Mark Scheme (Results)

Summer 2025

Pearson Edexcel GCE A Level
In Physics (9PH0)
Paper 01: Advanced Physics I

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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.

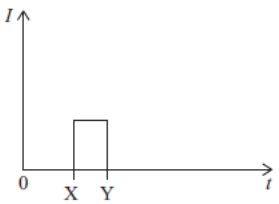
5. Quality of Written Expression

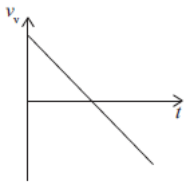
5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

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

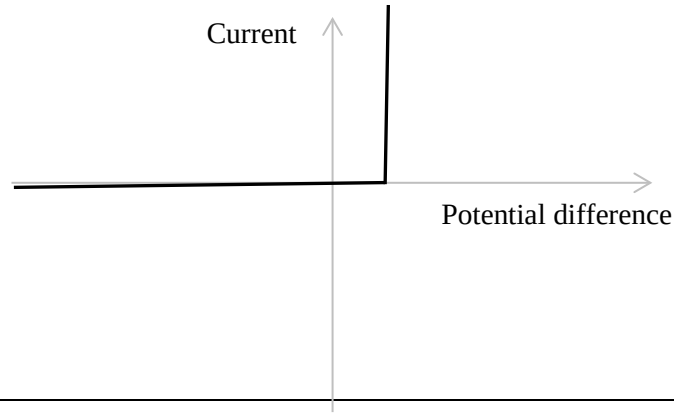
5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Acceptable Answer	Additional Guidance	Mark
1	**The only correct answer is A** (structure of an atom) B is not the correct answer, as this experiment investigated the structure of the atom C is not the correct answer, as this experiment investigated the structure of the atom D is not the correct answer, as this experiment investigated the structure of the atom		**1**
2	**The only correct answer is A** (charge) B is not the correct answer, as displacement is a vector C is not the correct answer, as electric field strength is a vector D is not the correct answer, as force is a vector		**1**
3	**The only correct answer is C** (There is a force on the person due to Newton's third law.) A is not the correct answer, as a centripetal force acts on the ball B is not the correct answer, as Newton's first law describes the force on the ball D is not the correct answer, as weight does not act in the horizontal plane		**1**
4	**The only correct answer is D** $\frac{R}{4}$ A is not the correct answer, as $R = \rho l/A$ and A is four times larger B is not the correct answer, as $R = \rho l/A$ and A is four times larger C is not the correct answer, as $R = \rho l/A$ and A is four times larger		**1**

5	**The only correct answer is B** (into the page) A is not the correct answer, as the positron is anticlockwise, the force is to the centre of the spiral and use of Flemings left hand rule C is not the correct answer, as the positron is anticlockwise, the force is to the centre of the spiral and use of Flemings left hand rule D is not the correct answer, as the positron is anticlockwise, the force is to the centre of the spiral and use of Flemings left hand rule		**1**
6	**The only correct answer is C** (P to Q ; increased) A is not the correct answer, as the field direction is towards the plate connected to the negative terminal and the field strength is increased B is not the correct answer, as the field direction is towards the plate connected to the negative terminal and the field strength is increased D is not the correct answer, as the field direction is towards the plate connected to the negative terminal and the field strength is increased		**1**
7	**The only correct answer is C**  A is not the correct answer, as current is only present when capacitor changes so charges or discharges B is not the correct answer, current is only present when capacitor changes and charges or discharges D is not the correct answer, as current is only present when capacitor changes and charges or discharges		**1**

8	**The only correct answer is B** $\frac{2}{\ln 3}$ A is not the correct answer, as Time constant $RC = t/\ln 3$ C is not the correct answer, as Time constant $RC = t/\ln 3$ D is not the correct answer, as Time constant $RC = t/\ln 3$		**1**
9	**The only correct answer is D**  A is not the correct answer, as the only force acting on the ball is weight B is not the correct answer, as the only force acting on the ball is weight C is not the correct answer, as the only force acting on the ball is weight		**1**
10	**The only correct answer is A**  B is not the correct answer, as the acceleration in the vertical plane is g C is not the correct answer, as the acceleration in the vertical plane is g D is not the correct answer, as the acceleration in the vertical plane is g		**1**

