AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.3.2.2 TEMPERATURE CHANGES IN A SYSTEM AND SPECIFIC HEAT CAPACITY (PACK 2)

SCORE	PERCENTAGE
/90	%

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Q1.

(a) *x*-axis labelled **and** suitable scale

1

points plotted correctly

*allow 5 correctly plotted for **2** marks, 3−4 correctly plotted for **1** mark*
allow ± ½ square

2

line of best fit

1

(b) $\frac{4.5}{60}$

*allow ecf from line of best fit in part **(a)***

1

0.075 (°C/s)

1

*an answer of 0.075 (°C/s) scores **2** marks*

(c) $\Delta\theta$ = 11.5 (°C)

a calculation using an incorrect temperature scores max 3 marks

1

ΔE = 1.50 × 900 × 11.5

1

ΔE = 15 525 (J)

1

ΔE = 15.525 (kJ)

1

*an answer of 15.525 (kJ) **or** 15.53 (kJ) **or** 15.5 (kJ) scores **4** marks*

*an answer of 15 525 (kJ) scores **3** marks*

(d) any **two** from:

- mass of block*
- size / dimensions of block*
- material of block*

allow same block for **1 mark*

- current through heater

allow power of heater

- thickness of insulation*
- material of insulation*

allow same insulation for **1 mark*

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- time interval
- starting temperature (of block / heater)

2

[12]

Q2.

(a) 80 °C

1

ΔE = 0.5 × 3400 × 80

1

ΔE = 136 000 (J)

*an answer of 136 000 (J) scores **3** marks*

1

(b) energy is dissipated into the surroundings

allow any correct description of wasted energy

1

(c) put a lid on the pan

allow any sensible practical suggestion
eg add salt to the water

1

(d) efficiency = 300/500

1

efficiency = 0.6

*an answer of 0.6 or 60% scores **2** marks*
allow efficiency = 60%
*an answer of 0.6 with a unit scores **1** mark*
*an answer of 60 without a unit scores **1** mark*

1

(e) lower rate of energy transfer

1

(so) potato soup will remain at a higher temperature

1

[9]

Q3.

(a) 80

1

E = 5.0 × 4200 × 80

1

E = 1 700 000 (J)

an answer of 1 700 000 (J) or
*1 680 000 (J) scores **3** marks*
allow 1 680 000

1

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(b) in part **A** the increase in internal energy raises the temperature of the water

1

in part **B** the increase in internal energy changes the state

1

without changing the temperature

1

(c) the heater would continue to transfer energy which would not be transferred to the water

1

so would raise the temperature of the device

1

causing it to be damaged

1

(d) brown

blue

green and yellow stripes

*allow **1** mark for 2 correct*

2

(e) it stops the casing of the appliance becoming live

1

(f) $P = I^2R$

$I = \sqrt{(P/R)}$

1

P = 2 500 (W)

1

$I = \sqrt{(2\ 500 / 17)}$

1

I = 12.1267812

1

I = 12 (A)

*an answer of 12 (A) scores **5** marks*

1

[17]

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

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(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]

Q5.

(a) mass of oil

or

time the heater was turned on

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

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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]

Q6.

(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

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

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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]

Q29.

(a) so it is a good insulator

ignore references to efficiency

allow low (rate of) energy / 'heat' transfer

*do **not** accept prevents energy transfer*

1

(b) air is a(n) (good) insulator

allow air is a poor conductor

1

(so) air reduces conduction

*do **not** allow stops conduction*

1

trapped air / air bubbles reduce(s) / stop(s) convection

1

(c) any **three** from:

- ice-pack is (much) colder than the cool box contents
- ice-pack reduces the (overall) temperature of the cool box / air (in the cool box)
- ice pack requires a lot of energy to heat up / increase temperature / change temperature

  allow 'heat' for energy
- ice-pack requires heating up before the cool box contents warm up

  allow 'heat' for energy
  allow ice-pack takes a long time to heat up / increase temperature / change temperature
- ice-pack cools the air which becomes more dense and sinks

  allow ice-pack cools the air and causes (a) convection (current)

  accept energy / 'heat' is needed to melt the (contents of the) ice-pack

3

[7]

Q30.

(a) 400(kWh)

*65850 – 65450 gains **1** mark provided no subsequent step shown*

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2

(b) (i) reflectors

1

(ii) insulator

1

(c) 100 000(J)

*correct substitution i.e.50 × 1000 × 2 gains **1** mark provided no subsequent step shown*

2

[6]

Q31.

(a) water

allow H_2O / OH_2

1

(b) water (filled heater)

allow 3kW

1

highest power (output) / most powerful / highest number of watts

only scores if first marking point correct

allow highest energy / heat <u>output</u>

allow has more power

ignore stores most energy /references to heat

1

(c) $E = m \times c \times \theta$

27 000

*allow **1** mark for correct substitution into correct equation:*

2 × 900 × 15

or

2000 × 900 × 15

or

27 000 000

2

[5]

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Q1.

