AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



MARK SCHEME

4.1.1.3 ENERGY CHANGES IN SYSTEMS (PACK 1)

SCORE	PERCENTAGE
/167	%

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Q1.

(a) biofuel

1

geothermal

1

(b) it is predictable

1

(c) 2.8 MW

1

(d) any **two** from:
- visual pollution
- noise pollution
- dangerous to birds
- may lower house prices

2

(e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- less fossil fuel burnt
- more nuclear fuel used
- more renewables used
- gas remained the same
- less carbon dioxide released
- less greenhouse gases
- less global warming
- less acid rain
- less environmental pollution
- more hazardous waste produced (nuclear)
- the percentage generated by coal has decreased 8%
- the percentage generated by renewables has increased by 6%
- the percentage generated by nuclear has increased by 2%

[10]

Q2.

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

1

points plotted correctly

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*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*

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

2

[12]

Q3.

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

1

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(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

allow their calculated
P_{input} = 36 × 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]

Q4.

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(a) kinetic energy = 0.5 × mass × (speed)^2

allow $E = \frac{1}{2}mv^2$

1

(b) 0.5 × 9000 × 30^2

1

4 050 000

1

4050 (kJ)

*an answer of 4050 (kJ) scores **3** marks*

*an answer of 4 050 000 scores **2** marks*

1

(c) efficiency =

$$\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

1

(d) $$0.80 = \frac{\text{useful output energy transfer}}{4050}$$

allow ecf from (b)

1

(useful output energy transfer =) 0.80 × 4 050

1

= 3240 (kJ)

*an answer of 3240 (kJ) scores **3** marks*

1

(e)

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	3-4
Level 1: Relevant features are identified and differences noted.	1-2
No relevant content	0
Indicative content **advantages of both methods:** • both renewable sources of energy • both have no fuel (cost) • no carbon dioxide produced **advantages of wind** • higher average power output	

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advantages of hydroelectric • constant / reliable power (output) • lower (installation) cost **disadvantages of wind** • higher (installation) cost • variable / unreliable power output **disadvantages of hydroelectric** • lower power output **disadvantages of both methods** • (may be) noisy • visual pollution	

4

[12]

Q5.

(a) thermometer

1

stopclock / stopwatch

accept measuring cylinder

accept top pan balance

1

(b) independent: type of oil

1

dependent: temperature rise in °C

1

(c) wear safety goggles

1

oil not heated directly

accept any reasonable comment about not handling hot apparatus.

1

(d) repeat the experiment

1

and calculate the mean temperature rise

OR

heat the oil for a longer period of time (1)

to get a wider range of temperatures (1)

1

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(e) (17 + 17 + 18) / 3 (= 17.33)

1

temperature rise = 17 (°C)

1

*accept 17 (°C) with no working shown for **2** marks*
*allow 17.33 with no working shown for **1** mark*

(f) E = 0.025 × 1800 × 20 (J)

1

E = 900 (J)

1

*allow 900 without working shown for the **2** calculation marks*

Joule

1

[13]

Q6.

(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.

Indicative content

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

<u>Solid</u>

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

<u>Melting</u>

- 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

<u>Liquid</u>

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

6

(b) The current in the heating element

1

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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]

Q7.

(a) the store of chemical energy (in the battery) decreases

1

the internal energy of the surrounding air increases.

1

*accept description of energy becoming less usefully stored for **2** marks*

(b) kinetic energy = ½ mass × velocity^2

1

(c) $E_K = ½ \times 0.8 \times 12^2$

1

$E_K = 57.6$ (J)

1

*allow 57.6 (J) without working shown for **2** marks*

(d) lower proportion of wasted energy
accept less energy is wasted

1

higher proportion of energy is converted into <u>kinetic</u> energy
accept more kinetic energy

1

(e) **Level 2 (3–4 marks):**
A relevant and coherent argument which demonstrates processing and numerical analysis of the information presented and draw a conclusion which is logically consistent with the reasoning and refers to payback time for the vehicles.

Level 1 (1–2 marks):
Simple comparisons are made which demonstrate a basic ability to numerically analyse
the information presented. The conclusion, if present, may not be consistent with the calculations.

