



Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced
Level In Physics (WPH14)
Paper 01: Further Mechanics, Fields and
Particles

Question Number	Answer	Mark
1	B is the correct answer , as $N = A - Z$	1
2	D is the correct answer , as this is a description of thermionic emission	1
3	C is the correct answer , as $F = Bqv \sin \theta$ and $\sin \theta = 1$	1
4	C is the correct answer , as a short wavelength gives a high resolution	1
5	A is the correct answer , as the electric field between parallel plates is uniform	1
6	D is the correct answer A is not correct because lepton number is not conserved B is not correct because charge is not conserved C is not correct because charge is not conserved	1
7	D is the correct answer , as each capacitor stores a charge Q	1
8	B is the correct answer A is not correct because the poles at X and Y must be opposite C is not correct because this would not oppose the change in flux linkage D is not correct because the poles at X and Y must be opposite	1
9	D is the correct answer , as $F\Delta t = \Delta p$ and $\Delta p = -2mv$	1
10	C is the correct answer A is not correct because the alpha must be repelled from the nucleus B is not correct because the alpha doesn't deflect enough D is not correct because the alpha deflects in the wrong direction	1

Question Number	Answer	Mark
11	Use of tolerance as +20%. (see anywhere) (1)	3
	Use of $W = \frac{1}{2}CV^2$ (1)	
	$W = 0.83 \text{ J}$ (1)	
	<u>Example of calculation</u>	
	Maximum $C = 1.2 \times 2200 \mu\text{F} = 2640 \mu\text{F}$ $W = \frac{1}{2} \times 2640 \times 10^{-6} \text{F} \times (25 \text{ V})^2 = 0.825 \text{ J}$	
Total for question 11		3

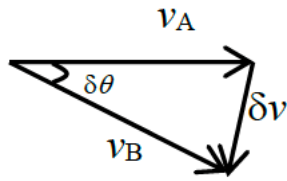
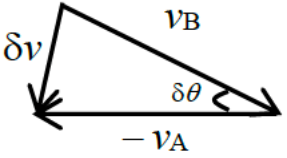
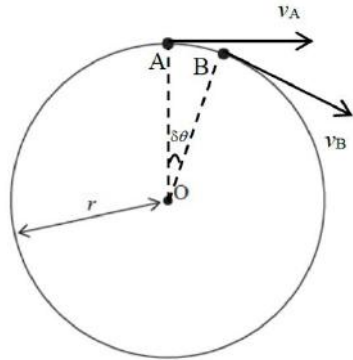
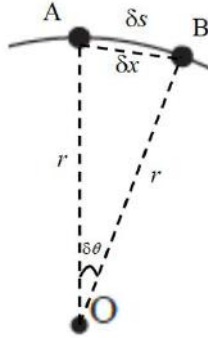
Question Number	Answer	Mark
12	There are no tracks after P (1)	3
	(Only) charged particles leave tracks Or Uncharged /neutral particles leave no tracks (1)	
	‘V’ points on photograph identified as subsequent decays (1)	
	Total for question 12	3

Question Number	Answer	Mark
13(a)	Use of $F = \frac{Q_1Q_2}{4\pi\epsilon_0r^2}$ or Use of $F = \frac{kQ_1Q_2}{r^2}$ (1)	2
	$F = 7.4 \times 10^{-8} \text{ N}$ (1)	
	<u>Example of calculation</u>	
	$F = \frac{(2 \times 1.6 \times 10^{-19} \text{ C}) \times (1.6 \times 10^{-19} \text{ C})}{4\pi \times 8.85 \times 10^{-12} \text{ F m}^{-1} \times (7.9 \times 10^{-11} \text{ m})^2} = 7.38 \times 10^{-8} \text{ N}$	
13(b)	Use of $E = \frac{F}{Q}$ (1)	2
	Or Use of $E = \frac{Q}{4\pi\epsilon_0r^2}$ (Allow use of $E = \frac{kQ}{r^2}$)	
	$E = 4.6 \times 10^{11} \text{ N C}^{-1}$ (ecf from (a)) (1)	
	<u>Example of calculation</u> $E = \frac{7.38 \times 10^{-8} \text{ N}}{1.6 \times 10^{-19} \text{ C}} = 4.61 \times 10^{11} \text{ N C}^{-1}$	
Total for question 13		4

