



GCSE MARKING SCHEME

SCIENCE - PHYSICS

SUMMER 2013

INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2013 examination in GCSE SCIENCE - PHYSICS. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

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GCSE SCIENCE - PHYSICS 1

FOUNDATION TIER

Question		Marking details	Marks
1.	(a)	visible light – infrared - microwaves all correct – 2 marks 1 or 2 correct – 1 mark	2
	(b)	(i) 17[%] (accept 100-83)	1
		(ii) increases / heats up / rises (accept – very hot / gets hot / warms it up)	1
	(c)	ticks in boxes 2, 3 & 4 (3x(1) – each additional tick over 3 loses a mark)	3
Question total			[7]
2.	(a)	2.2 [kW]	1
	(b)	(i) X	1
		(ii) 3 960 000 J	1
	(iii)	use of 1.6 (1) conversion of 30 min to 0.5 h and multiply (1) Answer 0.8 [kWh] scores (2) Answer 48 – 1 mark (1.6 x 30 – uses the correct power) 0.5 / 1.1 / 500 / 1 100 / 800 – 1 mark (has converted time correctly) (1.6 ÷ 0.5) = 1 mark only	2
	(iv)	0.8 (ecf) x 15 = 12 [p] mark is for the answer. Don't accept £0.12 p	1
Question total			[6]
3.	(i)	beta	1
	(ii)	Any 2 x (1): - alpha would not penetrate through [that much] air - gamma would not be absorbed by [that much] air - beta blocked by that much air answer must refer to penetration through air or implied through air e.g. alpha would not get that far	2
	(iii)	Any 2 x (1): repeat [the experiment] (accept more results) measure [counts] over a longer period of time take readings at smaller distance intervals start taking readings at 0 (accept increase the range) use a different part of the quarry wall Don't accept: more people do the experiment / better detectors	2
	(iv)	[decay is] random / no pattern / decay at different times / decay is disorganised. (Do not accept unpredictable.)	1
Question total			[6]

Question		Marking details	Marks
4.	(a)	(i) 1 000 x 25 = 25 000 [kg] mark is for the answer on answer line	1
		(ii) 25 000 (ecf) x 120 (1) = 3 000 000 [J] (1)	2
	(b)	$\frac{1.8}{2} \times 100$ (1) = 90[%] (1) Answer 0.9 – 1 mark	2
	(c)	back up or quick start (1) when demand increases e.g. at breakfast time / break in a sporting event / another power station has broken down (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(d)	(i) reduce energy or heat losses / increase efficiency (do not accept just reduce the current or there is no heat loss)	1
		(ii) [low voltages are] safer / high voltages are dangerous / for safety	1
Question total			[9]
5.	(a)	(i) 30 thousand [years]	1
		(ii) 8.3 [minutes] (ignore reference to light if written)	1
		(iii) 13 [light hours]	1
		(iv) accept > 0.4 [AU] and <1 [AU]	1
	(b)	(i) absorbing (1)	2
		(ii) red shifted (1)	
	(c)	(i) A	1
		(ii) B	1
Question total			[8]

Question		Marking details	Marks
6.	(a)	(i) Gas (1) because it produces <u>smallest amount / less carbon dioxide or carbon monoxide</u> (1) accept converse argument. Either mark can be awarded on its own but only award 2 marks if they are linked.	2
		(ii) Gas (1) because it produces <u>smallest amount / less sulfur dioxide or nitrous oxide</u> (1) (e.g. accept because sulphur dioxide is 1). Accept converse argument. Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(b)	(i) heats water / produces steam (accept they use cold water)	1
		(ii) operates 24 hours a day (accept not always sunny / rocks are always hot / produces electricity in the night / [more] reliable)	1
	(c)	(i) plots (2) $\pm \frac{1}{2}$ small square division (ignore any other points that are plotted) -1 mark for each incorrect plot up to a max of 2 straight line (1) (ignore any line before the 1 st point). Don't accept double lines / wispy / disjointed / wobbly lines or the line missing points.	3
		(ii) 6.5 ± 0.05 [km] ecf value must be taken from their graph	1
	(d)	$\frac{2400000}{2000}$ (1) = 1 200 (1)	2
	Question total		