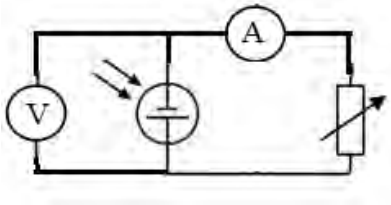
(Total for Multiple Choice Questions = 10 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
11(a)	• $I = 0$ for V less than 0 [Ignore any breakdown pd]	**(1)**	Allow I close to 0 Allow curve or positively sloping straight line rather than abrupt right angle <u>Example of graph</u>  	**2**
	• $I = 0$ from 0 to a positive value of V and then increases with a steep gradient	**(1)**		
11(b)	• Use of $E = V_1 + V_2$	**(1)**	<u>Example of calculation</u> $5\ \text{V} - 3.2\ \text{V} = 20 \times 10^{-3}\ \text{A} \times R$ $R = 90\ \Omega$	**3**
	• Use of $V = IR$	**(1)**		
	• Resistance = 90 Ω	**(1)**		

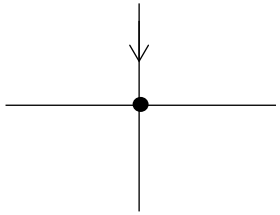
(Total for Question 11 = 5 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
12(a)	• Resultant force = 0 **(1)** • Resultant moment (about any point) = 0 **(1)**	Accept Clockwise moment = anticlockwise moment (about a point)	**2**
12(b)	• Use of Moment = $F.x$ around P **(1)** • Use of perpendicular component ie cos80 **(1)** • Use of clockwise moment = anticlockwise moment **(1)** • W = 3.3 N **(1)**	Accept: Use of Moment = $M.x$ around P Example of calculation Clockwise moment = 0.260 kg × 9.81 N kg^{-1} × 0.04 m = 0.102 N m Anticlockwise moment = W × 0.18 m × cos80 So 0.102 N m = W × 0.0313 W = 3.26 N	**4**
12(c)	• The whole lever-arm rotates through the same angle **(1)** • As the distance of pointer from the pivot is larger **O**r distance of the pan from pivot is smaller **(1)**	Accept as lever-arm radius is larger **Or** radius to pan is smaller	**2**

(Total for Question 12 = 8 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
13(a)	• Voltmeter in parallel with solar cell • Ammeter in series with variable resistor	**(1)** **(1)**	Example of circuit diagram 	**2**
13(b)(i)	• Use of $P = IV$ • P = 1.8 (W)	**(1)** **(1)**	Example of calculation P = 0.54 V × 3.4 A P = 1.84 W Allow range of values calculated between points on the graph from 0.50 V 3.6 A [gives 1.80 W] to 0.55 V 3.2 A [gives 1.76 W]	**2**
13(b)(ii)	• Use of $I = P / A$ • Use of efficiency = P_{out} / P_{in} • Efficiency = 0.18 **O**r 18 % (allow ecf from (b)(i))	**(1)** **(1)** **(1)**	Example of calculation Power of sunlight = 1000 W m^{-2} × 104 × 10^{-4} m^2 = 10.4 W Efficiency = 1.84 W / 10.4 W = 0.177 [Show that value gives 0.19]	**3**
13(b)(iii)	• Recognise E = 0.58 V • Determine p.d. across internal resistance • Internal resistance = 0.012 Ω [allow ecf from (b)(i) ie pair of values for V and I that were out of range]	**(1)** **(1)** **(1)**	Example of calculation Internal resistance = $\frac{0.58\text{ V} - 0.54\text{ V}}{3.4\text{ A}}$ = 0.012 Ω	**3**

(Total for Question 13 = 10 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
14(a)	• At least four straight equispaced lines • Arrow on at least one line pointing to the charge	**(1)** **(1)**	Example 	**2**
14(b)(i)	• Use of $V = {}^{Q}/_{4\pi\varepsilon_0 r}$ • Converts to nC • Q = (−) 0.11 (nC)	**(1)** **(1)** **(1)**	Example of calculation $-16\text{ V} = \frac{Q}{4\pi \times 8.85 \times 10^{-12}\text{ F m}^{-1} \times 0.06\text{ m}}$ $Q = -1.07 \times 10^{-10}$ C $Q = -0.11$ nC	**3**
14(b)(ii)	• Use of $E = {}^{Q}/_{4\pi\varepsilon_0 r^2}$ • Either calculates r = 0.091 (m) using E = 120 V m^{-1} or E = 99 (V m^{-1}) using r = 0.10 m (Show that value gives r = 0.087 (m) using E = 120 V m^{-1} or E = 90 (V m^{-1}) using r = 0.10 m) • Comparison of student's answer for distance with r = 10 (cm) and an opinion about the statement **Or** Comparison of student's answer for field strength with the field strength = 120 (V m^{-1}) and an opinion about the statement	**(1)** **(1)** **(1)**	Example of calculation (−)120 V m^{-1} = $\frac{(-)\ 1.1 \times 10^{-10}\text{ C}}{4\pi \times 8.85 \times 10^{-12}\text{ F m}^{-1} \times r^2}$ r = 0.091 m Or calculates the field strength $E = \frac{(-)\ 1.1 \times 10^{-10}\text{ C}}{4\pi \times 8.85 \times 10^{-12}\text{ F m}^{-1} \times 0.10^2}$ E = 99 V m^{-1} Accept statement is incorrect because the bee can detect the field at 9.1 (cm) or less **Or** Accept statement is incorrect because the bee cannot detect the field at 10 (cm)	**3**
14(c)	• Hair must be charged • As an electric field exerts a force on a charge	**(1)** **(1)**	Accept "negative" or "positive" Accept as like charges repel **Or** opposite charges attract	**2**

