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Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE
in Physics (6PH04)
Paper 01R 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. '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 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.
   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	C	**1**
6	C	**1**
7	B	**1**
8	A	**1**
9	B	**1**
10	D	**1**

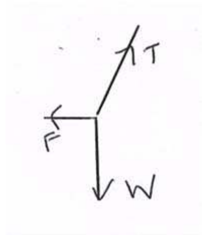
Question Number	Answer		Mark
11(a)(i)	R= 9.32 kN <u>Example of answer</u> R = 950 kg × 9.81 m s^{-2} R = 9320 N	**(1)**	**1**
11(a)(ii)	Use of $F = mv^2/r$ $R = mg - mv^2/r$ R = 2480 N ecf their value of R <u>Example of calculation</u> R = 9320 N − (950 kg × 12.0^2 m^2 s^{-2} / 20.0 m) R = 2480 N	**(1)** **(1)** **(1)**	**3**
11(b)	An answer that either states implicitly or implies that 'The required centripetal force > *mg* and so cannot be provided'.	**(1)**	**1**
	Total for question 11		**5**

Question Number	Answer	Mark
*12	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6** **Fixed target** There is momentum before the collision so there must be momentum after the collision. **(1)** So particle(s) created must have some kinetic energy **(1)** So not all KE converted to mass **(1)** **Colliding beams** (If particles have the same mass and speed), total initial momentum is zero **(1)** Momentum after collision will be zero **(1)** If one stationary particle is created **(1)** All of the kinetic energy of the particle is converted to mass **(1)**	**6**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)	The wavelength (associated) with a particle/electron **(1)** with a given momentum **(1)** **Or** $\lambda = h/p$ **(1)** all terms defined **(1)**	**2**
13(b)(i)	Use of $E_k = eV$ **(1)** Use of $E_k = p^2/2m$ **Or** use of $E_k = mv^2/2$ **and** $p = mv$ **(1)** Momentum = 1.21×10^{-23} kg m s^{-1} **(1)** <u>Example of calculation</u> $E_k = 1.6 \times 10^{-19}$ C× 500 V $p^2 = 2\ m\ E_k = 2 \times 9.11 \times 10^{-31}$ kg × $(1.6 \times 10^{-19} \times 500)$ J $p = 1.21 \times 10^{-23}$ kg m s^{-1}	**3**
13(b)(ii)	Use of $\lambda = h/p$ **(1)** $\lambda = 5.49 \times 10^{-11}$ m (ecf value of p from (i)) **(1)** (show that value gives 6.63×10^{-11} m) <u>Example of calculation</u> $p = 6.63 \times 10^{-34}$ J s / 1.21×10^{-23} kg m s^{-1} $\lambda = 5.49 \times 10^{-11}$ m	**2**
	Total for question 13	**7**

Question Number	Answer		Mark
14(a)	Only (moving) charged particles are deflected by a magnetic field **Or** Only charged particles can be accelerated to produce a beam	**(1)** **(1)**	**1**
14(b)	Into the page	**(1)**	**1**
14(c)	Use of $F = mv^2/r$ **Or** use of $r = p/BQ$ Use of $F = Bqv$ **Or** use of $p = mv$ $m = 6.64 \times 10^{-26}$ kg <u>Example of calculation</u> $mv^2/r = Bqv$ $m = Bqr/v =$(0.673 T × 1.6 × 10^{-19} C × 7.40 × 10^{-2} m) / 1.20 × 10^5 m s^{-1} $m = 6.64 \times 10^{-26}$ kg	**(1)** **(1)** **(1)**	**3**
14(d)	Semicircle drawn starting from same initial point <u>and</u> a smaller radius	**(1)**	**1**
	Total for question 14		**6**

Question Number	Answer		Mark
15(a)	Use of $\Phi = BA$ Converts cm to m Or mT to T $\Phi = 1.1 \times 10^{-4}$ Wb Example of calculation $\Phi = 6.0 \times 10^{-2}$ m × 2.4×10^{-2} m × 74×10^{-3} T $\Phi = 1.07 \times 10^{-4}$ Wb	**(1)** **(1)** **(1)**	**3**
15(b)	Use of $\mathcal{E} = \Delta\Phi/\Delta t$ Use of time = distance/speed $\mathcal{E}$ = 5.3 mV (5.0 mV or 5.5 mV depending on value of Φ used, ecf value of Φ from (a)) **Or** Quotes $\mathcal{E} = Blv$ $l = 6.0 \times 10^{-2}$m used $\mathcal{E}$ = 5.3 mV Example of calculation Time = 0.024 m / 1.2 m s^{-1} t = 0.020 s $\mathcal{E} = 1.1 \times 10^{-4}$ Wb / 0.02 s = 5.5 mV	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
15(c)	Use of $I = V/R$ Use of $F = BIl$ $F = 9.8 \times 10^{-5}$ N (ecf value of $\mathcal{E}$ from (b)) This force is too small to be felt. (this comment must be consistent with their value of force) Example of calculation I = 5.5 mV/ /0.25 Ω = 0.022 A $F = 74 \times 10^{-3}$ T × 0.022 A × 0.060 m $F = 9.8 \times 10^{-5}$ N	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 15		**10**

