AQA GCSE PHYSICS (HIGHER) · 8463

# PHYSICS



## MARK SCHEME

### 4.3.1 CHANGES OF STATE AND THE PARTICLE MODEL (PACK 1)

| SCORE | PERCENTAGE |
| --- | --- |
| /134 | % |

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## Q1.

(a) **Level 2:** The method would lead to the production of a valid outcome. 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**

- 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

(b) $\text{density} = \frac{48.6}{18.0}$

**1**

density = 2.70 (g/cm$^3$)

**1**

*an answer of 2.70 (g/cm$^3$) scores **2** marks*

(c) limestone

**1**

(d) eye position when using measuring cylinder
**or**
water level in can (at start) not at level of spout
**or**
not all water displaced by stone is collected in container

**1**

(e) volume would be lower / higher

**1**

**[9]**

## Q2.

(a) $1.2 = \frac{m}{2.3 \times 10^4}$

**1**



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$m = 1.2 \times 2.3 \times 10^4$

1

$m = 27\,600$ (kg)

*allow an answer of 28 000 (kg) or $2.8 \times 10^4$ (kg)*

**or**

$m = 2.76 \times 10^4$ (kg)

1

*an answer of 27 600 (kg) scores **3** marks*

(b) mass of air passing the turbine blades is halved which decreases kinetic energy by a factor of two

1

(wind speed is halved) decreasing kinetic energy by a factor of four

1

so kinetic energy decreases by a factor of eight

1

*allow power output for kinetic energy throughout*

(c) $388\,000 = 0.5 \times 13\,800 \times v^2$

*this mark may be awarded if P is incorrectly / not converted*

1

$$v^2 = \frac{(2 \times 388\,000)}{13\,800}$$

*this mark may be awarded if P is incorrectly / not converted*

**or**

$$v^2 = \frac{388\,000}{(0.5 \times 13\,800)}$$

**or**

$v^2 = 56.2$

1

$v = 7.50$ (m/s)

*an answer that rounds to 7.50 (m/s) only*

1

**[9]**

## Q3.

(a) minimum distance between wind turbines is at least 500 m in all directions

*turbines can rotate to face into wind and still maintain the minimum distance*

1

(b) density = mass/volume

*allow $\rho = m / V$*



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1

(c) $1.2 = \frac{51000}{V}$

1

$V = \frac{51000}{1.2}$

1

V = 42 500

1

V = 43 000

1

$m^3$

*an answer of 43 000 scores **4** marks*
*an answer of 42 500 scores **3** marks*

1

(d) $2.4 \times 10^9 / 1.6 \times 10^6$

1

1500

*an answer of 1500 scores **2** marks*

1

(e) wind power is unreliable

1

(very) large numbers of wind turbines would need to be constructed

*allow calculation of this (15 625)*

1

**[11]**

## Q4.

(a) Student A's measurements had a higher resolution

1

Student B was more likely to misread the temperature

1

(b) a random error

1

(c) 8.4 °C

1

(d) 740 (seconds)

*allow answers in the range 730 – 780*

1

(e) 0.40 × 199 000

1

79 600 (J)



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1

*accept 79 600 (J) with no working shown for **2** marks*

(f) stearic acid has a higher temperature than the surroundings

*accept stearic acid is hotter than the surroundings*

1

temperature will decrease until stearic acid is the same as the room temperature / surroundings

1

**[9]**

## Q5.

(a) range of speeds

1

moving in different directions

*accept random motion*

1

(b) internal energy

1

(c) density = mass / volume

1

(d) 0.00254 / 0.0141

1

0.18

1

*accept 0.18 with no working shown for the **2** calculation marks*

kg / $m^3$

1

**[7]**

## Q6.

**Level 3 (5–6 marks):**
Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.

**Level 2 (3–4 marks):**
Clear description of one method to measure density **or** partial description of both methods. Steps may not be logically ordered.