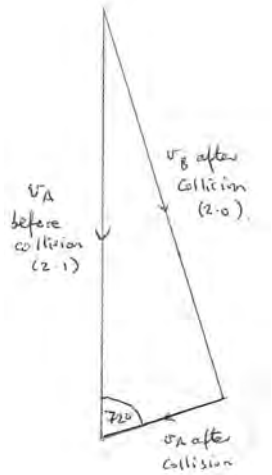
(Total for Question 14 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
15(a)	• Correct symbol for pion and neutron **(1)** • Pion marked positive **(1)**	Do note award MP1 if an additional symbol appears Example $(\Sigma^+) \rightarrow \pi^+ + n$ Ignore 0 if written next to *n*	**2**
15(b)	• Charge: +1 → +1 + 0 **(1)** • Baryon number: 1 → 0 + 1 **(1)**		**2**
15(c)	• Three quarks **(1)** • (s) u u **(1)**		**2**
15(d)(i)	• The neutron is a neutral particle **Or** the neutron is not charged **Or** neutrons do not produce ionisation **(1)**		**1**
15(d)(ii)	• Measures radius 3.5 cm [range 3.0 cm to 9.0 cm] **(1)** • Uses scale correctly (× 15) **(1)** • Use of $r = p/BQ$ with $Q = 1.6 \times 10^{-19}$ C **(1)** • B = 1.3 T [value consistent with their measured scaled radius note 3.0 cm leads to 1.5 T and 9.0 cm leads to 0.51 T] **(1)**	Example of calculation $r = 0.035 \times 15 = 0.525$ m Typical range after scaling 0.45 to 1.35 m $0.525 \text{ m} = \frac{1.1 \times 10^{-19} \text{ N s}}{B \times 1.6 \times 10^{-19} \text{ C}}$ B = 1.3 T	**4**

(Total for Question 15 = 11 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
16(a)(i)	• Use of $p = mv$ • p = 38 (N s)	**(1)** **(1)**	Example of calculation $p = 18\text{ kg} \times 2.1\text{ m s}^{-1}$ $p = 37.8\text{ N s}$	**2**
16(a)(ii)	• Expression for component of p_B East • Expression for component of p_B South • Uses momentum conservation along line South • Uses $\tan\theta = \frac{\text{component } x}{\text{component } y}$ • $\theta = 72^o$ and so stone A moves in the direction shown **Or** $\theta = 72^o$ and so stone A doesn't move in the direction shown [if using show that value $\theta = 62^o$ and this is not in the right direction]	**(1)** **(1)** **(1)** **(1)** **(1)**	**Reference to direction for examiners only – no penalties for omission** Example of calculation p_B in east direction $= 18\text{ kg} \times 2\text{ m s}^{-1} \times \sin 17^o$ $= 10.53\text{ N s}$ p_B in south direction $= 18\text{ kg} \times 2\text{ m s}^{-1} \times \cos 17^o$ $= 34.43\text{ N s}$ Momentum conservation in South direction $37.8\text{ N s} = 34.43\text{ N s} + p_{\text{A in South direction}}$ **Or** $p_{\text{A in south direction after collision}} = 37.8 - 34.43 = 3.37\text{ N s}$ [If show that value used = 5.57 N s] p_A in west direction $= p_B$ in east direction $= 10.53\text{ N s}$ $\tan\theta = \frac{10.53}{3.37}$ $\theta = 72^o$ to south direction [Note this could all be done using velocity values as the mass of each stone is the same]	**5**