Foundation

(a) Most students made a good attempt at selecting a linear scale and labelling the x-axis. The label should include the unit.

Plotting was generally correct on major gridlines, but many plotting mistakes were seen. The line of best fit was a smooth curve in this instance. Straight lines of best fit and dot-to-dot did not gain the fourth marking point.

This question discriminated well with 82% of students achieving some credit, and 42% achieving three or four marks.

(b) 2% of students could calculate the gradient of the graph. Students need to ensure they bring a calculator to the exam so as not to be disadvantaged in these calculation questions. When attempted, a single value was often read from each axis, and then divided.

Students did not appear to notice that the *y*-axis does not begin at zero, requiring a difference between two points on each axis to be determined before dividing.

(c) Many students used the final temperature, rather than calculating the temperature change. Three out of four marks were still available for subsequent stages if the correct method was used. Answers frequently used the time in seconds, rather than the temperature change. Again, subsequent marks were available.

Most students did not attempt the unit conversion from joules to kilojoules. Of those who attempted the unit conversion, as many multiplied by 1000, as divided by 1000.

(d) Students could generally give one control variable (29% of students), but few (11%) gave two correctly. Many incorrect answers of ‘temperature’ unqualified were seen. At this level, simple statements to keep it a fair test, or to use the same equipment, with no detail given, are insufficient.

Higher

(a) Most students could choose a sensible linear scale and label the *x*-axis. Some errors in plotting were seen. The line of best fit was a smooth curve in this instance. Straight lines of best fit and dot-to-dot did not gain the fourth marking point. 75% of students achieved three or four marks.

(b) 79% of students could not calculate the gradient. Some students attempted to count the squares of the graph paper to calculate the gradient, rather than use the appropriate scale.

Students were expected to calculate the gradient in ‘°C/second’ because seconds were the unit of time provided, however, some students calculated the gradient in ‘°C/minute’. This could achieve full marks if the method was clear. Just calculating the change in temperature was insufficient.

(c) 53% of students could calculate the change in thermal energy using the equation on the Physics Equations Sheet, although some did attempt to use an incorrect equation. Errors in calculating the temperature change were frequent. Unit

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conversion from joules to kilojoules was generally correct when attempted.

(d) 32% of students could state two control variables. however students should be aware that general statements regarding keeping equipment the same are insufficient. The answer should apply to the investigation given in the question.

Q29.

(a) Some students lost marks because the response needed to specify a good insulator, rather than insulator alone. Many students implied that no energy would be transferred, which is incorrect. There were many poorly phrased responses such as “To keep heat out”, “To stay cool” or “To increase efficiency”, all of which were ignored.

(b) The question instructed students to refer to the processes of heat transfer in their answer. Some students mentioned all three processes, whilst others mentioned none. Comments relating to infrared radiation were ignored as there was no mention of surface colour in the question. “Air is a poor conductor” was frequently seen, but was often followed by air stopping conduction, which is incorrect. Several students thought heat transfer would be stopped or that particles of energy were trapped, both of which were ignored. Few students referred to convection, but “Convection is stopped” was credited, as the trapped air cannot move even though convection would still occur within the air bubbles themselves. There were several references to air being a vacuum.

(c) Only a fifth of students scored any marks on this question. Many students made no reference to the ice-pack but instead continued with the ideas in part(b) about insulation. Many of these answers included confused descriptions of the insulation preventing the cold, or cold energy escaping. A few students gained a mark for saying that its high specific heat capacity would mean a lot of energy would be needed to increase the temperature of the ice-pack. Others gave a description of convection within the cool box, although some thought the ice-pack released cold air or cool particles. Many misconceptions related to energy transfer were seen.

Q30.

(a) Three quarters of the students correctly calculated the number of kilowatt-hours of electricity used in April. Some just gave the reading for the end of April, without carrying out a subtraction. A common error was to add the two readings together, instead of subtracting them.

(b) (i) Around three quarters of the students said shiny surfaces are good reflectors of infrared radiation.

(ii) Around three quarters of the students knew that air is a good insulator.

(c) Almost half of the students gained full marks for this calculation. A few students gained 1 mark for showing the correct working. Often students made an error when writing their final answer by missing a zero off. A few multiplied the mass of the air by its specific heat capacity, but then divided this by the temperature change instead of multiplying.

Q31.

(a) Most students correctly selected water as storing the most energy.

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(b) Whilst most students correctly chose the water-filled heater, many students failed to identify the highest power output as the reason, despite the stem of the question stating that the power output was shown. Many students answered in terms of it having the most energy. Some students just gave the heater as being a radiator, rather than naming it, which could not be credited. Students should be encouraged to use the language given in the question.

(c) Almost a third of students gained full marks for this question. Students who presumably did not have a calculator often gave an incorrect number of zeros, but had attempted to use the correct equation.

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