OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P7.2 POWER AND EFFICIENCY

SCORE	PERCENTAGE
/194	%

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Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	**1**	
2			C	1	
			Total	**1**	
3	a		59 (anomalous result should be left out of calculation) (1)	1	
	b		28 (1)	1	
	c		Green results unreliable / large variation / anomalous result (1) Should have repeated 31 (green) reading / other results (red, blue, white, yellow) are reliable (1) A sensible suggested improvement (1)	3	e.g. use camera to measure bounce heights (1)
	d	i	bounce height / drop height × 100% = 85% useful, therefore 15% wasted. (1) transferred to heat and sound (1)	2	
		ii	If the bounce height was greater then the efficiency would be higher / **ORA** (1)	1	
			Total	**8**	
4			C	1	
			Total	**1**	
5			D	1	
			Total	**1**	
6			Reduce the friction between the car and track / lubrication (1) Make the shape of the car more streamlined to reduce drag (1)	2	
			Total	**2**	
7	a		28 (1)	1	

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Question			Answer/Indicative content	Marks	Guidance
	b		(Josh's is only) 50% efficient / AW (1) And any one from: (Kate's) red is 76% efficient (1) Blue is 61% efficient (1) White is 85% efficient (1)	2	
			Total	3	
8	a		Energy for oil is 672 000 (J) (1) Energy for water is 1 680 000 (J) (1) Recall P=E/t (1) Calculation to show: 672 000 / 400 = 1680 AND 1680000 / 1000 = 1680 (1)	4	
	b		Half of the (previously) wasted power or energy / 0.5 kW is being used to heat water (1) Less energy needed from other sources to heat water (1) Fire X is (4/5 × 100% =) 80% efficient (1) Fire Y is (4.5/5 × 100% =) 90% efficient (1)	4	**ALLOW** some energy from fire now used to heat water scores (1)
			Total	8	
9			Lorry has more KE than a car at the same velocity (1) More absorption of energy by larger brake discs (1) Higher rate of dissipation of energy to surrounding air (1) Brakes less likely to overheat (1)	4	
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
10		i	input = (total) output [1] idea that energy is wasted as heat [1]	2	**allow** answers in calculations e.g.1000 (MJ) = 1000 (MJ) or 1000(MJ) = 650(MJ) + 350(MJ) [1] if no marks awarded then **allow** useful output is less than the input [1] Examiner's Comments This question was not answered well by many candidates. Examiners were looking for the idea, energy in = energy out, and that the wasted energy was usually heat.
		ii	0.35 or 35% [2] **but if answer is incorrect or incomplete then:** $\frac{350}{1000}$ [1] **or** $\frac{350 \times 100}{1000}$ [1]	2	**allow** 0.35% [1] **allow** 35 with no unit or incorrect unit [1] Examiner's Comments The majority of candidates performed the calculation correctly, but a significant number of candidates were penalised 1 mark for putting % after 0.35 or missing % after 35.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
11	a		[Level 3] Sensible reference to: trapped air reducing convection, shiny foil reflecting radiation back into the building AND wall B is thicker than wall A so less conduction. ORA Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Sensible reference to trapped air as an insulator, AND shiny foil reflecting 'heat' back into the building OR wall B is thicker than wall A so less conduction. ORA Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Sensible reference to air or foam as an insulator OR shiny foil reflecting 'heat' OR wall B is thicker / better insulator than wall A.ORA Quality of written communication impedes communication of the science at this level. (1–2 marks) Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include: Level 3: • trapped air reduces convection • shiny foil reflects IR / radiation back into house Level 2: • trapped air is a good insulator / poor conductor • shiny foil reflects heat back into house Level 1: • air is a good insulator / poor conductor • air is trapped in B • foam is an insulator / prevents heat loss • shiny foil reflects heat • wall A is a better conductor than wall B ignore heat trapped Use the L1, L2, L3 annotations in Scoris; do not use ticks. <u>Examiner's Comments</u> Candidates were asked to explain why one wall lost less heat than the other wall. The question asked candidates to use ideas about conduction, convection and radiation, but very few candidates mentioned convection and, therefore, excluded themselves from the level 3 marks. This was targeted at level C and was a common question with the higher paper. Candidates could have gained full marks by a simple statement about each wall and the method of heat transfer eg air is a good insulator; trapped air reduces convection; shiny foil reflects IR back into the house; and wall B is thicker than wall A so less conduction.

