COMPONENT 3 – Concepts in Physics

HIGHER TIER

MARK SCHEME

GENERAL INSTRUCTIONS

<u>Recording of marks</u>

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response questions).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

<u>Marking rules</u>

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

<u>Extended response question</u>

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

<u>Marking abbreviations</u>

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao =   correct answer only
ecf =   error carried forward
bod =   benefit of doubt

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			Selection of: $v = u + at$ (1)	1					
				Manipulation of equation: $a = \dfrac{(v-u)}{t}$ accept by implication (1)		1				
				Substitution: $\dfrac{27}{6.5}$ (1)		1				
				Acceleration = 4.2 [m/s^2] (accept 4.1, 4.15) (1)		1		4	3	
	(b)			A car travelling at a slower speed has significantly less KE (1) So less time needed to stop the car / less stopping distance (1)		2		2		
				Question 1 total	**1**	**5**	**0**	**6**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			720 in cell in the force needed column (1) 1 776 in cell in the work done column (1)		2		2	2	
	(b)	(i)		Small<u>est</u> distance lifted compared to the other weightlifters (1) Relevant work done = force × distance comment e.g. weightlifter D has the lowest product of force and distance (1)	1	1		2		
		(ii)		Recall of: $\text{power} = \dfrac{\text{energy transferred}}{\text{time}}$ (1) $\dfrac{1600}{5} = 320$ [W] (1)	1	1		2	1	
		(iii)		Competitor D (1) Least work done in set time (1)		2		2		
				Question 2 total	**2**	**6**	**0**	**8**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			Single complete loop (1) Resistor symbol correct (1) Ammeter symbol correct (1) 	3			3		3
	(b)	(i)		4 + 2 = 6 [Ω]	1			1		1
		(ii)		Recall of: $V = IR$ (1) Manipulation: $I = \dfrac{12}{6}$ (1) Ammeter reading = 2 [A] (1)	1	1 1		3		3
		(iii)		The 4 Ω resistor gets the hottest / has the biggest power (1) Identical (current)^2 through each resistor but multiplied by higher resistance (1)			2	2		2
				Question 3 total	**5**	**2**	**2**	**9**	**0**	**9**
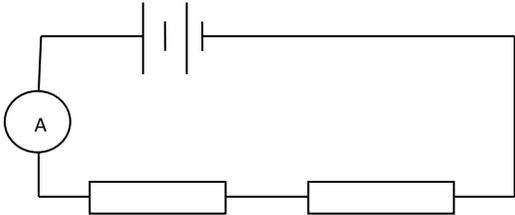
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	[-] 10 [m/s]		1		1		
		(ii)	Recall of: $a = \dfrac{\Delta v}{t}$ (1)	1					
			Substitution: $a = \dfrac{10}{50}$ (1)	1					
			Deceleration = 0.2 [m/s^2] (1)		1		3	2	
	(b)		Recall of: $F = ma$ (1)	1					
			Substitution: 55×0.2 (1)	1					
			Resultant force =11 [N] (**ecf**) (1)		1		3	2	
	(c)		Larger distance covered / bigger area / velocity is more (1) In the same time interval / same 300 s (1)			2	2	2	
			Question 4 total	**4**	**3**	**2**	**9**	**6**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			Use a video camera to record the height to which the ball bounces / have one person drop the ball and a different person to record the height to which it bounces (1) Ensure there is repeat data for each temperature (1)			2	2		2
	(b)			Too many significant figures used/ should use 2 significant figures			1	1		1
	(c)			Low COR value shows (a lot of) energy lost as heat (1) raising the temperature of the ball. (1) At higher temperatures COR is higher (1) so the ball bounces back faster (1)			4	4		
				Question 5 total	**0**	**0**	**7**	**7**	**0**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			Recall of: distance = speed × time (1) Substitution: $3 \times 10^8 \times 500 = 1.5 \times 10^{11}$ [m] (1) Substitution into: Time = $\dfrac{\text{Distance}}{\text{Speed}}$ i.e. $t = \dfrac{1.5 \times 10^{11} (\text{ecf})}{3.2 \times 10^6}$ (1) t = 46 875 [s] (1)	1 1 	 1 1		 4	 3	
	(b)	(i)		Microwave			1	1		
		(ii)		$f = \dfrac{c}{\lambda} = \dfrac{3 \times 10^8}{11 \times 10^{-6}}$ (1) **ecf** on λ = 2.7 × 10^{13} [Hz] (1) (**ecf** on conversion) Not detected as higher value than frequency range stated (1) (**ecf** on previous answer) **Alternative solution:** $\lambda = \dfrac{c}{f} = \dfrac{3 \times 10^8}{6 \times 10^9}$ (1) = 5 × 10^{-2} [m] (1) Not detected as much higher value than the peak value (1)		1 1 	 1	 3	 3	
	(c)			0 (top) and -1 (bottom) for beta (1) 7 top and 3 bottom for Li (1)	2			2		
				Question 6 total	**4**	**4**	**2**	**10**	**6**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		Recall of: $p = m\,v$ (1)	1					
				p = 1 400 $\times$ 12 = [-]16 800 [kg m/s] (1)		1		2	1	
		(ii)		Total momentum before = total momentum after (1)						
				No external forces act (1)	2			2		
		(iii)		[-]16 800 = 800 $\times$ v (1)						
				v = [-] 21 [m/s] (1)		2		2	2	
		(iv)		$\left(\dfrac{30}{2}\right) \times 0.9 = 13.5$ [m/s] which is less than speed of the car (1)						
				Allow ecf on calculation						
				The claim of the driver is not consistent with the evidence from the CCTV (1)			2	2	1	
	(b)			Longer time (1)						
				For same momentum change (1)						
				Smaller resultant force (1)	3			3		
				Question 7 total	**6**	**3**	**2**	**11**	**4**	**0**

