Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE
in Physics (6PH04)
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)	<u>Horizontal force of hinge on table top</u> 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] Example of answer: 80 cm × 50 cm × 1.8 cm = 7200 cm^3 7200 cm^3 × 0.70 g cm^{-3} = 5040 g	 ✓ ✓ ✓	3

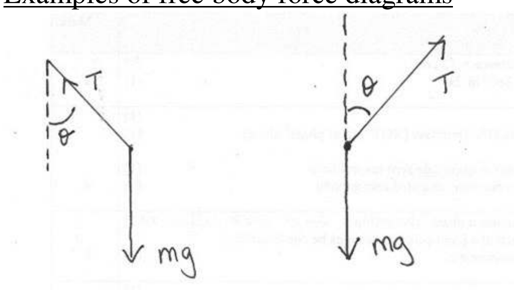
5040×10^{-3} kg × 9.81 N/kg = 49.4 N		

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

Question Number	Answer	Mark
***11**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Either** Initial momentum is zero Nucleus and alpha particle have equal momentum **(1)** (accept $m_n u_n = m_\alpha u_\alpha$ or $p_n = p_\alpha$) alpha particle and **(1)** nucleus move in opposite directions Mass of alpha **(1)** particle < mass of nucleus (therefore $v_n < v_\alpha$) **(1)** **Or** The nucleus and alpha particle exert an equal but opposite force on **(1)** each other. **(1)** Mass of alpha particle < mass of nucleus **(1)** Acceleration of nucleus < acceleration of alpha particle Force/acceleration acts for same time so Δv for nucleus is smaller for **(1)** nucleus	**4**
	Total for question 11	**4**

Question Number	Answer	Mark
12	Free body force diagram showing 2 forces only Weight/*W/mg* **(1)** Tension / *T* **(1)** (Each additional forces e.g. horizontal component or resultant force, 1 mark penalty) **If θ is angle to the vertical then**: (Resolving vertically): $T\cos\theta = mg$ **(1)** (Resolving horizontally): $T\sin\theta = mv^2/r$ **Or** $T\sin\theta = mr\omega^2$ **(1)** Derives $\tan\theta = v^2/ rg$ **and** links to observations **Or** Derives $\tan\theta = r\omega^2/ g$ **and** links to observations **(1)** If angle to horizontal is used candidates can score MP3 and 4.[then sin and cos swop over and tan of angle will be reciprocal of above] <u>Examples of free body force diagrams</u>  (full credit for the last 3 marks can be given to candidates who draw a vector triangle and derive $\tan\theta = T_{horzt}/mg$ and then $\tan\theta = r\omega^2/ g$ **and** observation)	**5**
	Total for question 12	**5**

Question Number	Answer		Mark
13(a)	Use of eV conversion Use of $E_k = p^2/2m$ Or $E_k = 1/2mv^2$ **and** $p =$ mv $p = 1.4 \times 10^{-23}$ (N s) <u>Example of calculation</u> $p^2 = 2 \times 9.11 \times 10^{-31}$ kg $\times 1.6 \times 10^{-19}$ C $\times 700$ V $p^2 = 2.04 \times 10^{-46}$ N^2 s^2 $p = 1.4 \times 10^{-23}$ N s	**(1)** **(1)** **(1)**	**3**
13(b)	Use of $\lambda = h/p$ ecf from (a) $\lambda = 4.6 \times 10^{-11}$ m (show that value → 6.6×10^{-11} m)	**(1)** **(1)**	**2**
13(c)	Wavelengths need to be similar to the size of the atom **Or** reference to atomic spacing being similar to answer in (b)	**(1)**	**1**
	Total for question 13		**6**

