Pearson

Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced Level in Physics
Paper 01: Further Mechanics, Fields and Particles

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.

Mark scheme notes

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. 'resonance'

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 C** (86 64) A is not correct because the number of neutrons is 86 and the number of protons is 64 B is not correct because the number of neutrons is 86 and the number of protons is 64 D is not correct because the number of neutrons is 86 and the number of protons is 64	**1**
2	**The only correct answer is B** (electric potential) A is not correct because this is a vector quantity C is not correct because this is a vector quantity D is not correct because this is a vector quantity	**1**
3	**The only correct answer is D** (to provide energy to produce new particles) A is not correct because this is not related to ionisation B is not correct because quarks do not exist on their own C is not correct because this is not related to forces between particles	**1**
4	**The only correct answer is C** ($0.075 \times 0.12 \times 0.046 \times \sin 40°$) A is not correct because the angle is not considered B is not correct because this gives the length of conductor parallel to the field D is not correct because the tan is incorrect	**1**
5	**The only correct answer is D** $\left(8.99 \times 10^{9} \times 1.6 \times 10^{-19}\left(\frac{1}{0.30^{2}} + \frac{1}{0.10^{2}}\right)\right)$ A is not correct because this gives electric potential B is not correct because this gives electric potential C is not correct because the field strengths should be added	**1**
6	**The only correct answer is B** (increase the p.d. applied to the heater) A is not correct because this would not change the current C is not correct because this would stop the current D is not correct because this would decrease the current	**1**
7	**The only correct answer is D** (The nucleus consists of protons and neutrons.) A is not correct because this is a true conclusion B is not correct because this is a true conclusion C is not correct because this is a true conclusion	**1**
8	**The only correct answer is C** (The particles do not accelerate when they are inside the drift tubes.) A is not correct because the drift tubes increase in length B is not correct because there is no electric field inside the drift tubes D is not correct because the p.d. changes when the particles are inside the drift tubes	**1**

9	**The only correct answer is C** (2) A is not correct because the alpha has twice the charge and four times the mass B is not correct because the alpha has twice the charge and four times the mass D is not correct because the alpha has twice the charge and four times the mass	**1**
10	**The only correct answer is D** $\left(\frac{mv^2}{r} + mg\right)$ A is not correct because centripetal force is in the wrong direction B is not correct because it does not include centripetal force C is not correct because the weight is in the wrong direction	**1**

Question Number	Answer		Additional Guidance	Mark
11	Use of $F = Bqv\sin\theta$ $B = 0.024$ T	**(1)** **(1)**	<u>Example of calculation</u> $B = \frac{9.2 \times 10^{-14}\ \text{N}}{2 \times 1.6 \times 10^{-19}\ \text{C} \times 1.2 \times 10^{7}\ \text{m s}^{-1}} = 0.0240\ \text{T}$	**2**
	Total for question 11			**2**

Question Number	Answer	Additional Guidance	Mark
12(a)	Use of $T = \frac{2\pi}{\omega}$ **(1)** $\omega = 0.42$ (rad s^{-1}) **(1)**	Example of calculation $\omega = \frac{2\pi \text{ rad} \times 1}{15 \text{ s}} = 0.419 \text{ rad s}^{-1}$	**2**
12(b)	**EITHER** Calculates fraction of the circle divided by ω **(1)** Converts degrees to radians **(1)** t=10 s (ecf (a)) (Show that gives 10.9 s) **(1)** **OR** Calculates fraction of the circle multiplied by time **(1)** With 360°−110°= 250° **(1)** t=10 s **(1)**	Example of calculation $t = \frac{(360° - 110°) \times 2\pi \text{ radian}}{360° \times 0.42 \text{ radian s}^{-1}} = 10.4 \text{ s}$	**3**
	Total for question 12		**5**

Question Number	Answer	Additional Guidance	Mark
13(a)	Leptons are fundamental particles whereas mesons are made up of quarks **Or** Leptons are fundamental particles whereas mesons are not **Or** Mesons are made up of quarks whereas leptons are not **Or** Mesons have internal structure whereas Leptons do not. **(1)**	Allow muon instead of lepton and pion instead of meson	**1**
13(b)	Charge $-1e \rightarrow -1e + 0 + 0$ **(1)** So $-1 = -1$ and yes charge is conserved [dependent MP1] **(1)** Lepton $1 \rightarrow 1 + +1 + (-1)$ **(1)** So $1 = 1$ and yes lepton number is conserved [dependent MP3] **(1)**		**4**
	Total for question 13		**5**

