Pearson Edexcel

Mark Scheme (Results)

October 2020

Pearson Edexcel GCE
In Physic (9PH01)
Paper 1: 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. '<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 means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be 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 mean that one mark will not be awarded. (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 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

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

4.3 **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.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

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

1. Quality of Written Communication

1.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

1.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

2. Graphs

2.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

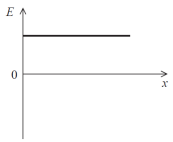
2.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

2.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

2.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Acceptable answers	Additional guidance	Mark
1	**The only correct answer is B** **energy**	A,C,D are vectors	**1**
2	**The only correct answer is C** **1** | **0**	A and B are incorrect as a neutron has mass D is incorrect as a neutron is neutral	**1**
3	**The only correct answer is D** $\frac{F}{4}$	A,B and C do not show an inverse square	**1**
4	**The only correct answer is A** **ampere**	B,C and D are not base units	**1**
5	**The only correct answer is B** **n + π^+**	A, C and D do not follow conservation laws	**1**
6	**The only correct answer is A** 	B,C and D are not the negative potential gradient	**1**

7	**The only correct answer is B** **decreases** | **increases**	C and D are incorrect as the resistance decreases A is incorrect as *n* increases	**1**
8	**The only correct answer is C** $\frac{1.67 \times 10^{-27} \times (3.00 \times 10^{8})^{2}}{1.60 \times 10^{-10}}$	A,B and D all contain numerical errors	**1**
9	**The only correct answer is D** **314**	A, B and C all contain numerical errors	**1**
10	**The only correct answer is A** **-1.0** | **0.5**	B,C and D are incorrect as for each, momentum is not conserved.	**1**

(Total for Multiple Choice Questions = 10 marks)

Question Number	Acceptable answers		Additional guidance	Mark
11a	• the point through which the weight (of a body) acts **Or** The point around which the mass is equally distributed **Or** if supported at/below this point the body would be in equilibrium	**(1)**	alt. the point at which the entire mass can be assumed to be located.	**1**
11b	• take one moment around P • Use of $W = mg$ • Use of weight/mass of paving slab at centre point • It would tip because the moment of the weight of person is 103 N m / 10300 N cm and is larger than the moment of the weight of slab 93 N m / 9300 N cm	**(1)** **(1)** **(1)** **(1)**	either person or paving slab e.g. distance to P = 30 cm <u>Example of calculation</u>: Moment of weight of person = 70 kg×9.81 N kg^{-1}×0.15 m = 103 N m Moment of weight of paving slab = 310 N ×0.30 m = 93 N m	**4**

(Total for Question 11 = 5 marks)

Question Number	Acceptable answers	Additional guidance	Mark
12a	• use of $V = IR$ for the ammeter **(1)** • calculates current through the shunt **(1)** • Shunt resistance = 9.0×10^{-3} (Ω) (dependent on MP2) **(1)** Alternative if using $1/R$ rule for parallel resistors • use of $V = IR$ for the ammeter • Calculates equivalent resistance of the circuit • Uses $1/R$ rule to calculate shunt resistance = 9.0×10^{-3} (Ω)	Example of calculation: $V = 1.0 \times 10^{-3}$ A $\times 18\ \Omega = 0.018$ V $I = 2.0A - 0.001$ A$=1.999$ A $R = \frac{0.018\text{ V}}{1.999\text{ A}} = 9.0 \times 10^{-3}\ \Omega$ Alternative: $V = 1.0 \times 10^{-3}$ A $\times 18\ \Omega = 0.018$ V $R_T = \frac{0.018\text{ V}}{2\text{A}} = 0.009\ \Omega$ $\frac{1}{0.009} = \frac{1}{18} + \frac{1}{R_S}$ $R_S = 9.0 \times 10^{-3}\ \Omega$	**3**
12b	• Use of πr^2 **(1)** • Use of $R = \rho l/A$ **(1)** • Length = 0.056 m **(1)**	Example of calculation: Area $= \pi(0.95 \times 10^{-3}\text{m})^2 = 2.8(4) \times 10^{-6}$ m^2 $l = \frac{9.0 \times 10^{-3}\Omega \times 2.8(4) \times 10^{-6}\text{ m}^2}{4.55 \times 10^{-7}\ \Omega\text{ m}} = 0.0\ 56$ m "Show that" value $l = 0.062$ m	**3**

(Total for Question 12 = 6 marks)

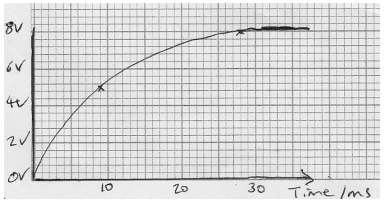
Question Number	Acceptable answers		Additional guidance	Mark
13a	• A (resultant) force *F* is required to maintain circular motion • This force is friction (between car/slider and track) • As *v* increased *F* required increased until it exceeds friction and car slides off track	**(1)** **(1)** **(1)**	alt: A (resultant) force acts to the centre of the circle.	**3**
13bi	• use of $s = \frac{(u+v)}{2} \times t$ • $v = 3.1$ (m s^{-1})	**(1)** **(1)**	<u>Example of calculation</u>: 1.1 $\quad m = \frac{(0+v)}{2} \times 0.77$ s $v = 3.1$ m s^{-1}	**2**
13bii	• use of $F = mv^2/r$ • $F = 11$ N (allow ecf from (i))	**(1)** **(1)**	<u>Example of calculation</u>: $F = \frac{0.050 \text{ kg} \times 3.1^2 \text{ (m s}^{-1})^2}{0.042 \text{ m}}$ $F = 11.4$ N "show that value" gives $F = 10.7$ N	**2**