Question		Marking details	Marks
7.	(a)	4 (1), 20 (1)	2
	(b)	<p>Indicative content:</p> <p>The advantages of insulating the loft are of primary importance. The money spent is the least, it is recouped in the shortest time and gives the greatest gain in energy loss reduction (2 700 W), this accounts for £800 of the spending money. The cavity wall insulation is of second priority with an outlay of £1200, a payback time of just 10 years and the next greatest energy saving of 1 700 W. The remaining money of £1200 is better spent on replacing their doors because of the smaller payback time. The doors have a payback time of 60 years but save only 200 W in total. [The total spend is £3 200 with an annual saving of £340 giving a payback time of 9.4 years.]</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>	6
	(c)	loft / roof, cavity / wall, windows [2 marks for all correct, 1 mark for 1 or 2 parts correct]	2
	(d)	[Inner] wall / house <u>heats</u> the <u>air</u> (1) which becomes <u>less dense</u> / <u>rises</u> (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2
		Question total	[12]
Foundation tier paper total			[60]

HIGHER TIER

Question			Marking details	Marks
1.	(a)	(i)	Gas (1) because it produces <u>smallest amount / less carbon dioxide or carbon monoxide</u> (1) accept converse argument. Either mark can be awarded on its own but only award 2 marks if they are linked.	2
		(ii)	Gas (1) because it produces <u>smallest amount / less sulfur dioxide or nitrous oxide</u> (1) (e.g. accept because sulphur dioxide is 1). Accept converse argument. Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(b)	(i)	heats water / produces steam (accept they use cold water)	1
		(ii)	operates 24 hours a day (accept not always sunny / rocks are always hot / produces electricity in the night / [more] reliable)	1
	(c)	(i)	plots (2) $\pm \frac{1}{2}$ small square division (ignore any other points that are plotted). -1 mark for each incorrect plot up to a max of 2 straight line (1) (ignore any line before the 1 st point). Don't accept double lines / wispy / disjointed / wobbly lines or the line missing points.	3
		(ii)	6.5 ± 0.05 [km] ecf value must be taken from their graph	1
	(d)		$\frac{2400000}{2000}$ (1) = 1 200 (1)	2
Question total				[12]
2.	(a)		4 (1), 20 (1)	2
	(b)		Indicative content: The advantages of insulating the loft are of primary importance. The money spent is the least, it is recouped in the shortest time and gives the greatest gain in energy loss reduction (2 700 W), this accounts for £800 of the spending money. The cavity wall insulation is of second priority with an outlay of £1200, a payback time of just 10 years and the next greatest energy saving of 1 700 W. The remaining money of £1200 is better spent on replacing their doors because of the smaller payback time. The doors have a payback time of 60 years but save only 200 W in total. [The total spend is £3 200 with an annual saving of £340 giving a payback time of 9.4 years.] 5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.	6

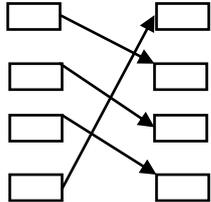
Question		Marking details	Marks
		<p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>	
	(c)	loft / roof, cavity / wall, windows [2 marks for all correct, 1 mark for 1 or 2 parts correct]	2
	(d)	[Inner] <u>wall</u> / <u>house</u> <u>heats</u> the <u>air</u> (1) which becomes <u>less dense</u> / <u>rises</u> (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(e)	Reduced temperature difference between inside and outside (1) results in less money (spent and) saved / less energy used on heating (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(f)	$\text{Units saved} = \frac{12000}{15} \left[\text{or } \frac{120}{0.15} \right] = 800 \text{ (1 conv+substitution, 1 ans)}$ $\text{Time} = \frac{800}{1.7} \text{ (1 ecf for 800= [470.588 hours]}$ <p>Answer of 470.588 / 470.59/470.6/471/470 – award 3 marks 470.58/470.5/ 0.47– award 2 marks 4.7 – award 1 mark 0.0047 – award 0 marks</p> <p>Question total</p>	3
		Question total	[17]
3.	(a)	Alpha and beta completely stopped by any thickness (1), gamma intensity reduced (1) by an amount that depends on the thickness of the concrete (1) {NB1 for “alpha, beta, gamma all stopped give 1 mark only} {NB2 for “gamma stopped if the concrete is thick enough” 1 mark}	3
	(b) (i)	e.g. stored underground / vitrification / in tanks of deep water / lead lined or concrete containers / at sea. Don't accept put into space.	1
	(b) (ii)	suitable advantage such as safe from terrorism/secure/away from living things (1) suitable disadvantage such as may get into water supply / containers leak in time / difficult to monitor / earthquakes (1) Don't accept reference to cost or time. (Accept unrelated answer to part (i))	2
		Question total	[6]

