Mark Scheme (Results)

October 2025

Pearson Edexcel International Advanced
Subsidiary level In Physics
WPH14/01

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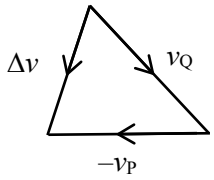
General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1	**The only correct answer is A** because it shows field lines with arrows going in the right direction B is not correct because it shows field lines with arrows going in the wrong direction C is not correct because it does not show field lines D is not correct because it does not show field lines	1
2	**The only correct answer is D** (a positively charged meson) A is not correct because it must be positively charged and can't be a baryon B is not correct because it must be positively charged C is not correct because it can't be a baryon	1
3	**The only correct answer is B** $(E/4)$ A is not correct because $E_k = \frac{p^2}{2m}$ if p is halved E is divided by 4 C is not correct because $E_k = \frac{p^2}{2m}$ if p is halved E is divided by 4 D is not correct because $E_k = \frac{p^2}{2m}$ if p is halved E is divided by 4	1
4	**The only correct answer is A** (capacitance) B is not correct because it has an associated direction C is not correct because it has an associated direction D is not correct because it has an associated direction	1
5	**The only correct answer is C** (Lifetime of muons increases, Rate of decay of Muons decreases) A is not correct because lifetime increases B is not correct because lifetime increases and rate of decay decreases D is not correct because rate of decay decreases	1
6	**The only correct answer is B** (increasing the frequency of the a.c. supply) A is not correct because this would reduce emf C is not correct because this would reduce emf D is not correct because this would reduce emf	1

7	**The only correct answer is A** (Proton number 5 Nucleon number 11) B is not correct because it has too many nucleons C is not correct because it has too many protons D is not correct because it has too many protons and nucleons	**1**
8	**The only correct answer is D** (The frequency depends upon the velocity of the particle.) A is not correct because the frequency depends on the charge B is not correct because the frequency depends on the mass C is not correct because the frequency depends on the magnetic flux density	**1**
9	**The only correct answer is C** $\left(\frac{3mv}{2\Delta t},\ \text{downwards}\right)$ A is not correct because the answer is $\frac{3mv}{2\Delta t}$ downwards B is not correct because the answer is $\frac{3mv}{2\Delta t}$ downwards D is not correct because the answer is $\frac{3mv}{2\Delta t}$ downwards	**1**
10	**The only correct answer is D**  A is not correct because it is not the correct vector diagram B is not correct because it is not the correct vector diagram C is not correct because it is not the correct vector diagram	**1**

Question Number	Answer		Additional Guidance	Mark
11	Use of $E = \frac{Q}{4\pi\varepsilon_0 r^2}$	**(1)**	Allow correct use of $k = 8.99 \times 10^9 \text{Nm}^2\text{C}^{-2}$	**2**
	$E = 2.6 \times 10^{12}$ V m^{-1}	**(1)**	Allow NC^{-1} Example of calculation $E = \frac{4.8\times10^{-18}\text{C}}{4\pi 8.85\times10^{-12}\text{Fm}^{-1}(1.3\times10^{-10})^2} = 2.55 \times 10^{12}$ V m^{-1}	
	Total for question 11			**2**

Question Number	Answer		Additional Guidance	Mark
12	Use of 20%	**(1)**		**3**
	Use of $W = ½\, CV^2$	**(1)**		
	Maximum energy = 4.5 J	**(1)**	Example of calculation $C_{\text{max}} = \frac{120}{100} \times 47 \times 10^{-6}$ F $= 56.4 \times 10^{-6}$ F $W = \frac{1}{2} \times 56.4 \times 10^{-6}$ F $\times (400\text{ V})^2 = 4.51$ J	
	Total for question 12			**3**