Question Number	Answer	Mark
14	<p>Most alphas went straight through Or Most alpha particles were undeviated (1)</p> <p>So atom is mainly empty (space) (MP2 dependent on MP1) (1)</p> <p>A few alpha particles were deflected by small angles (1)</p> <p>very few alpha particles had a deflection $> 90^\circ$ Or Very few alpha particles came straight back (1)</p> <p>There is a concentration of charge in the atom (MP5 dependent on MP3 or MP4) Or There is a concentration of mass in the atom (1) (MP5 dependent on MP4)</p>	5
Total for question 14		5

Question Number	Answer	Mark
15	<p>Use of $\lambda = \frac{h}{p}$ (1)</p> <p>Use of $E_k = \frac{p^2}{2m}$ Or Use of $E_k = \frac{1}{2}mv^2$ and $p = mv$ (1)</p> <p>Use of $V = \frac{W}{Q}$ with $W = E_k$ (1)</p> <p>$V = 2300 \text{ V}$ (1)</p> <p><u>Example of calculation</u> $p = \frac{6.63 \times 10^{-34} \text{ Js}}{2.55 \times 10^{-11} \text{ m}} = 2.60 \times 10^{-23} \text{ N s}$ $E = \frac{(2.60 \times 10^{-23} \text{ N s})^2}{2 \times 9.11 \times 10^{-31} \text{ kg}} = 3.71 \times 10^{-16} \text{ J}$ $V = \frac{3.71 \times 10^{-16} \text{ J}}{1.6 \times 10^{-19} \text{ C}} = 2320 \text{ V}$</p>	4
Total for question 15		4

Question Number	Answer	Mark
16	<p>Use of $\frac{dA}{dt} = Lv$ (1)</p> <p>Or In 1 second, area swept out by wings = Lv (1)</p> <p>Use of $\varphi = BA$ (1)</p> <p>Use of $\varepsilon = -\frac{d(N\varphi)}{dt}$ (1)</p> <p>$v = 280 \text{ (m s}^{-1}\text{)} > 250 \text{ (m s}^{-1}\text{)}$ so the pilot's statement is not correct</p> <p>Or $\text{emf} = 0.36 \text{ (V)} < 0.40 \text{ (V)}$ so the pilot's statement is not correct (1)</p> <p><u>Example of calculation</u></p> $\varepsilon = -\frac{d(N\varphi)}{dt} = \frac{d(NBA)}{dt} = B \frac{dA}{dt}$ $\frac{dA}{dt} = 35 \text{ m} \times v$ $0.40 \text{ V} = 41 \times 10^{-6} \text{ T} \times 35 \text{ m} \times v$ $v = \frac{0.40 \text{ V}}{41 \times 10^{-6} \text{ T} \times 35 \text{ m}} = 279 \text{ m s}^{-1}$	4
Total for question 16		4

Question Number	Answer	Mark
17(a)	<p>Correct vector diagram showing velocity at the two positions and the corresponding velocity change (1)</p> <p>Use small angle approximation, so $\delta\theta \approx \delta v / v$ (1)</p> <p>Use of $\delta\theta / \delta t = \omega$ and $v = r\omega$ Or Use of similar triangles and $\delta\theta = \delta s / r$ and $\delta s / t = v$ (1)</p> <p>Use of $\delta v / \delta t = a$ (1)</p> <p>Algebra to show $a = v^2 / r$ (1)</p> <p><u>Example of derivation</u></p> <div></div> <p>$v_A = v_B = v$ Small angle, so $\delta\theta = \delta v / v$ $\delta\theta = \omega\delta t$ $\delta\theta = v\delta t / r$ $v\delta t / r = \delta v / v$ $\delta v / \delta t = v^2 / r$ $a = v^2 / r$</p> <p>Or $v_A = v_B = v$ Small angle, so $\delta v / v \approx \delta\theta$ $\delta s / r \approx \delta\theta$ Similar triangles, so $\delta v / v = \delta s / r$ $\delta v / t = v \delta s / tr$ $\delta v / t = v^2 / r$ $a = v^2 / r$</p> <div></div>	5

17(b)	Use of $F = \frac{mv^2}{r}$ (1)	4
	Use of $F = mg$ (1)	
	Use of Pythagoras	
	Or Use of trigonometry sufficient to determine tension (1)	
	$T = 31 \text{ (N)}$, which is less than 35 (N) so the wire will not break (1)	
	<p><u>Example of calculation</u></p> $F = \frac{1.55 \text{ kg} \times (22.5 \text{ m s}^{-1})^2}{28.5 \text{ m}} = 27.5 \text{ N}$ $F = 1.55 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 15.2 \text{ N}$ $T = \sqrt{(27.5 \text{ N})^2 + (15.2 \text{ N})^2} = 31.4 \text{ N}$ <p>Or</p> $F = \frac{1.55 \text{ kg} \times (22.5 \text{ m s}^{-1})^2}{28.5 \text{ m}} = 27.5 \text{ N}$ $F = 1.55 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 15.2 \text{ N}$ $\tan \theta = \frac{15.2 \text{ N}}{27.5 \text{ N}}$ $\theta = 28.9^\circ$ $T \sin 28.9^\circ = 15.2 \text{ N}$ $T = 31.45 \text{ N}$	
	Total for question 17	9

