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Mark Scheme (Results)

Summer 2015

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.

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. 'resonance'

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 $g = 10\ \text{m s}^{-2}$ or $10\ \text{N kg}^{-1}$ instead of $9.81\ \text{m s}^{-2}$ or $9.81\ \text{N kg}^{-1}$ will be penalised by one mark (but not more than once per clip). Accept $9.8\ \text{m s}^{-2}$ or $9.8\ \text{N kg}^{-1}$

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.

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

Question Number	Answer		Mark
11(a)	As separation doubles force decreases to a quarter of its previous value. **Or** Fr^2 is a constant **Or** F is proportional to $1/r^2$ **Or** a graph of F against $1/r^2$ is a straight line graph through the origin From A→B r doubles **Or** r_B/r_A = 2:1 so force falls from 3.6 →0.9 **Or** 0.9/3.6 = ¼ **Or** calculates the value for Fr^2 twice (accept reverse argument from B →A with appropriate factors)	 **(1)** **(1)**	 **2**
11(b)	Use of $F = kQ_1 Q_2/r^2$ Use of ×2 & ×79 F = 18 N **Or** Use of Fr^2 = constant With values from (a) F = 16 N -18 N <u>Example of calculation</u> $F = kQ_1 Q_2/r^2$ $F = 8.99 \times 10^9$ N m^2 C^{-2}×(2 ×1.6 × 10^{-19} C)×(79 ×1.6 × 10^{-19} C)/(4.5 × 10^{-14} m)^2 F = 18 N	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 **3**
	Total for Question 11		**5**

Question Number	Answer		Mark
12(a)	Use of $C=Q/V$ $Q = 1.0 \times 10^{-6}$ C <u>Example of calculation</u> $Q = 680 \times 10^{-9}$ F × 1.5 V $Q = 1.02 \times 10^{-6}$ C	**(1)** **(1)**	**2**
12(b)	Use of $Q = Q_o\, e^{-t/RC}$ converts ms → **and** nF → F $Q = 1.3 \times 10^{-9}$ C (ecf their Q from (a)) Negligible charge **Or** fully discharged **Or** % charge remaining quoted correctly <u>Example of calculation</u> $Q = Q_o\, e^{-t/RC}$ $Q = (1.0 \times 10^{-6}\ \text{C})\, e^{-0.001\text{s}/(220\ \Omega \times 680 \times 10^{-9}\ \text{F})}$ $Q = 1.25 \times 10^{-9}$ C	**(1)** **(1)** **(1)** **(1)**	**4**
12(c)	$I = fQ$ $I = 5.1 \times 10^{-4}$ A ecf their Q from (a) <u>Example of calculation</u> $I = fQ$ = 500 Hz × 1.02×10^{-6} C $I = 5.1 \times 10^{-4}$ A	**(1)** **(1)**	**2**
	Total for Question 12		**8**

Question Number	Answer	Mark
13(a)	Sum of momenta before (collision) = sum of momenta after (collision) **Or** the total momentum before (a collision) = the total momentum after (a collision) **Or** total momentum remains constant **Or** the momentum of a system remains constant **(1)** Providing no external/unbalanced/resultant force acts **Or** in a closed/isolated system **(1)**	**2**
13(b)(i)	Use of $p = mv$ **(1)** Subtraction of initial momenta **(1)** Velocity of Be10 = 168 m s^{-1} **(1)** Arrow on/near circle to the right for a + velocity **(Or** Arrow on/near circle to the left for a – velocity) **(1)** (If initial momenta added MP4 cannot be awarded) Example of calculation Total initial momentum = (1.67×10^{-27} kg × 3250 m s^{-1}) **-** (1.50×10^{-26} kg × 175 m s^{-1}) = 2.80×10^{-24} kg m s^{-1} velocity of Be10 = (2.80×10^{-24} kg m s^{-1})/ 1.67×10^{-26} kg Velocity of Be10 = 168 m s^{-1}	**4**
13(b)(ii)	Use of KE = $mv^2/2$ **(1)** Demonstrates total KE before impact > KE after impact with **correct calculations** with ecf from (b)(i) (so inelastic collision) **(1)** Example of calculation KE before impact (1.67×10^{-27} kg × (3250 m $s^{-1})^2$)/2 + (1.50×10^{-26} kg × (175 m $s^{-1})^2$)/2 = 9.05×10^{-21} J KE after collision (1.67×10^{-26} kg × (168 m $s^{-1})^2$)/2 = 2.36×10^{-22} J	**2**
	Total for Question 13	**8**

Question Number	Answer		Mark
14(a)	The induced e.m.f. (in a conductor) Is equal/proportional to the rate of change of (magnetic) flux (linkage) **Or** $\varepsilon = (-)\mathrm{d}(N\Phi)/\mathrm{d}t$ with all symbols defined	**(1)** **(1)**	**2**
14(b)*(i)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Cables under road produce an alternating/changing (magnetic) field Idea of flux linkage/cutting with the coil (on the bus) (Induced) e.m.f. → (current) → charges batteries (there must be a link to the batteries)	 **(1)** **(1)** **(1)**	**3**
14(b)(ii)	Battery charged repeatedly/often/periodically/frequently The idea that: The bus gains enough charge to travel the distance to next cable **Or** the bus (having been charged) can travel a distance without cables **Or** battery charges quickly. **Or** battery charges completely over one cable section batteries small because they don't need to store much charge	**(1)** **(1)** **(1)**	**3**
	Total for Question 14		**8**