Question Number	Answer		Additional Guidance	Mark
13	Conversion between eV and J	**(1)**		
	Use of $E = \frac{p^2}{2m}$ **Or** $E = \frac{1}{2}mv^2$	**(1)**		
	$m = 3.31 \times 10^{-25}$ (kg) $\approx 3.33 \times 10^{-25}$ (kg) so it is mercury	**(1)**	Example of calculation $1.60 \times 10^{-19} \times 1.25 \times 10^{6}$ J $= 2.00 \times 10^{-13}$ (J) 2.00×10^{-13} J $= \frac{m(1.1 \times 10^{6}\ \text{m s}^{-1})^2}{2}$ $m = 3.31 \times 10^{-25}$ kg $\approx 3.33 \times 10^{-25}$ kg so it is mercury	**3**
	Total for question 13			**3**

Question Number	Answer		Additional Guidance	Mark
14(a)(i)	$B_{vert} = 4.98 \times 10^{-5}$ T	**(1)**	Example of calculation $B = 55 \times 10^{-6}\text{T} \times \sin(65°) = 4.98 \times 10^{-5}$ T	**1**
14(a)(ii)	Use of $\varphi = BA\sin\theta$ Use of $\varepsilon = (-)\ \frac{dN\phi}{dt}$(ecf (a)(i)) $\varepsilon = 0.87$V	**(1)** **(1)** **(1)**	A must be the area swept out by the wings Allow use of Blv leading to correct answer. Accept show that value of 0.88V Example of calculation $\varepsilon = 4.98 \times 10^{-5}\text{ T} \times 68.4\text{ m} \times 256\text{ m s}^{-1} = 0.873\text{ V}$	**3**
14(b)	There is no change in flux (linkage) Because there is no vertical component of the magnetic field (above the equator) **Or** Because the magnetic field of the Earth is horizontal (above the equator)	**(1)** **(1)**	Allow does not cut the field lines.	**2**
	Total for question 14			**6**

Question Number	Answer		Additional Guidance	Mark
15(a)	A meson has one quark and one antiquark	**(1)**		**1**
15(b)	c $\bar{s}$ u $\bar{d}$ **Or** u$\bar{d}$u$\bar{d}$ **Or** u$\bar{s}$u$\bar{s}$ **Or** c$\bar{d}$c$\bar{d}$ **Or** c$\bar{s}$c$\bar{s}$ **Or** c$\bar{d}$u$\bar{d}$ **Or** c$\bar{s}$u$\bar{s}$ **Or** c$\bar{s}$c$\bar{d}$ **Or** u$\bar{s}$u$\bar{d}$	**(1)**	Accept symbols or words. Any order is acceptable.	**1**
15(c)	Use of $\Delta E = \Delta mc^2$ Conversion between eV and J $1.88\text{GeV/c}^2 < 2.9\ \text{GeV/c}^2$ so masses are not equal **Or** $3.34 \times 10^{-27}\ \text{kg} < 5.16 \times 10^{-27}\ \text{kg}$ so masses are not equal	**(1)** **(1)** **(1)**	Example of calculation $\frac{2 \times 1.67 \times 10^{-27}\ \text{kg} \times (3 \times 10^{8}\ \text{m s}^{-1})^2}{1.6 \times 10^{-10}\ \text{C}} = 1.88\ \frac{\text{GeV}}{\text{c}^2}$ $1.88\text{GeV/c}^2 < 2.9\ \text{GeV/c}^2$ so no	**3**
15(d)	The protons needed a (very) large kinetic energy (So) some of this energy can be converted into the mass (of the new particles)	**(1)** **(1)**		**2**
	Total for question 15			**7**

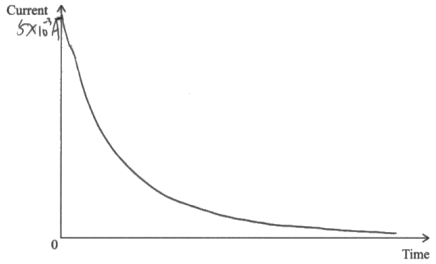
Question Number	Answer		Additional Guidance	Mark
16(a)	Weight (of water)	**(1)**	Allow gravitational force (of water)	
	Reaction/contact force (of bottom of bucket on water)	**(1)**		**2**
16(b)	Centripetal/resultant force is the sum of the weight and the reaction force	**(1)**		
	The minimum value of reaction force is zero **Or** Minimum velocity is when reaction force is zero	**(1)**		
	$mv^2/r = mg$ gives minimum speed **Or** $F = mv^2/r$ as m and r are constant v must be at a minimum to provide F.	**(1)**	If no other marks awarded, allow 1 mark for stating a centripetal force is a resultant force (acts on the water)	**3**
	Total for question 16			**5**

