Mark Scheme (Results)

Summer 2014

Pearson Edexcel International Advanced Level in Physics (WPH05)
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]	✓	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.

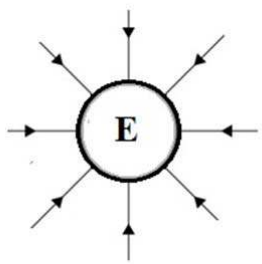
6.4 Points should be plotted to within 1 mm.

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

Question Number	Answer		Mark
11	One peak is higher than the 5500 K peak and one is lower than the 5500K peak.	**(1)**	
	One peak is to the left of the 5500 K peak and one is to the right of the 5500K peak	**(1)**	
	Both graphs correct (6000 K peak is the left of and above the 5500 K peak and the 5000 K peak is to the right of and below the 5500 K peak) **and** both labelled	**(1)**	**3**
	Total for Question 11		**3**

Question Number	Answer	Mark
12(a)	Use of $g = \frac{GM}{r^2}$ **(1)** Use of ratio **(1)** $g_2 = 9.7\ \mathrm{N\,kg^{-1}}$ (accept $\mathrm{ms^{-2}}$) **(1)** **Or** Use of $g_1 = \frac{GM_E}{r_1^2}$ to calculate M_E **(1)** Use this value in $g_2 = \frac{GM_E}{r_2^2}$ **(1)** $g_2 = 9.7\ \mathrm{N\,kg^{-1}}$ (accept $\mathrm{ms^{-2}}$) **(1)** <u>Example of calculation</u> $\frac{g_2}{g_1} = \frac{r_1^2}{r_2^2}$ $g_2 = \left(\frac{6400\,\mathrm{km}}{6437\,\mathrm{km}}\right)^2 \times 9.81\,\mathrm{N\,kg^{-1}} = 9.70\,\mathrm{N\,kg^{-1}}$	3
12(b)	At least four straight evenly spaced radial lines (tolerate lines that extend inside the circle). **(1)** Arrows pointing towards centre **(1)** 	2
12(c)	The jump took place in a very small region of the Earth's field **Or** The height of the jump is much less than the radius of the Earth **(1)** Field lines are (approximately) parallel **Or** idea that g is approximately constant **(1)**	2
	Total for Question12	**7**

	Answer		Mark
13(a)	Use of $\Delta E = mc\Delta T$	**(1)**	
	$\Delta E = 5.4 \times 10^8$ J	**(1)**	
	Assumption: No energy transferred to surroundings **Or** all energy from heater used to heat water	**(1)**	**3**
	<u>Example of calculation</u> $\Delta E = mc\Delta T = 1.6 \times 10^4 \text{ kg} \times 4200 \text{ J kg}^{-1} \text{ K}^{-1} \times (20 - 12) \text{K} = 5.38 \times 10^8 \text{ J}$		
13(b)	Use of $W = VIt$ **Or** Use of $P = \frac{\Delta E}{\Delta t}$ **and** $P = VI$ **Or** Use of $V = \frac{W}{Q}$ **and** $I = \frac{Q}{t}$	**(1)**	
	Converts hours to seconds	**(1)**	
	$I = 22$ A	**(1)**	**3**
	<u>Example of calculation</u> $P = \frac{\Delta E}{\Delta t} = \frac{0.55 \times 10^9 \text{ J}}{(30 \times 60 \times 60) \text{s}} = 5.09 \times 10^3 \text{ W}$ $I = \frac{P}{V} = \frac{5.09 \times 10^3 \text{ W}}{230 \text{ V}} = 22.1 \text{ A}$		
	Total for Question 13		**6**

Question Number	Answer		Mark
14(a)	Use of $\lambda_{max} T = 2.898 \times 10^{-3}$ $\lambda_{max} = 9.5 \times 10^{-7}$ m <u>Example of calculation</u> $\lambda_{max} = \dfrac{2.898 \times 10^{-3}\ \text{m K}}{3.04 \times 10^{3}\ \text{K}} = 9.53 \times 10^{-7}$ m	**(1)** **(1)**	**2**
14(b)(i)	Use of $L = 4\pi r^2 \sigma T^4$ $L = 6.2 \times 10^{20}$ (W) <u>Example of calculation</u> $L = 4\pi r^2 \sigma T^4$ $L = 4\pi(3.2 \times 10^{6})^2 \times 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4} \times (3.04 \times 10^{3}\ \text{K})^4$ $L = 6.23 \times 10^{20}$ W	**(1)** **(1)**	**2**
14(b)(ii)	Use of $F = \dfrac{L}{4\pi d^2}$ $d = 1.9 \times 10^{8}$ m <u>Example of calculation</u> $d = \sqrt{\dfrac{L}{4\pi F}} = \sqrt{\dfrac{6.2 \times 10^{20}\ \text{W}}{4\pi \times 1.38 \times 10^{3}\ \text{W m}^{-2}}} = 1.89 \times 10^{8}$ m	**(1)** **(1)**	**2**
	Total for Question 14		**6**

