Pearson Edexcel

Mark Scheme (Results)

October 2019

Pearson Edexcel International Advanced Level
In Physics (WPH04)
Paper 01
Physics on the Move

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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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

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.

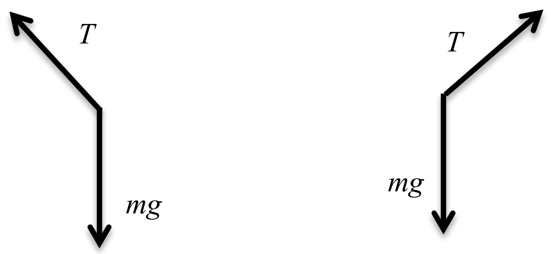
4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

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

Question Number	Answer	Mark
1	C	**1**
2	C	**1**
3	B	**1**
4	A	**1**
5	C	**1**
6	D	**1**
7	B	**1**
8	B	**1**
9	C	**1**
10	A	**1**

Question Number	Answer	Mark
11(a)	Attempt to find area under graph (1) Use of $p = mv$ (1) $p_{\text{final}} = p_{\text{initial}} + \Delta p$ (1) $v = 41$ m s^{-1} (1) **Or** Attempt to find area under graph Use of $p = mv$ $v_{\text{final}} = v_{\text{initial}} + \Delta v$ $v = 41$ m s^{-1} <u>Example of Calculation</u> Area = 60 N × 0.16 s /2 = 4.8 N s Initial momentum = 0.056 kg × 45 m s^{-1} = 2.52 N s Final momentum = 2.52 N s + (– 4.8 N s) = – 2.28 N s v = – 2.28 N s / 0.056 kg v = (–) 40.7 m s^{-1}	**(4)**
11(b)	Measure the distance moved by the ball from a fixed scale in the video (recording) (1) Obtain time from video (recording) **and** use velocity = distance/time (1)	**(2)**
	Total for question 11	**6**

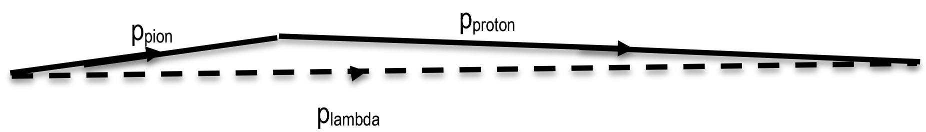
Question Number	Answer	Mark
12(a)	at least 3 horizontal straight lines touching both sides (1) equispaced (by eye) (1) arrow pointing to the right (1)	**(3)**
12(b)	Use of $W = \frac{1}{2}CV^2$ **Or** $Q = CV$ **and** $E = QV/2$ (1) $W = 1.5 \times 10^{-10}$ J (1) <u>Example of calculation</u> $W = ½ \times 12 \times 10^{-12}$ F $\times$ (5.0 V)^2 $W = 1.5 \times 10^{-10}$ J	**(2)**
12(c)	Use of $Q = CV$ (1) Use of total charge before = total charge after **Or** Use of $Q_1 / Q_2 = C_1 / C_2$ (1) (accept use of total capacitance = sum of capacitances) $V = 4.4$ V (1) <u>Example of calculation</u> Total charge = 12×10^{-12} F $\times$ 5.0 V = 6.0×10^{-11} C 6.0×10^{-11} C = 12×10^{-12} F $\times V + 1.5 \times 10^{-12}$ F $\times V$ $V = 4.4$ V	**(3)**
	Total for question 12	**8**

Question Number	Answer	Mark
13(a)	Line vertically down labelled mg / weight / W / gravitational force (1) Force T / tension labelled along "lever direction" (1) <u>Example of diagram</u> 	**(2)**

