Mark Scheme (Results)

Summer 2018

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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

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.

4. Quality of Written Communication

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

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

5. Graphs

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

5.2 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.

5.3 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.

5.4 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	Answer	Mark
1	**The only correct answer is A** B *is not correct because they have subtracted 4 protons and added 4 neutrons* C *is not correct because number of neutrons is total number of p and n* D *is not correct because they have subtracted 4 p and total nucleon number is wrong*	**1**
2	**The only correct answer is B** A *is not correct because KE not conserved in inelastic collision* C *is not correct because momentum is always conserved* D *is not correct because momentum is always conserved*	**1**
3	**The only correct answer is C** A *is not correct because effective capacitance is 2C* B *is not correct because this is the energy stored on one capacitor* D *is not correct because this would be energy stored on four parallel capacitors*	**1**
4	**The only correct answer is D** A *is not correct because there are no nuclei to decay* B *is not correct because metal wires consist of ions and free electrons* C *is not correct because no light is being directed to filament*	**1**
5	**The only correct answer is D** A *is not correct because force must be perpendicular to field and current* B *is not correct because force must be perpendicular to field and current* C *is not correct because this would exert a downwards force due to FLHR*	**1**
6	**The only correct answer is C** A *is not correct because charge is conserved* B *is not correct because charge is conserved* D *is not correct because charge is conserved*	**1**
7	**The only correct answer is B** A *is not correct because baryons must have three quarks (and charge would be 5/3e)* C *is not correct because uud gives a charge of +e* D *is not correct because baryons must have three quarks (and charge would be -5/3e)*	**1**
8	**The only correct answer is C** A *is not correct because r has not been doubled* B *is not correct because both charges have been doubled* D *is not correct because neither charge has been doubled*	**1**
9	**The only correct answer is B** A *is not correct because magnitude of emf is no greater* C *is not correct because time is longer* D *is not correct because time is longer and magnitude of emf is lower*	**1**
10	**The only correct answer is D** A *is not correct because field direction and magnitude are wrong* B *is not correct because field magnitude is wrong* C *is not correct because field direction is wrong*	**1**

Question Number	Answer		Mark
11	Use of $F = EQ$	**(1)**	
	Use of $F = ma$	**(1)**	
	Use of $s = ut + ½ at^2$ with $u = 0$	**(1)**	
	$y = 0.021$ m	**(1)**	**4**
	<u>Example of calculation</u> $F = 13\ 000\ \text{N C}^{-1} \times 1.6 \times 10^{-19}$ C $F = 2.08 \times 10^{-15}$ N $a = F/m = 2.08 \times 10^{-15}\ \text{N} / 9.11 \times 10^{-31}\ \text{kg} = 2.28 \times 10^{15}\ \text{m s}^{-2}$ $s = ½ \times 2.28 \times 10^{15}\ \text{m s}^{-2} \times (4.3 \times 10^{-9}\ \text{s})^2$ $y = 0.021$ m		
	Total for question 11		**4**

Question Number	Answer		Mark
12(a)	**Max 4 for linked observations and conclusions**		
	Most alpha particles were undeviated	**(1)**	
	Most of the atom is empty space (MP2 dependent on MP1)	**(1)**	
	Few alpha particles were scattered by small angles	**(1)**	
	There is a concentration of charge in the atom (MP4 dependent on MP3)	**(1)**	
	Very few alpha particles were deviated by more than 90°	**(1)**	
	Most of the mass is concentrated in a small region of the atom **Or** Most of the mass is concentrated in nucleus (Accept Mass of nucleus much greater than mass of alpha particle) (MP6 dependent on MP5)	**(1)**	**4**
12(b)(i)	Use of factor of 1.6×10^{-19} C to convert eV to J	**(1)**	
	Use of $E_k = p^2/2m$ **Or** Use of $E_k = ½\, m\, v^2$ **and** $p = mv$	**(1)**	
	Use of $\lambda = h/p$	**(1)**	
	$\lambda = 6.4 \times 10^{-15}$ m	**(1)**	**4**
	<u>Example of calculation</u> $5 \times 10^6\ \text{eV} \times 1.6 \times 10^{-19}\ \text{C} = p^2 / 2 \times 6.64 \times 10^{-27}$ kg $p = 1.03 \times 10^{-19}\ \text{kg m s}^{-1}$ $\lambda = 6.63 \times 10^{-34}\ \text{J s} / 1.03 \times 10^{-19}\ \text{kg m s}^{-1}$ $\lambda = 6.4 \times 10^{-15}$ m		
12(b)(ii)	Correct conclusion using answer to (b)(i) e.g., Wavelength is much smaller than the interatomic spacing so there is very little diffraction	**(1)**	**1**
	Total for question 12		**9**

