Mark Scheme (Results)

Summer 2025

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2025
Question Paper Log Number P78756A
Publications Code WPH14_01_2506_MS

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.

Mark Scheme Notes:

This mark scheme is published to help teachers and candidates understand the exam requirements. Please note that the mark schemes can be better understood when viewed alongside the question paper and the Principal Examiner Report for Teachers.

It's important to emphasise that a mark scheme is a work in progress that can be further refined and expanded based on students' responses to a particular paper.

It is important to avoid making assumptions about future mark schemes based on a document from one year.

Although the guiding principles of assessment remain constant, the details may vary based on the content of a particular examination paper.

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. **It is not a set of model answers.**

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. '<u>resonance</u>'
1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.
1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.
2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
2.5 The mark scheme will indicate if no unit error is to be applied by placing brackets around the unit.

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 **use of** the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.2 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working. If the question is worth 3 marks then only 2 marks will be available.

4.3 The mark scheme will show a correctly worked answer for illustration only.

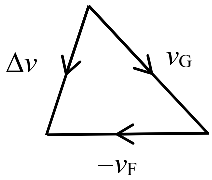
5. Quality of Written Expression

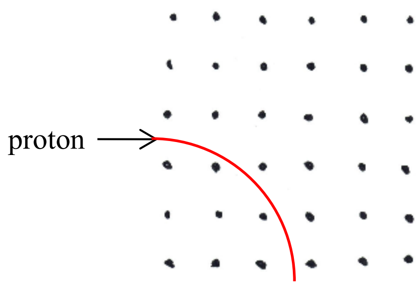
5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Answer	Mark
1	**The only correct answer is B** (85 protons 128 neutrons) A is not correct because the number of protons is 85 and the neutron number is the mass number- the proton number. C is not correct because the number of protons is incorrect D is not correct because the number of neutrons is incorrect; it should be the mass number – the proton number	**1**
2	**The only correct answer is D** (The inverse of the gradient of the line) A is not correct because this is energy B is not correct because this is energy C is not correct because this is the inverse of capacitance	**1**
3	**The only correct answer is A** $\left(\sqrt{\frac{1.6 \times 10^{-19}}{4\pi \times 8.85 \times 10^{-12} \times 0.77}}\right)$ B is not correct because the charge is squared C is not correct because quantity is not rooted D is not correct because the quantity is not rooted, and the charge is squared	**1**
4	**The only correct answer is C** ($v \approx c$) A is not correct because the muons cannot travel faster than the speed of light B is not correct because muons cannot travel at the speed of light D is not correct because the muons would not experience relativistic effects with this speed	**1**
5	**The only correct answer is C** (position Y) A is not correct because nearly all the particles went straight through so would not be deflected to W B is not correct because very few particles will be detected at such large angles D is not correct because nearly all the particles went straight through so would not be deflected to Z	**1**
6	**The only correct answer is D** (thermionic emission) A is not correct because the process is thermionic emission B is not correct because the process is thermionic emission C is not correct because the process is thermionic emission	**1**
7	**The only correct answer is A** ($9.11 \times 10^{-31} \times (3 \times 10^{8})^{2}$) B is not correct because 3×10^{8} is not squared C is not correct because this the energy of two photons D is not correct because 3×10^{8} is not squared and this is the energy of two photons.	**1**
8	**The only correct answer is A** (So that new particles are created.) B is not correct because the electrons undergo inelastic collisions; this energy is ‘converted’ into mass C is not correct because the wavelength is short D is not correct because quarks cannot exist in isolation.	**1**

9	**The only correct answer is C** $\left(\sqrt{2}\right)$ A is not correct because $E = \frac{p^2}{2m}$ B is not correct because this would be the ration of $\frac{\text{momentum of S}}{\text{momentum of T}}$ D is not correct because $E = \frac{p^2}{2m}$	**1**
10	**The only correct answer is C**  A is not the correct vector diagram B is not the correct vector diagram D is not the correct vector diagram	**1**

Question Number	Acceptable Answer		Additional Guidance	Mark
11(a)	Use of $F = Bqv \sin\theta$ $v = 7.8 \times 10^{6}$ m s^{-1}	**(1)** **(1)**	Example of calculation $6.5 \times 10^{-13}\ \mathrm{N} = 0.52\ \mathrm{T} \times 1.6 \times 10^{-19}\ \mathrm{C} \times v$ $v = \dfrac{6.5 \times 10^{-13}\ \mathrm{N}}{0.52\ \mathrm{T} \times 1.6 \times 10^{-19}\ \mathrm{C}} = 7.81 \times 10^{6}\ \mathrm{m\ s^{-1}}$	**2**
11(b)	Path curves Clockwise curve towards bottom of the page	**(1)** **(1)**	Example of diagram 	**2**