13(b)	Use of $\omega = 2\pi / T$ **Or** $\omega = 2\pi f$ (1) State or use time for revolution = 60 s / 62 **Or** f = 62 / 60 s (1) State or use $mg = T\cos\theta$ (1) State or use $T\sin\theta = mr\omega^2$ (1) **Or** State or use $T\sin\theta = mv^2 / r$ **and** $v = \omega r$ State or use $r = l\sin\theta$ (1) $\theta = 30^\circ$ **Or** 0.53 radians (1) <u>Example of calculation</u> $\omega = 2\pi f = 2\pi \times 62$ s / 60 = 6.49 radian s^{-1} $T\cos\theta = mg$ $T\sin\theta = mr\omega^2 = = ml\sin\theta\,\omega^2$ $T = ml\omega^2$ $ml\omega^2 \cos\theta = mg$ $\cos\theta = g/l\omega^2$ $\cos\theta = 9.81$ N kg^{-1} / 0.27 m × (6.49 radian s^{-1})^2 $\theta = 30.3^\circ$ or 0.53 radians	**(6)**
	Total for question 13	**8**

Question Number	Answer	Mark
***14(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) P.d./E-field accelerates protons between dees (1) This is an alternating p.d./E-field **Or** the p.d./ E-field reverses when the proton is in the dees (1) Magnetic field perpendicular to (plane of) dees/proton motion (1) Proton path curved by magnetic field **Or** magnetic field exerts centripetal force (1) As momentum/velocity/speed/$E_{kinetic}$ of protons increases radius of path in dees increases (1) The time for which a proton is in a dee remains constant (1) **Or** the frequency of p.d./E-field is constant	**(6)**
14(b)(i)	${}^{1}_{1}\text{p} + {}^{18}_{8}\text{O} \rightarrow {}^{18}_{9}\text{O} + {}^{1}_{0}\text{n}$ Left hand side correct (1) Right hand side correct (1) Neutron produced (dependent an equation) (1)	**(3)**

14b(ii)	Use of $F = \frac{kQ_1 Q_2}{r^2}$ (1) with $e \times 8e$ (1) F = 180 N (1) <u>Example of calculation</u> $$F = \frac{8.99 \times 10^9 \text{Nm}^2\text{C}^{-2} \times 1.6 \times 10^{-19}\text{C} \times 8 \times 1.6 \times 10^{-19}\text{C}}{(3.2 \times 10^{-15}\ \text{m})^2}$$ F = 179.8 N	**(3)**
	Total for question 14	**12**

Question Number	Answer	Mark
15(a)	Curvature is opposite to the curvature of the proton (1) (Curvature is) due to magnetic field **and** proton is positive (so pion is negative) **Or** (Curvature is) due magnetic field so charge on pion is opposite to charge on proton (so pion is negative) (1)	**(2)**
15(b)	Zero **Or** 0 (1)	**(1)**
15(c)(i)	into page **Or** into paper (1)	**(1)**
15(c)(ii)	Evidence of radius from diagram (1) Evidence of applying scale (1) Use of $p = Bqr$ (1) $p = 4.4 \times 10^{-20}$ Ns (range between 3.8×10^{-20} Ns and 4.9×10^{-20} Ns) (1) <u>Example of calculation</u> $p = 1.7\ \text{T} \times 1.6 \times 10^{-19}\ \text{C} \times 0.16\ \text{m}$ $p = 4.4 \times 10^{-20}$ Ns	**(4)**
15(c)(iii)	 Correct sketch addition of vectors: $p_{pion} + p_{proton} = p_{lambda}$ (1) vector p_{proton} larger than p_{pion} (1) almost a straight line for these two vectors (1) [Angle between p_{pion} and p_{proton} should be no more than 20 degrees]	**(3)**
	Total for question 15	**11**