Question Number	Answer	Mark
18(a)(i)	<p>Corresponding pair of values read from graph line (1)</p> <p>Substitution into $V = V_0 \left(1 - e^{-\frac{t}{RC}}\right) \dots$ (1)</p> <p>...with $V_0 = 6.0 \text{ V}$ (1)</p> <p>$C = 2.2 \times 10^{-4} \text{ F}$ (220 μF) (Allow answers in the range 2.1×10^{-4} to $2.3 \times 10^{-4} \text{ F}$) MP4 dependent on MP3 (1)</p> <p>OR</p> <p>Read time for $V_0 \left(1 - \frac{1}{e}\right)$ or 63 % $\times V_0$ from graph, (1)</p> <p>Use of time constant = RC (1)</p> <p>...with $V_0 = 6.0 \text{ V}$ (1)</p> <p>$C = 2.2 \times 10^{-4} \text{ F}$ (220 μF) MP4 dependent on MP3 (Allow answers in the range 2.1×10^{-4} to $2.3 \times 10^{-4} \text{ F}$) MP4 dependent on MP3 (1)</p> <p><u>Example of calculation</u></p> $V = V_0 \left(1 - e^{-\frac{t}{RC}}\right)$ $5.1 \text{ V} = 6.0 \text{ V} \left(1 - e^{-\frac{70 \text{ s}}{168 \times 10^3 \Omega \times C}}\right)$ $\frac{5.1 \text{ V}}{6.0 \text{ V}} = 1 - e^{-\frac{70 \text{ s}}{168 \times 10^3 \Omega \times C}}$ $e^{-\frac{70 \text{ s}}{168 \times 10^3 \Omega \times C}} = 1 - 0.85$ $\frac{70 \text{ s}}{168 \times 10^3 \Omega \times C} = 1.90$ $C = \frac{70 \text{ s}}{168 \times 10^3 \Omega \times 1.90} = 2.19 \times 10^{-4} \text{ F}$	4
18(a)(ii)	<p>Use of $I = \frac{V}{R}$ (1)</p> <p>$I = 3.6 \times 10^{-5} \text{ A}$ and marked on current axis at time $t = 0$ (1)</p> <p>Exponential decreasing curve (1)</p> <p><u>Example of calculation</u></p> $I = \frac{6.0 \text{ V}}{168 \times 10^3 \Omega} = 3.57 \times 10^{-5} \text{ A}$	3
18(b)	<p>Resistance in circuit would decrease (1)</p> <p>So current in circuit would increase Or so time constant will decrease Or so $T = RC$ will decrease (1)</p> <p>(Hence) capacitor would charge more quickly (1)</p> <p>MP2 dependent on MP1, MP3 dependent on MP2</p>	3
Total for question 18		10

Question Number	Answer	Mark
19(a)	<p>Use of $E = hf$ with $c = f\lambda$ (1)</p> <p>Use of $E_k = \frac{1}{2}mv^2$</p> <p>Or Use of $E_k = \frac{p^2}{2m}$ and $p = mv$ (1)</p> <p>$v = 8.8 \times 10^5 \text{ m s}^{-1}$ (1)</p> <p><u>Example of calculation</u></p> <p>$f = \frac{c}{\lambda} = \frac{3.0 \times 10^8 \text{ m s}^{-1}}{560 \times 10^{-9} \text{ m}} = 5.36 \times 10^{14} \text{ Hz}$</p> <p>$E = hf = 6.63 \times 10^{-34} \text{ J s} \times 5.36 \times 10^{14} \text{ Hz}$</p> <p>$E = 3.55 \times 10^{-19} \text{ J}$</p> <p>$v = \sqrt{\frac{2 \times 9.11 \times 3.55 \times 10^{-19} \text{ J}}{9.11 \times 10^{-31} \text{ kg}}} = 8.83 \times 10^5 \text{ m s}^{-1}$</p>	3

