edexcel

Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE
in Physics (6PH05)
Paper 01
Physics from Creation to Collapse

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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] 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	✓ ✓ ✓	3

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

Question Number	Answer		Mark
11	Use of $F = \frac{Gm_1m_2}{r^2}$ $F = 8.2 \times 10^{16}$ N <u>Example of calculation:</u> $F = \frac{Gm_1m_2}{r^2} = \frac{6.67\times10^{-11}\ \mathrm{N\,m^2\,kg^{-2}} \times 6.4\times10^{23}\ \mathrm{kg} \times 6.0\times10^{24}\ \mathrm{kg}}{(5.6\times10^{10}\ \mathrm{m})^2}$ $F = 8.17\times10^{16}$ N	**(1)** **(1)**	**2**
			2

Question Number	Answer		Mark
12	(Observed frequency is less, so) source is receding (from Earth) Use of $\frac{\Delta f}{f} = \frac{v}{c}$ Or $z = \frac{\Delta f}{f}$ $v = 1.5\times10^6\ \mathrm{m\,s^{-1}}$ Or z = 5.0×10^{-3} (min 2 sf answer required) <u>Example of calculation:</u> $\Delta f = (4.547 \times 10^{14} - 4.570 \times 10^{14})$ Hz = (–)2.3×10^{12} Hz $v = \frac{c\,\Delta f}{f} = \frac{3.0\times10^8\ \mathrm{m\,s^{-1}} \times 2.3\times10^{12}\ \mathrm{Hz}}{4.57\times10^{14}\ \mathrm{Hz}} = 1.51\times10^6\ \mathrm{m\,s^{-1}}$	**(1)** **(1)** **(1)**	**3**
	Total for question 12		**3**

Question Number	Answer		Mark
13(a)	Idea that internal energy is the sum of (Total) kinetic energy and potential energy of molecules/atoms	**(1)** **(1)**	**2**
13(b)(i)	Use of $\Delta E = mc\Delta\theta$ ΔE = 8100 (J) <u>Example of calculation:</u> $\Delta E = mc\Delta\theta = 175\times10^{-3}\ \text{kg}\times4200\ \text{J kg}^{-1}\ \text{K}^{-1}\times(85-74)\text{K} = 8090\ \text{J}$	**(1)** **(1)**	**2**
13(b)(ii)	Use of ΔE value from (i) in $\Delta E = mc\Delta\theta$ m = 0.030 kg No energy transferred to surroundings **Or** all energy transferred from tea used to heat milk <u>Example of calculation:</u> $\Delta E = mc\Delta\theta$ $8100\ \text{J} = m\times3900\ \text{J kg}^{-1}\ \text{K}^{-1}\times(74-4.5)\text{K}$ $\therefore \text{m} = \dfrac{8100\ \text{J}}{3900\ \text{J kg}^{-1}\ \text{K}^{-1}\times69.5\ \text{K}} = 0.0299\ \text{kg}$	**(1)** **(1)** **(1)**	**3**
	Total for question 13		**7**

Question Number	Answer		Mark
14(a)	Use of $pV = NkT$ Pressure difference **Or** temperature conversion $\Delta N = 5.0 \times 10^{21}$ <u>Example of calculation:</u> $\Delta N = \frac{\Delta p.V}{kT} = \frac{(6.5\times10^{5} - 5.8\times10^{5})\text{Pa}\times 2.9\times10^{-4}\,\text{m}^{3}}{1.38\times10^{-23}\,\text{JK}^{-1}\times(273+20)\text{K}} = 5.0\times10^{21}$	**(1)** **(1)** **(1)**	**3**
14(b)	Use of $pV = NkT$ T_2 = 307 (K) stated or implied **Or** 293(K) subtracted ΔT = 14 K <u>Example of calculation:</u> $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ $T_2 = \frac{6.8\times10^{5}\,\text{Pa}}{6.5\times10^{5}\,\text{Pa}}\times 293\text{K} = 307\text{K}$ ΔT = (307 – 293) K = 14 K	**(1)** **(1)** **(1)**	**3**
14(c)	**Max 3** (Average) <u>kinetic</u> energy of molecules/atoms is greater **Or** molecules/atoms move faster Collision rate with walls of container is greater There is more momentum (exchanged) per collision **Or** the rate of change of momentum is greater Therefore a greater force on the container walls (dependent upon mp2 or mp3)	**(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 14		**9**