Question Number	Answer	Additional Guidance	Mark
14(a)	**EITHER** Use a phone/video (directly vertically above the tracks) **(1)** (Play back the video and) measure angle with a protractor **Or** Analyse video using motion tracking software (to determine angle) **(1)** **OR** Use carbon paper underneath the spheres to show the sphere's tracks **(1)** Use a protractor to measure the angles **(1)**		**2**
14(b)(i)	**EITHER** Use of $E_k = \frac{1}{2}mv^2$ **(1)** Final kinetic energy equated to initial kinetic energy **(1)** $u = 0.249$ (m s^{-1}) **(1)** **OR** Use of $p = mv$ **(1)** Correctly resolves momentum into components **(1)** $u = 0.249$ (m s^{-1}) **(1)**	Example of calculation $E_{\text{k,final}} = \frac{1}{2}(0.0510\text{ kg} \times (0.170\text{ m s}^{-1})^2 + \frac{1}{2}(0.0320\text{ kg} \times (0.230\text{ m s}^{-1})^2$ $E_{\text{k,final}} = 0.00158$ J $u = \sqrt{\frac{0.00158\text{ J}}{0.5 \times 0.0510\text{ kg}}} = 0.2492\text{ m s}^{-1}$	**3**
14(b)(ii)	Use of conservation of momentum **(1)** Use of trigonometry to calculate angle **(1)** **Or** resolves momentum into components	Accept $\theta = 41.2°$ if momentum resolved vertically	**3**

	$\theta = 42(°) \approx 43(°)$, so the student's measurement is correct (ecf (b)(i)) **Or** $\theta = 42(°) < 43(°)$, so student's measurement is incorrect (ecf (b)(i)) [show that value gives 40.9(°)] **Or** $p = 0.0127$ kg ms^{-1}>0.0125 kg ms^{-1} so student's measurement is incorrect **(1)**	Example of calculation $p_i = 0.249 \text{ m s}^{-1} \times 0.051 \text{ kg} = 0.0127 \text{ kg ms}^{-1}$ $p_f = 0.17 \text{ m s}^{-1} \times 0.051 \text{ kg} \cos(34) + 0.23 \text{ m s}^{-1} \times 0.032 \text{ kg } \cos(\theta)$ $\cos\theta = \frac{(0.0127 - 0.00719)\text{kg m s}^{-1}}{0.032 \text{ kg} \times 0.23 \text{ m s}^{-1}} = \frac{0.00551\text{kg m s}^{-1}}{0.00736\text{kg m s}^{-1}} = 0.749$ $\theta = 41.5° \approx 43°$ so the student's measurement is correct	
	Total for question 14		**8**

Question Number	Answer	Additional Guidance	Mark
15(a)	Use of $W = \frac{1}{2}CV^2$ (or equivalent) **(1)** Energy stored = 180 (J) **(1)** 180 (J) > 150 (J), so the energy is enough to restart a heart **(1)** **Or** Comparison of calculated value of energy with 150 (J) and consistent conclusion	Example calculation $W = \frac{1}{2} \times 120 \times 10^{-6}\ \text{F} \times (1750\ \text{V})^2 = 184\ \text{J}$ Energy stored = 180 J > 150 J, the energy is enough to restart a heart	**3**
15(b)(i)	Use of $I = I_0 e^{-\frac{t}{RC}}$ **(1)** **Or** Use of $\ln I = \ln I_0 - \frac{t}{RC}$ t = 0.0096 s **(1)**	Example of calculation $\ln\left(\frac{8.0\ \text{A}}{20.0\ \text{A}}\right) = -\frac{t}{120 \times 10^{-6}\ \text{F} \times 87.5\ \Omega}$ $t = 0.00962$ s	**2**
15(b)(ii)	**EITHER** Determines p.d. across capacitor **(1)** Use of $Q = CV$ **(1)** Q = 0.084 C **(1)** **OR** Use of $Q = Q_0 e^{-\frac{t}{RC}}$ (ecf (i))	Allow use of $V=IR$, proportion or exponential equation $V = V_0 e^{-\frac{t}{RC}}$	