(Total for Question 11 = 4 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
12	Use of $p = mv$ Use of conservation of momentum $\theta = 51°$	**(1)** **(1)** **(1)**	Example of calculation $0.40\ \text{ms}^{-1} \times 0.035\ \text{kg} = 2 \times 0.21\ \text{ms}^{-1} \times 0.037\ \text{kg}\ \cos\left(\frac{\theta}{2}\right)$ [conversion to kg not essential] $\frac{\theta}{2} = \cos^{-1}\left(\frac{0.0140}{0.0155}\right) = 25.7°$ $\theta = 51.4°$	**3**

(Total for Question 12 = 3 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
13	Use of $W = mg$ **(1)** Use of $F = BIL \sin\theta$ **(1)** $B = 3.6 \times 10^{-2}$ T **(1)**	<u>Example of calculation</u> $W = 0.45 \times 10^{-3}\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 4.41 \times 10^{-3}\ \text{N}$ $B = \dfrac{4.41 \times 10^{-3}\ \text{N}}{3.1\ \text{A} \times 40 \times 10^{-3}\ \text{m}} = 0.0356\ \text{T}$	**3**

(Total for Question 13 = 3 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
14(a)(i)	(Mesons are) a quark and an antiquark **(1)**		**1**
14(a)(ii)	Baryon: $0 + 1 \rightarrow 1 + 0 + 0$ **(1)** Charge: $-1(e) +1(e) \rightarrow -1\ (e) +1\ (e)\ + 0$ **(1)**		**2**
14(b)	Use of 1 eV = 1.6×10^{-19} J **(1)** Use of $\Delta E = c^2 \Delta m$ **(1)** Percentage difference = 0.04 (%) **(1)** [accept an answer rounding to 0.6% to 0.3%]	<u>Example of calculation</u> $m = \frac{2.9714 \times 10^{-27}\text{ kg } \times (3.0 \times 10^{8}\text{ m s}^{-1})^2}{1.6 \times 10^{-19}\ \times 10^{6}\text{ J MeV}^{-1}}$ $= 1671.4\text{ MeV}$ $\% = \frac{1672 - 1671.4}{1672} \times 100 = 0.036\%$	**3**
14(c)	Neutral particles do not leave tracks **Or** Only charged particles leave tracks **(1)** Reference to conservation of momentum **(1)** There must be a (neutral) particle going off to the left as the Ω^- (and K^+) goes off to the right **(1)**	Accept K^0 does not leave track	**3**

(Total for Question 14 = 9 marks)

Question Number	Acceptable Answer			Mark
15(a)(i)	**EITHER** calculates T Use of $\omega = \frac{2\pi}{T}$ $\omega = 1.27\ (\text{rad s}^{-1})$ **OR** converts from degrees to radians Applies knowledge of the definition of ω ($\omega = \frac{\delta\theta}{\delta t}$) $\omega = 1.27\ (\text{rad s}^{-1})$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	Example of calculation $T = \frac{360° \times 2.2\ s}{160°} = 4.95\ \text{s}$ $\omega = \frac{2\pi}{4.95\ \text{s}} = 1.27\ (\text{rad s}^{-1})$	**3**
15(a)(ii)	The angular velocity depends on the time period **Or** reference to $\omega = \frac{2\pi}{T}$ The (tangential) velocity depends on radius **Or** reference to $v = \omega r$ **Or** Velocity (because it is a vector, and the) direction is always changing.	**(1)** **(1)**	Allow or $\omega = \frac{\delta\theta}{\delta t}$	**2**
15 (b)(i)	Use of $F = m\omega^2 r$ r = 0.203 m (ecf ω from 15(a)(i)) [Show that value gives 0.193 (m)] Subtracts r from 25 cm. Correct comparison of their calculated value and with consistent conclusion	**(1)** **(1)** **(1)** **(1)**	Example of calculation $r = \frac{9.81\ \text{m s}^{-2}}{30 \times 1.3^2\ \text{rad}^2\ \text{s}^{-2}} = 0.193\ (\text{m})$ distance = 25 − 19.3 = 5.7 cm e.g. distance = 5.7 cm > 5.0 cm so they are correct	**4**
15(b)(ii)	The centripetal force and the frictional force are both proportional to the mass **Or** equations showing maximum radius doesn't depend on mass So the glasses would be equally likely to slide because they are not affected by mass	**(1)** **(1)**		**2**

