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Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCE in Physics (6PH04) Paper 01 Physics on the Move

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Summer 2015
Publications Code UA042379

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.

For example:

(iii) <u>Horizontal force of hinge on table top</u>

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] ✓ **1**
[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.

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:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

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.

6.5 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	D	**1**
3	B	**1**
4	D	**1**
5	A	**1**
6	C	**1**
7	B	**1**
8	D	**1**
9	C	**1**
10	C	**1**

Question Number	Answer	Mark
11	Arrow added to diagram downwards on or near the copper rod **(1)** An indication that the field is at right angles to the page or copper rod **(1)** Magnetic field into page **(1)** (Upward arrow for current →magnetic field out of page. If no arrow on rod MP2 &3 can still be scored)	**3**
	Total for question 11	**3**

Question Number	Answer	Mark
12(a)	$\bar{u}d$ **(1)**	**1**
12(b)	Conversion to Joules by $\times 1.6 \times 10^{-19}$ (C) **(1)** Divide by $(3 \times 10^8)^2$ **(1)** Mass = 2.49×10^{-28} kg **(1)** <u>Example of calculation</u> Mass = 140×10^6 eV $\times 1.6 \times 10^{-19}$ J eV^{-1} / $(3 \times 10^8$ m s$^{-1})^2$ Mass = 2.49×10^{-28} kg	**3**
	Total for question 12	**4**

Question Number	Answer	Mark
13(a)	Evidence of frictional force = (0.35 ×*mg*) **(1)** Use of $F = mr\omega^2$ **Or** $F = mv^2/r$ **(1)** Use of $\omega = 2\pi/T$ **Or** $v = 2\pi r/T$ **(1)** $t = 3.0$ s **(1)** <u>Example of calculation</u> frictional force = 0.35 × 20 kg × 9.81 m s^{-2} = 68.7 N $F = mr\omega^2$ $\omega = \sqrt{}$ (68.7 N / (20 kg × 0.80 m) ω =2.1 rad s^{-1} $t = 2\pi/2.1$ rad s^{-1} $t = 3.0$ s	**4**
13(b)	There would be no difference **(1)** Both expressions for force depend on mass **Or** algebraic equation for ω or T derived (could be in the working for (a)) showing ω or T independent of m **Or** statement that masses cancel if supported by evidence in (a) **(1)**	**2**
	Total for question 13	**6**

Question Number	Answer	Mark
***14**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) statement that indicates that the conservation of momentum does apply **(1)** the idea that the probe and tank move in opposite directions [accept move apart] **Or** the idea that the probe and tank experience equal and opposite forces **(1)** Probe and tank experience equal **changes** in momentum (in opposite directions) **(1)** Statement that indicates that (total) energy is conserved **(1)** Kinetic energy of the system increases (so speed increases) **(1)** (Some) chemical energy converted to KE **(1)**	**6**
	Total for question 14	**6**

Question Number	Answer	Mark
15(a)	Use of $C=Q/V$ **(1)** V= 15 V **(1)** Use of $W = QV/2$ **Or** $W = CV^2/2$ **Or** $W = Q^2/2C$ **(1)** $W = 2.5 \times 10^{-5}$ J **(1)** (candidates who use 6.6×10^{-6} C can only score MP1 and MP3) <u>Example of calculation</u> $V = Q/C = 3.3 \times 10^{-6}$ C / 220×10^{-9} F V= 15 V $W = QV/2 = (3.3 \times 10^{-6}$ C × 15 V)/2 $W = 2.5 \times 10^{-5}$ J	**4**
15(b)	$Q = 0.2\ Q_0$ **Or** $Q = 6.6\times 10^{-7}$ C **(1)** Use of $Q = Q_o\ e^{-t/RC}$ **(1)** t = 7.1 s **(1)** (candidates who use $Q = 0.8\ Q_0$ can only score MP2) <u>Example of calculation</u> $Q = 0.2\ Q_0$ $Q = Q_0\ e^{-t/RC}$ $0.2\ Q_0 = Q_0\ e^{-t/RC}$ ln (0.2) = **-** t/ ($20\times 10^6\ \Omega \times 220 \times 10^{-9}$ F) t = 7.1 s	**3**
15(c)	**Either** refers to $W = Q^2/2C$ **Or** $W \propto Q^2$ **(1)** If Q halves, $W \rightarrow Q^2/8C$ Or halving Q quarters W **(1)** (Since W becomes a quarter in the time for Q to half) it takes less time for the energy to halve than the charge to halve. (dependent mark on either MP1 or MP2) **(1)** **Or** Refers to $W = QV/2$ **(1)** Q and V both decrease over time **(1)** W will decrease faster so takes less time to half in value. (dependent mark on either MP1 or MP2) **(1)**	**3**
15(d)	Synchronous readings **Or** data logger records readings at exact time **Or** voltmeter and stop watch need 2 people and data logger only one **(1)** More readings can be taken in a shorter time **Or** higher sampling rate **(1)** (treat as neutral any reference to graph plotting automatically, human reaction time or accuracy)	**2**
	Total for question 15	**12**

