Mark Scheme (Results)

October 2017

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.

Physics Specific Marking Guidance

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.
For example:
Horizontal force of hinge on table top
66.3 (N) or 66 (N) **and** correct indication of direction [no ue]
[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]
This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

Mark scheme format

• Bold lower case will be used for emphasis.
• Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
• Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

Unit error penalties

• A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
• Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
• There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given.
• The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
• Occasionally, it may be decided not to penalise a missing or incorrect 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.
• The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

• Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
• Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
• Using $g = 10\ \text{m s}^{-2}$ **will** be penalised.

Calculations

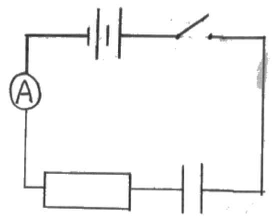
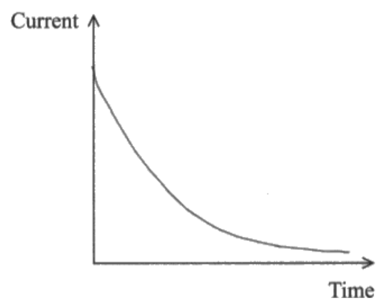
• Bald (i.e. no working shown) correct answers score full marks unless in a 'show that'
question.
• Rounding errors will not be penalised.
• If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
• use 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.
• recall of the correct formula will be awarded when the formula is seen or implied by substitution.
• The mark scheme will show a correctly worked answer for illustration only.

Question Number	Answers	Mark
1	**The only correct answer is A** ***B*** *is not correct because this is mass × acceleration* ***C*** *is not correct because it is not a base unit* ***D*** *is not correct because it is not a base unit*	**1**
2	**The only correct answer is B** ***A*** *is not correct because the accelerating p.d. does not create the need for a change in length* ***C*** *is not correct because no energy is gained while the particles are in the tubes* ***D*** *is not correct because the change in length is to keep the time the same*	**1**
3	**The only correct answer is C** ***A*** *is not correct because: = 15000 rpm ÷ (2π × 60 s)* ***B*** *is not correct because: = 15000 rpm ÷ 60 s* ***D*** *is not correct because: = 15000 rpm × 2π*	**1**
4	**The only correct answer is D** ***A*** *is not correct because: = hλ/m* ***B*** *is not correct because: = h/m* ***C*** *is not correct because: = m/h*	**1**
5	**The only correct answer is A** ***B*** *is not correct because magnetic flux density is parallel to coil, so no flux linkage* ***C*** *is not correct because magnetic flux density is parallel to coil, so no flux linkage* ***D*** *is not correct because magnetic flux density is parallel to coil, so no flux linkage*	**1**
6	**The only correct answer is B** ***A*** *is not correct because acceleration decreases as it reaches relativistic speeds* ***C*** *is not correct because it never reaches the speed of light.* ***D*** *is not correct because the speed does not decrease – the acceleration decreases.*	**1**
7	**The only correct answer is A** ***B*** *is not correct because this is only proportional to momentum* ***C*** *is not correct because this represents no change, despite the higher momentum meaning a higher velocity and therefore energy* ***D*** *is not correct because this is inversely proportional to momentum*	**1**

8	**The only correct answer is B** ***A*** *is not correct because: = Fm/t* ***C*** *is not correct because: = mt/F* ***D*** *is not correct because: = mtF*	**1**
9	**The only correct answer is D** ***A*** *is not correct because ionisation is not thermionic emission* ***B*** *is not correct because photoelectric effect is not thermionic emission* ***C*** *is not correct because relativistic effect is not thermionic emission*	**1**
10	**The only correct answer is D** ***A*** *is not correct because does not include the term* mv^2/r ***B*** *is not correct because this is the force for the reverse curve, i.e. going down and curving upwards* ***C*** *is not correct because this is weight minus resultant force*	**1**
	Total for multiple choice questions	**10**