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Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Left hand motor rule (1) First finger of (left hand) represents B-field direction (N to S) **and** second finger of (left hand) represents current direction (+ to -) (1) Direction thumb points gives the force direction (1) (coil will rotate clockwise)	3			3		3
	(b)			Reverse current (1) Reverse magnetic field (1)	2			2		2
	(c)			Manipulation of $F = BIl$ i.e. $I = \dfrac{F}{Bl}$ (1) $I = \dfrac{2.4 \times 10^{-3}}{(5 \times 10^{-3} \times 0.12)} = 4\ [A]$ (1)		2		2	2	
	(d)			Current doubles force but field is half the force (1) Net effect is zero (1)		2		2		2
				Question 8 total	**5**	**4**	**0**	**9**	**2**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			Half-life = 14 days (1) 14 × 6 = 84 days (1) **ecf**		2		2	1	
	(b)			Original activity of 960 kBq will drop to 15 kBq after six half-lives (1) The measured count rate is less than 15 kBq so the radioactive source needs to be replaced (1)		1	1	2	1	
				Question 9 total	**0**	**3**	**1**	**4**	**2**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			Good thermal contact between block and thermometer/heater	1			1		1
	(b)	(i)		Substitution: $V = \pi \times 4^2 \times 10$ (1) Volume = 502.7 [cm^3] (1) Recall of: $density = \dfrac{mass}{volume}$ Manipulation: $2.7 \times 502.7 = 1\,357$ g (1) allow ecf Conversion into kg: 1.357 [kg] (1)	1 1	1 1 1		5	3	5
		(ii)		Temperature change $\Delta\theta = 32 - 15 = 17\,^{\circ}$C (1) Manipulation of $\Delta Q = mc\Delta\theta$ i.e. $c = \dfrac{22.6 \times 10^3}{1.357 \times 17}$ (1) $c = 980$ J/kg $^{\circ}$C (1)	1	1 1		3	2	3
	(c)			Measured temperature rise will be less (1) Calculated specific heat capacity is greater (1)			2	2		2
				Question 10 total	**4**	**5**	**2**	**11**	**5**	**11**

Question	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
10	**Indicative content:** **AO1 allocation** - An earth wire is one safety feature. It is connected to the metal casing of the toaster and provides a low resistance path to earth so that if a fault develops which makes the metal casing live then the user is protected from electrocution by the current going to earth through the wire rather than through the user. A fuse is another safety feature and is found in the plug. It is connected to the live wire and its fuse wire breaks when too much current flows through the toaster due to a fault occurring. This breaks the circuit and safeguards the lead from overheating and causing a fire. **AO2 allocation** - The value of the fuse is calculated from $I = \dfrac{P}{V} = \dfrac{1600}{230}$ = 7.0 [A]. Therefore a 10 or 13 A fuse should be fitted in its plug. **5 – 6 marks** A detailed description of both safety features with calculation present. Clear explanations of purpose and principle of both safety feature. *There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant to the argument.* **3 - 4 marks** Description of safety features with calculation present. Explanations of purpose and principle of both safety features. One of these features is explained in some detail. *There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument.* **1-2 marks** Basic description of safety features. There is little in the way of explanation of the features. *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument.* **0 marks** *No attempt made or no response worthy of credit.*	4	2		6	1	
	Question 10 Total	**4**	**2**	**0**	**6**	**1**	**0**

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SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	5	0	6	3	0
2	2	6	0	8	3	0
3	5	2	2	9	0	9
4	4	3	2	9	6	0
5	0	0	7	7	0	3
6	4	4	2	10	6	0
7	6	3	2	11	4	0
8	5	4	0	9	2	7
9	0	3	1	4	2	0
10	4	5	2	11	5	11
11	4	2	0	6	1	0
TOTAL	35	37	18	90	32	30