19(b)	<p>Use of $p = mv$ (1)</p> <p>Use of $r = \frac{p}{BQ}$ (1)</p> <p>Use of $v = \frac{2\pi r}{T}$ and $f = \frac{1}{T}$</p> <p>Or Use of $\omega = \frac{v}{r}$ and $\omega = \frac{2\pi}{T}$ and $f = \frac{1}{T}$ (1)</p> <p>Use of $c = f\lambda$ (1)</p> <p>$\lambda = 224 \text{ (m)} \approx 220 \text{ (m)}$, so the radiation emitted by the electron would cause interference with the radio station broadcast</p> <p>Or $f = 1.34 \times 10^6 \text{ (Hz)} \approx 1.36 \times 10^6 \text{ (Hz)}$, so the radiation emitted by the electron would cause interference with the radio station broadcast (1)</p> <p>OR</p> <p>Use of $F = Bqv$ (1)</p> <p>Use of $F = \frac{mv^2}{r}$ (1)</p> <p>Use of $v = \frac{2\pi r}{T}$ and $f = \frac{1}{T}$</p> <p>Or Use of $\omega = \frac{v}{r}$ and $\omega = \frac{2\pi}{T}$ and $f = \frac{1}{T}$ (1)</p> <p>Use of $c = f\lambda$ (1)</p> <p>$\lambda = 224 \text{ (m)} \approx 220 \text{ (m)}$, so the radiation emitted by the electron would cause interference with the radio station broadcast</p> <p>Or $f = 1.34 \times 10^6 \text{ (Hz)} \approx 1.36 \times 10^6 \text{ (Hz)}$, so the radiation emitted by the electron would cause interference with the radio station broadcast (1)</p> <p><u>Example of calculation</u></p> <p>$p = 9.11 \times 10^{-31} \text{ kg} \times 1.65 \times 10^6 \text{ m s}^{-1} = 1.50 \times 10^{-24} \text{ kg m s}^{-1}$</p> <p>$r = \frac{1.50 \times 10^{-24} \text{ kg m s}^{-1}}{48 \times 10^{-6} \text{ T} \times 1.6 \times 10^{-19} \text{ C}} = 0.196 \text{ m}$</p> <p>$f = \frac{1.65 \times 10^6 \text{ m s}^{-1}}{2\pi \times 0.196 \text{ m}} = 1.34 \times 10^6 \text{ Hz}$</p> <p>Either</p> <p>$f = \frac{3.0 \times 10^8 \text{ m s}^{-1}}{220 \text{ m}} = 1.36 \times 10^6 \text{ Hz}$</p> <p>Or</p> <p>$\lambda = \frac{3.0 \times 10^8 \text{ m s}^{-1}}{1.34 \times 10^6 \text{ Hz}} = 224 \text{ m}$</p>	5
	Total for question 19	8

Question Number	Answer	Mark
20(a)	<p>Total momentum remains constant Or Total momentum before a collision = Total momentum after a collision (1)</p> <p>Provided no (resultant) external force acts Or In an isolated / closed system (1)</p>	2
20(b)(i)	<p>Velocities/momenta resolved into components (1)</p> <p>Use of $p = mv$ (1)</p> <p>Use of principle of conservation of momentum (1)</p> <p>$v = 5.64 \times 10^6 \text{ (m s}^{-1}\text{)}$ (1)</p> <p><u>Example of calculation</u> $v \times 6.64 \times 10^{-27} \text{ kg} \times \sin 70^\circ = 1.55 \times 10^7 \text{ m s}^{-1} \times 6.64 \times 10^{-27} \text{ kg} \sin 20^\circ$ $v = \frac{1.55 \times 10^7 \text{ m s}^{-1} \times 0.342}{0.940} = 5.641 \times 10^6 \text{ m s}^{-1}$</p>	4
20(b)(ii)	<p>Use of $E_k = \frac{1}{2}mv^2$ (1)</p> <p>Correct calculation of one kinetic energy (1)</p> <p>$9.04 \times 10^{-13} \text{ (J)} \approx 9.01 \times 10^{-13} \text{ (J)}$, so collision is elastic (1) (ecf from (b)(i) and show that value gives $9.02 \times 10^{-13} \text{ J}$)</p> <p><u>Example of calculation</u> $E_k = \frac{1}{2} \times 6.64 \times 10^{-27} \text{ kg} \times (1.55 \times 10^7 \text{ m s}^{-1})^2$ $+ \frac{1}{2} \times 6.64 \times 10^{-27} \text{ kg} \times (5.64 \times 10^6 \text{ m s}^{-1})^2$ $E_k = 7.98 \times 10^{-13} \text{ J} + 1.06 \times 10^{-13} \text{ J}$ $E_k = 9.04 \times 10^{-13} \text{ J}$</p>	3
Total for question 20		9