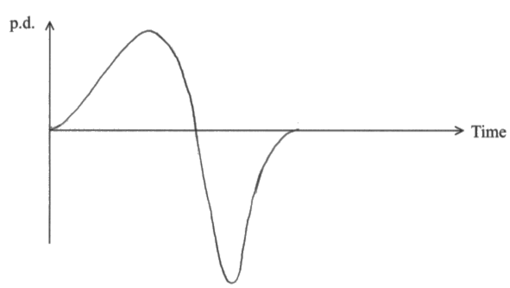
Question Number	Answers	Mark
11(a)	There is a horizontal component of L **(1)** at right angles to velocity **Or** which acts as a centripetal force **(1)**	**2**
11(b)(i)	$L\cos\theta$ = weight **(1)** $L\sin\theta = mv^2/r$ **(1)** Combines above equations and rearranges **(1)** **Or** Triangle or parallelogram of forces with arrows in correct direction to show resultant **(1)** Correct identification of sides of triangle (e.g. mg and mv^2/r **or** horizontal lift component and vertical lift component) **(1)** tan $\theta = (m\,v^2 / r) \div (mg)$ and rearranges **(1)** <u>Example of calculation:</u> $mg = L\cos\theta$ $\frac{mv^2}{r} = L\sin\theta$ $\tan\theta = \frac{\frac{mv^2}{r}}{mg}$ $\tan\theta = \frac{v^2}{rg}$	**3**
11(b)(ii)	Use of tan $\theta = v^2/rg$ **(1)** r = 13000 m **(1)** <u>Example of calculation:</u> $r = v^2/(g \tan\theta)$ $r = (150\text{ m s}^{-1})^2/(9.81\text{ m s}^{-2} \times \tan 10°)$ r = 13000 m	**2**
	Total for question 11	**7**

Question Number	Answer		Mark
12(a)	3 quarks	**(1)**	**1**
12(b)(i)	$\Lambda^0 \rightarrow p^+ + \pi^-$	**(1)**	**1**
***12(b)(ii)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Initial momentum of Λ is zero proton moves off in opposite direction to pion so, momentum of particles is equal and opposite mass-energy of Λ = mass and E_k of p and π **Or** links decrease in total mass to increase in kinetic energy	**(1)** **(1)** **(1)** **(1)**	**4**
12(c)	**Diagram** Path curves in opposite sense With a greater radius of path (line must start at A, upwards) **Explanation** Anti-helium has opposite charge to proton **Or** reference to proton as positive and anti-helium as negative Reference to $r = p/BQ$ to justify larger radius of curvature	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 12		**10**

Question Number	Answer	Mark
13(a)(i)	Resistor in series with capacitor and cells(s) **(1)** Ammeter in series with capacitor **(1)** 	**2**
13(a)(ii)	Current intercept on y axis (i.e. not infinity) **(1)** Exponential curve i.e. decreasing gradient **(1)** Example of graph: 	**2**

13(b)	Tangent drawn on graph at $t = 0$ Intercept on time axis t = 1.2 - 1.8 s C = 1.2 mF -1.8 mF **Or** record a pair of values from graph use of $V = V_o e^{-t/RC}$ C = 1.5 mF -1.8 mF **Or** records time for V to fall to 1/e (1.84 V, 1.6 s) **or** records time for V to fall to 37% (1.85 V, 1.6 s) Use of $t = RC$ C = 1.5 mF – 1.8 mF **Or** Records time for V to fall to ½ (2.5 V, 1.1 s) Use of $RC = t_{½}$ / ln 2 C = 1.5 mF – 1.8 mF <u>Example of calculation:</u> $V = V_o e^{-t/RC}$ $1.6 \text{ V} = 5 \text{ V } e^{-2 \text{ s}/1000\ \Omega \times C}$ C = 2 s / 1000 Ω × 1.14 C = 1.7 mF	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
13(c)	Use of $Q=CV$ **and** $W = ½ QV$ W = 0.021 J (ecf from (b)) <u>Example of calculation:</u> $Q = 1.7 \times 10^{-3}$ F × 5.0 V $= 8.5 \times 10^{-3}$ C $W = ½ \times 8.5 \times 10^{-3}$ C × 5.0 V $= 2.1 \times 10^{-2}$ J (Show that value gives 0.025 J)	**(1)** **(1)**	**2**
13(d)	See appropriate logarithmic relationship Identify suitable variables to plot State gradient for graph State how to determine C from gradient <u>Example</u> ln V = ln $V_0 - t/RC$ plot ln V on y-axis and t on the x-axis gradient = (−)1/RC for ln V vs t C = (−) 1/gradient × R	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 13		**13**

Question Number	Answer		Mark
14a	Use $E = c^2 \Delta m$ with Δm = 8000× mass of electron Use $eV = E$ $V = 4.1 \times 10^9$ V <u>Example of calculation:</u> $1.6\times10^{-19}\,(\mathrm{C})\mathrm{V} = 8000\times9.11\times10^{-31}\,(\mathrm{kg})\times(3\times10^{8}\,\mathrm{ms}^{-2})^2$ $V = 4.1\times10^{9}$ V	**(1)** **(1)** **(1)**	**3**
***14b**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** High energy electrons will have large momentum $\lambda = h/p$, so have small wavelength (if momentum large) **Or** According to de Broglie large momentum corresponds to small wavelengths so wavelengths have approximately the same size as nucleons **Or** small wavelength needed to resolve fine detail	**(1)** **(1)** **(1)**	**3**
	Total for Question 14		**6**