0 marks:
No relevant content

Indicative content

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- The electric car costs £12 000 more to buy
- Running cost of electric car = £3 000
- Running cost of petrol engine car = £24 000
- Total cost of electric car = £30 000
- Total cost of petrol engine car = £39 000
- The electric car cost £1 750 less to run each year
- The electric car will save £9 000
- Additional cost is covered in 6.9 years
- So the electric car will be cheaper over the 12 year lifetime

or

Electric
27000 / 12 = 2250
Annual cost = 2250 + 250 = 2500

Petrol
15000 / 12 = 1250
Annual cost = 1250 + 2000 = 3250

So electric is £750 cheaper per year

4

[11]

Q8.

(a) water boils at the same temperature each time

1

control starting temp by allowing enough time for water and kettle to reach room temperature

1

(b) uncertainty = (302 – 298) / 2

1

uncertainty = ± 2 (s)

ignore missing ±

1

(c) (Energy transferred = Power × time)

E = 2.20 × 300

1

E = 660 (kJ)

1

*allow 660 (kJ) without working shown for **2** marks*

*allow answer calculated using incorrect value for t (298 or 302) for **1** mark*

(d) (mass × change in temperature) / mass

*allow **1** mark for any correct pair of values from the table*

1

eg 20 / 0.25

80 (°C)

1

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*allow 80 (°C) without working shown for **2** marks*

(e) four points plotted correctly

*allow **1** mark for three correctly plotted points*

2

ecf their 5.3

allow ± 1mm

accurate line drawn

line should be straight and drawn with a ruler

1

line must not go through the origin

(f) values read correctly from graph

1

correct conversion into J

1

correct use of $\Delta y / \Delta x$

1

value in range 4200 – 4800

1

*allow value in range 4200 – 4800 without working shown for **4** marks*

(g) some of the energy supplied does not raise the temperature of the water

some of the energy is wasted is insufficient

1

(h) (the power of the kettle may not be 2.2kW)

(by measuring the power) the student can accurately calculate the amount of energy supplied to each mass of water

1

[17]

Q9.

(a) **Level 3 (5–6 marks):**
A full, detailed and coherent plan covering all the major steps is provided, which outlines what needs to be measured to calculate specific heat capacity. The steps are set out
in a logical manner that could be followed by another person to calculate the specific heat capacity.

Level 2 (3–4 marks):
The substantive content of a plan is present but may be missing some steps. The plan
may not be in a completely logical sequence but leads towards the calculation of the specific heat capacity.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be
in a logical order. The plan would not allow another person to calculate specific heat

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capacity.

0 marks:
No relevant content.

Indicative content

- measure the mass of metal
- correct use of balance
- description of how work is done or energy transferred to metal
  eg electrical work, mechanical work (eg dropping lead shot)
- how energy transfer or work done is measured
  eg electrical using joulemeter, mechanical decrease in potential energy store of falling lead shot
- equate work done / energy transferred = increase in thermal energy store of the metal
- calculate specific heat capacity

6

(b) 4 600 = 1 × 657 × temperature change

1

temperature change = 4 600 / 657

1

= 7 (°C)

*allow 7 with no working shown for **3** marks*

1

(c) Type of material

1

(d) heat loss

1

then any **one** from:

- turned off the power supply too early
- incorrectly measured mass of material
- incorrectly measured temperature
- incorrectly read the change in thermal energy

1

(e) would give a more accurate value **or** the calculated specific heat capacity will be smaller

1

because the bubble wrap insulates the material **or** prevents heat loss

1

[14]

Q10.

(a) 600 kg = 5880 N

1

power = $\frac{5880 \times 35}{45}$

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1

= 4573.3 (W)

*this step without the previous steps stated gains **3** marks*

1

% Eff. = $\frac{4573.3}{8000} \times 100$

1

= 57.17 (%)

*allow 57.17 with no working shown for **5** marks*

1

(b) gpe = 600 × 9.8 × 35

1

= 205 800

1

gpe = KE = ½ m v^2

1

$v = \sqrt{\frac{2 \times kE}{m}}$

1

$= \sqrt{\frac{411\,600}{600}}$

1

= 26.2 (m / s)

*allow 26.2 with no working shown for **6** marks*

1

[11]

Q21.