Question Number	Answer	Mark																																								
*21(a)	<p>This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.</p> <table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr><tr><td>6</td><td>4</td><td>2</td><td>6</td></tr><tr><td>5</td><td>3</td><td>2</td><td>5</td></tr><tr><td>4</td><td>3</td><td>1</td><td>4</td></tr><tr><td>3</td><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>0</td><td>2</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr></table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table><tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table> <p>Indicative content</p> <p>IC1 The current produces a magnetic field</p> <p>IC2 Alternating current, so alternating/varying magnetic field</p> <p>IC3 There is a change of flux linkage with kettle/core due to the alternating current</p> <p> Or Lines of magnetic flux cut the kettle/core.</p> <p>IC4 An <u>e.m.f. is induced</u> across the kettle/core</p> <p>IC5 Currents circulate in (the iron of) the kettle/core</p> <p>IC6 The kettle heats as energy is dissipated by the heating effect of currents</p> <p> Or the core heats as energy is dissipated and the thermal energy is transferred to the kettle by conduction</p>	IC points	IC mark	Max linkage mark	Max final mark	6	4	2	6	5	3	2	5	4	3	1	4	3	2	1	3	2	2	0	2	1	1	0	1	0	0	0	0		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	6
IC points	IC mark	Max linkage mark	Max final mark																																							
6	4	2	6																																							
5	3	2	5																																							
4	3	1	4																																							
3	2	1	3																																							
2	2	0	2																																							
1	1	0	1																																							
0	0	0	0																																							
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21(b)	<p>Only pan is heated</p> <p>Or Surface of cooker does not get hot</p> <p>Or Egg is not a conductor (1)</p> <p>As current can only circulate in a conductor</p> <p>Or there is no current in the surface</p> <p>Or there is a current in the pan because it is a conductor (1)</p>	2																																								
Total for question 21		8																																								

Question Number	Answer	Mark
22(a)(i)	<p>$s \bar{u}$ (1)</p> <p>The meson must be a quark-antiquark pair and include a strange quark Or The meson must be a quark-antiquark pair and have a charge of -1 (1)</p>	2
22(a)(ii)	<p>Use of $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ (1)</p> <p>Use of $\Delta E = c^2 \Delta m$ (1)</p> <p>$\Delta m = 8.8 \times 10^{-28} \text{ (kg)}$ (1)</p> <p><u>Example of calculation</u> $\Delta E = 494 \times 10^6 \text{ eV} \times 1.6 \times 10^{-19} \text{ J eV}^{-1}$ $\Delta E = 7.90 \times 10^{-11} \text{ J}$ $\Delta m = \frac{7.90 \times 10^{-11} \text{ J}}{(3.0 \times 10^8 \text{ m s}^{-1})^2} = 8.78 \times 10^{-28} \text{ kg}$</p>	3
22(b)(i)	<p>MAX 4</p> <p>Electric field / p.d. accelerates particles Or Electric field / p.d. gives particles energy (1)</p> <p>Magnetic field / force at right angles to particles path (1)</p> <p>Magnetic field/force maintains circular motion (whilst in dees) Or Particle experiences centripetal force / acceleration (whilst in dees) (1)</p> <p>p.d. switches every half cycle Or Polarity of dees switches every half cycle Or p.d. switches when particle is in dees (1)</p> <p>p.d. has a constant time period Or p.d. has a constant frequency Or period is independent of speed of particle (1)</p>	4
22(b)(ii)	<p>Use of $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ (1)</p> <p>Use of $E_k = \frac{p^2}{2m}$ Or Use of $E_k = \frac{1}{2}mv^2$ and $p = mv$ (1)</p> <p>Use of $r = \frac{p}{Bq}$ (1)</p> <p>$B = 0.74 \text{ T}$ (1)</p> <p><u>Example of calculation</u> $E_k = 80 \times 10^3 \text{ eV} \times 1.6 \times 10^{-19} \text{ J eV}^{-1}$ $E_k = 1.28 \times 10^{-14} \text{ J}$ $p = \sqrt{2 \times 1.67 \times 10^{-27} \text{ kg} \times 1.28 \times 10^{-14} \text{ J}} = 6.54 \times 10^{-21} \text{ N s}$ $B = \frac{6.54 \times 10^{-21} \text{ N s}}{1.6 \times 10^{-19} \text{ C} \times 0.055 \text{ m}} = 0.743 \text{ T}$</p>	4
Total for question 22		13