Question			Marking details	Marks
4.	(a)	(i)	A network of [power] <u>cables/ wires</u> (1) that <u>connect power stations to consumers / homes / schools / factories.</u> (1)	2
		(ii)	lower <u>er</u> current (1) to <u>reduce</u> energy / heat losses or to improve efficiency (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2
	(b)	(i)	<u>step-down</u> because output voltage is smaller / input voltage higher / reduces voltage <u>or</u> less turns on output coil / more turns on input coil / turns reduced. (Accept it supplies homes / schools / industry.)	1
		(ii)	[power = voltage x current] $I = \frac{10000000}{400000}$ (1 sub/manip, 1 conv) {for $\frac{10}{400}$ with answer = 1 mark, but with any compatible conversion gets both marks e.g. $\frac{10000}{400}$ – 2 marks} = 25[A] (1 ans)	3
	(iii)	$99 = \frac{\text{power output}}{10 \times 10^6} \times 100$ $\text{power output} = \frac{99}{100} \times 10 \times 10^6 = 9.9 \times 10^6 \text{ W or } 9.9 \text{ MW}$ (1sub, 1 manip, 1 ans with correct unit)	3	
Question total				[11]
5.	(a)		<i>....stays above the same point on the Earth (1)and orbits the Earth in 24 hours / same time / same rate as Earth spins [once]. (1)</i> Don't accept orbits the Earth at the same speed	2
	(b)	(i)	2(1) <u>x</u> 0.2 (1) = [0.4 V] On the answer line: If 0.4 only award 2 marks / 0.2 award 1 mark / 2 or 0.8 award 0 marks	2
		(ii)	signal has to travel twice as far [as 36 million km] / up and down	1
		(iii)	[single cycle of] smaller amplitude (1) starting at 0.24 ± 0.02 on horizontal axis (1) Ignore the wavelength or number of cycles.	2
Question total				[7]

Question		Marking details	Marks
6.	(a)	the <u>distance/ how far</u> light travels in 4 years	1
	(b)	<p>Indicative content:</p> <p>Light coming from the centre of stars is absorbed by the gases in their atmospheres / interstellar gases and re-emitted in all directions. Their frequency / wavelength gives information about the gases present and the fact that they are red shifted gives information about their distance away and the speed at which they are moving away – by the application of Hubble’s measurements and law.</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p>Question total</p>	6
			[7]
Higher tier paper total			[60]

GCSE SCIENCE - PHYSICS 2

FOUNDATION TIER

Question		Marking details	Mark
1.	(a)	<p>All correct - 3 marks 2 or 3 correct – 2 marks 1 correct – 1 mark</p> 	3
	(b)	(i) fission OR chain [reaction]	1
		(ii) krypton or barium (accept Kr or Ba)	1
	(c)	<p>Any 2 x (1):</p> <ul style="list-style-type: none"> - they have <u>long half- lives</u> - <u>highly/very radioactive</u> - prevents leaks / getting into the environment or food chain or water supply - <u>harmful/poisonous/toxic/dangerous to living things</u> or <u>ionises cells / mutates cells</u> or <u>risk to health/cancer</u> - prevent theft/use as weapons/use by terrorists <p>If 2 correct answers given on 1 line only then award 2 marks. If 2 correct answers given on 1 line and then on the 2nd line an incorrect answer is given award 1 mark only. If 1 correct answer and 1 incorrect answer are given on the same line then no mark awarded.</p> <p>Question total</p>	2
			[7]
2.	(a)	(i) 3 [A]	1
		(ii) Point at coordinates (9, 3) ± ½ small square division (ignore any other points that are plotted).	1
		(iii) Straight(ish) line from origin through (9,3) ± ½ small square division (allow ecf)	1
	(b)	(i) $\frac{9}{3} (1) = 3 (1)$ Ohms or $\Omega (1)$ If 3/9 written no marks for substitution and answer can be awarded.	3
		(ii) $9 \times 3 (1) = 27 (1)$ Watts or W or J/s (1)	3
	Question total	[9]	

