurate plotting of the three bars required.

Some students tried to put far too many values on the *y*-axis making it difficult to judge if they were correct and giving more of a chance of getting one or more of the values wrong.

(c) Only a fifth of students gained both marks and just over half scored zero. It was possible to get the correct answer of 80 in a variety of ways, and students did, but the concept of uncertainty seemed to be poorly understood.

Q2.

(a) This question on a Required Practical Activity was not answered well with 62% of students unable to achieve any marks. A 'measuring jug' was the most common piece of equipment used.

Most students seemed to know that there has to be water displacement and so the second marking point of either method was the one most often awarded.

Whichever route they took, it was the third marking point they seldom gained as calculating or measuring volume with a measuring cylinder was not referred to by most students. Answers such as 'measure the water' or 'find the difference' were more common.

(b) The full range of answers were seen in this question, with 30% of students choosing correctly.

(c) 85% of students were able to calculate volume using the equation given.

(d) 77% of students achieved full marks for calculating density. 11% of students did not attempt this question.

(e) 81% of students were able to interpret the data given to correctly identify haematite.

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Q18.

In this QWC question students were asked to compare solids, liquids and gases in terms of the arrangement, movement and energy of their particles. Many students had not read the question carefully and did not compare all three states. Others just wrote about the properties of solids, liquids and gases, rather than the particles. A good tip for students is to underline important instructions and words in the question, and use these to check that they have answered the question fully.

Quite a lot of students sitting the Foundation paper used the drawings to help them to describe the arrangement of particles. However, 'they are arranged in rows in a solid', 'solids have a better arrangement of particles' or 'there are only a few particles in a gas' were insufficient. Some students described conduction and convection, or melting and evaporation. Quite a lot of students were confused about the energy of the particles. They thought there would be a lot of friction between the particles in a solid, which would increase their energy.

Good responses were usually set out logically, for example describing solids in terms of arrangement, movement and energy of the particles, followed by liquids and gases. Alternatively, some students described the comparative arrangement of particles in all three states, and then went on to compare them in terms of their movement and energy.

Q19.

(a) Two thirds of the students answered the question correctly, saying 'condensation'. The most common incorrect response was 'evaporation'.

(b) Very few students gained 2 marks for this question. Half of the students gained the first marking point for the idea that the towel on the rail would have a larger surface area. This was often described as being spread out more, which was credited. For the second mark a comparison was needed in relation to evaporation being faster, or more water evaporating or escaping. Some students said more air would be able to get to the towel, but didn't link this to evaporation, so did not gain this mark. Reference to the towel drying faster was often given, but as this was stated in the question it was not creditworthy.

Q20.

(a) Most students could recognise how the model represented the movement of particles in a gas. Some had not followed the instructions and ticked more than two boxes.

(b) Many students misinterpreted the question stem, or did not understand what a state of matter is, and answered yes or no. Some gave air instead of gas.

Q21.

(a) Many responses included biological explanations of thermoregulation, much of which did not relate to this question. Few students mentioned that energy is transferred from the athlete to the sweat. Some explained that the particles would gain energy, but did not go on to say that the most energetic or fastest particles would escape. The third marking point was the one that most students gained, for stating that the sweat evaporated. However, many thought that particles evaporated, rather than the liquid. Reference to lowering the average energy of the particles that were left on the skin was rarely seen. "Lowering temperature" was seen more often.

(b) Most students gained a mark for saying that the foil blanket would reflect energy

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back to the athlete, although others thought it would reflect radiation from the Sun, which was ignored. Some mentioned that shiny surfaces are poor emitters of infrared radiation, but students could not gain this mark if they said no energy was emitted. The idea that air was trapped by the blanket was rarely seen.

Q22.

(a) A large number of students gave liquid A as their answer, so gained zero marks. The most common correct answer was that liquid C cooled the quickest. Some thought it was being heated and there were a lot of references to boiling.

(b) Very few students gave a correct response. Most said that the room temperature prevented it cooling further, or that room temperature was 7 °C. There were many incorrect references to boiling or freezing points, condensing and turning to a liquid. A poor understanding of cooling by evaporation and change of state was demonstrated.

(c) Many students did not understand the graph which led to confused responses. It was clear that evaporation is not well understood. Few students realised that the particles with the most energy evaporated. The most common mark gained was for particles escaping from the liquid. Some students gave descriptions referring to the total energy of the liquid reducing but few went on to mention that this lowered the temperature of the liquid. They usually just repeated information given in the question and said the liquid cooled down, which was not enough for the last marking point.

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