(a) (i) infrared radiation

1

(ii) absorbed

1

(b) France has more hours of sunlight (all year round)

or

France has more hours of sunlight in every month of the year

accept the converse

allow France is sunnier

1

(so) there will be more energy to heat the water

or

(so) more energy can be absorbed / transferred

allow (so) more water can be heated

allow 'heat' for energy

1

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(c) 42 000 000

allow 4.2×10^7

*allow for **1** mark correct substitution*

$200 \times 4200 \times 50$ provided no subsequent step shown

or

42 000

2

joules

*42 000 kJ = **3** marks*

1

[7]

Q22.

(a) a value of 1°C or less

reason only scores if a correct value for the resolution is given

*do **not** allow 0 / zero*

1

temperatures in investigation are recorded to the nearest degree (Celsius)

or

differences between temperature rises for different materials is greater than 1°C

1

(b) any **one** from:

- room temperature / start temperature (of material)
- type of insulation
- thickness of insulation
- time that cylinder was heated for
- the power output of the immersion heater

allow amount

1

(c) aluminium

reason only scores if 'aluminium' is given

1

smallest temperature rise

allow smaller temperature rise (than the other metals)

accept justification by calculation

1

(d) 500(J / kg °C)

*allow temperature increase = 18 °C for **1** mark*

*correct substitution 18000 = 2 x c x 18 gains **2** marks provided no subsequent step*

or

correct substitution and rearrangement

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*c = 18000 / (2 x 18) gains **2** marks provided no subsequent step*

*allow **2** marks for 474 (J / kg °C) (a SHC calculated using a temperature of 19 °C)*

*allow **1** mark for substitution 18000 = 2 x c x 19 provided no subsequent step*

or

substitution and rearrangement

c = 18000 / (2 x 19) provided no subsequent step

*allow **2** marks for a SHC calculated using a temperature increase of an incorrect metal, ie*
900 (J / kg °C for aluminium)
391 (J / kg °C for copper)
450 (J / kg °C for iron)
134 (J / kg °C for lead)

3

[8]

Q23.

(a) radiation

ignore infra red, IR, or heat

1

(b) (i) 105 000 000

(E = mcθ)

accept answers in standard form eg. 1.05×10^8

*E = 5000 × 4200 × 5 gains **1** mark*

Unit mark is independent, but must match value given for full marks

if no other marks gained 1 mark for any correct unit of energy

2

J / joules

not lower case j

allow Joules

allow units in words eg kilojules

*allow 105 000 kJ or 105 MJ for **3** marks. These figures must have units.*

allow units written as words Eg. kilojoules

not KJ, kj, mJ, Mj

1

(ii) 6600(s) / 6560(s) / 6563(s) / 6562.5(s)

(E = Pt)

allow ecf from (b)(ii)

allow answers in minutes and hours provided correct and unit changed on answer line

eg. 109 / 110 minutes or 1.8 hours

*if correct answer given with incorrect unit, maximum mark of **2** eg 6600 minutes*

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*105 000 000 = 16 000 × t gains **1** mark*

*t = 105 000 000 / 16 000 gains **2** marks*

*t = 105 000 000 / 16 gains **1** mark*

or

6 562 500(s) gains 2 marks

3

(iii) energy gained from surroundings / air

allow heat

ignore air is warmer or pool is colder

1

[8]

Q24.

(a) (i) as temperature difference increases, power output increases <u>at an increasing rate</u> / as temperature difference doubles, power output <u>more than doubles</u>

1

(ii) reduce the temperature difference (between air and water)

ignore turn power / heating down

ignore insulation

1

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

1000 J/kg °C

*allow **2** marks for 1000*

*allow **1** mark for correct substitution and correct rearrangement of correct equation,*

eg $c = \frac{580000}{58 \times 10}$

*give **1** mark for unit (allow J/kgK)*

3

[5]

Q25.

(a) reflector of infrared radiation

allow reflector of infrared / IR / radiation / heat / energy

ignore bounces off

or

<u>poor</u> emitter of (infrared) radiation

*do **not** accept **no** radiation emitted*

1

(b) 3(kg)

*allow **1** mark for evidence of correct calculation of temperature change (78 °C)*

*allow **1** mark for correct substitution and rearrangement 982 800/(4200 × 78)*

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*if temperature change is incorrect but used correctly in calculation allow maximum of **2** marks*

3

(c) 18000 (joules)

*allow **1** mark for correct substitution (10 × 1800)*

***or** (10 × 30 × 60)*

*allow **1** mark for an answer of 300*

*an answer 10 × 0.5 or 5 gains **1** mark*

ignore incorrect units for compensation marks

*if answer given is 0.005 kWh award **2** marks*

2

(d) any **one** from:

- uses less electricity / energy

allow saves energy or wastes less energy

ignore power

- reduced cost
- instant availability of hot water

allow it's quicker

allow you don't have to wait

1

[7]

Q26.

