Mark Scheme (Results)

Summer 2014

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 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.

For example:

(iii)	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.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

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.

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 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.

2.3 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, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 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.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 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.

3.2 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}

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.

4.6 Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>		
Use of L × W × H	✓	
Substitution into density equation with a volume and density	✓	
Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] [If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] [Bald answer scores 0, reverse calculation 2/3]	✓	**3**
Example of answer: 80 cm × 50 cm × 1.8 cm = 7200 cm^3 7200 cm^3 × 0.70 g cm^{-3} = 5040 g 5040 × 10^{-3} kg × 9.81 N/kg = 49.4 N		

5. Quality of Written Communication

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

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

6. Graphs

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

6.2 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.

6.3 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.

6.4 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.

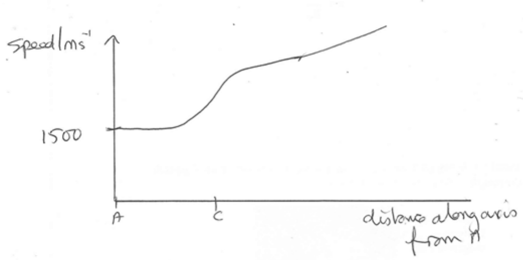
Question Number	Answer	Mark
1	B	**1**
2	C	**1**
3	B	**1**
4	D	**1**
5	D	**1**
6	C	**1**
7	D	**1**
8	B	**1**
9	B	**1**
10	D	**1**

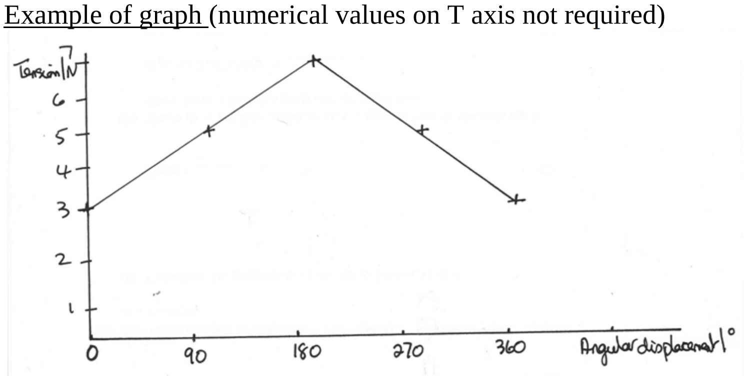
Question Number	Answer	Mark
***11**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Most of the alpha particles went through undeflected/undeviated **(1)** Nucleus much smaller than the atom **Or** atom is mostly empty space. **(1)** A small proportion experience large deflection/deviation **(1)** <u>Nucleus</u> must be charged **(1)** Most of the mass of atom is in the <u>nucleus</u> **(1)**	**5**
	Total for question 11	**5**

Question Number	Answer	Mark
12	p uud **(1)** Ω^- sss **(1)** K^- $s\bar{u}$ **and** K^+ $u\bar{s}$ **(1)** K^0 $\bar{s}d$ **(1)**	**4**
	Total for question 12	**4**

Question Number	Answer		Mark
***13**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) Max **5** Idea that there is a changing (magnetic) field/flux (linked with the coil) Or Idea that the coil cuts (magnetic) field/flux e.m.f. induced e.m.f. / V depends upon speed **Or** e.m.f. / V depends on rate of change/cutting of flux When magnet is stationary, e.m.f. / V = 0 Or When magnet at maximum displacement, e.m.f. / V = 0 e.m.f. / V positive or negative depends on direction Frequency / T of oscillation matches frequency /T of e.m.f. / V variation **Or** frequency of oscillation of the spring/magnet is 1Hz **Or** time period of oscillation of the spring/magnet is 1s.	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 **5**
	Total for question 13		**5**

Question Number	Answer	Mark
14(a)	**Either** Use of $\lambda = h/p$ to find momentum of photon **(1)** Change of momentum of photon = $2p$ **(1)** Equates to change of momentum of hydrogen **(1)** $v = 1.2\ \text{m s}^{-1}$ or $1.3\ \text{m s}^{-1}$ **(1)** **Or** Use of $\lambda = h/p$ to find momentum of photon **(1)** Use of a conservation of momentum equation for photon and hydrogen atom (ignoring direction errors) **(1)** Momentum of photon after has a negative value **(1)** $v = 1.2\ \text{m s}^{-1}$ or $1.3\ \text{m s}^{-1}$ **(1)** <u>Example of calculation</u> Change in momentum of photon = $2h/\lambda$ Change in momentum of hydrogen = mv $v = 2h/\lambda m$ $v = (2 \times 6.63 \times 10^{-34}\ \text{J s}) / (640 \times 10^{-9}\ \text{m} \times 1.67 \times 10^{-27}\ \text{kg})$ $v = 1.24\ \text{m s}^{-1}$	**4**
14(b)	Conservation of energy identified **(1)** (Appears to be) more energy after the collision than before **Or** Hydrogen atom has (more) energy after the collision **Or** Photon should lose energy in impact **Or** Energy transferred from photon **(1)** (More significant figures would indicate a) difference/change in photon wavelength. **(1)** Reflected wavelength should be larger than the incident wavelength **(1)**	**4**
	Total for question 14	**8**