13c	• inner lane covers a smaller distance **(1)** • inner lane has a smaller radius of curvature **(1)** • (maximum horizontal force is the same for both cars) therefore maximum speed is greater for the car on the outside lane (so outcome unclear) **(1)**		**3**

(Total for Question 13 = 10 marks)

Question Number	Acceptable answers		Additional guidance	Mark
14 (a)	• The curved surface is (analogous to) a radial field • (as $h \propto {}^{1}/_{r}$ then) potential (energy) $\propto {}^{1}/_{r}$ • compares with $V \propto {}^{1}/_{r}$ around a point charge	**(1)** **(1)** **(1)**		**3**
14 (b)	Maximum of 4 marks for MP1,3,5 and any one of MP2,4 or 6 • a few alpha's reflect straight back • can be represented by the ball bearing being directly aimed at the centre of the "hill" • some alpha's slightly deflected/through small angles • can be represented by the ball bearing being aimed close to the centre line of the hill • Many/most alpha's undeflected • can be shown by aiming the ball bearing so that it touches/misses the edge of the hill	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 accept deflect through large angles/more than 90° MP2 dependent on being linked to MP1 MP4 dependent on being linked to MP3 MP6 dependent on being linked to MP5	**4 Max**

(Total for Question 14 = 7 marks)

Question Number	Acceptable answers	Additional guidance	Mark
15a	• line approximately exponential curve starting at 0 and increasing potential **(1)** • beginning to flatten off at a maximum of 8 V (at 30 ms above 7.5 V) **(1)** • Use of time constant *RC* **(1)**	 This can be evidenced with an exponential curve passing through about 5 V at 9 ms **Or** approximately 2/3 of their maximum	**3**
15bi	• Use of $\text{In}V = \text{In}V_o - \frac{t}{RC}$ **(1)** • Substitution V = 2.0 V and V_o= 8.0 V **(1)** • t = 5.6(1) ms **(1)**	Alternative use of $V = V_o e^{-\frac{t}{RC}}$ Rearrange to In 4 = t / 2700 Ω × 1.5 × $10^{-6}F$ <u>Example of calculation</u> $t = 2700\ \Omega \times 1.5 \times 10^{-6}\ \text{F}\ (\ln 8 - \text{In}2)$ t = 5.61 ms	**3**
15bii	• Use of $W = ½\ CV^2$ **(1)** • $W = 3.0 \times 10^{-6}$ J **(1)**	<u>Example of calculation</u> $W = \frac{1}{2} 1.5 \times 10^{-6}\text{F} \times 2^{\,2}\ \text{V}^2 = 3.0 \times 10^{-6}\ \text{J}$	**2**

Question Number	Acceptable answers	Additional guidance	Mark
15c	• Deduce the p.d. across the total resistance **(1)** • Use of $P = I^2 R$ or V^2/R **(1)** • $P = 3.3 \times 10^{-3}$ W **(1)**	Example of calculation $I = \frac{6\ \text{V}}{3.3\ k\Omega + 2.7\ k\Omega} = 1.0\ \text{mA}$ $P = (1.0\ \text{mA})^2 \times 3300\Omega = 3.3 \times 10^{-3}\ \text{W}$ Alternative $V = 6\ \text{V} \times \frac{3.3}{3.3 + 2.7} = 3.3\ \text{V}$ $P = \frac{3.3^2\ \text{V}^2}{3300\ \Omega} = 3.3\ \times 10^{-3}\ \text{W}$	**3**

(Total for Question 15 = 11 marks)

Question Number	Acceptable answers	Additional guidance	Mark
16 (a)(i)	• distance between at least two pairs of images **(1)** • distances between images are the same in x direction **(1)** • distance between images varies in y direction showing a changing velocity **(1)** • velocity in the x direction is constant so x direction is independent of y direction **(1)**	MP1 and 2 could come from marks on the diagram	**4**
16 a)(ii)	• use of $v^2 = u^2 + 2as$ or $s = ut + \frac{1}{2}at^2$ **(1)** • initial vertical component velocity = 0.47 m s^{-1} **(1)** • use of $v_H = d/t$ in the horizontal **(1)** • Use of Pythagorus with v_H and u_V **(1)** • Resultant velocity = 1.1 m s^{-1} **(1)**	alt to MP2 : 0.5 m s^{-1} (allow 0.4 to 0.6) if using distance taken from first two images and $v_H = d/t$ Example of calculation: $0 = u^2 - 2 \times 9.81 \text{ m s}^{-2} \times 0.011 \text{ m}$ $u_V = 0.465 \text{ m s}^{-1}$ $v_H = \frac{0.08 \text{ m}}{0.08 \text{ s}}$ $v_H = 1.0 \text{ m s}^{-1}$ $v = \sqrt{(0.47^2 + 1.0^2)}$ Resultant velocity = 1.1 m s^{-1}	**5**