Question		Marking details	Mark	
3.	(a)	$^{12}_6\text{C}$	1	
	(b)	14 (1), 1 (1) N.B. must look like a subscript	2	
	(c)	6 (1), 8 (1), 0 (1)	3	
	Question total		[6]	
4.	(a)	(i)	15 [m/s]	1
		(ii)	16 [m] ecf must be applied from (i)	1
	(b)	(i)	$\frac{15(1)}{25} = 0.6$ [s] (1)	2
		(ii)	50(1)+ 15(1) = [65 m] If 65 only award 2 marks. Do not accept 50 or 15 on the answer line.	2
		(iii)	any factor that reduces the braking distance of the car e.g. - improved/good tread on tyres, - rougher road surface, - good/better brakes, - good/better weather conditions, - correct tyre pressure, - good/better/newer tyres etc. Accept converse arguments if explained.	1
	Question total		[7]	
	5.	(a)	(i)	0.15 x 20 (1 for substitution) = 3 [kg m/s] (1)
(ii)			$\frac{3}{0.5}$ (1) allow ecf from (i) = 6 [N] (1)	2
(iii)			3 [N] allow ecf from (i) which gives the same answer as in (i) or allow ecf from (ii) which gives half the answer to (ii)	1
(b)		(i)	e.g. car crash / emergency stop / sudden braking / landing on ground	2
		(ii)	<u>Stretchy</u> seat belt / air bag / crumple zone to achieve it/ bending legs on landing Mark parts (i) and (ii) together.	
Question total		[7]		

Question			Marking details	Mark	
6.	(a)	(i)	The time/how long it takes/it takes 6 000 years for half of the <u>undecayed</u> atoms/mass/amount/activity/count rate to fall by half.	1	
		(ii)	The nucleus emits/loses (1) an electron (1) OR identifies the nucleus (1) in which neutron splits into proton and electron (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2	
	(b)	(i)	plots correct (2) [lose 1 for each incorrect plot allow $\pm \frac{1}{2}$ small square division up to a maximum of 2 marks] reasonable curve through the points (1)	3	
		(ii)	Value to be taken from candidate's graph ± 10 [About ± 130]. Credit an answer of between 120-140 when no line is drawn.	1	
		(iii)	10 (1) x 6 000 (1) = [60 000 years]	2	
	(c)	(i)	7 400 years (value to be taken from candidate's graph)	1	
		(ii)	reduce activities from the graph by a factor of 10 (1), line from 320 on graph to find time (1) or converse, (or reference to) lines drawn on graph at 320 (and down to the time axis). Alternative - for an extended graph and lines drawn at 80 (1) and "32" drawn on an extended line (1), award both marks for method either explained or drawn. N.B. No marks can be awarded for the age because of the uncertainty in this method.	2	
				Question total	[12]

Question	Marking details	Mark
7.	<p>(i) Indicative content: The initial velocity of the bus is 5 m/s. It continues at this velocity for 10 s. Then it accelerates at a constant rate of 1.5 m/s² for 10 s to 20 m/s. It travels at a constant velocity of 20 m/s for 20 s. At 40 s, it decelerates at a decreasing rate until it comes to a rest at 70 s. The mean deceleration is 0.67 m/s².</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p>(ii) Scales using at least half of each axis [at least one intermediate point required and a sensible scale] (1) point (10,50) [point may not be clear but award if line ends at this point. Ignore intermediate points]. (1) Straight(ish) line to that point and must be from (0,0) [Do not award this mark for an obvious curve] (1). Any line that goes past (10,50) is penalised 1 mark. Straight line to wrongly plotted point gets the line mark.</p> <p>(iii) 20 (1) x 20 (1) = 400 [m] (1) Repeated multiplications e.g. 20 x 20, 20 x 40, 20 x 5 [1 only]</p> <p>Question total</p>	<p>6</p> <p>3</p> <p>3</p> <p>[12]</p>
	Foundation Tier Paper Total	[60]