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Question			Answer/Indicative content	Marks	Guidance
	b		Correct comparison: cost higher than expected / less than 18% saving / **saving is less** [1] correct relevant calculation [1] some years are warmer / colder than others [1] the average may not be representative / average calculated over atypical years AW [1] differences in behaviour [1] cost of energy higher in later years [1]	3	**allow** 2012 and 2013 are higher / 2014 is lower [1] **allow** average is £920 **allow** any other correct use of data e.g. 2014 is £98 lower / £32 per year saving / £96 saved over 3 years [1] eg. only 15% lower / [2] **not** merely 'different weather' [0] **allow** examples e.g. 2009-11 may have been warmer than usual [1] allow examples e.g. Simon may have had windows opened more (often) / more people at home / more time at home / more heating used / more TV watched / settings on heating changed / alterations to house / different or extra appliances used / other or different insulation or energy collecting methods fitted [1] <u>Examiner's Comments</u> The first part of this question performed well with the majority of candidates making a relevant comparison of the costs. The second part proved more difficult for the majority of candidates. The examiners were looking for candidates to think of reasons as to why the heating bills were higher than expected. These include: increases in the cost of energy; **extra** appliances being used; cold weather requiring more heating; heat loss by leaving windows open etc.
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
12			payback time (of double glazing) is 25 (years) [2] long(est) payback time scores [1]	2	**allow** 25 on / at side of table clearly linked to **double glazing** [2] **allow** CWI saves £50 per year more than DG [2] **allow** takes a long time to payback / takes a long time to get your money back / AW [1] **allow** other correct payback calculations to help prove point: eg. CWI 4 years or DP 120/72 (1.67) or LI 3 years [1] **allow** does not save as much money per year as cavity wall insulation [1] **ignore** comparisons of the 'cost to fit' **Examiner's Comments** This question on payback time and house insulation discriminated well. This was very well answered with 25-years calculated for the payback time being commonplace. It was a common question with the foundation paper (B751-01).
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
13			Idea that they (different colours) suggest different heat losses / temperatures [1] BUT white / yellow / red / light(er) show most heat loss / highest temperature AW scores [2] Or black / dark blue / purple / dark(er) show least heat loss / lowest temperature [2]	2	Allow (different colours) show where (more) insulation is needed [1] Allow (different colours) show which parts are (well) insulated [1] Allow most heat lost through windows and / roof or less heat lost through walls [1] allow white / yellow / red / light(er) shows where most insulation is needed [2] allow black / dark blue / purple / dark(er) shows where less insulation is needed [2] Examiner's Comments Many knew that the colour of the thermogram was important but failed to explain the correct link clearly enough. Many wrote about where insulation was required and some went on to relate it correctly to the colours and the heat loss e.g. Red and yellow show were most heat is lost so these need more insulation [2]. One common misunderstanding was that blue showed cold areas so these must be losing most heat. Others referred to heat loss but failed to relate it to the colours at all.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
14	a		1800 (J) [1]	1	Examiner's Comments This question about energy use in the home was well answered. Many were able to sensibly interpret the Sankey diagrams and use the concept of efficiency. This enabled them to use processed information in their answers. Most used the Sankey diagrams correctly to give the right answer of 1800J.
	b		60% or 0.6 [2] if answer is incomplete or incorrect then: $\frac{600}{1000}$ (x 100%) [1]	2	**allow** 60 with incorrect or no unit [1] eg 60 J/s or 60 scores [1] **allow** 0.6% [1] Examiner's Comments Many gave the correct efficiency calculation but it was common to see answers that failed to write '%' so limiting them to [1] mark.
	c		lowest (useful) energy output / input [1] (usefully) uses a greater proportion of energy / wastes a lower proportion of energy / AW [1]	3	**Eg.** Uses least amount of energy [1] **allow** longer time idea explained e.g. Energy = Power x time, and less power but longer time for slow cooker [1] **only** uses 160J/s (output) 200J/s (input) or **only** wastes 40J [1] **ignore** higher / most efficiency **allow** wastes less energy (than others) [1]

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Question			Answer/Indicative content	Marks	Guidance
			BUT 80% or 0.8 efficient / [2]		eg **only** wastes 20% or 0.2 [2] **allow** 80 (linked to efficiency) with incorrect or no unit [1] eg. 80 J/s or 80 scores [1] **allow** 0.8% [1] evidence of the correct efficiency calculation [1] eg 160/200 [1] **Examiner's Comments** Most calculated the efficiency of the slow cooker as 80% and went on to say it had the lowest energy input for 3 marks. Those that did use calculations could still get [2] marks from the alternatives given in the mark scheme –e.g. It's the most efficient [1] and only wastes 40 [1].
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
15	a	i	(£) 562 [1]	1	
		ii	no (no mark) **any one from** (£) 5320 is more than (£) 4100 / AW [1] It will cost £5320 (to fit all insulation) [1]	1	**allow** (£) 1220 shortfall [1]
		iii	payback time (of double glazing) is 25 (years) [2] **but if incorrect or no calculation then** long(est) payback time scores [1]	2	**allow** 25 on / at side of table clearly linked to **double glazing** [2] **allow** CWI saves £50 per year more than DG [2] **allow** takes a long time to payback / takes a long time to get your money back / AW [1] **allow** other correct payback calculations to help prove point: eg. CWI 4 years or DP 120/72 (1.67) or LI 3 years [1] **allow** does not save as much money per year as cavity wall insulation [1] **ignore** comparisons of the 'cost to fit' **Examiner's Comments** Most candidates were able to calculate the saving for the insulation in part (i) and successfully perform the calculation for fitting insulation in part (ii). In part (iii) candidates were asked to perform a calculation; many candidates just quoted data from the table and so were unable to score the full marks.
	b		**Level 3: (5 – 6 marks)** **Reference to red and yellow show most heat escaping AND more heat escapes on a cold day.** Quality of written communication does not impede communication of the science at this level.	6	This question is targeted up grade C Indicative scientific points may include: **Level 3:** • yellow / red / white shows higher temperatures than other colours **AND** cold day means more heat is lost (because of bigger temperature difference) **allow** reverse argument e.g. blue / black shows lower temperatures than others