Question Number	Acceptable answers		Additional guidance	Mark
16(a)(iii)	• Use of $\Delta W = F \Delta s$ • Use of $E_k = ½ mv^2$ • $F = 0.015$ N Alternative • Use of $v^2 = u^2 + 2as$ • Use of $F = ma$ (dependent on MP1) • $F = 0.015$ N	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	Allow ECF from 16(a)(ii) Example of calculation: $2 \times F \times 0.003\text{m} = \frac{1}{2} \times 150 \times 10^{-6}\text{kg} \times 1.1^2 \ (\text{m s}^{-1})^2$ $F = 0.015$ N "show that" value gives $F = 0.013$ N Alternative $1.1^2 \ (\text{ms}^{-1})^2 = 2 \times a \times 0.003$ m $a = 202$ m s^{-2} $2 \times F = 150 \times 10^{-6}$ kg$\times 202$ ms^{-2} $F = 0.015$ N	**3**
16(b)	• the tension will equal the mass (of spider) ×acceleration (as the thread brings spider's fall to a stop) • plus the weight (of the spider) so is incorrect	**(1)** **(1)**		**2**

(Total for Question 16 = 12 marks)

<table>
<tr><th>Question Number</th><th>Acceptable answers</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.

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.

Indicative content:
Generator:
• coil has to be rotated
• cuts magnetic flux Or rate of change of flux linkage
• induces an emf

Motor:
• current provided to coil
• Force on sides of coil that are perpendicular to magnetic field
• rotate coil as forces provide a moment</td><td><table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark available</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></td><td>6</td></tr>
<tr><td>17(b)(i)</td><td>• Use of $P = IV$ (1)

• Use of $V = \varepsilon - Ir$ Or $V = 180 - 0.036I$ (1)

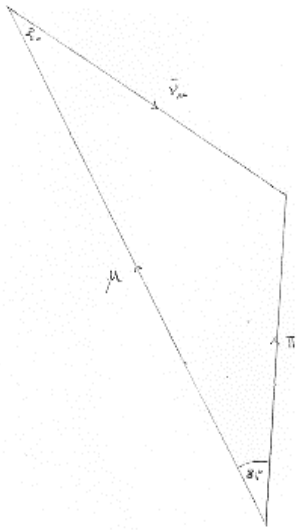
• Converts kW to W and rearranges equation to that shown (1)</td><td>Example of derivation:
$88\ \text{kW} = I \times V$
$88\ \text{kW} = I \times (180 - 0.036I)$
$88000 = 180I - 0.036I^2$
$0.036I^2 - 180I + 88000 = 0$</td><td>3</td></tr>
<tr><td>17(b)(ii)</td><td>• Use of $Q = It$ (1)

• Time that batteries can deliver this power = 40 s so more than 7 s (1)</td><td>Example of calculation:
$6.1\ \text{A h} = 550\ \text{A} \times \text{t}$

$t = 0.011$ h $= 40$ s</td><td>2</td></tr>
</table>

(Total for Question 17 = 11 marks)

Question Number	Acceptable answers	Additional guidance	Mark
18(a)	• it does not leave a track so it is not charged **(1)** • the charge before the decay is -1 (the pion) and after is -1 (the muon) + 0 (the antineutrino) so it is not charged **(1)**	Not charged should appear in MP1 or MP2 to get 2 marks	**2**
18(b)	• $\pi^- \rightarrow \mu(^-) + \overline{\nu_{(\mu)}}$ **(1)**	Any symbol allowed for the muon	**1**
18(c)	• Muon is a lepton **(1)** • Muons / leptons are fundamental particles **(1)** • Pion is a meson **(1)** • Pions / mesons consist of a quark and antiquark **(1)**		**4**
18(d)	• measures radius (allow between 4 cm and 6 cm) **(1)** • Use of $p = Bqr$ **(1)** • B = 1.1 T (range 0.95 T – 1.42 T) **(1)** • direction: out of page **(1)**	Allow use of their measured radius in MP2 Example of calculation: $9.1 \times 10^{-20}\text{N s} = B \times 1.6 \times 10^{-19}\text{C} \times 0.52\text{ m}$ B = 1.09 T	**4**

18(e)	• Draws one labelled scaled vector (either pion or muon) **(1)** • start of muon line should begin at start of pion line **Or** end of muon line should coincide with end of pion line **(1)** • angle between them should be approx 30° **(1)** • p of antineutrino = 9.5×10^{-20} N s ± 0.5×10^{-20} N s **(1)** • angle of antineutrino with muon = 150° ± 5° **Or** angle of antineutrino with pion = 120° ± 5° **(1)**	Label can be "pion" or momentum value. The line should be straight and have an arrow. 	**5**

(Total for Question 18 = 16 marks)

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