Question Number	Answer	Mark
15(a)	(when released) there is no (horizontal) force acting **(1)** Force is needed to change direction **Or** sphere travels in a straight/tangential line **(1)**	**2**
15(b)(i)	Use of $v = r\omega$ **(1)** $\omega = 11 \text{ rad s}^{-1}$ **(1)** <u>Example of calculation</u> $\omega = 18 \text{ m s}^{-1} / 1.7 \text{ m}$ $\omega = 10.6 \text{ rad s}^{-1}$	**2**
15(b)(ii)	Use of $F = mv^2/r$ **Or** $F = mr\omega^2$ **Or** $F = mv\omega$ **(1)** $F = 1400$ N ecf from (b)(i) **(1)** (MP1 not awarded if ω from (i) is used as v) <u>Example of calculation</u> $F = 7.3 \text{ kg} \times (18 \text{ m s}^{-1})^2 / 1.7 \text{ m}$ $F = 1390$ N	**2**
15(c)(i)	Three arrows all pointing to the centre of the circle **(1)** (accept free hand and lines of varying length but they must touch the spheres)	**1**
***15(c)(ii)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) The centripetal force is the resultant force **(1)** Maximum at Z / bottom **and** Minimum at X / top **(1)** At Z Tension T greater than weight (accept $T - W = mv^2/r$ or $T = W + mv^2/r$) **(1)** At X tension force is less than the weight. (accept $W + T = mv^2/r$ or $T = mv^2/r - W$) **(1)** (The symbols W mg T mv^2/r $mr\omega^2$ and F_C accepted without definitions but any other symbols must be defined) This is a qwc question so a bald statement of the equations can score marks but to get full marks there must be clear explanation	**4**
	Total for Question 15	**11**

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Question Number	Answer	Mark
16*(a)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Between the plates there is a force (references to repulsion and attraction are not sufficient) **(1)** Gives a downward acceleration **Or** accelerates towards the negative plate **(1)** Constant horizontal velocity **Or** no forces act horizontally **(1)** Outside the plates no (electric) field /force acts **Or** Outside the plates speed so large that gravitational effect negligible **(1)**	**4**
16(b)(i)	Magnetic force = electric force **Or** $Eq = Bqv$ **(1)** Forces must act in opposite directions **Or** resultant force is zero. **Or** (magnetic) field into page **(1)** (do not credit if forces stated as being perpendicular to each other)	**2**
16(b)(ii)	Use of $E = V/d$ **(1)** Evidence of equating two forces $Bqv = Eq$ (award if you see $Bv = E$) **(1)** Both unit conversions correct. **(1)** $B = 5.1 \times 10^{-3}$ T **(1)** (There is no credit for alternative methods where assumptions have to be made about value of charge and /or mass) <u>Example of calculation</u> $E = V/d$ $Bqv = Eq$ $B = E/v = V/dv$ $B = 60\ \text{V} / (4.5 \times 10^{-2}\ \text{m} \times 260 \times 10^{3}\ \text{m s}^{-1})$ $B = 5.1 \times 10^{-3}$ T	**4**
16(c)	Upward path (not downwards) **Or** magnetic path is arc of a circle **(1)** Magnetic force changes direction as ions path changes **Or** magnetic force perpendicular to path/velocity of ion. **(1)** Electric force constant direction **Or** electric force always acts downwards. **Or** electric path is parabolic **(1)**	**3**
	Total for Question 16	**13**

Question Number	Answer	Mark
17(a)(i)	Top terminal positive and bottom terminal negative **(1)** (accept labels added to tubes C + and B –) Electron is repelled from B **and** attracted to C **Or** (electric) field acts from C to B **Or** electron is repelled from – and attracted to + if the labels have been added to the tubes. **(1)**	**2**
17(a)(ii)	Electron needs to be in each tube for the same time **(1)**	**1**
17(a)(iii)	Use of $V = W/Q$ to calculate energy **(1)** Multiplies by a number of tubes (3 or 4) **(1)** Increase in KE = 1.2×10^{-13} (J) **(1)** <u>Example of calculation</u> Increase in KE = $3 \times 250 \times 10^{3}$ V $\times 1.6 \times 10^{-19}$C Increase in KE = 1.2×10^{-13} J	**3**
17(b)(i)	Top box: anti-electron or positron **and** bottom box: anti-proton **(1)**	**1**
17(b)(ii)	opposite charges **(1)** Same mass **Or** same amount of charge **(1)**	**2**
17(b)(iii)	The idea that the particles will annihilate when they meet. **(1)**	**1**
17(c)(i)	2/3 charge of an electron **(1)** Positive charge **Or** opposite charge to electron **(1)**	**2**
17(c)(ii)	Mass of 4 MeV/c^2 (must include unit) **Or** mass = 7.1×10^{-30} kg **(1)** Charge of −2/3(e) **Or** charge = -1.07×10^{-19} C **(1)**	**2**
17(c)(iii)	Conversion to Joules by multiplying a 'mass' $\times 1.6 \times 10^{-19}$ (C) **(1)** Divide by $(3 \times 10^{8})^2$ **(1)** Mass = 1.42×10^{-28} kg **(1)** <u>Example of calculation</u> Mass = 80×10^{6} eV $\times 1.6 \times 10^{-19}$ C / $(3 \times 10^{8}$ m s$^{-1})^2$ Mass = 1.42×10^{-28} kg	**3**
	Total for Question 17	**17**

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