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Question			Answer/Indicative content	Marks	Guidance
			Level 2: (3 – 4 marks) **Simple reference to red and yellow on thermogram show hottest areas OR more heat escapes on a cold day.** Quality of written communication partly impedes communication of the science at this level. **Level 1: (1 – 2 marks)** **Simple reference to colours on thermogram show hottest areas.** Quality of written communication impedes communication of the science at this level. **Level 0: (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.		**AND** cold day means more heat is lost (because of bigger temperature difference / heating is on) ORA less heat loss on warm day (because of smaller temperature difference) **Level 2:** • yellow / red / white / lighter colours show higher temperatures than others **OR** cold day means more heat escapes / have heating on inside the house on a cold day. **allow** reverse argument e.g. blue / black shows lower temperatures than others **OR** cold day means more heat escapes / have heating on inside the house on a cold day. **Level 1:** • some colours show higher temperatures than others Use the L1, L2, L3 annotations; do not use ticks. **Examiner's Comments** This was a 6 mark question about a thermogram. Most candidates scored some marks by linking the yellow and red to areas that were hot and lost most heat, but few were able to explain why a cold day gave better results. Examiners were looking for the ideal that there was a larger temperature difference between the inside and the outside of the house on a cold day and so a greater amount of heat lost.
			Total	**10**	

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Question			Answer/Indicative content	Marks	Guidance
16			Correct comparison: cost higher than expected / less than 18% saving **/ saving is less** [1]	3	**allow** 2012 and 2013 are higher / 2014 is lower [1] **allow** average is £920
			correct relevant calculation [1]		**allow** any other correct use of data e.g. 2014 is £98 lower / £32 per year saving / £96 saved over 3 years [1] eg. only 15% lower [2]
			some years are warmer / colder than others [1]		**not** merely 'different weather' [0] **allow** examples e.g. 2009-11 may have been warmer than usual [1]
			the average may not be representative / average calculated over atypical years AW [1]		
			differences in behaviour [1]		allow examples e.g. Simon may have had windows opened more (often) / more people at home / more time at home / more heating used / more TV watched / settings on heating changed / alterations to house / different or extra appliances used / other or different insulation or energy collecting methods fitted [1]
			cost of energy higher in later years [1]		Examiner's Comments The first question on section A module P1 was about heating in the home. The double-glazing advert worked well in that it got candidates into the paper and answering freely with a range of marks being awarded. Most could make a judgement about the energy costs and gained a mark here. Some went on and processed the data further to gain a second mark. Most however attempted an explanation but unfortunately many of these explanations were preoccupied with double glazing and payback cost as a reason for 2012/13 being higher. Some wrote about different weather but were not specific enough to get the mark. Better answer referred to colder winters or windows left open so the heating would have to be used more. About a third of candidates gained two or more marks here.

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Question			Answer/Indicative content	Marks	Guidance
			Total	3	
17			19800 (MJ) (3) **But if answer is incorrect** 330 (MW) (2) 66% of 500 or .66 x 500 (1)	3	**if no other marks scored allow** evidence of power x time (1) **allow** 500 – 170 OR 330 (2) **allow** 34% of 500 or 0.34 x 500 = 170 (1) **Examiner's Comments** This question was a developed calculation. The majority of candidates successfully completed the first part of the calculation and calculated the energy loss each second as 330MJ but could not complete the calculation to find the energy lost each minute. Candidates were credited at each stage of the calculation. This question was about generating electricity.
			Total	3	
18			500 000 (MJ) (1)	1	**Examiner's Comments** Most could calculate the energy input from the coal. Any errors were usually too many or too few zeros in the answer. Also common were: • Those candidates who worked out 34% of the output energy and obtained an answer 57800 J. • Those candidates who divided the output energy by 34 (instead of 34% = 0.34) and obtained an answer of 5000 J.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
19	a		most heat lost from hot / poorly insulated areas **indicated by** colours white / yellow / red (1) least heat lost from cool / well insulated areas **indicated by** colours black / dark blue / purple (1)	2	must correctly link heat loss area to correct colour must correctly link heat loss area to correct colour look also for a combination of ideas: eg red areas are hot and lose most heat, purple areas are cold (2) if no mark awarded idea of white is hotter **and** dark is colder scores (1) **Examiner's Comments** Virtually all candidates were familiar with thermograms. The question was well attempted although many wrote at length that, 'a thermogram uses colours to show where heat energy is lost' and then omitted to give any colours or to relate them to areas of most or least heat loss. Also there were references to bright or dark, which did not really specify the colour.
	b		**all 4** payback times correct in table or elsewhere in answer 48 / 6 / 3 / 2 (1) **then** idea that they (C and D) have a short / low payback times (1) they (C **and** D) • save more (annually than A and B) / AW • are cheaper to fit (than A and B) / AW • reduce energy losses by 50% / AW (1) maximum of (1) for each marking point	3	**eg** D – greatest annual saving (1) **eg** C is cheapest to fit (1) **Examiner's Comments** This data handling question on payback time was well answered by most. The calculations were usually correct along with the explanations.