HIGHER TIER

Question			Marking details	Mark	
1.	(a)	(i)	The time/how long it takes/it takes 6000 years for half of the <u>undecayed</u> atoms/mass/amount/activity/count rate to fall by half.	1	
		(ii)	The nucleus emits/loses (1) an electron (1) OR identifies the nucleus (1) in which neutron splits into proton and electron (1) Either mark can be awarded on its own but only award 2 marks if they are linked.	2	
	(b)	(i)	plots correct (2) [lose 1 for each incorrect plot allow $\pm \frac{1}{2}$ small square division up to a maximum of 2 marks] reasonable curve through the points (1)	3	
		(ii)	Value to be taken from candidate's graph ± 10 [About 130]. Credit an answer of between 120-140 when no line is drawn.	1	
		(iii)	10 (1) <u>$\times 6\ 000$</u> (1) = [60 000 years]	2	
	(c)	(i)	7 400 years (value to be taken from candidate's graph)(1)	1	
		(ii)	reduce activities from the graph by a factor of 10 (1), line from 320 on graph to find time (1) or converse, (or reference to) lines drawn on graph at 320 (and down to the time axis). Alternative - for an extended graph and lines drawn at 80 (1) and "32" drawn on an extended line (1), award both marks for method either explained or drawn. N.B. No marks can be awarded for the age because of the uncertainty in this method.	2	
				Question total	[12]

Question		Marking details	Mark
2.	(i)	<p>Indicative content: The initial velocity of the bus is 5 m/s. It continues at this velocity for 10 s. Then it accelerates at a constant rate of 1.5 m/s² for 10 s to 20 m/s. It travels at a constant velocity of 20 m/s for 20 s. At 40 s, it decelerates at a decreasing rate until it comes to a rest at 70 s. The mean deceleration is 0.67 m/s².</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>	6
	(ii)	<p>Scales using at least half of each axis [at least one intermediate point required and a sensible scale] (1) point (10,50) [point may not be clear but award if line ends at this point. Ignore intermediate points]. (1) Straight(ish) line to that point and must be from (0,0) [Do not award this mark for an obvious curve] (1). Any line that goes past (10,50) is penalised 1 mark. Straight line to wrongly plotted point gets the line mark.</p>	3
	(iii)	<p>20 (1) \times 20 (1) = 400 [m] (1) Repeated multiplications e.g. 20 x 20, 20 x 40, 20 x 5 [1 only]</p>	3
		Question total	[12]