(Total for Question 15 = 11 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*16(a)</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning.
<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 The p.d. provides an electric field
IC2 The electric field accelerates the particles
IC3 Electric field is between the tubes in a linac and between the dees in the cyclotron
IC4 The p.d. is alternating so the particles are always accelerated
IC5 In both machines the particles' paths get longer when not in the electric fields
Or The time taken between leaving and entering the electric field in each machine is the same
IC6 In both machines the frequency of the alternating p.d. is constant
</td><td>
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>Number of indicative points seen in answer</th><th>Number of marks awarded for indicative points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
<table>
<tr><th></th><th>Number of marks awarded for structure and lines of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkage 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 linkage between points and is unstructured</td><td>0</td></tr>
</table>
IC 3 allow- electric field is across a gap
IC 5 Accept references constant time in the dees and constant time in the tubes instead of the Electric field
</td><td>6</td></tr>
</table>

16(b)(i)	Use of $V = \frac{W}{Q}$ **(1)** Uses 1.67×10^{-27} (kg) **(1)** Uses $E_{\mathrm{k}} = \frac{1}{2}mv^2$ **(1)** $v = 1.8 \times 10^7$ (m s^{-1}) **(1)**	<u>Example of calculation</u> $W = 0.40 \times 10^6 \text{ V} \times 1.6 \times 10^{-19}\text{C} \times 4 = 2.56 \times 10^{-13}$ J $v = \sqrt{\frac{2.56 \times 10^{-13} \text{ (J)} \times 2}{1.67 \times 10^{-27} \text{ (kg)}}} = 1.75 \times 10^7 \text{ m s}^{-1}$	**4**
16(b)(ii)	Use of $r = \frac{p}{BQ}$ **(1)** $v = 1.53 \times 10^7$ (m s^{-1}) **(1)** 1.8×10^7 (m s^{-1}) $> 1.5 \times 10^7$ (m s^{-1}) so the increase in speed was not the same **Or** 2×10^7 (m s^{-1}) $> 1.5 \times 10^7$(m s^{-1}) so the increase in speed was not the same **Or** Correct conclusion based on comparison of candidate's calculated values (ecf from (a)(i) for the value of v) **(1)**	<u>Example of calculation</u> $p = 0.55\text{T} \times 1.6 \times 10^{-19}\text{C} \times 0.29\text{m}$ $= 2.55 \times 10^{-20}$ kg m s^{-1} $v = \frac{2.55 \times 10^{-20} \text{ kg m s}^{-1}}{1.67 \times 10^{-27}\text{kg}} = 1.53 \times 10^7 \text{ m s}^{-1}$ 1.75×10^6 m s^{-1} $> 1.53 \times 10^7$ m s^{-1} so no, the increase in speed was not the same	**3**

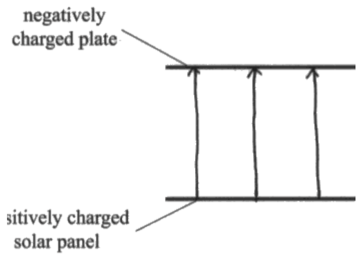
(Total for Question 16 = 13 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
17(a)	Value in range 3.5 V to 3.6 V	**(1)**		**1**
17(b)(i)	Pair of voltages with corresponding time difference on one discharge cycle from capacitor graph. Use of $\ln V = \ln V_0 - \frac{t}{RC}$ **Or** Use of $V = V_0 e^{\frac{t}{RC}}$ $R =$ 6.6 (kΩ) [accept an answer rounding to 6.9 kΩ to 6.3 kΩ] Use of 5% Correct comparison and conclusion	**(1)** **(1)** **(1)** **(1)** **(1)**	<u>Example of calculation</u> $\ln 3.55 = \ln 5.0 - \frac{7.5 \times 10^{-3}}{RC}$ $RC = \frac{-7.5 \times 10^{-3} (s)}{-0.342} = 0.0219$ (s) $R = \frac{0.0219 \text{ (s)}}{3.3 \times 10^{-6} \text{ (F)}} = 6640\Omega$ $6800\Omega \times 0.05 = 340\Omega$ So $6800\Omega \pm 340$ so minimum value = 6460Ω $6640\Omega. > 6460\Omega$ so yes, the resistances does agree.	**5**
17(b)(ii)	Use of $W = \frac{1}{2}CV^2$ Use of a difference in p.d. $W = 2.0 \times 10^{-5}$ J	**(1)** **(1)** **(1)**	e.g. 5^2 and 3.55^2 V^2 Allow Range 2.10×10^{-5}J to 1.99×10^{-5}J <u>Example of calculation</u> $W = \frac{1}{2} 3.3 \times 10^{-6}(F)\ (5^2 - 3.55^2)(V^2) = 2.04 \times 10^{-5}$J	**3**
17(b)(iii)	Time constant is (much) smaller (So,) the capacitor discharges (much) more quickly The capacitor completely discharges (in the time before the next charge)	**(1)** **(1)** **(1)**	Accept Smaller resistance leads to greater current	**3**