Question Number	Answer		Mark
14(a)	The idea that electron(s) have been removed/added from an atom/molecule/particle.	**(1)**	**1**
14(b)	Flemings left hand (rule) **Or** FLHR	**(1)**	**1**
14(c)	**Max 5** Only charged particles leave a trail so photon is neutral **Or** the two particles produced are charged because they leave a track Particles are oppositely charged because they curve/spiral in opposite directions **Or** Particles are oppositely charged to conserve charge (Applying FLHR) , top particle is positive and bottom one negative. Because they have the same curvature/radius on the spirals **Or** because the paths have identical shape Particles have the same momentum The photon enters from the left because the (resultant) momentum afterwards is to the right.	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**5**
	Total for question 14		**7**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>15(a)(i)</td><td>Max 2
Inconsistent number of significant figures or decimal places
Or results recorded to different precision /resolution
No repeat readings
More readings needed up to <u>1.5</u> cm</td><td>

(1)
(1)
(1)</td><td>2</td></tr>
<tr><td>15(a)(ii)(1)</td><td>Attempt to use Vr= constant
Correctly finds two values of Vr from values in table and makes comment
Or uses Vr value with another r or V to confirm corresponding value and makes comment

<u>Example of calculation</u>

<table><tr><th>r/cm</th><th>V/V</th><th>rV/ cmV</th></tr><tr><td>1.0</td><td>0.725</td><td>0.725</td></tr><tr><td>1.5</td><td>0.483</td><td>0.725</td></tr><tr><td>2.0</td><td>0.363</td><td>0.726</td></tr><tr><td>2.5</td><td>0.29</td><td>0.725</td></tr><tr><td>3.0</td><td>0.242</td><td>0.726</td></tr><tr><td>3.5</td><td>0.21</td><td>0.735</td></tr></table></td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>15(a)(ii)(2)</td><td>The graph would be a straight line graph through the origin.
(accept a sketch of a straight line graph going through the origin graph)</td><td>(1)</td><td>1</td></tr>
<tr><td>15(b)(i)</td><td>An e.m.f. is (induced) when there is a changing (magnetic) field/flux.

Because the <u>current</u> is constant there is a constant magnetic field. Or Because the <u>current</u> is constant there isn’t a changing magnetic field.</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>15(b)(ii)</td><td>Movement of either the coil or the wire
Use an alternating current/signal/supply/AC
Switch the current on/off Or change current e.g. use of variable resistor</td><td>(1)
(1)

(1)</td><td>3</td></tr>
<tr><td></td><td>Total for question 15</td><td></td><td>10</td></tr>
</table>

Question Number	Answer		Mark
16(a)	(Electric field strength (at a point in a field) is) the force per unit charge (accept force per coulomb of charge) Acting on a (small) positive charge.	**(1)** **(1)**	**2**
16(b)(i)	Use of $E = kQ/r^2$ Electric field due to $Q_1 = 4.1(1) \times 10^6$ (N C^{-1}) Use of 11.9 cm to find field due to Q_2 **Or** Use of $E = kQ/r^2$ Use of $E1 / E2 = Q1\ r22 / Q2\ r12$ $E_1 / E_2 = 1$ <u>Example of calculation</u> Electric field due to Q_1 $= (8.99 \times 10^9$ N m^2 $C^{-2}) \times (3 \times 10^{-6}$ C$) / (8.1 \times 10^{-2})^2$ $= 4.11 \times 10^6$ N C^{-1} Electric field due to Q_2 $= (8.99 \times 10^9$ N m^2 $C^{-2}) \times (6.5 \times 10^{-6}$ C$) / (11.9 \times 10^{-2})^2 = 4.13 \times 10^6$ N C^{-1}	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
16(b)(ii)	(Force on charge is) zero/negligible/approx zero (Allow values less than 0.1 N)	**(1)**	**1**
16(b)(iii)	At midpoint repulsive force due to Q_2 > repulsive force due to Q_1 **Or** the <u>resultant</u> field/force is repulsive <u>Work</u> must be done against the repulsive force/field to move the charge to this position.	**(1)** **(1)**	**2**
	Total for question 16		**8**