(a) 16 800 000

*allow **1** mark for substitution into correct equation ie 100 × 4200 × 40*

2

(b) 7

allow ecf from part (a)

1

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

No relevant content.

0 marks

There is a brief explanation of the advantages and disadvantages of using solar energy to heat the water rather than using an electric immersion heater, including either advantages or disadvantages from the **examples** below.

Level 1 (1–2 marks)

There is some explanation of the advantages **and** disadvantages of using solar energy to heat the water rather than using an electric immersion heater, with at least **one** advantage and **one** disadvantage from the **examples** below.

Level 2 (3–4 marks)

There is a clear, balanced and detailed explanation of the advantages

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and disadvantages of using solar energy to heat the water rather than using an electric immersion heater, with a minimum of **two** advantages and **two** disadvantages from the **examples** below.

Level 3 (5–6 marks)

examples of the points made in the response

advantages

- a renewable energy source
- energy is free
- does not pollute the atmosphere
  accept specific examples of polluting gases
- no fuel is burnt
- energy can be stored (in the water)

disadvantages

- only available in daylight hours
- availability fluctuates
  accept unreliable energy source
- insufficient hours of sunlight in some countries
- average low intensity in some countries

[9]

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Q1.

(a) 90% of students gained at least 1 mark and nearly 60% gained both marks for correctly choosing two renewable resources.

(b) Fewer students showed an understanding of reliability with over 70% gaining no marks on this question. The majority of students ticked the box that gave the meaning of renewable.

(c) Over three-quarters of students correctly determined the power of one turbine.

(d) More than three-quarters of students gained at least one mark for describing or stating visual or noise pollution. 35% of students gained both marks. Some students made vague statements such as “they are big”. Some students thought that the wind turbines acted as fans and would make the surrounding area windier.

(e) This levels of response question produced a wide variety of responses. Fewer than 20% of students gained more than two marks; a similar number scored no marks with a significant number making no attempt at all. Most commented on the percentages supplied, but many students failed to expand their answer to give environmental impacts. For some students their written English impaired their ability to answer this question.

Students must read the question carefully and tailor their responses accordingly. Limiting the answer to comparing the two pie charts does not answer the question sufficiently but some credit was given for doing this − particularly if numerical comparisons were made. To access the higher marks, examiners were looking for explanations of the environmental impacts and clear logical linking between the changes and their effects.

There were frequent incorrect references to ozone layer depletion. Misconceptions about nuclear power were seen, such as carbon dioxide and toxic gases were emitted. The best answers made clear that decreasing use of coal and increasing use of renewables would decrease the amount of carbon dioxide and link this to the greenhouse effect and global warming.

Q2.

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.

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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 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.

Q3.

(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

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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.

Q21.

(a) (i) Less than half the students correctly said that the solar panel is black to increase energy transfer to the water by infrared radiation. Almost as many thought it was to reduce energy transfer by conduction.

(ii) The majority of students correctly said that the solar panels have a large surface area to absorb more energy.

(b) Most students gained the first marking point for saying that there are more hours of sunlight in France. This was phrased in a variety of ways. Few students gained the second marking point due to poor use of language. Some reference to more energy being absorbed was required. 'More sun' or 'more light' were ignored.

(c) Most students gained at least 1 mark for either substituting correctly into the equation, or for selecting the correct unit. There were quite a lot who did not attempt the question, and did not select a unit, which might have been worth a guess. Those who gained two marks were able to correctly calculate the energy needed but then gave an incorrect unit, or they gave the correct unit and substituted into the equation correctly, but then made a mistake in the calculation. This was often by omitting a 0 from a correctly calculated value on the answer line.

Q22.