	Alternative making use of angle of 70° to determine the velocity of A by considering momentum conservation in two directions and comparing the two results • Expression for component of v_B South **(1)** • Uses conservation along line South **(1)** • Expression for component of v_B East **(1)** • Uses conservation East West **(1)** • Gives two correct values of velocity/momenta for stone A *eg* 0.56 ($m\,s^{-1}$) and 0.62 ($m\,s^{-1}$) after the collision with a comparison of the two values and sensible conclusion such as the two values are not consistent so the stone does not move in this direction **(1)** [If momenta used the two values for momenta of A after the collision are 10.1 (Ns) and 11.2 (Ns)]	The alternative is shown using velocity values but could be done using momentum values as above. v_B in south direction $= 2\,m\,s^{-1} \times \cos 17^o$ $= 1.91\,m\,s^{-1}$ Conservation in South direction $2.1\,m\,s^{-1} = 1.91\,m\,s^{-1} + v_A$ in south direction after collision **Or** v_A in south direction after collision $= 2.1\,m\,s^{-1} - 1.91\,m\,s^{-1}$ $0.19\,m\,s^{-1} = v_A \cos 70$ Gives $v_A = 0.56\,m\,s^{-1}$ v_B in east direction $= 2\,m\,s^{-1} \times \sin 17^o$ $= 0.585\,m\,s^{-1}$ Momentum conservation in East west direction $v_A \sin 70 = v_B$ in east direction $= 0.585$ Gives $v_A = 0.62\,m\,s^{-1}$ MP5 Note: can compare the components of A and B in the East -west direction after the collision	

	If using a Vector diagram • Labelled line representing p_A / v_A before collision **(1)** • Uses or states sensible (more than half the space) scale **(1)** • Line representing p_B / v_B after collision starting at one end of p_A / v_A before collision line **(1)** • Line representing p_A / v_A after collision and completes triangle **(1)** • Measures angle: $\theta = 70^o$ and this is the required angle so stone A moves towards the button after the collision **(1)**	<u>Example of vector diagram</u> Note this could be done using momenta or velocities as masses are the same. 	

16(b)	• Use of $v^2 = u^2 + 2as$ • Use of $E_k = \frac{1}{2}mv^2$ • Determines E_k of A before collision = 40 J **Or** Determines E_k of A after collision = 3.5 J • Total kinetic energy after = 39.5 J and suggests elastic / inelastic	**(1)** **(1)** **(1)** **(1)**	Example of calculation $0 = u^2 + 2 \times 0.10\ \text{m s}^{-1} \times 1.9\ \text{m}$ $u = 0.62\ \text{m s}^{-1}$ Note that the velocity of A could be taken from a(ii) if so award MP1 for the extra work already done as long as it is correct (range between 0.55 and 0.62 depending on rounding) E_k of A before collision $= \frac{1}{2} 18\ \text{kg} \times 2.1^2 (\text{m s}^{-1})^2$ $= 39.7\ \text{J}$ E_k of B after collision $= \frac{1}{2} 18\ \text{kg} \times 2.0^2 (\text{m s}^{-1})^2$ $= 36.0\ \text{J}$ E_k of A after collision $= \frac{1}{2} 18\ \text{kg} \times 0.62^2 (\text{m s}^{-1})^2$ $= 3.5\ \text{J}$ Total E_k after collision $= 36.0 + 3.5 = 39.5\ \text{J}$ [Note this could all be done using velocity values as the mass of each stone is the same then unit $\text{m}^2\,\text{s}^{-2}$]	**4**

(Total for Question 16 = 11 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*17(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 There is a change in the (magnetic) field/flux (linkage with aluminium disc)
Or (disc is) cutting (magnetic) field/flux
IC2 So an <u>e.m.f.</u> is <u>induced</u>

IC3 There is a current (in the disc)
IC4 Force acts on the disc, as there is a current in a magnetic field
Or Field due to current in disc interacting with field due to magnet to cause force on disc

IC5 The disc moves to reduce the change in field/flux
IC6 According to Lenz's law
</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>
IC4 Accept reference to $F = BIl$ if current in disc has been mentioned