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Question			Answer/Indicative content	Marks	Guidance
	c	i	70% (3) **but if answer is incorrect** (7000 ÷ 10000) × 100 (2) **but if this is incorrect** useful energy = 7000(J) (1)	3	**ignore** 0.7 on answer line unless % clearly crossed out and no other unit added 0.7 **on its own** scores max (2) alternatively **allow** (3000 ÷ 10000) × 100 (1) **Examiner's Comments** Most candidates obtained 3 marks for calculating the efficiency correctly and giving 70%. Occasionally 7000/3000 was used, but candidates who wrote this usually got the useful energy mark. Also 30% was obtained on a few occasions.
		ii	idea that wasted energy is given to surroundings / atmosphere / energy is conserved / AW (1) wasted energy and useful energy add up to input energy (so not totally lost / energy just transferred) / AW (1)	1	**allow** idea that 3000J / wasted energy is converted to different forms of energy (1) Eg. 3000J lost as heat (1) **ignore** lost as sound **allow** the idea of energy conservation (1) **eg.** 7000J + 3000J output = 10000J input eg. combined width / size of output arrows = input (1) **Examiner's Comments** This proved a challenge for some in that they had difficulties in communicating their idea. Some communicated the idea of conservation clearly or used numbers to illustrate it. Eg. 10 000 input = 3 000 + 7 000 output [1]. Others were able to explain that the energy was not lost but wasted as heat [1].
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
20			0.34 or 34% (2) but if answer incorrect 170 000 (MJ) / 500 000 (MJ) (×100) (1)	2	0.34% (1) 34 (1) Examiner's Comments Candidates, in general correctly calculated the efficiency of the power station.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
21	a		colour(s) (1) thermogram (1)	2	**ignore** shades of grey / black and white **allow** thermograph **allow** thermophotograph **ignore** thermal image / photograph **ignore** infrared image / photograph Examiner's Comments Most candidates knew that thermal imaging cameras produce photographs that show different colours and most of those candidates knew that the picture was called a thermograph or themogram. Thermal image was not allowed as this was given in the question.
	b		max two from: double glazing (in the windows) cavity wall insulation / foam in wall cavity loft insulation insulation above ceiling (2) max two from: measure(s) suggested have trapped air in them (1) (trapped) air is a good insulator (1)	3	**allow** carpets on the floor **allow** curtains at the window **ignore** wall insulation on its own **ignore** roof insulation on its own **ignore** reduces energy loss **allow** higher level answers in terms of correctly identified reduction of conduction / convection / radiation Examiner's Comments Candidates were asked to describe energy saving methods and explain how air is important. Examiners did not accept simplistic answers such as 'insulate the roof' or 'insulate the walls'. A more detailed description was needed, for example, insulate the roof with fibreglass or fill the cavity in the walls with foam. A maximum of 2 marks was awarded for method, and a maximum of 2 marks was awarded for describing how air was important. The question had a maximum of 3.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
22			Level 3 (5–6 marks) Candidates must conclude correctly and quantitatively the efficiencies or fractional energy loss or output of both heaters. This should be justified with reasons for the different efficiencies. When only one reason is in the answer award 5 marks. Quality of written communication does not impede communication of science at this level. Level 2 (3–4 marks) Candidates must conclude that heater A is more efficient and offer a reasonable qualitative or quantitative explanation as to why. Correct efficiency or fractional calculations will be awarded 4 marks. When only one heater explained award 3 marks. Quality of written communication partly impedes communication of science at this level. Level 1 (1–2 marks) Answers should have a simple explanation that heater A gives more heat to room and B gives less to the room or a reason for this. When only one heater is mentioned or the reason is unclear award 1 mark. Quality of written communication impedes communication of science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to E Relevant points include: heater A • efficiency is 0.8 or 80% • gives more heat to the room / AW • (only) 1/5 of energy / heat goes up chimney • has a lower energy input • less energy given to wall / less wasted • is all in room • has a larger surface area giving out heat • black /dark colour emits more heat heater B • efficiency is 0.5 or 50% • gives less heat to the room / AW • ½ of heat / energy goes up chimney • has greater energy input • more energy given to wall / up chimney / wasted • is in / behind the wall • has a smaller surface area giving out heat • white / light colour emits less heat A or B: heaters have different flue / chimney systems Use the L1, L2, L3 annotations in scoris. Do not use ticks. Examiner's Comments The best answers quickly got to the point; the correct efficiency calculations were followed by reasons for the higher efficiency of heater A. Good answers that did not score 6 marks failed to justify the higher efficiency, whilst weaker answers merely gave some information about A and / or B without references to efficiency. Candidates should be aware that merely regurgitating information from the question will gain little or no credit. Few responses

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Question			Answer/Indicative content	Marks	Guidance
					contained any mention of emissions from darker or lighter surfaces.
			Total	6	
23		i	70% (3) **but if answer is incorrect** (7000 ÷ 10000) × 100 (2) **but if this is incorrect** useful energy = 7000(J) or (3000 ÷ 10000) × 100 (1)	3	**ignore** 0.7 on answer line unless % clearly crossed out and no other unit added 0.7 **on its own** scores a maximum (2) **Examiner's Comments** Most candidates correctly calculated the efficiency of Allan's boiler and identified it as being in band F which was next to the bottom band.
		ii	yes (no mark) in the second worst / second bottom (efficiency) band or in the worst / lowest two (efficiency) bands / in band F (1)	1	**allow** ecf from c (i) if correctly linked **allow** one of the worst / there are five bands above it
			Total	4	
24	a		spray foam (1) thinnest / lowest thickness / AW (1)	2	**allow** less needed or only 74mm needed **ignore** takes up less space **Examiner's Comments** The common error was to choose ‘Sheep's wool’, presumably because those candidates thought that the largest recommended thickness of insulating material would be best.
	b		(foil) reflects **heat or IR** or **energy** (back into house) (1)	1	**ignore** attracts heat **ignore** bounces **ignore** particles **not** merely reflects **Examiner's Comments** Usually correct but reflecting light, absorbing, attracting or blocking IR or heat were poor answers given by some candidates. Heat or heat particles bouncing off the foil appeared in some answers.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
25			Level 3: (5 – 6 marks) Temperature rises calculated correctly AND correct judgement made AND a detailed explanation of one or more mechanisms Quality of written communication does not impede communication of the science atthis level. Level 2: (3 – 4 marks) Temperature rises calculated correctly AND correct judgement made and a part explanation. Quality of written communication partly impedes communication of the science at this level. Level 1: (1 – 2 marks) Temperature rises calculated correctly OR correct judgement made. Quality of written communication impedes communication of the science at this level. Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade E Indicative scientific points may include: Explanation and mechanisms: • (colour) black absorbs heat / energy (better) • (surface) shiny reflects heat / energy (away) or • air is a good insulator / AW • (material) expanded polystyrene is a better insulator • (material) expanded polystyrene traps air • Polystyrene without air bubbles is a better conductor Judgement made (any one judgement): • C chosen as the best cup to keep the drinks cooler • C heats up the least • A B and D are worse at keeping the drinks cool • A B and D heat up more • Temperature rises calculated: • A – 80°C • B – 140°C • C – 20°C • D – 50°C allow heat for IR ignore light Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments

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Question			Answer/Indicative content	Marks	Guidance
					This was a six mark extended prose level of response question and was targeted at the lower grades G, F and E. Most candidates calculated the temperature rises correctly to satisfy the level 1 criterion. Most answers also went on to also select C as the best choice for keeping the drink cool [4]. Level 3 answers neededsome scientific explanation about shiny surfaces reflecting the IR radiation or energy away. Others answered in terms of the bubbles trapping air leading to good insulation.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
26	a		80 (%) **or** 0.8 [2] **but if answer is incorrect** 100 × 800 / 1000 **or** 800 / 1000 [1]	2	0.8% [0] Take the answer on the answer line first. If this answer is absent or incompletethen mark the answer in the table. **ignore** any units **Examiner's Comments** Mostly correct efficiency calculations of 80% or 0.8 [2].
	b		**any one from** both 50% efficient [1] both 50% efficient or 0.5 [1] both use (only) 50% of energy (input) [1]	1	 **Ignore** equally efficient **allow** half energy lost / they are both half [1] idea that both have same ratio of input: absorbed energy / AW [1] **allow** 600/1200 = 700/1400 [1] **Examiner's Comments** This was a different way of approaching data and the concept of efficiency. It was answered well with most responses showing 50% efficiency in the table. Other answers such as 'the energy absorbed is half the input' also gained the mark.

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Question			Answer/Indicative content	Marks	Guidance
	c		appropriate equipment any one from suitable equipment or use of equipment thermometer [1] stopwatch [1] measure time to cook the food [1] measure a temperature [1] fair test any two from same amount of food / same mass of food / same volume of food / same meal [1] same container [1] same time / same time intervals [1] same starting temperature [1] method / procedure maximum of two from measure temperature rise [1] (by) measuring the start and finishing temperatures [1] measure time to heat the food up to same temperature) [1]	3	maximum 3 marks award same marking points if shown on a diagram ignore ‘same food’ or ‘same type of food’ Examiner's Comments This three mark question invited candidates to describe an experiment to find the fastest cooking oven. Some had ideas on measuring times / temperatures or using stopwatches / thermometers [1]. Some also had an idea of controlling variables, eg same amount of same food [1] or heat each for the same time [1]. Rather fewer could describe the end point convincingly. Eg. time how long it takes to heat the foods by 50°C. Most were more vague and used phrases like ‘time how long it cooks for’, etc.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
27			Factor (no mark) **any two from** (idea that) efficiency decreases with increasing current [1] best efficiency at 4 amps or best efficiency at 4 amps is 94% [1] best efficiency at 6 amps is 87% [1] (idea that) motor needs to have the best efficiency in range between 4 amps and 6 amps [1]	2	**ignore** choice of motor **if no marks awarded allow** the idea that Factor has the highest average efficiency [1] **Examiner's Comments** This “how science works” question involved choosing the most efficient motor using data across a range of currents. Although most candidates could correctly identify the best choice of motor most struggled to explain two acceptable reasons for this choiceusing the data provided.
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
28			one payback time calculated (1) **and any one from:** draught proofing because it has the shortest payback time (2) loft insulation because it saves the most each year/AW (2) cavity wall insulation because it has the largest yearly saving/AW (2)	3	double glazing 100 years loft insulation 2 years cavity wall insulation 3 years draught proofing 0.5 years/6 months no marks for insulation on its own, must be linked to correct reason for (2) allow 1 mark for draught proofing is cheapest to install if no marks scored on the second part, allow a second mark if two correct payback times calculated
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
29			**Level 3: 5–6 marks** Two detailed quantitative comments / comparisons **and** a reasoned decision made. Quality of written communication does not impede communication of science at this level. **Level 2: 3–4 marks** Two quantitative comments / comparisons **or** two simple comments / comparisons and reasoned decision. Quality of written communication partly impedes communication of science at this level. **Level 1: 1–2 marks** **Two simple comments / comparisons (qualitative)** Quality of written communication impedes the communication of science at this level **Level 0: 0 marks** Insufficient or irrelevant science. Not worthy of credit.	6	**This question is targeted up to C** **Indicative scientific points may include (but are not limited to) the following:** **Allow** correct statements that refer to halogen bulbs <u>Level 3</u> Leo should buy LED bulbs for 25000 hours you need 1 LED bulb for £6 and 10 halogen bulbs for £15 the saving is £9 for LED bulbs the energy cost for the LED bulb will only be a sixth of that for halogen bulbs <u>Level 2</u> LED bulbs cost four times halogen bulbs to buy LED bulbs last ten times longer than halogen bulbs halogen bulbs use six times the energy compared to LED bulbs <u>Level 1</u> halogen bulbs are cheaper to buy LED bulbs last longer halogen bulbs use more energy than LED bulbs
			Total	**6**	