Question Number	Answer		Additional Guidance	Mark
17(a)	Use of $p = mv$	**(1)**		**4**
	Applies conservation of momentum	**(1)**		
	Applies trigonometry to calculate final angle for B	**(1)**	Example of calculation Initial momentum in original direction = final momentum in original direction $2.38\ \text{m s}^{-1} \times 45\ \text{kg} = 1.36\ \text{m s}^{-1} \times 45\ \text{kg}\cos(33) + 30\ \text{kg}\ v\cos\theta$ $(107.1 - 51.3)\ \text{kg m s}^{-1} = 30\ \text{kg}\ v\cos\theta$ Final momentum perpendicular to original direction $1.36\ \text{m s}^{-1} \times 45\ \text{kg}\sin(33) = 30\ \text{kg}\ v\sin\theta$ $33.3\ \text{kg m s}^{-1} = 30\ \text{kg}\ v\sin\theta$ $\tan\theta = \dfrac{33.3\ \text{kg m s}^{-1}}{(107.1\ \text{kg m s}^{-1} - 51.3\ \text{kg m s}^{-1})} = 0.597$ $\theta = 30.86°$	
	$\theta = 30.9°$	**(1)**		
17(b)	Applies conservation of momentum in one direction to calculate v	**(1)**		**4**
	Or Applies conservation of momentum in one direction to calculate momentum of child B	**(1)**	Example of calculation $v = \dfrac{1.36\ \text{ms}^{-1} \times 45\ \text{kg}\sin(33)}{30\ \text{kg}\sin(30.9)} = 2.16\text{ms}^{-1}$	
	Use of $E_k = ½\ mv^2$ **Or** $E_k = \dfrac{p^2}{2m}$	**(1)**	$E_k = \frac{45\ \text{kg} \times (2.38\ \text{m s}^{-1})^2}{2} = 127$ J (A before) $E_k = \frac{45\ \text{kg} \times (1.36\ \text{m s}^{-1})^2}{2} = 41.6$ J (A after) $E_k = \frac{30\ \text{kg} \times (2.16\ \text{m s}^{-1})^2}{2} = 70.0$ J (B after) 41.6 J + 70.0 J = 112 J 127 J > 112 J, so it is inelastic	
	Initial E_k = 130 J **and** Final E_k = 110 J (allow ecf from (a))	**(1)**		
	Initial E_k is not equal to final E_k, so collision not elastic **Or** Comparison of initial E_k and final E_k with correct conclusion for their calculated values			
	Total for question 17			**8**

Question Number	Answer	Additional Guidance	Mark
18(a)	The charged particle/pion experiences a force in a magnetic field. **(1)** The force is perpendicular to the motion of the π^+ **(1)** This provides a centripetal force/acceleration, so the particle moves in a circle **(1)**	Allow spiral/curve for circle	**3**
18(b) (i)	The second particle must be neutral to conserve charge **Or** the second particle must be neutral as it does not (ionise and) leave tracks **(1)** The second particle must be a lepton to conserve lepton number **(1)**	Allow the second particle has a lepton number of +1 to conserve lepton number Allow 1 mark for "the second particle is neutral and a lepton"	**2**
18 (b) (ii)	(The second particle must go in the opposite direction) to conserve momentum **(1)**		**1**
	Total for question 18		**6**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*19(a)</td>
<td>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.
<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>
Indicative content
IC1 Almost all the alpha particles are undeflected
IC2 This shows the atom is mainly empty space
IC3 Some alpha particles are scattered through small angles
IC4 This shows there is a concentration of charge
IC5 A few alpha particles are scattered through angles greater than 90°
IC6 This shows (almost all) the mass of an atom is concentrated in a very small space</td>
<td>The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></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>
</td>
<td>6</td>
</tr>
</table>