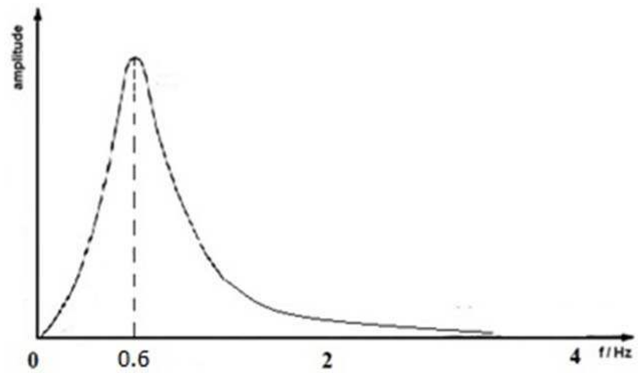
<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>15(a)(i)</td><td>Ionising radiation removes electrons from atoms/molecules</td><td>(1)</td><td>1</td></tr>
<tr><td>15(a)(ii)</td><td><table><tr><td colspan="3">Least ionising → most ionising</td></tr><tr><td>γ</td><td>β</td><td>α</td></tr></table></td><td>(1)</td><td>1</td></tr>
<tr><td>15(b)(i)</td><td><table><tr><th></th><th>Paper</th><th>0.5 cm aluminium</th><th>0.5 cm lead</th></tr><tr><td>α radiation</td><td>stopped</td><td>stopped</td><td>stopped</td></tr><tr><td>β radiation</td><td>passes through</td><td>stopped</td><td>stopped</td></tr><tr><td>γ radiation</td><td>passes through</td><td>passes through</td><td>passes through</td></tr></table></td><td>(1)
(1)
(1)</td><td>3</td></tr>
<tr><td>15(b)(ii)</td><td>(There is the possibility of) exposure to neutrons

Uncharged particles are not (directly) ionising</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td></td><td>Total for question 15</td><td></td><td>7</td></tr>
</table>

Question Number	Answer		Mark
16(a)(i)	Redshift is the (fractional) increase in wavelength received (by an observer) Due to source and observer receding (from each other)	**(1)** **(1)**	**2**
***16(a)(ii)**	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate** Measure frequency/wavelength of light (from the galaxy) Compare (measured) frequency/wavelength to the frequency/wavelength for a source on the Earth States appropriate Doppler formula (consistent with mp1/mp2) and how it is used to calculate velocity	 **(1)** **(1)** **(1)**	**3**
16(b)	(Standard candles are stellar) objects of known luminosity	**(1)**	**1**
16(c)	See $v = H_0d$ and $v = d/t$ Therefore $t = 1/H_0$ (dependent mark)	**(1)** **(1)**	**2**
16(d)(i)	If density less than critical value, expansion would continue for ever If density greater than critical, expansion would stop and universe would contract again If density equals critical value, expansion rate would decrease to zero but universe would not contract again	**(1)** **(1)** **(1)**	**3**
16(d)(ii)	The mass of the universe is uncertain because of the amount of dark matter is uncertain The value of the Hubble constant is uncertain **Or** The amount of dark matter (in the universe) is uncertain Since dark matter doesn't interact via the electromagnetic interaction **Or** The value of the Hubble constant is uncertain Since measurements of distances to distant galaxies are uncertain	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**2**
	Total for question 16		**13**