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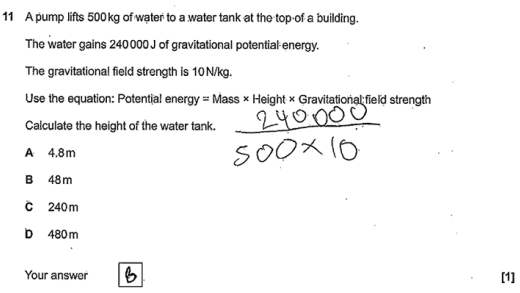
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Question			Answer/Indicative content	Marks	Guidance
30			1,050,000 J (3) If incorrect or incomplete then: 450000 J (2) or 1,500,000 × 0.3 (1)	3	
			Total	3	
31			any two from less or least energy transferred to the surroundings (1) for the same amount transferred to moving the robot (1) most efficient (1)	2	
			Total	2	
32			0.3 or 30% (2) If incorrect or incomplete then: 30 / 100 or 30 x 100/100 or 0.3% or 30 (1)	2	
			Total	2	
33			D ✓	1 (AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
34			B ✓	1 (AO2.2)	Examiner's Comments Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below. Exemplar 1  11 A pump lifts 500 kg of water to a water tank at the top of a building. The water gains 240 000 J of gravitational potential energy. The gravitational field strength is 10 N/kg. Use the equation: Potential energy = Mass × Height × Gravitational field strength Calculate the height of the water tank. 240000 / 500×10 A 4.8 m B 48 m C 240 m D 480 m Your answer B [1]
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
35		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO1.2)	ALLOW equation in any form
			11 x 11 x 23 or 11^2 x 23 or 121 x 23 ✓	(AO2.1)	
			= 2783 ✓	(AO2.1)	
			Conversion to kW = 2.8 ✓	(AO2.1)	ALLOW ECF candidates answer to 3rd marking point converted to kW Examiner's Comments This question required candidates to recall the equation: *power = current² x resistance* before converting their answers into kW. Out of the candidates who gained credit, most were credited with all four marks. A few candidates were only credited with one mark for converting the power output in W into kW. A significant number of candidates used an incorrect equation for power, most commonly using *current* rather than *current²* AfL When a physics question requires candidates to apply their mathematical skills they should always write down how they are answering the question. Using brief notes is and writing down intermediate calculations helps the examiner to see what the candidate is doing. A single finger error will result in many candidates receiving no credit because they only write down their final answer. Marks may be available for each stage of the process, using the correct equation, rearranging the equation, substituting in correct values. Choosing to access

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Question			Answer/Indicative content	Marks	Guidance
					these compensatory marks by showing workings is good examination technique.
		ii	Wind speed varies / AW ✓	1 (AO2.1)	**ALLOW** it depends on the strength of the wind / how windy it is / AW **IGNORE** there might not be any wind / wind changes direction / AW
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO2.1)	**ALLOW** (it) may not generate enough power / energy / AW Examiner's Comments Most candidates gained full credit for Q16(d)(ii) and (d)(iii). Those who did not gain credit often provided non-specific generalised reasons about the weather or the wind turbine 'breaking'.
			Total	6	
36			C ✓	1 (AO 2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
37	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 60 000 (J) award 2 marks 48 000 + 12 000 ✓ = 60 000 (J) ✓	2 (AO 2.2) (AO 2.2)	Check table Examiner's Comments Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		ii	C ✓	1 (AO 3.2b)	Examiner's Comments Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		iii	B ✓	1 (AO 3.2b)	Examiner's Comments Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.

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Question			Answer/Indicative content	Marks	Guidance
		iv	Heat / sound / KE of particles passed to other particles / AW ✓	1 (AO 1.1)	ALLOW (energy) transferred to surroundings / by friction Examiner's Comments A large number of candidates correctly stated that the motor would produce heat and/or sound or indicated that the energy was 'wasted' through friction. Some candidates wrote out all the energy transfers in an electric motor (e.g. "heat, sound and kinetic energy") which could not gain credit as it did not describe how energy is 'wasted'. Credit was given when it was clear that the 'waste' resulted from the transfer of the kinetic energy store of particles passed on to other particles or to the surroundings but not a vague transfer of 'kinetic energy to the atmosphere'.
		v	Lubrication / oil ✓	1 (AO 2.1)	ALLOW reduce friction Examiner's Comments Candidates found this question extremely challenging. There were very few suggestions of specific improvements to the electric motor such as lubricating it or applying oil to the moving parts. Many candidates suggested general energy efficiency tips such as switching it off when it not in use, running the motor at a slower speed or putting insulation around the motor.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 89 (%) award 3 marks	3	
			48 000 ÷ 54 000 (× 100) ✓	(AO 2.1)	
			= 88.88888….etc ✓	(AO 2.1)	
			= 89(%) (2 sig figs) ✓	(AO 1.2)	ALLOW two marks for 0.89 or 88(%) ALLOW one mark for 0.88 Examiner's Comments Two thirds of candidates were credited with some marks for this question. Candidates needed to use the equation provided and give their final answer as a percentage. Many candidates did not show any working so could only be credited with any marks if their final answer was correctly given as a percentage. There was a compensatory mark for showing 48000 divided by 54000 in a candidate's workings which almost every candidate could have accessed. OCR support The answer to two significant figures is 89%. Many candidates gave their final answer to two significant figures as 0.8/ 80% or 0.9/90% or 0.88 /88%. .The Mathematical Skills Handbook provides support on the use of significant figures and other required mathematical skills. http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	9	