Question Number	Answer		Mark
16(a)(i)	*W/mg* and *T* correct *F/E/* electric force correct Example of diagram 	**(1)** **(1)**	 **2**
16(a)(ii)	See $T\cos\theta = W$ See $T\sin\theta = F$ **Or** Draws a correct triangle of forces Correctly labels θ (if a triangle is drawn it must be a closed polygon with correctly orientated direction of arrows)	**(1)** **(1)** **(1)** **(1)**	 **2**
16(b)(i)	Records 1pair of values from graph Records 2nd pair of values from graph Use of $F\,r^2$ Shows that $F_1r_1^2 = F_2r_2^2$ (accept answers with or without the powers of ten included) Example of answer Ignoring powers of 10 $115\text{ N} \times 20^2\text{ m}^2 = 46000$ $51\text{ N} \times 30^2\text{ m}^2 = 45900$	**(1)** **(1)** **(1)** **(1)**	 **4**
16(b)(ii)	Uses constant from (b) ignoring powers of ten errors **Or** uses a pair of values from graph Use of $F = kQ_1 Q_2 / r^2$ with 1.6×10^{-19} C $Q = 7.2 \times 10^{-9}$ C Example of answer $100\,Q^2 = 46000 \times 10^{-9}\text{ N m}^2 / 8.99 \times 10^9\text{ N m}^2\text{ C}^{-2}$ $Q^2 = 5.12 \times 10^{-17}\text{ C}^2$ $Q = 7.2 \times 10^{-9}$ C	 **(1)** **(1)** **(1)**	 **3**
	Total for question 16		**11**

Question Number	Answer		Mark
17(a)	The capacitor stores charge **Or** capacitor charges from the supply The idea that the capacitor doesn't fully discharge before being recharged.	**(1)** **(1)**	**2**
17(b)(i)	(6.4 + 4.4)/2 = 5.4 V	**(1)**	**1**
17(b)(ii)	Use of $V = IR$ Average $I = 5.4\ \text{V}/(2.2 \times 10^{3}\Omega) = 2.5 \times 10^{-3}$ A ecf value form (b)(i)	**(1)** **(1)**	**2**
17(b)(iii)	Time = 17 ms or 17.5 ms	**(1)**	**1**
17(b)(iv)	Use of $Q = It$ Use of $C = Q/V$ Use of $\Delta V = 2.0$ V $C = 21\ \mu\text{F}$ (ecf values of I and t from above) <u>Example of calculation</u> $Q = 2.5 \times 10^{-3}\ \text{A} \times 17 \times 10^{-3}\ \text{s} = 4.25 \times 10^{-5}\ \text{C}$ $C = 4.25 \times 10^{-5}\ \text{C} / 2.0\ \text{V}$ $C = 21\ \mu\text{F}$	**(1)** **(1)** **(1)** **(1)**	**4**
17(c)	Uses a larger capacitance Because a larger time constant is needed **Or** stores more charge **Or** less $\Delta V \rightarrow \Delta Q/C$	**(1)** **(1)**	**2**
	Total for question 17		**12**

Question Number	Answer	Mark
18(a)	$\bar{u}$d **(1)** (allow $\bar{c}$d $\bar{c}$s $\bar{u}$s)	**1**
18(b)	π^0 **(1)**	**1**
18(c)	Use of $v = s/t$ **(1)** $t = 2.6 \times 10^{-8}$ s **(1)** <u>Example of answer</u> $t = 5.9$ m / 2.3×10^8 m s^{-1} $t = 2.57 \times 10^{-8}$ s	**2**
***18(d)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6** Pions are charged so leave a track **(1)** Pion interacts with a stationary charged particle **(1)** 2 neutral particles produced **(1)** Because there are gaps in the trail **Or** no tracks produced **(1)** Tracks are in different directions so that momentum is conserved **(1)** Both particles decay into two charged particles **(1)** At each decay particles have opposite charges **(1)** Because charge is conserved **Or** particles move in opposite curvature. **(1)** At each decay momentum is conserved **(1)**	**6**
18(e)(i)	Antiproton **(1)** Same mass as proton **and** opposite charge **(1)**	**2**
18(e)(ii)	It will annihilate with a proton/particle **(1)**	**1**
	Total for question 18	**13**

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