	Or Use of $\ln Q = \ln Q_0 - \frac{t}{RC}$ **(1)** Use of $Q_0 = CV$ **(1)** $Q = 0.084\,\text{C}$ **(1)**	Example of calculation $V = \frac{8.0\,\text{A}}{20.0\,\text{A}} \times 1750\,\text{V} = 700\,\text{V}$ $120 \times 10^{-6}\,\text{F} \times 700\,V = 0.0840\,\text{C}$	**3**
15(c)	**EITHER** Reads maximum charge from graph **(1)** **Or** $Q_0 = CV$ Reads pair of values off graph **(1)** Use of $Q = Q_0 - Q_0 e^{-\frac{t}{RC}}$ **(1)** $R = 4.2 \times 10^5\,\Omega$ [$3.8 \times 10^5\,\Omega$ to $4.6 \times 10^5\,\Omega$] **(1)** **OR** Reads maximum charge from graph **Or** $Q_0 = CV$ **(1)** Reads time for $Q_0\left(1 - \frac{1}{e}\right)$ **Or** $0.63\,Q_0$ from graph **(1)** Use of time constant = RC **(1)** $R = 4.2 \times 10^5\,\Omega$ [$3.8 \times 10^5\,\Omega$ to $4.6 \times 10^5\,\Omega$] **(1)**	Example of calculation Reads maximum charge off graph 0.215 C Reads pair of values e.g. 0.135 C and 50 s $0.135\text{C} = 0.215\,\text{C} - 0.215\,C\,e^{-\frac{50}{RC}}$ So $R = \frac{50.6s}{0.989} = 50.6\text{s}$ So $C = \frac{50\text{s}}{120\times10^{-6}\,\text{F}} = 4.21 \times 10^5\,\Omega$ **OR** Reads maximum charge off graph 0.215 C $0.215\,\text{C} \times \left(1 - \frac{1}{e}\right) = 0.136\,\text{C}$ Reads time constant off the graph = 50 s $R = \frac{50\,\text{s}}{120\times10^{-6}\,\text{F}} = 4.17 \times 10^5\,\Omega$	**4**
	Total for question 15		**12**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>16(a)</td><td>Opposite charge (1)

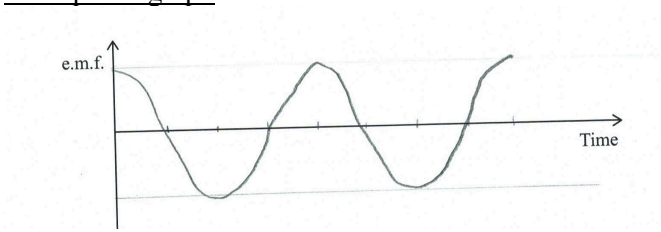
Opposite (sign of) lepton number (1)</td><td>Accept lepton anti-lepton</td><td>2</td></tr>
<tr><td>16(b)</td><td>Use of 1 eV = 1.6×10^{-19} J (1)

Use of $\Delta E = c^2 \Delta m$ (1)

E = 1.0 (MeV) < (1.2 MeV), so the photon has sufficient energy
Or $E = 1.92 \times 10^{-13}\text{J} > 1.64 \times 10^{-13}\text{J}$ so photon has sufficient energy
Or $m = 2.1 \times 10^{-30}$ kg > 1.8×10^{-30} kg so sufficient (1)</td><td>Do not accept comparisons of speed

<u>Example of calculation</u>
$E = \frac{2 \times 9.11 \times 10^{-31}\ \text{kg}\ (3 \times 10^{8}\ \text{m s}^{-1})^2}{1.6 \times 10^{-13}\ \text{J}} = 1.02\ \text{MeV}$</td><td>3</td></tr>
<tr><td>16(c)</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 fi</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td></td></tr>
<tr><td>5</td><td>3</td><td>2</td><td></td></tr>
<tr><td>4</td><td>3</td><td>1</td><td></td></tr>
<tr><td>3</td><td>2</td><td>1</td><td></td></tr>
<tr><td>2</td><td>2</td><td>0</td><td></td></tr>
<tr><td>1</td><td>1</td><td>0</td><td></td></tr>
<tr><td>0</td><td>0</td><td>0</td><td></td></tr>
</table></td><td>The following table shows how the marks should be awarded for structure and lines of reasoning.</td><td>6</td></tr>
</table>