(Total for Question 17 = 12 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
18(a)	The current (in the charger coil) produces a magnetic field **(1)** Alternating current, so alternating / varying magnetic field produced **(1)** There is a change of (magnetic) flux linkage with the coil in the (mobile) phone **(1)** **Or** The coil in the (mobile) phone cuts lines of (magnetic) flux An <u>e.m.f.</u> is <u>induced</u> **(1)**	Allow coil in mobile phone cuts magnetic field lines	**4**
18(b)(i)	Calculates area of coil **(1)** Applies knowledge of flux = magnetic flux density × area **(1)** Applies knowledge of flux linkage = $N\varphi$ **(1)** $N\varphi = 1.1 \times 10^{-3}$ Wb **(1)**	Allow Weber Turns or T m^2 <u>Example of calculation</u> $A = \pi\left(\frac{4 \times 10^{-2}\text{ m}}{2}\right)^2 = 1.26 \times 10^{-3}\text{ m}^2$ $N\varphi = 18 \times 10^{-3}\text{ T} \times 1.26 \times 10^{-3}\text{ m}^2 \times 50$ $= 1.13 \times 10^{-3}$ Wb	**4**
18(b)(ii)	Not all the flux produced (by the coil with the a.c. supply), links with the coil (with the digital voltmeter) **Or** There is no iron core joining the two coils **Or** The coils are (too) far apart **(1)**		**1**

(Total for Question 18 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
19(a)	Arrows upwards **(1)** At least three equi-spaced vertical parallel lines touching the wires. **(1)**	Example of minimum acceptable  Ignore curved edges at the edge of plates	**2**
19(b)(i)	Charged particles experience a force in an electric field **(1)** Force due to electric field is greater than weight of particle **Or** There is a resultant upwards force acting on the sand particle **(1)**	Accept charged particle experiences electrostatic force	**2**
19(b) (ii)	Use of $E = \frac{V}{d}$ **(1)** $E = 8.13 \times 10^5$ (V m^{-1} or N C^{-1}) **(1)**	Example of calculation $E = \frac{12\ 200\ \text{V}}{0.015\ \text{m}} = 813\ 000\ \text{V m}^{-1}$	**2**

19(b)(iii)	Use of $F = EQ$ (Allow use of value from (b)(ii)) **(1)** Use of $W = mg$ **(1)** Use of $\rho = \frac{m}{V}$ **(1)** Calculates radius from volume using $V = \frac{4}{3}\pi r^3$ **Or** Calculates Volume from radius using $V = \frac{4}{3}\pi r^3$ **(1)** d = 620 μm **(1)** 620 μm so the size is 590 μm **Or** Comparison of their calculated value with value in table and consistent conclusion **(1)**	Their choice of size must be less than their calculated value <u>Example of calculation</u> $F_{up} = 810\,000 \times 4.0 \times 10^{-12} = 3.24 \times 10^{-6}$ N $F_{down} = 3.24 \times 10^{-6}\text{ N} = m \times 9.81$ $m = \frac{3.24 \times 10^{-6}\text{ N}}{9.81\text{ N kg}^{-1}} = 3.30 \times 10^{-7}$ kg $V = \frac{3.32 \times 10^{-7}\text{ kg}}{2600\text{ kg m}^{-3}} = 1.27 \times 10^{-10}\text{ m}^3$ $r = \sqrt[3]{\frac{1.27 \times 10^{-10}\text{m}^3 \times 3}{4\pi}} = \sqrt[3]{3.03 \times 10^{-11}}$ $= 3.12 \times 10^{-4}$ m So d = 624 μm < 720 μm so the size is 590 μm	**6**

19(c)(i)	Vertically downward arrow from particle labelled weight / W / mg Arrow perpendicular to the plate~~,~~ labelled F_E / electrical force	Allow gravitational force Allow EQ,	**2**
19(c)(ii)	The field only lifts a component of the weight ($mg\cos\theta$) of the particle **Or** A component of the weight ($mg\sin\theta$) acts parallel to the slope **(1)** More massive particles can be lifted (for a given electric field strength) **(1)** MP2 dependent on MP1		**2**

(Total for Question 19 = 16 marks)
TOTAL FOR PAPER = 90 MARKS

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom