Paper 1 Mark Scheme

Question	Answer	Mark
Number		
1	B energy, mass, power	1
2	B area under a velocity-time graph	1
3	$\mathbf{A} \; \frac{mgh}{Pt}$	1
4	A 11cos18°	1
5	D 16	1
6	C Lenz's law	1
7	B A s V ⁻¹	1
8	C electric potential difference	1
9	B It depends on the dimensions of the wire	1
10	C the kinetic energy of the proton	1

(Total for Multiple Choice Questions = 10 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
11(a)(i)	 has charge -1 and has charge has charge 	(1) (1)		2
11(a)(ii)	 Meson (no mark) Made up of a quark and an anti-quark OR show that the Baryon number is 0 	(1)		1
11(b)	• 0 / neutral	(1)	Example of calculation (-1)+(+1)=(0)+(0)	1
11(c)	 Adds kinetic energy of kaon to its rest mass-energy Subtracts 2 × rest mass-energy of pion 1.52 × 10⁻¹⁸ (J) 	(1) (1) (1)	Example of calculation $0.497 \text{ GeV} + 9.30 \text{ GeV} - (2 \times 0.14 \text{ GeV}) = 9.517 \text{ GeV}$ $9.517 \text{ GeV} \times 1.6 \times 10^{-19} \text{C} = 1.52 \times 10^{-18} \text{ J}$	3

(Total for Question 11 = 7 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
12(a)	 Circuit diagram ammeter in series and voltmeter in parallel with cells variable resistor correctly connected to change the current in the circuit 	(1) (1)		2
12(b)	 extends the graph to cut the y-axis links internal resistance with (-) gradient divides y-intercept by 5 or divides their gradient by 5 ε = 4.5 V r = 0.60 Ω 	(1) (1) (1) (1) (1)	$\frac{\text{Example of calculation}}{\epsilon = \frac{22.5 \text{ V}}{5} = 4.5 \text{ V}}$ $gradient = \frac{(22.5 - 18.9)\text{ V}}{1.2 \text{ A}} = 3.00 \Omega$ $r = \frac{3.00 \Omega}{5} = 0.60 \Omega$	5

(Total for Question 12 = 7 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
13(a)	• Use of $f = \frac{1}{T}$ with conclusion comparing their answer to 50 Hz	(1)	Example of calculation	
	• Use of $V_{rms} = \frac{V_0}{\sqrt{2}}$ either	(1)	$f = \frac{1}{(0.04/2)s} = 50 \text{ (Hz)}$	
	 233 (V) Comparison of their answer with 230 V and recognising the 10 % tolerance Or 	(1) (1)	$V = \frac{330 V}{\sqrt{2}} = 233 (V)$	
	 325 (V) Conclusion that this is within the allowable range of 330 (V) 	(1) (1)	V2	4
13(b)	• By Faraday's law: induced e.m.f. is proportional to rate of change of flux linkage	(1)		
	• The AC supply creates an AC current in the primary that produces a changing flux linkage in the core	(1)		
	• The rate of change of flux linkage depends on the frequency of the current in the primary	(1) (1)		4
	• So a higher frequency induces a larger e.m.f. in the secondary coil			

(Total for Question 13 = 8 marks)

Question		Acceptable	Answer	Additional Guidance	Mark
Number					
*14	This question assesses structured answer with Marks are awarded for and shows lines of rest The following table is content. Number of indicative marking points seen in answer 6 5 - 4 3 - 2 1 0 The following table is	es a student's ability to s th linkages and fully-sus or indicative content and asoning. shows how the marks sh Number of marks awarded for indicative marking points 4 3 2 1 0 shows how the marks sh	show a coherent and logically stained reasoning. d for how the answer is structured ould be awarded for indicative	Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).	