(a) Most students did not understand the term "resolution". Students who did give a value of 1 °C or lower frequently wrote "accuracy" as their reason. The reason

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should have related to the results, but many linked it to the graph scale. Answers of around 67 °C to 70 °C were common as this was the highest value, or it would include all the values shown for all the metals. “10 °C” was less commonly seen, but their reason for this choice was that it was the lowest result. Values of 18 °C to 23 °C were often given because they were the most common or average values for the results. “20 °C” was also seen because that is room temperature.

(b) Less than half of the students could give a control variable. Students who gained the mark often said the type or amount of insulation used. Some said the mass or amount of metal, or the amount of energy transferred, both of which were given in the question. Other responses that were ignored included the surface area, volume or colour of the metals, various pieces of apparatus used, such as the thermometer; and some thought that there was water in the cylinder so gave volume of water as a variable.

(c) Just under two thirds of the students gained no marks. The most common answer was lead, with the reason that it had the highest temperature rise. Some students correctly identified aluminium as having the highest specific heat capacity but then said it was due to increasing in temperature by only 10 °C, when a comparative statement was needed. Other students demonstrated a good understanding by going on to explain that, since the rise in temperature was the lowest, this meant the amount of energy required to raise the temperature of 1kg by 1 °C was the highest. A few justified their response by calculating the specific heat capacity of aluminium.

(d) Students should be told that the first mark in a calculation is for the substitution, not for the rearrangement. Many students scored no marks because they did not show their working. In this calculation, 1 mark was given for reading the bar chart, 18°C, and 2 marks for the substitution into the equation, i.e. 18000 = 2 x c x 18. This substitution would gain two thirds of the total marks. There were no further marks for the rearrangement, but 3 marks for the final answer of 500 (J / kg°C). Students who calculated the specific heat capacity for a different metal were awarded 2 marks. Students who misread the increase in temperature as 19°C and used this to calculate the specific heat capacity as 474 (J / kg°C) were also awarded 2 marks.

Q23.

(a) The question asked for a method of energy transfer, but many students gave infrared radiation as the answer. In this instance, infrared was ignored, so they gained the mark.

(b) (i) Most students gained at least 1 mark for 5000 × 4200 × 5, however they often then wrote down an incorrect answer. It is always good to check the answer. Some made avoidable errors when writing down the number of noughts. A variety of units was given.

Any unit of energy could gain a mark, if no other marks had been given, as long as it was written correctly. Many wrote j instead of J, or KJ instead of kJ.

(ii) Most students managed to substitute into the correct equation and many also reorganised the equation to find the time. However, a lot of students forgot to convert the kJ to J, so could only gain 2 marks.

(iii) Many responses referred to the air being warmer than the pool, but did not go on to explain that the water would absorb energy from the air or surroundings. Some talked about the Sun being hotter or cooler, or the use of heaters.

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Q24.

(a) (i) Few students realised that there was more to the question than both temperature and power increased, omitting reference to increasing rate.

(ii) Most students simply advised the homeowners to turn the temperature down, not considering the data about temperature difference. The temperature on a thermostat is controllable but the temperature difference to the air proved to be a difficult concept.

(b) The calculation was often correctly performed but relatively few gave a fully correct unit (J/kg^0C). A number of students could not use a calculator correctly to work out 58 000 / (58 × 10).

Q25.

(a) The majority of correct responses were for reflection of radiation, with most students stating heat rather than infrared radiation, which was allowed. A few answers gained the mark for stating the shiny metal was a poor emitter of radiation, but those that stated no radiation was emitted were not credited. Incorrect responses included reference to absorption and conduction of radiation.

(b) Many students selected the wrong equation from the sheet and tried to calculate efficiency. A mark was picked up by the majority of students for calculating the temperature change but then made errors in the rearrangement of the equation. Even where a correct substitution and rearrangement of the equation was shown, students often came up with the wrong answer, probably due to misuse of their calculator and not realising 4200 × 78 had to be calculated first. A third of students scored full marks.

(c) By far the most common answer was 300 J as students forgot to convert the time to seconds. Several students tried to use the wrong equation. An answer of 930 was often given, from multiplying power by temperature. Only a few students gained two marks for this question.

(d) Many creditworthy responses were in terms of saving energy or saving money. Some students said it wasted less water which did not gain the mark as this was too similar to the information given in the stem of the question, and a different advantage was asked for.

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