Question Number	Answer		Mark
15(a)	Use of $E = kQ/r^2$ with $Q = 4.0 \times 10^{-13}$ (C) Their E value × cos 49 2 components added $E = 0.043$ N C^{-1} (Candidates who calculate Force can score MP2 and MP3 only) <u>Example of calculation</u> Resultant field = 2 × (kQ/r^2) cos 49 $E = (2 \times 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \times 4.0 \times 10^{-13} \text{ C} \times 0.656)/0.33^2$ $E = 0.043$ N C^{-1}	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)	At A fields are equal and opposite (in direction) Explains decrease in terms of E α $1/r^2$.	**(1)** **(1)**	**2**
15(c)(i)	Use of $F = EQ$ with $Q = 3.2 \text{ x } 10^{-19}$ (C) Use of $F = ma$ $a = 2.1 \times 10^6$ m s^{-2} <u>Example of calculation</u> $EQ = ma$ $a = EQ/m$ $a = (0.0\ 44 \text{ N C}^{-1} \times 3.2 \times 10^{-19} \text{ C}) / 6.6 \times 10^{-27}$ kg $a = 2.1 \times 10^6$ m s^{-2}	**(1)** **(1)** **(1)**	**3**
15(c)(ii)	Graph with initial velocity marked as 1500 (m s^{-1}) Continuously increasing speed Maximum positive gradient at C and graph extends beyond C <u>Example of graph</u> 	**(1)** **(1)** **(1)**	**3**
	Total for question 15		**12**

Question Number	Answer	Mark
16(a)	Weight acts/pulls (vertically) downwards **(1)** There must be a component of tension in the vertical direction **Or** refers to Tcos θ with cos θ = 0 when horizontal **(1)**	**2**
16(b)(i)	Use of $mr\omega^2$ (or combining mv^2/r with $v=r\omega$) **(1)** tension = $mr\omega^2 - mg$ (might be implicit in calculation) **(1)** Converts cm → m and g → kg **(1)** Minimum tension = 3.0 N **(1)** Example of calculation $T_{min} = mr\omega^2 - mg$ T_{min} = 0.204 kg × 0.25 m × (9.90 rad $s^{-1})^2$ − (0.204 kg × 9.81 N kg^{-1}) T_{min} = 5.0 N − 2.0 N = 3.0 N	**4**
16(b)(ii)	Non zero value of T at 0° **(1)** Same value at 360 ° as at 0° **(1)** **Single** peak/trough, non-zero, at 180 ° (not if horizontal line) **(1)** Positive gradient from 0° **(1)** (ignore shape e.g. accept straight or curved between the points) (Anything incorrect after 360 degrees loses MP2) Example of graph (numerical values on T axis not required) 	**4**
	Total for question 16	**10**

Question Number	Answer		Mark
17(a)	A region where a force is exerted On a moving charge **Or** on a current-carrying conductor (dependent mark)	**(1)** **(1)**	**2**
17(b)(i)	Negative / -q / -ve	**(1)**	**1**
17(b)(ii)	The path is circular Because the <u>force</u> (is always) at right angles to the direction of motion of the particle.	**(1)** **(1)**	**2**
17(b)(iii)	A clear and unambiguous use of the formula $F = Bqv(\sin\theta)$ Using $F = mv^2/r$ and equating it to the above expression for force leading to the derivation of $r=mv/Bq$	**(1)** **(1)**	**2**
17(c)(i)	Arrow in clockwise direction Radius above foil is smaller than radius below foil Particle has less energy/momentum/speed after the foil ("Curvature becomes greater" acceptable for "radius smaller" on MP2) (Candidates with an anticlockwise arrow can score MP2 if they have the radius greater below the foil, but cannot score MP3)	**(1)** **(1)** **(1)**	**3**
17(c)(ii)	Use of p (or mv) = rBq **Or** p proportional to r Ratio = 0.73 (cao) <u>Example of derivation</u> Final momentum/initial momentum Bqr_{final} / $Bqr_{initial}$ = 6.1 cm/ 8.4 cm = 0.73	**(1)** **(1)**	**2**
	Total for question 17		**12**

Question Number	Answer		Mark
18(a)(i)	(Capacitor) discharges **Or** loses charge **Or** p.d. across capacitor falls The idea that the discharge is not instantaneous [e.g., gradually, exponentially, over time]	**(1)** **(1)**	**2**
18(a)(ii)	Decay curve starting on *y* - axis but not touching *x* -axis. Initial current 2 mA Time axis labelled to indicate ($t_{1/2}$ =) 0.03 s **Or** Time axis labelled to indicate (RC =) 0.04 s **Or** Time axis labelled to indicate (5RC =) 0.2s	**(1)** **(1)** **(1)**	**3**
18(a)(iii)	Initially large current **Or** capacitor charges up Over a very short time **Or** happens instantaneously Because resistance is not in the charging circuit **Or** because *R* = 0	 **(1)** **(1)** **(1)**	**3**
18(b)	Use of $V = V_0 e^{-t/RC}$ with V_0 = 20V Correct conversion of both units *V* = 0.13 V <u>Example of calculation</u> $V = V_0 e^{-t/RC}$ $V = 20\ V\ e^{-0.20\ /\ 10 \times 10^3 \times 4 \times 10^{-6}}$ *V* = 0.13 V	**(1)** **(1)** **(1)**	**3**
18(c)	Use of $W = CV^2/2$ Use of KE = $mv^2/2$ Ec/E_k = 0.023 <u>Example of calculation</u> $E_C = CV^2/2 = 2600\ F \times (2.5\ V)^2 / 2 = 8125\ J$ $E_K = mv^2/2 = 800\ kg \times (30\ m\ s^{-1})^2 / 2 = 360\ 000\ J$ E_C/E_k = 0.023	**(1)** **(1)** **(1)**	**3**
	Total for question 18		**14**

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