	Number of marks awarded for structure of answer and sustained line of reasoning		
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2		
Answer is partially structured with some linkages and lines of reasoning	1		
Answer has no linkages between points and is unstructured	0		
 Indicative content the switch is closed and the capacitor since there is no resistance in the characteristic equals the supply voltage and the baracteristic equals the switch is opened the capacitor voltage across R/buzzer decreases Use of V = V₀e^{-t/RC} t = 14.9 s conclusion based on a comparison openation of the solution o	or charges harging circuit the voltage across <i>R</i> /buzzer uzzer sounds instantly acitor discharges through R and the of calculated value of time and stated	Accept conclusion that is consistent with candidate's calculated value of time <u>Example of calculation</u> $t = (47 \times 10^{-6} \text{F} \times 1.1 \times 10^{6} \Omega) ln \left(\frac{1}{0.75}\right) = 14.9 \text{ s}$	6
value of time			

(Total for Question 14 = 6 marks)

Question		Acceptable Answer			Additional Guidance	Mark
Number						
15 (a)	• Equates mgh and $\frac{1}{2}m$	uv^2	(1	1)	Example of calculation	
	• 51 11 5		(1	1)	$v = \sqrt{2 \times 9.81 \text{ms}^{-2} \times 50 \text{ m}} = 31.3 \text{ ms}^{-1}$	2
15 (b)	Any parabolic curve	e from bottom of slope to groun	nd (1)		1
*15 (c)	This question assesses a stud structured answer with linkaMarks are awarded for indic and shows lines of reasoningThe following table shows h content.Number of indicative marking points seen in answer65 - 43 - 210The following table shows h and lines of reasoning.	dent's ability to show a coherent ages and fully-sustained reasonic trative content and for how the a g. now the marks should be award Number of marks awarded for indicative marking points 4 3 2 1 0 now the marks should be award	nt and logically ing. answer is structured ed for indicative		Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).	

	Number of marks awarded for structure of answer and sustained line of reasoning	
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	
Answer is partially structured with some linkages and lines of reasoning	1	
Answer has no linkages between points and is unstructured	0	
Indicative content		
The horizontal displacement can be incre	eased by	
 The position of the ski jumper / s the air resistance / lift Low density materials give a low 	skis increases the vertical component of	
 The resultant downward force/ac 	cceleration is kept to a minimum or	
reduces terminal velocity		
 Increasing the time in the air The position of the jumper also a 	provides a minimum horizontal component	
of air resistance	stovides a minimum nonzontal component	
• Which increases the horizontal d	isplacement by preventing large	
horizontal deceleration or keepir	ng horizontal velocity to a maximum	

Question	Acceptable Answer		Additional Guidance	Mark
Number				
16(a)	 At rest/constant velocity R=W and scales record student's weight/mass When accelerating there must be a resultant force in the direction of the acceleration Appreciates that scale reading is the reaction R When accelerating upwards R>W and reading on scales increases 	 (1) (1) (1) (1) 		4
16(b)	 Use ma = R - mg with R = 1.06mg 0.59 m s⁻² Conclusion that the student's observed acceleration is greater than manufacturer's claim [accept conclusion consistent with their answer] 	(1) (1) (1)	Example of calculation a = 1.06g - g $a = 0.06 \times 9.81 \text{ m s}^2 = 0.59 \text{ m s}^{-2}$	3
16(c)(i)	 attempts to find area under graph by counting squares Or approximating area to combination of triangles and rectangles 0.48 m s⁻¹ 	(1)(1)(1)	Example of calculation Estimation to a trapezium $\frac{1}{2}(1.16+0.84 \text{ s}) \times 0.48 \text{ m s}^{-2} = 0.48 \text{ m}$ s^{-1}	3
16(c)(ii)	 attempts to find gradient of steepest part of slope j = 3.0 (m s⁻³) conclusion comparing their answer with 3.5 	 (1) (1) (1) 	Example of calculation $\frac{0.36 \text{ ms}^{-1}}{0.12 \text{ s}} = 3.0 \text{ (m s}^{-3}\text{)}$	3

(Total for Question 16 =13 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
17(a)(i)	• Uses $\frac{1}{2}mv^2$ and $p=mv$	(1)		
	Clear evidence of substitution	(1)		2
17(a)(ii)	• Use of $E_k = \frac{p^2}{2m}$ with $m = 1.67 \times 10^{-27}$ (kg)	(1)	Example of calculation	
	• $9.4 \times 10^{-20} (\text{kg m s}^{-1})$	(1)	$p = \sqrt{2 \times 4 \times 1.67 \times 10^{-27} \text{kg} \times 6.58 \times 10^{-13} \text{J}}$	
			$p = 9.4 \times 10^{-20} (\text{kg m s}^{-1})$	2
17(a)(iii)	• Use of $p=mv$ for thorium-234	(1)	Example of calculation	
	• $9.4 \times 10^{-20} \text{ (kg m s}^{-1}\text{)}$	(1)	$p = (234 \times 1.67 \times 10^{-27} \text{ kg}) \times 2.4 \times 10^5 \text{ m s}^{-1}$	
	• Conclusion that momenta are equal magnitude and	(1)	$p = 9.4 \times 10^{-20} (\text{kg m s}^{-1})$	
	opposite direction	(1)		3
17(b)	• Uses $V = \frac{Q}{4\pi\varepsilon_0 r}$ with $Q = 79e$	(1)	Example of calculation	
	• Uses $V = \frac{W}{Q}$ with $Q = 2e$	(1)	$8.99 \times 10^9 \text{ N m}^2 \text{C}^{-2} \times (79 \times 1.6 \times 10^{-19} \text{C})$	
	• 5.5×10^{-14} m	(1)	$=\frac{r}{6.58 \times 10^{-13} \text{J}}$	3
			$r = 5.5 \times 10^{-14} \text{ m}$	5

(Total for Question 17 = 10 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
18(a)(i)	Provides a force perpendicular to the velocity of the particles	(1)		2
	• Acts as centripetal force/ acceleration to ensure circular motion	(1)		
18(a)(ii)	• Accelerates particles in the gap between the dees	(1)		
	• Polarity swaps every half turn to maintain successive acceleration	(1)		2
18(b)(i)	• Equates $\frac{mv^2}{r}$ and BQv	(1)	Example of calculation	
	• Uses $v = \omega r$ and $T = \frac{2\pi}{2\pi} \mathbf{Or} T = \frac{2\pi r}{2\pi}$	(1)	$\frac{mv}{m} = BO$	
	• Leading to final result	(1)	r	3
			$m\omega = BQ$	U
			$\frac{m2\pi}{T} = BQ$	
18(b)(ii)	• Use of $T = \frac{2\pi m}{R_0}$	(1)	Example of calculation	
	• Use of $f = \frac{1}{2}$	(1)	$0.2 \text{ T} \times 1.6 \times 10^{-19} \text{ C}$	3
		(1)	$f = \frac{1}{2\pi \times 1.67 \times 10^{-27} \text{kg}}$	
	• $f = 3 \times 10^6 \text{ Hz}$	(-)	$f = 3 \times 10^6 \text{ Hz}$	

(Total for Question 18 =10 marks)

Question	Acceptable Answer		Additional Guidance	Mark
Number				
19(a)	An explanation that makes reference to the following points:			
	• the ions are moving perpendicular to the magnetic field	(1)		
	• use of Flemings LH rule	(1)		
	 ions are deflected downwards / towards Y 	(1)		
	• an accumulation of charge at one side of the artery leading to an electric potential difference between the electrodes	(1)		4
19(b)	• equate $F = EQ$ and $F = Bqv$	(1)	Example of calculation	
	• use of $E = \frac{v}{d}$ • 0.075 (m s ⁻¹) • use of $A = \pi \left(\frac{d}{2}\right)^2$ • use of <i>vol/sec</i> = Av • 9.4 × 10 ⁻⁷ m ³ s ⁻¹	 (1) (1) (1) (1) (1) (1) 	$v = \frac{60 \times 10^{-6} \text{ V}}{4 \times 10^{-3} \text{ m} \times 0.20 \text{ T}} = 0.075 \text{ (m s}^{-1})$ vol/sec = $\pi \left(\frac{4 \times 10^{-3} \text{ m}}{2}\right)^2 \times 0.075 \text{ m s}^{-1} = 9.4 \times 10^{-7}$ m ³ s ⁻¹	6

(Total for Question 19 = 10 marks)