Question Number	Answer		Mark
17(a)(i)	Use of Newton's 2nd law (F = ma) with F = –kx Acceleration/force is in opposite direction to the displacement from the equilibrium position **Or** acceleration/force is (always) towards the equilibrium/undisplaced/rest position <u>Example of calculation:</u> m a = - k x $a = -\frac{k}{m}x$	**(1)** **(1)**	**2**
17(a)(ii)	See $a = -\omega^2 x$ Compare with $a = -\frac{k}{m}x$ to give $\omega^2 = \frac{k}{m}$ Substitute for ω using $\omega = \frac{2\pi}{T}$ <u>Example of calculation:</u> $a = -\omega^2 x$ and $a = -\frac{k}{m}x$ $\omega^2 = \frac{k}{m}$ and $\omega = \frac{2\pi}{T}$ $\left(\frac{2\pi}{T}\right)^2 = \frac{k}{m} \quad \therefore T = 2\pi\sqrt{\frac{m}{k}}$	**(1)** **(1)** **(1)**	**3**
17(b)(i)	Use of $T = 2\pi\sqrt{\frac{m}{k}}$ Use of $f = \frac{1}{T}$ f = 0.59 Hz <u>Example of calculation:</u> $T = 2\pi\sqrt{\frac{3.5\times10^5\ \text{kg}}{4.8\times16^6\ \text{N m}^{-1}}} = 1.7\ \text{s}$ $f = \frac{1}{T} = \frac{1}{1.7\ \text{s}} = 0.588\ \text{Hz}$	**(1)** **(1)** **(1)**	**3**

17(b)(ii)	Correct shape **(1)** Single sharp peak **(1)** With the peak labelled at 0.6 Hz **(1)**  	**3**
17(b)(iii)	(Max) amplitude of oscillation is reduced **(1)** as energy is transferred from the mass-spring system **(1)** and then dissipated (in the surroundings) **(1)**	**3**
	Total for question 17	**14**

Question Number	Answer		Mark
18(a)(i)	Top line correct Bottom line correct $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$	**(1)** **(1)**	**2**
18(a)(ii)	Attempt at mass deficit calculation ΔE = 0.0175 GeV (accept 2.8 × 10^{-12} J) <u>Example of calculation:</u> Δm = (3.7274 + 0.939566 – 2.8089 – 1.8756) GeV/c^2 = 0.0175 GeV/c^2 ΔE = 0.0175 GeV	**(1)** **(1)**	**2**
18(a)(iii)	Momentum is conserved Mass of neutron is smaller, so speed is greater $E_k = ½ mv^2$, so E_k is larger **Or** Momentum is conserved $E_k = p^2/2m$ m of neutron is smaller, so E_k is larger	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
18(b)	Use of $\lambda = \frac{\ln 2}{t_{½}}$ Use of $A = A_0 e^{-\lambda t}$ t = 41 (years) <u>Example of calculation:</u> $\lambda = \frac{\ln 2}{t_{½}} = \frac{0.693}{12.3 \text{ year}} = 0.0563 \text{ year}^{-1}$ $A = A_0 e^{-\lambda t} \quad \therefore t = \frac{\ln\left(A/A_0\right)}{-\lambda} = \frac{\ln(0.1)}{-0.0563 \text{ year}^{-1}} = 40.9 \text{ years}$	**(1)** **(1)** **(1)**	**3**

*18(c)	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate** There is little possibility of a runaway fusion reaction (unlike fission) There would not be any radioactive waste produced in the fusion process **Or** the flux of neutrons would produce radioactive isotopes when absorbed by materials in the reactor A very/extremely high temperature (plasma) is required Plasma must not touch reactor walls, so strong magnetic fields are required If plasma touches the walls of the reactor its temperature falls (and fusion stops)	 **(1)** **(1)** **(1)** **(1)** **(1)**	5
	Total for question 18		**15**

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