IC6 dependent on IC5
</td>
<td>6</td>
</tr>
</table>

17(b)	• (The speedometer reading is proportional / related to) angular velocity of axle/cable **(1)** • As $v = r\omega$ different radii / r will lead to different (road) speeds **(1)** **Or** • (different diameter) therefore circumference of wheels are different **Or** one rotation leads to a different distance travelled **Or** different number of rotations over a set distance **(1)** • So the angular velocity is different for the same speed **Or** the velocity is different for the same angular velocity **(1)**	Accept angular frequency **Or** frequency of rotations Accept angular frequency **Or** frequency of rotations	**2**
17(c)	• Use of $P = W/t$ and $\Delta W = F\Delta s$ **(1)** • Use of $\Delta E_{\text{grav}} = mg\Delta h$ **(1)** • Use of principle of conservation of energy [MP3 dependent on MP2] **(1)** • Velocity = 5.5 (m s^{-1}) so speedometer reading slightly inaccurate **(1)** **Or** Velocity = 5.5 (m s^{-1}) so speedometer reading is quite accurate **Or** Total power = 334 (W) so speedometer reading must have been correct	<u>Example of calculation</u> 190 W = $F \times 8.3$ m s^{-1} F = 22.9 N Power loss due to friction and air resistance = 22.9 N × v Gain in G.P.E. / second = 75 kg × 9.81 m s^{-2} × $\frac{v}{20}$ 330 W = 22.9 N × v +75 kg × 9.81 m s^{-2} × $\frac{v}{20}$ $330 = 22.9v + 36.79v = 59.7v$ v = 5.53 m s^{-1} Alternative resulting on comparison of power: 190 W = $F \times 8.3$ m s^{-1} F = 22.9 N Gain in G.P.E. / second = 75 kg × 9.81 m s^{-2} × $\frac{5.6}{20}$ m s^{-1} Gain in G.P.E. / second = 206 W Power loss due to friction and air resistance = 22.9 N × 5.6 m s^{-1} = 128 W Total power = 334 W	**4**

	Alternative based on resolving forces: • Use of $P = W/t$ and $\Delta W = F\Delta s$ • Determines a component of force • Determines total force along the slope • Velocity = 5.5 (m s^{-1}) so (speedometer reading) slightly inaccurate **Or** Velocity = 5.5 (m s^{-1}) so (speedometer reading) is accurate **Or** Total power = 334 (W) so (speedometer reading) must be correct	Alternative based on resolving forces: 190 W = $F \times 8.3$ m s^{-1} F = 22.9 N Component of weight along slope =75 kg × 9.81 m s^{-2} × $\frac{1}{20}$ as $\sin\theta \sim \tan\theta = 1/20$ Force up slope from cyclist = 22.9 N + 75 kg × 9.81 m s^{-2} × $\frac{1}{20}$ = 59.7 N So velocity of cyclist = $\frac{330\text{ W}}{59.7\text{ N}}$ =5.53 m s^{-1} **Or** Cyclist Power = 59.7 N × 5.6 m s^{-1} = 334 W	

(Total for Question 17 = 12 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
18(a)	• The frequency of the ac supply is constant	**(1)**		**4**
	• The time in a tube = length of tube /speed	**(1)**		
	• As (the beam/particles/ions) speed increases	**(1)**		
	• The time between beam exiting each consecutive tube is constant	**(1)**	Accept time in each tube is constant	
18(b)(i)	• Determines charge on the ion: 80*e*	**(1)**	<u>Example of calculation</u> Ion charge = 80*e* Kinetic energy of U ion = 200 MeV × 238 U ion accelerated to a kinetic energy 80*e* × *V* = 200 MeV × 238 *V* = 595 MV	**4**
	• Use of *W* = *VQ*	**(1)**		
	• Recognises Nucleon Number: 238	**(1)**		
	• *V* = 600 MV	**(1)**		
18(b)(ii)	• Conversion MeV to J	**(1)**	<u>Example of calculation</u> E_k of U ion in J = 200×10^6 eV × 238 × 1.6×10^{-19} C = 7.616×10^{-9} J $\frac{1}{2}238 \times 1.66 \times 10^{-27}$ kg × v^2 = 7.616×10^{-9} J $v = 1.96 \times 10^8$ m s^{-1} $v / c = 1.96 \times 10^8$ m s^{-1} / 3.0×10^8 m s^{-1} = 65.3% Allow use of 1.67×10^{-27}ti calculate final value Note that 238 can be omitted on both sides of this equation: Kinetic energy of U ion in J = 200 MeV × 1.6×10^{-19} C = 3.2×10^{-11}J $\frac{1}{2}1.66 \times 10^{-27}$ kg × $v^2 = 3.2 \times 10^{-11}$J $v = 1.96 \times 10^8$ m s^{-1}	**3**
	• Use of $E_k = \frac{1}{2}mv^2$	**(1)**		
	• *v* / *c* = 65.3%	**(1)**		

18(c)	**2 max** • This isotope of magnesium has a lot more neutrons than the usual isotope **(1)** • Uranium has (far) more neutrons than protons **(1)** • so is likely to produce neutron rich isotopes **(1)**	Accept products produced with a lot of neutrons	**2**

(Total for Question 18 = 13 marks)

TOTAL FOR PAPER = 90 MARKS