Question Number	Answer	Mark
13(a)	The muon track curves the same way as the electron track so the muon also has <u>negative</u> charge **Or** the muon track curves the opposite way to the proton track so the muon has <u>negative</u> charge **(1)** The muon track curves less than the electron track so its mass is greater than the mass of the electron (accept *m/q* more or *q/m* less) **(1)** The muon track curves more than the proton track so its mass is less than the mass of the proton (accept *m/q* less or *q/m* more) **(1)**	**3**
13(b)	Use of factor of 1.6×10^{-19} C to convert eV to J **(1)** Use of $\Delta E = c^2 \Delta m$ **(1)** mass = 1.9×10^{-28} (kg) **(1)** <u>Example of calculation</u> $\Delta E = 106 \times 10^6$ eV $\times 1.6 \times 10^{-19}$ C $= 1.7 \times 10^{-11}$ J 1.7×10^{-11} J $= (3 \times 10^8$ m s$^{-1})^2 \times \Delta m$ mass = 1.9×10^{-28} kg	**3**
13(c)	Two correct comparisons, e.g. Muon is a fundamental particle and meson isn't **Or** muon has no known constituent particles but meson does **(1)** Muon is a lepton and a meson is made of quark-antiquark **(1)** (Accept muon is a lepton and meson is a hadron)	**2**
	Total for question 13	**8**

Question Number	Answer		Mark
14(a)	Equates weight of M to centripetal force for rubber bung Use of $W=mg$ and $F = mv^2 / r$ Speed = 4.3 m s^{-1} <u>Example of calculation</u> 0.08 kg × v^2 / 0.59 m = 0.25 kg × 9.81 N kg^{-1} v = 4.3 m s^{-1}	**(1)** **(1)** **(1)**	**3**
14(b)	Tension is constant (for a circular path tension =) mv^2/r, so if v greater, r must be greater fixed length of string, so M moves upwards as r increases **Or** At a higher speed mv^2 / r is initially greater than weight of M **Or** As the bung is rotated faster the tension in the string is insufficient to maintain the same circular path r increases, so mv^2 / r decreases so M moves upwards until mv^2 / r is again equal to weight of M**Or** fixed length of string, so M moves upwards as r increases	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
14(c)	With a fixed time there may not be a whole number of rotations **Or** with a fixed number there will always be a whole number of rotations It would not be possible to be precise about the fraction of a partial rotation, so a fixed number is better	**(1)** **(1)**	**2**
	Total for question 14		**8**

Question Number	Answer		Mark
15(a)(i)	Use of $r = p/BQ$ **and** $p = mv$ **Or** $F = BQv$ **and** $F = mv^2/r$ **Or** states $r = mv/BQ$ States $v = \pi r/t$ for half circle and working to arrive at $t = \pi m/BQ$	 **(1)** **(1)**	**2**
15(a)(ii)	t independent of r **Or** t independent of v **Or** $\pi m/BQ$ is constant **Or** time spent in each dee is constant For acceleration, (magnitude of) V must be maximum each time proton arrives at gap **Or** Particle is travelling in opposite direction, so direction of field/acceleration must reverse Time between maxima must be constant **Or** time for half of (a.c.) cycle is equal to time spent in dee **Or** p.d. must reverse polarity while proton is in dee	 **(1)** **(1)** **(1)**	**3**
***15(b)**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** With a stationary target, there is (initial) momentum whereas with colliding beams the (total initial) momentum is zero So particles must have movement/ke after collison (for cyclotron) **Or** (possibly) no movement/ke of particles after the collision (for LHC) Less energy to creation of particles (for cyclotron) **Or** Therefore more/all energy goes to the creation of particles (for LHC) Conservation of mass-energy or ref to $E = mc^2$, so more mass (for LHC)	 **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**9**