**Level 1 (1–2 marks):**
Basic description of measurements needed with no indication of how to use them.

**0 marks:**
No relevant content.

**Indicative content**



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**For both:**
- measure mass using a balance
- calculate density using ρ = m / V

**Metal cube:**
- measure length of cube's sides using a ruler
- calculate volume

**Small statue:**
- immerse in water
- measure volume / mass of water displaced
- volume of water displaced = volume of small statue

**[6]**

## Q7.

(a) dependent

**1**

(b) (probe) C

*allow 103.2*

**1**

largest difference between reading and actual temperature

*reason only scores if C chosen*
*accept larger*
*it is 3.2 greater is insufficient*
*comparing C with only one other probe is insufficient*

**1**

(c) (i) 12(°C)

*accept a value between 12.0 and 12.2 inclusive*

**1**

(ii) 140 (seconds)

*accept an answer between 130 and 150 inclusive*

**1**

<u>temperature</u> starts to rise

*only scores if time mark awarded*
*accept the <u>temperature</u> was lowest (at this time)*

**1**

(iii) increase

*accept faster (rate)*

**1**

**[7]**

## Q8.

(a) **solid**
<u>particles</u> vibrate about fixed positions

**1**

closely packed

*accept regular*



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1

**gas**
particles move randomly
*accept particles move faster*
*accept freely for randomly*
1

far apart
1

(b) amount of energy required to change the state of a substance from liquid to gas (vapour)
1

unit mass / 1 kg
*dependent on first marking point*
1

(c) 41000 **or** $4.1 \times 10^4$ (J)
*accept*
*41400 or* $4.14 \times 10^4$
*correct substitution of*
*0.018 × 2.3 ×* $10^6$ *gains **1** mark*
2

(d) **AB**
changing state from solid to liquid / melting
1

at steady temperature
*dependent on first **AB** mark*
1

**BC**
temperature of liquid rises
1

until it reaches boiling point
*dependent on first **BC** mark*
1

**[12]**

## Q9.

(a) (black) is a good absorber of (infrared) radiation
1

(b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)
*melt is insufficient*
1

unit mass / 1kg
1

(ii) $5.1 \times 10^6$ (J)



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*accept 5 x $10^6$*
*allow **1** mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$*

**2**

(c) (i) mass of <u>ice</u>
*allow volume / weight / amount / quantity of <u>ice</u>*

**1**

(ii) to distribute the salt throughout the ice

**1**

to keep all the ice at the same temperature

**1**

(iii) melting point decreases as the mass of salt is increased
*allow concentration for mass*
*accept negative correlation*
*do **not** accept inversely proportional*

**1**

(d) 60 000 (J)
*accept 60 KJ*
*allow **2** marks for correct substitution ie $E = 500 \times 2.0 \times 60$*
*allow **2** marks for an answer of 1000 **or** 60*
*allow **1** mark for correct substitution ie*
*$E = 500 \times 2.0$ **or** $0.50 \times 2.0 \times 60$*
*allow **1** mark for an answer of 1*

**3**

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

**0 marks**
No relevant content

**Level 1 (1–2 marks)**
There is *an attempt at a description of some advantages or disadvantages.*

**Level 2 (3–4 marks)**
*There is a basic description* of *some advantages **and** / **or** disadvantages for some of the methods*

**Level 3 (5–6 marks)**
There is a clear description of the advantages and disadvantages of all the methods.

**examples of the points made in the response**
***extra information***

**energy storage**

advantages:

- no fuel costs
- no environmental effects



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disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

**salt spreading**

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

**undersoil heating**

advantages:

- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

**6**

**[18]**

## Q10.

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 also apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content.

**Level 1 (1–2 marks)**
Considers either solid or gas and describes at least one aspect of the particles.

**or**

Considers both solids and gases and describes an aspect of each.

**Level 2 (3–4 marks)**
Considers both solids and gases and describes aspects of the particles.

**or**

Considers one state and describes aspects of the particles and explains at least one of the properties.