Question Number	Answer		Mark
17(a)(i)	Use of $Q = CV$ Q = 3900 (C) <u>Example of answer</u> Q = 1500 F × 2.6 V Q = 3900 C	**(1)** **(1)**	 **2**
17(a)(ii)	Straight line through the origin Passing through 2.6 V and answer to (a)(i) or 4000 C	**(1)** **(1)**	 **2**
17(a)(iii)	Use of $W = QV/2$ **Or** $W = CV^2/2$ **Or** use of area under graph W = 5.1 kJ (use of 4000 C gives W = 5.2 kJ (allow ecf from (a)(i)) <u>Example of answer</u> W = 3900 C × 2.6 V / 2 W = 5070 J	**(1)** **(1)**	 **2**
17(b)(i)	 Exponential decay Current decreases by equal fractions in equal time intervals	 **(1)** **(1)**	 **2**
17(b)(ii)	See attempt of I_0/e Finds time (accept 0.75-0.80s) Use of $\tau = RC$ R = 0.0005 Ω **Or** Finds the time for I_o to half Uses $t_{1/2} = \tau \ln 2$ Use of $\tau = RC$ R = 0.00050 – 0.00053 Ω **Or** See attempt of 37% of 5400 A Finds time (accept 0.75 to 0.80 s) Use of $\tau = RC$ R = 0.0005 – 0.00053Ω **Or** Draws tangent at t = 0 to meet time axis. Records intercept of tangent with axis (accept 0.6 s - 0.9 s) Use of $\tau = RC$ R = 0.0004 Ω – 0.0006 Ω **Or** reads a value off the y-axis and corresponding time Subs into formula using 5400 (A) to find RC Substitutes for C to find R R = 0.00050 Ω – 0.00058 Ω <u>Example of calculation</u> 37% of 5400 A is 1998 A Time to fall to this value is 0.75 s RC = 0.75 s R =0.75 s / 1500 F = 0.0005 Ω	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 **4**

7(c)	**Max 3** Ultracapacitor used for: overtaking **Or** going up a hill **Or** starting (from rest) **Or** accelerating. **(1)** Because this requires a large current/power. **(1)** Batteries used for travelling at constant speed **(1)** Because this requires a small current/power for a longer time **(1)**	**3**
	Total for question 17	**15**

Question Number	Answer	Mark
***18(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Electric field** Provides a force on the proton/particle **(1)** Which accelerate the proton/particle **Or** gives energy to the protons/particles **(1)** **Magnetic field** Provides a force on a moving proton **Or** Provides a force at right angles to the direction of motion (of the protons) **(1)** Acts as a centripetal force **Or** produces circular motion **(1)** **Additional detail about either field** E field across gap only **Or** The idea that the E field is reversed /alternates every half cycle **Or** B field perpendicular to the Dees **(1)** (this mark may be awarded from a diagram)	5
18(b)	Division by e (ignore powers of 10 error) **(1)** multiplication by c^2 **(1)** Mass = 0.14 (GeV/c^2) **(1)** <u>Example of calculation</u> Mass = $(2.5 \times 10^{-28}\ kg \times 9 \times 10^{16}\ m^2\ s^{-2})/1.6 \times 10^{-19}\ C$ Mass = $0.14 \times 10^{9}\ eV/c^2 = 0.14\ GeV/c^2$	3
18(c)	2/3 charge of a proton **Or** 2/3 charge of a positron **(1)** **Or** 2/3 <u>positive</u> value of the charge on an electron **Or** $2/3e^+$	1
18(d)(i)	<table><tr><th>Particle</th><th>Quark combination</th></tr><tr><td>K^-</td><td>$s\bar{u}$</td></tr><tr><td>K+</td><td>$u\bar{s}$</td></tr><tr><td>K0</td><td>$s\bar{d}$ or $d\bar{s}$</td></tr></table>(1) (1) (1)	3
18(d)(ii)	Mass-energy is conserved **Or** a comment about $E = mc^2$ **(1)** Appropriate reference to colliding particles having mass and kinetic energy **(1)** The extra mass comes from the <u>kinetic</u> energy. **(1)**	3
	Total for question 18	**15**

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