Question Number	Answer		Mark
16(a)	The <u>induced</u> <u>e.m.f.</u> Is equal/proportional to the rate of change of (magnetic) flux (linkage) **Or** $\varepsilon = (-)\, d(N\Phi)/\Delta t$ with symbols defined	**(1)** **(1)**	**2**
***16(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) the idea that due to the magnet moving there is a changing field around the ring An e.m.f. induced (in a closed circuit hence a current flows) Change in direction of magnet, changes the direction of e.m.f./current Magnitude of e.m.f. (and current) depends on the rate of change of flux linkage **Or** magnitude of e.m.f. (and current) depends on position/ speed of magnet	 **(1)** **(1)** **(1)** **(1)**	**4**
16(c)	Use of area $A = \pi r^2$ Use of $\varepsilon = BA/t$ Use of $I = V/R$ I= 4.1 A (accept 4.1 – 4.2 A depending on where rounding is done) (candidates who use a circumference instead of an area can only score MP3) <u>Example of calculation</u> Area of coil = $\pi \times (0.05\text{ m})^2 = 7.9 \times 10^{-3}\text{ m}^2$ $\varepsilon = BA/t = 0.035\text{ T s}^{-1} \times 7.9 \times 10^{-3}\text{ m}^2 = 2.8 \times 10^{-4}\text{ V}$ $I = \varepsilon/R = 2.8 \times 10^{-4}\text{ V} / 6.7 \times 10^{-5}\,\Omega$ I= 4.1 A	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**10**

Question Number	Answer		Mark
17(a)	**Using Equation** F − kg m s^{-2} Q − A s ε_0 − A^2 kg^{-1} m^{-3} s^4 **Or using the unit of F m^{-1}** C − A s J – kg m^2 s^{-2} ε_0 − A^2 kg^{-1} m^{-3} s	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1**	**3**
17(b)	**Diagram mark for parallel plate**: a minimum of 3 parallel equispaced lines touching plates (ignore edge effect) **Diagram mark for point charge**: minimum of 4 equispaced radial lines touching charged point Direction of fields correct for both diagrams consistent with charges labelled Parallel plate **-** field strength same at all points Point charge **-** field strength decreases with (increasing)distance from point **Or** obeys inverse square law	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**

17(c)	Use of $F_E = kQ_1Q_2/r^2$ **(1)** Use of $W = mg$ **(1)** Resolve vertically $T\cos\theta = mg$ **and** Resolve horizontally $T\sin\theta = F_E$ **(1)** Attempt to combine components to give tan θ ($\tan\theta = F_E/mg$) **(1)** $\theta = 41^\circ$ to 42° **(1)** $T = 0.035$ N **(1)** **Or** Use of $F_E = kQ_1Q_2/r^2$ **(1)** Use of $W = mg$ **(1)** Use of Pythagoras to find tension force **(1)** Tan $\theta = F_E/mg$ **Or** $\cos\theta = mg/T$ **Or** $\sin\theta = F_E/T$ **(1)** $\theta = 41^\circ$ to 42° **(1)** $T = 0.035$ N **(1)** (if they halve the separation or halve the electric force they can still get MP1 and so could score MP1,2, 3 & 4) <u>Example of calculation</u> Weight of sphere = 0.0027 kg × 9.81 N kg^{-1} = 0.026 N Electric force $F_E = kQ_1Q_2/r^2$ $= 8.99 \times 10^9 \text{N m}^2 \text{C}^{-2} \times (4.0 \times 10^{-7} \text{C})^2 / 0.25^2 \text{m}^2 = 0.023$ N Vertically $T\cos\theta = mg$ Horizontally $T\sin\theta = F_E$ Tan $\theta = F_E$/mg = 0.023 N/ 0.026 N $\theta = 41^\circ$ sub into vertical equation $T = mg/\cos\theta$ = 0.026 N /cos 41 $T = 0.034$ N	**6**
	Total for question 17	**14**

Question Number	Answer		Mark
18(a)(i)	Outward spiral from centre in either direction, minimum of two complete loops	**(1)**	**1**
18(a)(ii)	Direction consistent with diagram: Clockwise path, field out of page Anticlockwise path, field into page	**(1)**	**1**
18(a)(iii)	Electric field/p.d. between dees causes (resultant) force/acceleration Proton makes half a revolution in half a cycle of the a.c. **Or** facing dee (always) negative when proton reaches gap. **Or** whenever the proton gets to a gap, the p.d. has reversed k.e./speed (only)increases each time the proton crosses the gap **Or** work done by the field in the gap increases the k.e.	**(1)** **(1)** **(1)**	**3**
18(a)(iv)	$Bev=mv^2/r$ **Or** $r=p/Be$ $v=2\pi r/T$ $T=1/f$ (seeing $f=v/(2\pi r)$ scores MP2 & 3) **Or** $Bev=mr\omega^2$ $v=r\omega$ $\omega=2\pi f$ (seeing $v/r=2\pi f$ scores MP2 & 3)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
18(a)(v)	Use of $B=2\pi fm/e$ with mass of proton $f=1.8\times10^4$ Hz <u>Example of calculation</u> $f=eB/2\pi m$ $f=(1.6\times10^{-19}\text{ C}\times1.2\times10^{-3}\text{ T})/(2\pi\times1.67\times10^{-27}\text{kg})$ $f=1.8\times10^4$ Hz	**(1)** **(1)**	**2**
18(b)	At **X** the idea that 2 particles are produced One is uncharged/neutral so no track charged particle has same charge as incident particle to conserve charge **Or** path of (new) charged particle changes to conserve momentum At **Y** Neutral particle decays into two charged particles. Tracks curve in opposite directions as particles oppositely charged. **Or** particles have (equal and) opposite charge to conserve charge **Or** particles have equal (magnitude of) momenta since their (radius of) curvature is the same.	 **(1)** **(1)** **(1)** **(1)** **(1)**	**5**
	Total for question 18		**15**

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