Question Number	Answer		Mark
16(a)(i)	The field is (always) at 90° to current/wire/coil So $\sin\theta$ in $BIl\sin\theta$ is 1 and $F = BIl$ (MP2 accept – small element of coil is straight so $F = BIl$ applies to it, when the forces are added the lengths add up to the total length)	**(1)** **(1)**	**2**
16(a)(ii)	Use of $F = BIl$ with $l = \pi \times$ diameter F = 1.5 N <u>Example of calculation</u> $F = 0.8\ \text{T} \times 0.11\ \text{A} \times \pi \times 0.045\ \text{m} \times 120$ F = 1.5 N	**(1)** **(1)**	**2**
***16(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Varying current in smartphone coil produces varying magnetic field Therefore there is a changing magnetic flux in the amplifier unit coil <u>E.m.f. induced</u> in amplifier unit coil There is a complete circuit so there is a current in the loudspeaker	 **(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**8**

Question Number	Answer		Mark
17(a)	**Either** Use of $p = mv$ Use of trigonometry for component perpendicular to surface Use of force = momentum change / time including factor of 2 and working to arrive at $F = 2mv \sin\theta/t$ There is an equal and opposite force exerted on the surface **Or** Use of trigonometry for component of v perpendicular to surface Use of acceleration = 2 v_p / t Use of $F = ma$ and working to arrive at $F = 2mv \sin\theta/t$ There is an equal and opposite force exerted on the surface	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
17(b)(i)	Gradient = $F/\sin\theta$ gradient = $2mv/t$ Substitutes $m/t = vA\rho$ giving gradient = $2v^2A\rho$ **Or** Substitutes $m/t = vA\rho$ in $F = 2mv\sin\theta/t$ To get $F = 2v^2A\rho\sin\theta$ Comparison with $y = mx$ (+ c) giving gradient = $2v^2A\rho$ **Or** Gradient = $F/\sin\theta$ giving gradient = $2v^2A\rho$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
17(b)(ii)	Adds best fit line to graph Use of gradient = $2v^2A\rho$ Speed = 8.3 m s^{-1} (8.2 m s^{-1} to 8.4 m s^{-1}) <u>Example of calculation</u> Gradient = 0.33 N / 1.00 $= 2v^2 \times 2.0 \times 10^{-3}$ m^2 $\times$ 1.2 kg m^{-3} Speed = 8.3 m s^{-1}	**(1)** **(1)** **(1)**	**3**
17(c)	Molecules / particles / air could collide with each other **Or** Density of air could vary **Or** Not all particles hit the balance at the same angle **Or** Not all particles hit the balance Changing the force on the balance (so calculated speed is incorrect) **MP2 dependent on MP1**	 **(1)** **(1)**	**2**
	Total for question 17		**12**

Question Number	Answer	Mark
18(a)	Use of $V = IR$ **(1)** Use of $Q = It$ **(1)** Use of $C = Q/V$ **(1)** C = 4700 (μF) (at least 2 s.f) **(1)** <u>Example of calculation</u> $I = 6.0 \text{ V} / 28\,000\ \Omega = 2.1 \times 10^{-4}$ A $Q = 2.14 \times 10^{-4}$ A × 132 s = 0.028 C $C = 0.028 \text{ C} / 6.0 \text{ V} = 4.7 \times 10^{-3}$ F	**4**
18(b)	As charge increases, p.d. across capacitor increases **(1)** So p.d. across resistor decreases **(1)** Resistance of resistor must decrease to maintain current with reduced p.d. (Accept for MP3, current would fall, so resistance must decrease) **(1)**	**3**
18(c)(i)	$R = V/I$ and $C = Q/V$ **(1)** $RC = Q/I$ and $Q = It$ (so $RC = t$ so units s) **(1)** **Or** **(1)** Units R : V/A, C : C/V **(1)** C → A s (so units s)	**2**
18(c)(ii)	Use of $Q = Q_0 e^{-t/RC}$ **(1)** $Q / Q_0 = 6.7 \times 10^{-3}$ or 0.67% **(1)** Appropriate comment, e.g. this is only a tiny proportion of the original charge, so it is fair statement **Or** No, because there is still some charge **(1)** **Or** States RC is time to fall to $1/e$ of Q_0 **Or** States RC is time to fall to 37% of Q_0 **(1)** For 5 × RC this is $(1/e)^5 = 6.7 \times 10^{-3}$ or 0.67% **(1)** This is approximately 0, so it is fair statement **Or** No, because there is still some charge **(1)** <u>Example of calculation</u> Use of $Q = Q_0 e^{-5RC/RC}$ $Q \div Q_0 = e^{-5}$ $Q / Q_0 = 6.7 \times 10^{-3}$ or 0.67%	**3**
	Total for question 18	**12**

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