Question Number	Answer		Mark
15(a)	(As the magnet approaches the coil) there is a change in flux linkage and an <u>e.m.f.</u> is <u>induced</u> Induced e.m.f. is proportional to the rate of change of flux linkage As the magnet accelerates there is an increasing rate of change of flux linkage **Or** As the magnet getting closer to the coil there is an increasing rate of change of flux linkage (Accept answers in terms of wires cutting lines of flux)	**(1)** **(1)** **(1)**	**3**
15(b)	**Graph** At $t = 0$ $V = 0$ A positive and a negative section (either order) amplitude of 1st peak smaller than amplitude of 2nd peak time of 2nd section smaller than time of 1st section <u>Example of graph</u>  	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**7**

Question Number	Answer	Mark
16(a)	The atom is mainly empty space **(1)** A concentration of mass **(1)** A concentration of charge **(1)** (Award 1 mark for reference to a nucleus if neither MP2 or MP3)	**3**
16(b)(i)	79 protons **and** 197 nucleons **Or** 79 protons **and** 118 neutrons **Or** 79 is atomic number of gold **and** 197 is the mass number of gold **Or** 79 is proton number of gold **and** 197 is the nucleon number of gold **(1)**	**1**
16(b)(ii)	Use of $F = k\dfrac{Q_1Q_2}{r^2}$ **(1)** with correct charge on α and nucleus including 1.6 x 10^{-19} F = 15 N **(1)** Example of calculation: $F = 8.99\times10^{9}\,\mathrm{Nm^2C^{-2}}\ \dfrac{79\times2\times(1.6\times10^{-19})^2\,\mathrm{C}^2}{(5.0\times10^{-14})^2\,\mathrm{m}^2}$ **(1)** F = 14.5 N	**3**
	Total for question 16	**7**

Question Number	Answer	Mark
***17(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Momentum conserved **(1)** and first coin is stationary so second coin must have the same velocity as the first coin (before the collision) **(1)** This is elastic collision because total E_k conserved **(1)**	**3**
17(b)(i)	Resolves velocity perpendicular to initial direction of A **(1)** Applies conservation of momentum in this direction **(1)** Velocity = 2.9 cm s^{-1} **(1)** Example of calculation: m × 2.2 cm s^{-1} × cos 40° = m × v × cos 55° v = 2.9 cm s^{-1}	**3**
17(b)(ii)	Resolves velocity in initial direction of A **(1)** Applies conservation of momentum in this direction **(1)** v = 3.8 cm s^{-1} **(1)** Example of calculation: m × v = m × 2.2 cm s^{-1} × sin 40° + m × 2.9 cm s^{-1} × sin 55° v = 3.79 cm s^{-1}	**3**
	Total for question 17	**9**

Question Numbers	Answer	Mark
18(a)	Straight parallel lines perpendicular to the plates and touching both plates (ignore edge effects) **(1)** Equally spaced (min 3 lines) **(1)** Arrow pointing up **(1)**	**3**
18(b)	Use $F = qE$ and $E = \frac{V}{d}$ to find force **(1)** Use of $a = F/m$ **(1)** Use of $s = \frac{1}{2}at^2$ with vertical displacement to find t **(1)** Use of velocity = horizontal displacement /time **(1)** velocity 2.9×10^7 ms^{-1} **(1)** <u>Example of calculation:</u> $F = qV/d$ $F = \frac{1.60 \times 10^{-19}\,\text{C} \times 1500\text{V}}{0.050\text{ m}}$ $= 4.80 \times 10^{-15}\,\text{N}$ $a = \frac{F}{m} = \frac{4.80 \times 10^{-15}}{9.11 \times 10^{-31}}\,\frac{\text{N}}{\text{kg}} = 5.26 \times 10^{15}\,\text{m s}^{-2}$ Vertical displacement = 0.020 m $0.020 = \frac{5.26 \times 10^{15} t^2}{2}$ $t = 2.76 \times 10^{-9}\,\text{s}$ $v = \frac{0.080}{2.76 \times 10^{-9}} = 2.90 \times 10^{7}\,\text{ms}^{-1}$	**5**
18(c)(i)	Into the page **(1)**	**1**
18(c)(ii)	Equates $Ee = Bev$ **(1)** $B = 1.0 \times 10^{-3}$ T **(1)** <u>Example of calculation:</u> $B = E/v$ $B = 25\,000$ N C^{-1} / 2.4×10^7 ms^{-1} $B = 1.0 \times 10^{-3}$ T	**2**
	Total for question 18	**11**

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