19(b)(i)	Use of $V = \frac{Q}{4\pi\varepsilon_0 r}$ Use of $W = QV$ Minimum distance $= 4.3 \times 10^{-14}$ (m)	**(1)** **(1)** **(1)**	Allow correct use of $k = 8.99 \times 10^9 \text{Nm}^2\text{C}^{-2}$ <u>Example of calculation</u> $V = \frac{2 \times 1.6 \times 10^{-19}\ \text{C}}{4\pi \times 8.85 \times 10^{-12}\ \text{F m}^{-1}\ r}$ $8.5 \times 10^{-13}\ \text{J} = 79 \times 1.6 \times 10^{-19}\ \text{C} \times \frac{2 \times 1.6 \times 10^{-19}\ \text{C}}{4\pi \times 8.85 \times 10^{-12}\ \text{F m}^{-1}\ r}$ $r = \frac{79 \times 1.6 \times 10^{-19}\ \text{C} \times 2 \times 1.6 \times 10^{-19}\ \text{C}}{4\pi \times 8.85 \times 10^{-12}\ \text{F m}^{-1} \times 8.5 \times 10^{-13}\ \text{J}} = 4.28 \times 10^{-14}\ \text{m}$	**3**
19(b)(ii)	Use of $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ $F = 20\text{N}$ (ecf 18(b)(i)) (Use of show that value gives 23 N)	**(1)** **(1)**	Allow correct use of $k = 8.99 \times 10^9 \text{Nm}^2\text{C}^{-2}$ <u>Example of calculation</u> $F = \frac{79 \times 1.6 \times 10^{-19}\ \text{C} \times 2 \times 1.6 \times 10^{-19}\ \text{C}}{4\pi \times 8.85 \times 10^{-12}\ \text{F m}^{-1} \times (4.3 \times 10^{-14}\ \text{m})^2} = 19.7\ \text{N}$	**2**
	Total for question 19			**11**

Question Number	Answer		Additional Guidance	Mark
20(a)(i)	Use of $Q = CV$ 1.32×10^{-4}(C)	**(1)** **(1)**	Example of calculation $Q = 6.0\ \text{V} \times 22 \times 10^{-6}\ \text{F} = 1.32 \times 10^{-4}$(C)	**2**
20(a)(ii)	Use of 25% Use of $Q = Q_0 e^{-t/RC}$ (allow value of Q calculated in (a)(i)) $t = 0.037$ (s) < 0.05 (s) so touchscreen will be sensitive **Or** Q= 2.0×10^{-5}(C)<3.3×10^{-5}(C) so touchscreen will be sensitive **Or** 15%<25% so touchscreen will be sensitive	**(1)** **(1)** **(1)**	Example of calculation $1 = 4e^{-\frac{t}{22 \times 10^{-6}\ \text{F} \times 1200\ \Omega}}$ $\ln 0.25 \times 0.0264 = 0.0366$ s $t = 0.037$ s < 0.05 s so touchscreen will be sensitive	**3**
20(b)	Exponential discharge curve drawn At $t = 0$, maximum current = 0.005 A	**(1)** **(1)**	Example of calculation $I = \frac{V}{R} = \frac{6}{1200} = 0.005\ A$ 	**2**
	Total for question 20			**7**

Question Number	Answer		Additional Guidance	Mark
21(a)	<u>thermionic</u> emission	**(1)**	Allow <u>thermionic</u> effect	**1**
21(b)(i)	Use of $E = \frac{V}{d}$ d = 0.0080 m	**(1)** **(1)**	<u>Example of calculation</u> d = 120 V / 15 000 V m^{-1} = 0.008 m	**2**