Question		Marking details	Mark	
3.	(a)	Object continues in its state of rest/inertia/motion/constant speed [in a straight line] (1) unless acted upon by an [external/unbalanced] force (1)	2	
	(b)	(i)	2 250 x 8 (1 for substitution) = 18 000 [kg m/s](1) [Answer mark must be number on answer line]	2
		(ii)	(1 for subs + manip) $\frac{18000}{900} = 20$ (allow ecf from (i)) final velocity = 20 (ecf) + 5 = 25 [m/s] (1) OR Final momentum = 4 500 + 18 000 = 22 500 (1) $v = 25$ [m/s] (1) OR Momentum ratio = velocity ratio e.g. 18 000:4 500 = 4 so arrive at a [change in] velocity of 20 [m/s] (1) $v = 25$ [m/s] (1)	2
Question total			[6]	
4.	(a)	(i)	By using a moderator / graphite / water. Accept graphite rods / graphite monitor. BUT moderator + control rods (0) graphite and boron (0).	1
		(ii)	${}_{94}^{239}\text{Pu} + {}_0^1\text{n} \rightarrow {}_{39}^{89}\text{Y} + {}_{55}^{148}\text{Cs} + 3 {}_0^1\text{n}$ LHS: Correct symbol for a neutron ${}_0^1\text{n}$ NOT N (1), correct nuclear symbol for plutonium ${}_{94}^{239}\text{Pu}$ (1), RHS: correct nuclear symbols for Yttrium ${}_{39}^{89}\text{Y}$ and Caesium ${}_{55}^{148}\text{Cs}$ (1), 3 neutrons $3 {}_0^1\text{n}$ (1). Accept Y_{39}^{89} Accept $3 {}_0^1\text{N}$ or 3n	4
	(b)	Same/equal number (accept amount) of protons/atomic number/55 protons (1) different number (accept amount) of neutrons/mass number/nucleon number (1) Electrons are not awarded but regard as neutral. HOWEVER 'same number of electrons in neutral atoms' (1).	2	
Question total			[7]	
5.	(a)	Subs+manip $40/230$ (1) $I = 0.17$ [4] [A] (1) [Do not accept 0.173 but accept 0.2]	2	
	(b)	(i)	Subs+manip $I^2 = \frac{118}{82}$ (1) = 1.44 (1), $I = 1.2$ [A] (1) If 1.44 on the answer line then award 2 marks. If 1.43 used, no penalty for rounding I will = 1.19 [A] N.B. $\sqrt{1.4} = 1.18$	3
		(ii)	current through each lamp = $\frac{1.2(\text{ecf})}{12} = 0.1$ [A] (1) Either pd across dimmer = $1.2 \times 82 = 98$ [.4] (1) pd across lamps = $230 - 98.4$ ecf = 131.6 (accept 132) power = 131.6 ecf x 0.1 ecf = 13.16 [W] (accept 13.2) (1) OR resistance of each lamp = $\frac{230}{0.174} = 1\,322$ (1) ecf for 0.174 Power = 0.1^2 ecf x $1\,322$ ecf = 13.22 [W] (1)	3
Question total			[8]	

Question		Marking details	Mark	
6.	(a)	<p>Indicative content:</p> <p>As the car is pulled to the top of the hill it gains potential energy. Since this is the highest point of its journey, this will be the maximum potential energy that the car will gain. As the car runs down the other side of the hill, potential energy will be converted to kinetic energy. As the car begins to rise at the next hill, the kinetic energy is then converted back into potential energy and so on. However due to resistive forces, some of the energy is dissipated as heat so during the ride the total energy possessed by the car decreases. This explains why each successive hill must be lower than the previous one.</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p>	6	
	(b)	(i)	<p>Calculation of PE using mgh or by implication (1): $1\,200 \times 10 \times 90$ (1) = [1 080 000 J] If $1\,200 \times 10 \times 50$ or $1\,200 \times 10 \times 140$ used this implies use of mgh so award 1 mark. $1\,080\,000$ ecf = $\frac{1}{2}mv^2$ or $1\,080\,000$ ecf = KE (1) = $600v^2$ $v = 42.4$ [m/s] ecf (1)</p> <p>Alternatives: If PE = KE stated anywhere award 1 mark If show $\frac{1}{2}mv^2 = mgh$ anywhere award 2 marks</p>	4
		(ii)	<p>No (1), because $\frac{1}{2}mv^2 = mgh$ or m cancels out (1) Actual KE at bottom = $\frac{1}{2}1\,200 \times 37^2 = 821\,400$ [J] (1)</p>	2
		(iii)	<p>Energy loss = $1\,080\,000$ ecf – $821\,400$ ecf = $258\,600$ [J] (1) mean resistive force = WD ecf /distance = $2\,586$ [N] (1)</p>	3
Question total			[15]	
Higher Tier Paper Total			[60]	