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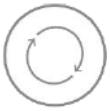
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Question			Answer/Indicative content	Marks	Guidance
38		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO 1.2)	ALLOW equation in any form
			11 × 11 × 23 or 112 × 23 or 121 × 23 ✓	(AO 2.1)	
			= 2783 ✓	(AO 2.1)	
			Conversion to kW = 2.8 (kW) ✓	(AO 2.1)	ALLOW ecf candidates answer to 3rd marking point converted to kW Examiner's Comments Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. .
		ii	Wind speed varies / AW ✓	1 (AO 2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW Examiner's Comments Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

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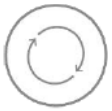
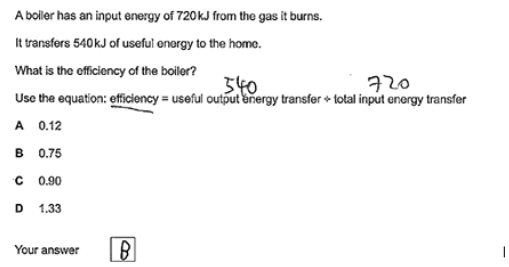
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Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	
39			D ✓	1 (AO 2.1)	
			Total	1	

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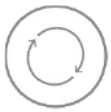
Question			Answer/Indicative content	Marks	Guidance
40			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.28 (W) award 3 marks Recall (Power =) potential difference x current ✓ 12 × 3.19 ✓ (P =) 38.28 (W) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW correct equation in any form ALLOW 38.3 (W) or 38 (W) <u>Examiner's Comments</u> Candidates had to recall the equation: power = potential difference x current and substitute the values provided in the question. Most candidates achieved full marks although some of the less able candidates could not recall the equation and therefore gained no credit.  AfL Candidates would benefit from writing down the equation and their calculations rather than just their final answer so that compensatory marks may possibly be awarded.
			Total	3	
41			B ✓	1 (AO2.1)	<u>Examiner's Comments</u> This question was well answered. Higher ability candidates used the space around the question for their working. Exemplar 1  5 A boiler has an input energy of 720 kJ from the gas it burns. It transfers 540 kJ of useful energy to the home. What is the efficiency of the boiler? Use the equation: efficiency = useful output energy transfer ÷ total input energy transfer 540 720 A 0.12 B 0.75 C 0.90 D 1.33 Your answer B This exemplar shows the candidate identifying the correct numbers for the given equation.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
42	a	i	40 (°C) ✓	1 (AO2.2)	Examiner's Comments The majority of the candidates calculated the difference correctly. Higher ability candidates often wrote 100 – 60 = 40
		ii	Any one from: Difference is much too high / difference should be lower than the previous result AW ✓ End temperature is too low ✓	1 (AO3.2a)	ALLOW does not follow the trend/pattern IGNORE not stirring/thermometer touching the bottom / start temperature / boiling temperature Examiner's Comments This question required candidates to identify that the last difference did not follow the pattern. The start temperature in this case was irrelevant and was not credited. Many candidates correctly identified that the end temperature was too low or that the temperature difference was too large. Candidates should be encouraged to include a comparison in this type of question.

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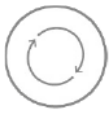
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Question			Answer/Indicative content	Marks	Guidance
	b		All points plotted correctly ✓ Appropriate straight line of best fit ✓	2 (AO 2×2.2)	**ALLOW** tolerance of ± half a square **DO NOT ALLOW** straight line from top to bottom **ALLOW** ECF for mis-plotted data points Examiner's Comments Many data points and lines were too thick. The second and fourth data points were often incorrectly plotted. It was expected that a straight line of best fit would be drawn. A large number of candidates drew lines dot-to-dot.  AfL Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. Straight lines should be drawn with a ruler. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.
	c		(As thickness of the insulation increases) temperature difference falls / ORA ✓	1 (AO3.1a)	Examiner's Comments The majority of candidates correctly stated that the temperature difference falls as the thickness of the insulation increases. Higher ability candidates included in their answer "as the thickness of the insulation increases".