21(b)(ii)	Use of $E = \frac{F}{Q}$ **(1)** Use of $F = ma$ **(1)** $a = 2.63 \times 10^{15}$ (m s^{-2}) **(1)**	<u>Example of calculation</u> $F = 1.5 \times 10^{4}\ \text{V m}^{-1} \times 1.6 \times 10^{-19}\ \text{C} = 2.40 \times 10^{-15}\ \text{N}$ $a = \frac{2.40 \times 10^{-15}\ \text{N}}{9.11 \times 10^{-31}\ \text{kg}} = 2.634 \times 10^{15}\ \text{m s}^{-2}$	**3**
21(b)(iii)	Use of suvat equation to calculate vertical displacement between plates **(1)** Use of suvat equation to calculate vertical velocity at end of plates **(1)** Use of suvat equation to calculate vertical displacement from end of plates to screen **(1)** Total displacement = 0.023 m (ecf from (b)(ii)) **(1)** 2.3 cm not equal to 3.4 cm so acceleration does not produce the student's value **Or** Comparison of their calculated value displacement with 3.4 cm and consistent conclusion **(1)**	<u>Example of calculation</u> $s_{\text{v end of plates}} = \frac{1}{2} \times 2.6 \times 10^{15}\ \text{m s}^{-2}(1.2 \times 10^{-9}\ \text{s})^2 = 1.9 \times 10^{-3}\ \text{m}$ $v_{\text{v end of plates}} = 2.6 \times 10^{15}\ \text{m s}^{-2} \times 1.2 \times 10^{-9}\ \text{s} = 3\ 100\ 000\ \text{m s}^{-1}$ $s_{\text{v plates to screen}} = 3\ 100\ 000\ \text{m s}^{-1} \times 6.9 \times 10^{-9}\ \text{s} = 0.021\ \text{m}$ Vertical displacement = $0.021\ \text{m} + 1.9 \times 10^{-3}\ \text{m} = 0.023\ \text{m}$ 2.3 cm < 3.4 cm so no students value incorrect	**5**
	Total for question 21		**11**

Question Number	Answer		Additional Guidance	Mark
22(a)	There is a current from P to Q By FLHR (force on copper rod is to right) so rod moves to right.	**(1)** **(1)**		**2**
22(b)	Use of $v^2 = u^2 + 2as$ Use of $F = ma$ Use of $F = BIL\sin\theta$ $B = 5.9 \times 10^{-3}$ T	**(1)** **(1)** **(1)** **(1)**	Example of calculation $a = \frac{(3.5 \times 10^{-2}\ \text{m s}^{-1})^2}{2 \times 6.5 \times 10^{-2}\ \text{m}} = 9.423 \times 10^{-3}\ \text{m s}^{-2}$ $B = \frac{1.5 \times 10^{-2}\ \text{kg} \times 9.423 \times 10^{-3}\ \text{m s}^{-2}}{0.32\ \text{A} \times 7.5 \times 10^{-2}\ \text{m}} = 5.89 \times 10^{-3}\ \text{T}$	**4**
22(c)	**EITHER** As the rod/conductor moves through the field, there is a change of flux (linkage) This induces an e.m.f. (across the ends of the rod) The e.m.f. acts to oppose the change that caused it **Or** Direction of e.m.f. given by Lenz's law Induced e.m.f. acts to oppose battery e.m.f. **Or** Induced e.m.f. reduces current in rod	**(1)** **(1)** **(1)** **(1)**	Allow As the rod/conductor moves through the field, it cuts lines of magnetic flux **Or** As the rod/conductor moves through the field, it cuts magnetic field lines in place of change of flux (linkage)	

	When induced e.m.f. is equal to battery e.m.f., resultant force is zero (so acceleration is zero so constant velocity is reached) **Or** When the current is zero resultant force is zero (so acceleration is zero (so constant velocity is reached) **OR** As the rod/conductor moves through the field, there is a change of flux (linkage) This <u>induces</u> an <u>e.m.f.</u> (across the ends of the rod) This produces a (induced) current in a complete circuit The (induced) current produces its own magnetic field and a force in the opposite direction When the two opposing forces are equal, resultant force is zero (so acceleration is zero so constant velocity is reached)	**(1)** **(1)** **(1)** **(1)** **(1)**	Allow cuts lines of magnetic flux **Or** cuts magnetic field lines in place of change of flux (linkage)	**5**
	Total for question 21			**11**