**or**



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Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

**Level 3 (5–6 marks)**
Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

**examples of the points made in the response**

***extra information***

**Solids**

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

*any explanation of a property must match with the given aspect(s) of the particles.*

**Gases**

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container)

**[6]**

## Q11.

(a) (i) 70

*accept ± half a square*
*(69.8 to 70.2)*

**1**

(ii) 15

*accept 14.6 to 15.4 for **2** marks*
*allow for **1** mark 70 − 55*
*ecf from (b)(i) ± half a square*

**2**

(iii) C

**1**

biggest drop in temperature during a given time

*accept it has the steepest gradient this is a dependent*

**1**

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

**1**

(v) because 20 °C is room temperature

*accept same temperature as surroundings*



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1

(b) (i) 6720

*correct answer with or without working gains **3** marks*
*6 720 000 gains **2** marks*
*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*
*correct substitution of E = 200 × 4200 × 8 gains **1** mark*

3

(ii) the fastest particles have enough energy

*accept molecules for particles*

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

*accept speed for energy*

1

the lower the mean energy of particles the lower the temperature (of the water)

*accept speed for energy*

1

**[14]**

## Q12.

(a) (i) Z

1

(ii) X

1

(b) (i) moving randomly

1

(ii) stronger than

1

(c) (i) evaporation

1

(ii) any **one** from:

- becomes windy
- temperature increases

*accept (becomes) sunny*
*"the sun" alone is insufficient*

- less humid

1

**[6]**

## Q13.



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(a) there are strong forces (of attraction) between the particles in a solid

*accept molecules / atoms for particles throughout*
*accept bonds for forces*

**1**

(holding) the particles close together

*particles in a solid are less spread out is insufficient*

**1**

**or**

(holding) the particles in a fixed pattern / positions

but in a gas the forces between the particles are negligible

*accept very small / zero for negligible*
*accept bonds for forces*

**1**

so the particles spread out (to fill their container)

*accept particles are not close together*
*gas particles are not in a fixed position is insufficient*

**1**

(b) (i) particles are (shown) leaving (the liquid / container)

*accept molecules / atoms for particles throughout*
*accept particles are escaping*
*particles are getting further apart is insufficient*

**1**

(ii) *accept molecules / atoms for particles throughout*
*accept speed / velocity for energy throughout*

particles with most energy leave the (surface of the) liquid

*accept fastest particles leave the liquid*

**1**

so the mean / average energy of the remaining particles goes down

**1**

and the lower the average energy (of the particles) the lower the temperature (of the liquid)

**1**

**[8]**

## Q14.

(a) (i) random distribution of circles in the box with at least 50 % of circles touching

**1**

random distribution of circles occupies more than 50 % of the space

*judged by eye*

**1**

(ii) (large) gaps between particles

*accept particles do not touch*
*accept particles are spread out*

**1**



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(so) easy to push particles closer (together)
**or**
forces between particles are negligible / none

*an answer in terms of number of particles is insufficient*

**1**

(b) (i) (both are) random

*accept a correct description of random eg unpredictable or move around freely or in all directions*

*they take up all the space is insufficient*

*they are spread out is insufficient*

*they move in straight lines is insufficient*

**1**

(ii) (speed also) increases

**1**

**[6]**

## Q15.

(a) ions / electrons gain (kinetic) energy

*accept atom / particles / molecules for ion*
*accept ions vibrate faster*
*accept ions vibrate with a bigger amplitude*
*accept ions vibrate more*
*do not accept ions move faster*

**1**

(free) electrons transfer energy by collision with ions
**or** energy transferred by collisions between vibrating ions

**1**

(b) move faster or take up more space

*do **not** accept start to move / vibrate*

**1**

(warmer) water expands **or** becomes less dense (than cooler water)

*do **not** accept answers in terms of particles expanding*

**1**

warm water rises (through colder water) **or** colder water falls to take its place

**1**

(c) transfer of energy by waves / infrared (radiation)

*accept rays for waves*

*do **not** accept transfer of energy by electromagnetic waves*

*ignore reference to heat*

**1**

**[6]**



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