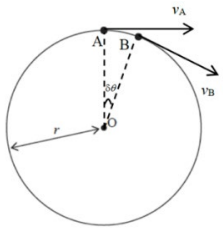
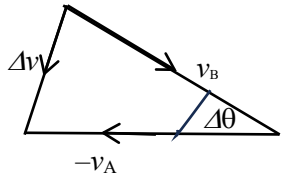
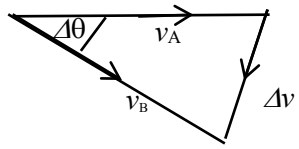
	Indicative content IC1 The photon doesn't leave a track as it hasn't got a charge IC2 The tracks are due to charged particles IC3 The tracks curve in different/opposite directions IC4 (This shows) the particles have opposite (magnitude of) charge IC5 The radius of curvature for each track is the same IC6 As $r=p/BQ$ (momentum must be conserved) so the mass is the same	<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>	
	Total for question 16		**11**

Question Number	Answer	Additional Guidance	Mark
17(a)(i)	A sinusoidal curve for at least two complete cycles **(1)** Constant time period and constant amplitude. **(1)** Maximum e.m.f. at $t = 0$ **(1)**	Example of graph  	**3**
17(a)(ii)	The rate of change of magnetic flux linkage increases **(1)** The (maximum) e.m.f. is doubled **(1)** The frequency is doubled **Or** The time period is halved **(1)**	Allow lines of magnetic flux cut faster Allow increased for doubled for e.m.f.	**3**
17(b)	Calculates area of coil **(1)** Uses flux = magnetic flux density × area **(1)** Use of $\varepsilon = \varphi\omega$ **(1)** $\varepsilon = 0.016$ V **(1)**	Example of calculation Area $= 0.095\ \text{m} \times 0.120\ \text{m} = 0.0114\ \text{m}^2$ $\varphi = 0.90\ \text{T} \times 0.0114\ \text{m}^2 = 0.0103\ \text{Wb}$ $\mathcal{E} = 0.0103\ \text{Wb} \times 1.57\ \text{rad}\ \text{s}^{-1} = 0.0162\ \text{V}$	**4**

17(c)	(By Lenz's law) the direction of the induced e.m.f. is such as to oppose the change in magnetic flux **(1)** There is a force opposing the movement of the coil **(1)**	Accept cutting of magnetic flux Accept opposing the change producing it.	**2**
	Total for question 17		**12**

Question Number	Answer	Additional Guidance	Mark
18(a)	At least four equi-spaced straight radial lines touching point charge **(1)** Arrows pointing outwards **(1)**	Example of drawing 	**2**
18(b)(i)	Use of $E = \frac{V}{d}$ **(1)** Use of $E = \frac{F}{Q}$ **(1)** Use of $F = ma$ **(1)** Use of $v = u + at$ **(1)** **Or** equivalent kinematic equations $v = 6.23\ \text{m s}^{-1}$ **(1)**	Example of calculation $E = \frac{45\ \text{V}}{3.0 \times 10^{-4}\ \text{m}} = 15000\ \text{Vm}^{-1}$ $F = 15000\ \text{Vm}^{-1} \times 1.40 \times 10^{-10}\ \text{C} = 2.1 \times 10^{-5}\text{N}$ $\text{a} = \frac{2.1 \times 10^{-5}\text{N}}{2.9 \times 10^{-10}\ \text{kg}} = 72\ 400\ \text{m s}^{-2}$ $v = 0 + 72\ 400\ \text{m s}^{-2} \times 8.6 \times 10^{-5}\ \text{s} = 6.226\ \text{m s}^{-1}$	**5**

18(b)(ii)	Use of $F\Delta t = \Delta p$ **(1)** $F\Delta t = 4.4 \times 10^{-9}$(N s) **(1)** 4.4×10^{-9} (N s) $>$ 4.2×10^{-9} (N s) so yes it will stick **(1)**\ **Or** Comparison of candidate's calculated value of impulse with consistent conclusion	Allow 4.4×10^{-9} (N s) $=$ 4.2×10^{-9} (N s) so yes it will stick Allow 15.2 ms^{-1} $>$ 14.5 ms^{-1}so yes it will stick <u>Example of calculation</u> $F\Delta t = 2.9 \times 10^{-10}$ kg $\times$ 15.2 m s^{-1} $= 4.41 \times 10^{-9}$ N s 4.41×10^{-9} N s $>$ 4.2×10^{-9} N s so yes it will stick	**3**
	Total for question 18		**10**