Question Number	Answer	Mark
***16(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Induced e.m.f. is equal to the rate of change of flux (linkage) **Or** Induced e.m.f. is proportional to the rate of change of flux (linkage) (1) Maximum e.m.f. when coil is horizontal **Or** e.m.f. zero when coil is vertical (1) When the coil is horizontal; (The side of the coil) is cutting the flux at maximum rate. **Or** the flux linkage is zero so any movement will lead to decrease/increase (1) When the coil is vertical; The (side of the) coil is moving parallel to the flux **Or** (The side of the coil) is not cutting the magnetic field lines (1) **Or** the flux linkage is maximum and slight movement of the coil will lead to very little change.	**(4)**
16(b)(i)	$\varepsilon\ \mathrm{d}t = \mathrm{d}(N\varphi)$ (1) where area = $\varepsilon\ \mathrm{d}t$ **and** $\mathrm{d}(N\varphi)$ = change in flux linkage (1)	**(2)**
16(b)(ii)	Attempt to determine an area from graph (1) Use Flux Linkage = BAN (1) $B = 0.010$ T (1) Accept: Use of $f = 1/T$ **and** $\omega = 2\pi f$ (1) Use of $\varepsilon = BAN\omega$ (1) (1) $B = 0.010$ T	

	<u>Example of calculation</u> area of square = 1 ms × 2 V = 2×10^{-3} Vs 6.5 squares in a quarter turn of coil so maximum flux linkage = 0.013 Wb $B = \dfrac{0.013\text{Wb}}{2.5 \times 10^{-3}\text{m}^2 \times 500}$ B = 0.010 T		**(3)**
16(c)	Amplitude is halved / peak value = 4 V Time period is doubled	(1) (1)	**(2)**
16(d)	There is a complete circuit so there is a current (in the coil) $F = BIl$ so there is a force acting that opposes the motion (increasing the force) (dependent mark) **Or** There is a magnetic force acting that opposes the motion (increasing the force) (dependent mark) **Or** This produces a magnetic field that opposes the motion (increasing the force) (dependent mark) **Or** Energy transferred to lamp (from generator) So, extra work is done (which requires an increase in force) (dependent mark)	(1) (1) (1) (1)	**(2)**
	Total for question 16		**13**

Question Number	Answer	Mark
17(a)	Use of $E = mc^2$ (1) Conversion between eV and J (1) mass of Xi = 1.05×10^{-26} kg **Or** mass of proton = 939 MeV/c^2 (1) compare to show mass of Xi > 6 × mass of proton (1) <u>Example of calculation</u> $m = \frac{5.9 \text{ GeV} \times 1.6 \times 10^{-19} (\text{J eV}^{-1}) \times 10^9}{(3 \times 10^8)^2 \ (\text{ms}^{-1})^2}$ m of $Xi_b = 1.05 \times 10^{-26}$ kg No of times that of a proton = $\frac{1.05\times10^{-26}}{1.67\times10^{-27}} = 6.3$	**(4)**
17(b)	Mass-energy is conserved (according to $E = mc^2$) (1) need large amounts of energy to create a large mass particle **Or** need large amount of energy as "c^2" is a large value (1) extra energy needed comes from <u>kinetic</u> energy of protons **Or** need to overcome (electrostatic) repulsion forces (between protons) (1) **Or** Rest energy of a particle is mc^2 (1) Rest energy of high mass particle is much greater than that of two protons (1) To conserve energy, lots of <u>kinetic</u> energy is required (1)	**(3)**

17(c)	Use of $v = s/t$ (1) Calculated speed = 3.3×10^8 m s^{-1} (1) Comparison with speed of light and relevant comment (e.g. this is impossible or relativistic effects apply) (1) (Accept reference to within experimental errors so the particle was travelling close to the speed of light) <u>Example of calculation</u> $v = 0.47 \times 10^{-3}$ m $\div$ 1.42×10^{-12} s = 3.3×10^8 m s^{-1}	**(3)**
17(d)	E.g. This leads to peer review **Or** helps to validate new scientific theories **Or** this allows scientists to comment on other's work **Or** allows scientists to learn from other people's work **Or** widens public education **Or** fosters an interest in science **Or** transparency to the public (1)	**(1)**
17(e)	E.g. New data is required to confirm/refine an (existing) theory or model **Or** new data is required to refute an (existing) theory or model **Or** to further our understanding of particle physics **Or** reference to general benefits of scientific investigation (1)	**(1)**
	Total for question 17	**12**

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