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Question			Answer/Indicative content	Marks	Guidance
	d		As thickness increases rate decreases / AW / ORA ✓	1 (AO3.2b)	ALLOW as thickness increases tea cools slower / takes longer to cool ORA Examiner's Comments Many candidates omitted to indicate a direction of change for the thickness of the insulation. Other candidates did not understand the meaning of the term 'rate'.  AfL Candidates should be encouraged to practise explaining equations in terms of the effect of increasing a quantity on another quantity.
	e		Any two from: Keep starting temperatures the same ✓ Keep room temperature the same ✓ Stir tea before taking measurements ✓ Use a lid / add (same) insulation underneath the cup / cover whole cup in (same) thickness insulation ✓ Repeat and average	2 (AO2×3.3b)	Examiner's Comments In this type of question, candidates need to give detailed ways of improving the experiment. Many candidates stated add insulation without being specific that the insulation should be either under the tea or as a lid. A number of candidates stated correctly that the start temperature should be the same and the room temperature should also be the same.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
43	a	i	**Any one from:** Ratio of 1:1 at a height of 40 cm ✓ ratio (seems to) increase by 0.1 when height decreases by 20 cm (until ratio is 1:1) / AW ✓	1 (AO3.2a)	**ALLOW** when drop height was 40 cm, bounce height was the same / bounce ratio coming closer to 1:1 each time / bounce height cannot be higher than drop height Examiner's Comments Many candidates answered this question correctly by referring to the previous bounce height being the same. This question again required candidates to interpret data from a table.
		ii	Some of the energy from the KE store is transferred to other energy stores as ball hits the ground AW ✓	1 (AO2.1)	**ALLOW** ball will lose energy (when it hits the ground) Examiner's Comments There was a clue in the question regarding energy. It was anticipated that candidates would understand that there is likely to be energy losses both as the ball travels through the air and as it bounces. It was hoped that there would be reference to energy being transferred from the kinetic energy store to other energy stores as the ball bounces.

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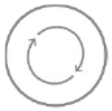
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Question			Answer/Indicative content	Marks	Guidance
	b		**Any two from:** Lower head to read bounce height / take bounce height readings at eye level / AW ✓ Take multiple readings and <u>average</u> them ✓ Take readings at other intervals (eg. 90, 70, 50) ✓	2 (AO2×3.3b)	**ALLOW** second person to read bounce height / idea of video camera and play back **ALLOW** drop from greater heights <u>Examiner's Comments</u> This was another question which required candidates to consider experimental procedures. Many candidates suggested taking other readings. Some candidates tried to suggest methods of improving the measurement of the bounce height but often the explanations were vague and lacked the necessary detail. AfL Candidates should be encouraged to consider improvements to experiments that are carried out as part of their practical course.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
44			As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓	2 (AO 3.1a) (AO 3.2b)	ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = 2×10 = 20 (m) for 2 marks <u>Examiner's Comments</u> Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed. The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.  AfL Understand how to test from a graph whether two quantities are directly proportional. 1. Take a quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2. See whether there is a straight line through the origin.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
45	a		Change the thickness of the cardboard (and repeat) ✓ Any 2 from: (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer / time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	3 (AO3 × 3.3a)	ALLOW use different boxes with different thicknesses / line the box with an insulator ALLOW same beaker / both beakers (don't) have a lid / same room temperature ALLOW a specified amount of water in the beaker / a specified starting temperature
	b	i	5 or 4 points correctly plotted to within ½ small square ✓✓	2 (AO2 × 2.2)	3 or 2 correctly plotted points gains 1 mark IGNORE 'blobs' more than ½ square diameter
		ii	Smooth curved line of best fit through most points ✓	1 (AO1.2)	DO NOT ALLOW a straight line of best fit
		iii	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2 (AO2 × 3.1a)	IGNORE non-linear relationship / positive/negative correlation ALLOW inverse proportion for this mark only ALLOW gradient decreases / temperature decreases more quickly at the start (than at the end) ALLOW use of data from the graph to show decreasing rate
		iv	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	2 (AO3.2b)	IGNORE shape of the line but no mark for a horizontal line ALLOW 90 +/- 2 °C
		v	Any one from: Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	1 (AO3.3b)	ALLOW any sensible suggestion IGNORE a longer time / use more thicknesses ALLOW use equipment with higher resolution / data logger IGNORE better equipment unless qualified

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Question			Answer/Indicative content	Marks	Guidance
	c		Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1 (AO3.2a)	**ALLOW** metal is a (better thermal) conductor / ORA
			Total	11	
46			Change the thickness of the cardboard (and repeat) ✓ **Any 2 from:** (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer / time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	3 (AO3 × 3.3a)	**ALLOW** use different boxes with different thicknesses / line the box with an insulator **ALLOW** same beaker / both beakers (don't) have a lid / same room temperature **ALLOW** a specified amount of water in the beaker / a specified starting temperature
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
47		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 72 (%) award 5 marks Select from data sheet: change in thermal energy = mass × specific heat capacity × change in temperature (no mark) (change in thermal energy =) 1.2 × 4200 × 75 ✓ (change in thermal energy =) 378 000 (J) ✓ (Recall: efficiency =) useful output energy transfer / input energy transfer OR (Efficiency =) 378 000 / 525 000 ✓ (Efficiency =) 0.72 ✓ (Efficiency =) 72 (%) ✓	5 (AO1.2) (AO2.1) (AO1.2) (AO2.1) (AO1.2)	ALLOW ecf for incorrect thermal energy calculated ALLOW 4 marks for answer of 0.72 (%)
		ii	some energy is transferred to the (thermal energy store of the) kettle/surroundings/air ✓	1 (AO2.1)	IGNORE sound
			Total	6	
48			Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1 (AO3.2a)	ALLOW metal is a (better thermal) conductor / ORA
			Total	1	
49			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.9 (A) award 2 marks (Rearrangement: I_p =) $I_s \times V_s / V_p$ ✓ OR (I_p =) 12 × 9.0 / 120 ✓ (I_p =) 0.9 (A) ✓	2 (AO1.2) (AO2.1)	
			Total	2	

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