Question Number	Answer	Additional Guidance	Mark
19(a)	Correct vector diagram showing velocity at the two positions and the corresponding velocity change **(1)** As $\Delta\theta$ is small so AB is an approximate straight line **Or** As $\Delta\theta$ is small so the sector can approximate to a triangle **Or** $\Delta\theta$ is small so it's a right-angled triangle **Or** As $\Delta\theta$ is small, so $sin\theta \approx \theta$ **(1)** (Using similar triangles) so $\Delta\theta \approx \Delta v / v$ **(1)** As $\Delta v / \Delta t = a$ **(1)** As $\Delta\theta / \Delta t = \omega$ **and** $v = r\omega$ **and** algebra to show $a = \frac{v^2}{r}$ **(1)**	Example of derivation  (Labels both velocities on diagram) Vector diagram, to show $v_B - v_A = \Delta v$ **Or** $v_B = \Delta v + v_A$  **Or**  	**5**

		$v_A = v_B = v$ Small angle approximation, so $\Delta\theta \approx \frac{\Delta v}{v}$ (1) $\frac{\Delta\theta}{\Delta t} = \omega$ so $\Delta\theta = \omega\Delta t$ (2) Equate equations (1) and (2) so $\Delta\theta = \omega\Delta t = \frac{\Delta v}{v}$ $v = r\omega$ (3) substituting for ω; $\Delta\theta = \omega\Delta t = \frac{v\Delta t}{r} = \frac{\Delta v}{v}$ by definition: $a = \frac{\Delta v}{\Delta t}$ $a = \frac{\Delta v}{\Delta t} = \frac{v^2}{r}$	
19(b)(i)	Use of $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ **(1)** Use of $F = \frac{mv^2}{r}$ **(1)** Equates centripetal force to electrostatic force **(1)** Use of $E_k = \frac{p^2}{2m}$ **Or** $E_k = \frac{1}{2}mv^2$ **(1)** $E_k = 2.2 \times 10^{-18}$ J **(1)**	Allow use of 8.99×10^9 $\mathrm{Nm^2C^{-2}}$ <u>Example of calculation</u> $F = \frac{(1.6\times10^{-19}\ \mathrm{C})^2}{4\pi\ 8.85\times10^{-12}\ \mathrm{F\ m^{-1}}\times(5.3\times10^{-11}\ \mathrm{m})^2} = 8.19 \times 10^{-8}\mathrm{N}$ $F_c = \frac{9.11\ \times 10^{-31}\ \mathrm{kg}\ v^2}{5.3 \times 10^{-11}\ \mathrm{m}} = 8.19 \times 10^{-8}\mathrm{N}$ $v^2 = 4.77 \times 10^{12}\ \mathrm{m^2\ s^{-2}}$ $E_k = \frac{9.11 \times 10^{-31}\ \mathrm{kg} \times 4.77 \times 10^{12}\ \mathrm{m^2\ s^{-2}}}{2} = 2.17 \times 10^{-18}$ J	**5**
19(b)(ii)	Use of $V = \frac{Q}{4\pi\varepsilon_0 r}$ **(1)** Use of $V = \frac{W}{Q}$ **(1)**	Allow use of 8.99×10^9 $\mathrm{Nm^2C^{-2}}$ Allow 27.1 eV	

	$E_P = (-)\ 4.3\ \times 10^{-18}$ J **(1)**	Example of calculation $V = \frac{1.6 \times 10^{-19}\ \text{C}}{4\pi\ 8.85 \times 10^{-12}\ \text{F m}^{-1} \times 5.3 \times 10^{-11}\ \text{m}} = 27.1\ \text{V}$ $W = 27.1\ \text{V} \times 1.6 \times 10^{-19}\ \text{C} = 4.34 \times 10^{-18}\ \text{J}$	**3**
19(c)	The kinetic energy of the electron would decrease **(1)** **Or** The potential energy would become more negative The electron would spiral into the nucleus/proton **(1)** **Or** The radius will decrease		**2**
	Total for question 19		**15**