GCSE SCIENCE - PHYSICS 3

FOUNDATION TIER

Question			Marking details	Mark		
1.	(a)		correct shape with no lines crossing & 2 lines minimum (1 on the top and 1 on the bottom ignore the middle) (1) direction (1)	2		
	(b)	(i)	stronger / accept more lines / bigger / increases	1		
		(ii)	stronger / accept more lines / bigger / increases	1		
		(iii)	reverses direction / opposite direction / goes the other way	1		
			Question total	[5]		
2.	(a)		current, primary, magnetic, core / primary, secondary. [5 x 1]	5		
	(b)	(i)	100 turns	1		
		(ii)	IC = 100 (1) OC = 1 000 (1) (allow 1 mark for any combination that increases voltage)	2		
				Question total	[8]	
3.	(a)	(i)	Reasonably straight line joining to C (arrowhead not required)	1		
		(ii)	X between incident ray and normal	1		
	(b)		Medium 2	Angle of incidence	What happens to the ray of light at the boundary?	4
			Air	35°	Refracts (1)	
			Glass	42°	Refracts (1)	
			Air	42°	Travel along the boundary (1)	
			Air	45°	TIR (1)	
				Question total	[6]	
4.	(a)	(i)	Surface waves travel on surface / P & S waves travel through Earth	1		
		(ii)	particle vibrations / oscillations (1) parallel/same direction as travel for P wave and at right angles for S wave (1) (accept up and down / back and for)	2		
	(b)	(i)	3 (1) only P waves detected / no S waves accept longest time (1)	2		
		(ii)	2 (1) Y is further away/greater distance to travel (1) so waves would arrive later (1) Either mark can be awarded on its own but only award 2 marks if they are linked. (Accept middle value distance and middle time.)	3		
				Question total	[8]	

Question			Marking details	Mark
5.	(a)	(i)	accept any value between 5 500 and 6 500 K inclusive	1
		(ii)	[ACB is] <u>smaller</u> / <u>cooler</u> or <u>lower</u> temperature/ <u>dimmer</u> or converse if referring to Sun but must be clear referring to Sun [any 2 x 1]	2
		(iii)	Both main sequence stars (accept balanced forces)	1
	(b)	(i)	radiation pressure/outward force becomes greater than gravitational force / inward force N.B. must compare the both. Unbalanced forces must be qualified.	1
		(ii)	becomes <u>larger</u> / <u>expands</u> , <u>brighter</u> , <u>cooler</u> / <u>redder</u> [3 x 1] Award marks if appropriate values for the properties given.	3
	(c)		X marked near white dwarf section	1
			Question total	[9]
6.	(a)		If no external / outside force acts (1) the <u>total</u> momentum remains constant /stays the same / is conserved or momentum before [collison/explosion] equals momentum after (1)	2
	(b)	(i)	$15 \times 800 (1) = 12\,000 \text{ [kg m/s]} (1)$	2
		(ii)	Subs 12 000 or ecf (1) subs 1 600 kg (1) ans = 7.5 [m/s] (1)	3
		(iii)	16 000 [N] (1) to the left (1) Award 2 marks for -16 000 or equal and opposite force	2
	(c)	(i)	0	1
		(ii)	equal and opposite momentum (1) so total momentum is zero (1) Either mark can be awarded on its own but only award 2 marks if they are linked. Award 1 mark only for momentum to the right cancels momentum to the left unless linked to 1 of the other marking points.	2
			Question total	[12]

Question			Marking details	Mark
7.	(a)	(i)	Plots $\pm \frac{1}{2}$ small square division (2), curve (1)	3
		(ii)	As the volume increases, the pressure decreases (1) in a non-linear way / decreasing rate (1) (inversely proportional / as volume doubles the pressure is halved award both marks)	2
		(iii)	Around 67 000 (take the value that occurs from their line ± 500)	1
	(b)	<p>Indicative content:</p> <p>As the volume increases, the molecules have further to travel between collisions with the container therefore they take a longer time to travel so the rate of change of momentum is reduced. This reduces the force from any one molecule when in collision with the walls. Since pressure = force / area, the decrease in the force gives a reason for a decrease in pressure / increase in area causes pressure.</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p>Question total</p>	6	
			Question total	[12]
			Foundation tier paper total	[60]

HIGHER TIER

Question		Marking details	Mark
1.	(a)	If no external / outside force acts (1) the <u>total</u> momentum remains constant /stays the same / is conserved or momentum before [collison/explosion] equals momentum after (1)	2
	(b)	(i)	2
		(ii)	3
		(iii)	2
	(c)	KE before collision = $\frac{1}{2} 800 \times 15^2 = 90\,000$ [J] (1) KE after collision = $\frac{1}{2} 1\,600 \times 7.5^2 = 45\,000$ [J] (1) ecf from (b)(ii) KE loss = 45 000 [J](1) Award a maximum of 2 marks	2
	(d)	(i)	1
	(ii)	2	
<p>equal and opposite momentum (1) so total momentum is zero (1) Either mark can be awarded on its own but only award 2 marks if they are linked. Award 1 mark only for momentum to the right cancels momentum to the left unless linked to 1 of the other marking points.</p> <p>Question total</p>			[14]

Question			Marking details	Mark
2.	(a)	(i)	Plots $\pm \frac{1}{2}$ small square division (2), curve (1)	3
		(ii)	As the volume increases, the pressure decreases (1) in a non-linear way / decreasing rate (1) (inversely proportional / as volume doubles the pressure is halved award both marks)	2
		(iii)	Around 67 000 (take the value that occurs from their line ± 500)	1
	(b)	(i)	Indicative content: As the volume increases, the molecules have further to travel between collisions with the container therefore they take a longer time to travel so the rate of change of momentum is reduced. This reduces the force from any one molecule when in collision with the walls. Since pressure = force / area, the decrease in the force gives a reason for a decrease in pressure / increase in area causes pressure. 5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. 3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. 1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. 0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.	6
		(ii)	increased speed / faster / KE increases	1
			Question total	[13]
3.	(a)		Refraction (1). Passing from a less to a more dense medium or material / light slows down (1)	2
	(b)	(i)	point E	1
		(ii)	Award 2 x(1): strikes at an angle greater than the critical angle/ 42° for glass (1) directed from a more to a less dense medium (1) angle of reflection is equal to the angle of incidence (1)	2
				Question total

Question			Marking details	Mark
4.	(a)		U	1
	(b)	(i)	coil A because it has the bigger voltage of the two [both points required for the mark] or it's a step-down transformer or A has less current	1
		(ii)	to set up a changing magnetic field [in the iron core] don't accept moving	1
		(iii)	to transfer / link the <u>field</u> into coil <u>B</u>	1
		(iv)	The <u>changing magnetic field</u> induces a voltage in coil B (cutting is neutral)	1
		(v)	$\frac{230}{12} = \frac{18400}{N_2}$ [1 sub] $N_2 = 18400 \times \frac{12}{230}$ $N_2 = 960$ (1)	2
			Question total	[7]
5.	(a)	(i)	[surface and] longitudinal / P waves [arrive between B and C]. (DO NOT ACCEPT "It is a shadow zone for S waves")	1
		(ii)	Surface waves / none [are detected between C and D]. (Accept it is in the shadow zones of S and P waves)	1
	(b)	Any 4 x (1): in the mantle stiffness increases with depth (1) so wave speed increases / refraction (1), solid mantle, liquid core (1) [entering the liquid core] the stiffness decreases / density increases (1) so the wave speed decreases / refracts the other way (1)	4	
			Question total	[6]
6.	(a)	(i)	$\frac{36 \pm 0.5(1)}{20(1)} = 1.8$	2
		(ii)	Take a very small interval of length (e.g. 5 cm) / draw a tangent and find its gradient	1
	(b)	Line below the one drawn from 60°C (1) down to, but never falling below room temp (1)	2	
	(c)	Presence of free electrons (1) which [transfer energy when they] <u>collide</u> (1) Award 1 mark only for moving particles which transfer energy by collisions.	2	
			Question total	[7]

Question		Marking details	Mark
7.	(a)	Using $E=mc^2$, $4 \times 10^{26} = m \times (3 \times 10^8)^2$ (1) $m \sim 4.4 \times 10^9$ [kg] (1)	2
	(b)	<p>Indicative content:</p> <p>At the end of the main sequence, hydrogen is exhausted and the balance between gravity and radiation pressure fails. Initially, radiation pressure drops and the core contracts, density increases and the temperature increases allowing heavier elements to fuse. This is the red giant stage. Meanwhile the lighter elements continue fusing in a shell around the nucleus. Stars like the Sun never reach sufficient temperatures to create elements as heavy as iron. Eventually, the core will run out of helium fuel, and in order to maintain equilibrium, the core will contract again to initiate the last type of fusion – carbon.</p> <p>5 – 6 marks The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>3 – 4 marks The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>1 – 2 marks The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>0 marks The candidate does not make any attempt or give a relevant answer worthy of credit.</p> <p>Question total</p>	6
			[8]
Higher tier paper total			[60]



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