Question Number	Answer		Mark
15(a)	A reference to the Doppler effect **Or** Relative movement of source and observer leads to a change in the (observed) wavelength (Particles at) X moving away from observer **and** (particles at)Y moving towards observer	**(1)** **(1)**	**2**
15(b)(i)	Use of $\omega = \frac{v}{r}$ Use of $T = \frac{2\pi}{\omega}$ $T = 7.58 \times 10^4\,\text{s} = 21\,(\text{hr})$ **Or** Use of $v = \frac{s}{t}$ with s = 2πr Use of $T = \frac{2\pi r}{v}$ $T = 7.58 \times 10^4\,\text{s} = 21\,(\text{hr})$ <u>Example of calculation</u> $\omega = \frac{v}{r} = \frac{1.45 \times 10^4\,\text{m s}^{-1}}{1.75 \times 10^8\,\text{m}} = 8.29 \times 10^{-5}\,\text{rad s}^{-1}$ $T = \frac{2\pi}{\omega} = \frac{2\pi}{8.29 \times 10^{-5}\,\text{s}^{-1}} = 7.58 \times 10^4\,\text{s}$ $T = \frac{7.58 \times 10^4\,\text{s}}{(60 \times 60)\,\text{s hr}^{-1}} = 21.1\,\text{hr}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
15(b)(ii)	Use of $\frac{GM_s m}{r^2}$ Use of $\frac{mv^2}{r}$ **Or** $m\omega^2 r$ $M_s = 5.5 \times 10^{26}$ kg <u>Example of calculation</u> $\frac{GM_s m}{r^2} = \frac{mv^2}{r}$ $M_s = \frac{v^2 r}{G} = \frac{(1.45 \times 10^4\,\text{m s}^{-1})^2 \times 1.75 \times 10^8\,\text{m}}{6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}} = 5.52 \times 10^{26}\,\text{kg}$	**(1)** **(1)** **(1)**	**3**
	Total for Question 15		**8**

Question Number	Answer		Mark
***16(a)**	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate** (Nuclear fission is) the splitting of a large nucleus into smaller nuclei The mass of the (fission) fragments is less than the mass of the original nucleus Reference to $\Delta E = c^2 \Delta m$ **Or** the binding energy per nucleon is greater in the fragments than in the original nucleus	 **(1)** **(1)** **(1)**	**3**
16(b)	Use of $\frac{\Delta N}{\Delta t} = -\lambda N$ $\frac{\Delta N}{\Delta t} = 1.6 \times 10^8 \text{ Bq}$ Example of calculation $\frac{\Delta N}{\Delta t} = -\lambda N = 1.3 \times 10^{-5} \text{ s}^{-1} \times 1.2 \times 10^{13} = 1.56 \times 10^8 \text{ Bq}$	**(1)** **(1)**	**2**
16(c)	Material must have a high density Concrete	**(1)** **(1)**	**2**
16(d)	Idea that fission reactors produce more radioactive waste Fuel for fission is a limited resource, whereas fuel for fusion is (virtually) unlimited. (accept specific examples uranium, hydrogen and deuterium) (do not accept "renewable"/"non-renewable" for "limited"/"unlimited")	**(1)** **(1)**	**2**
	Total for Question 16		**9**

Question Number	Answer		Mark
17(a)	Use of $\Delta E_k = m\ g\ \Delta h$ $\Delta E_k = 1.42$ J **Or** use of $v^2 = u^2 + 2as$ **and** $E_k = \frac{1}{2}mv^2$ $\Delta E_k = 1.42$ J– 1.44J <u>Example of calculation</u> $\Delta E_k = m\ g\ \Delta h = 57.0 \times 10^{-3}$ kg × 9.81 N kg^{-1} × 2.54 m = 1.42 J	**(1)** **(1)** **(1)** **(1)**	**2**
***17(b)(i)**	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate** **Max 4** (Average) kinetic energy of molecules is greater **Or** molecules move faster Volume available decreases (So) collision rate with walls of container is greater There is a greater rate of change of momentum Therefore a greater force on the container walls (dependent on MP4)	 **(1)** **(1)** **(1)** **(1)** **(1)**	**4**
17(b)(ii)	Use of $pV = NkT$ with T in K or °C T_2 = 299 K or 26 °C <u>Example of calculation</u> $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ $T_2 = \frac{197 \times 10^3 \text{ Pa} \times 101 \times 10^{-6} \text{ m}^3}{182 \times 10^3 \text{ Pa} \times 107 \times 10^{-6} \text{ m}^3} \times 293\text{K} = 299.4\text{ K}$	**(1)** **(1)**	**2**

17(b)(iii)	Use of $pV = NkT$ $N = 4.8 \times 10^{21}$ Using $E_k = \frac{3}{2}kT$ with 2 temperatures Use of $E = N E_k$ using their value for N or show that value <u>Example of calculation</u> $N = \frac{p.V}{kT} = \frac{182 \times 10^3\,\text{Pa} \times 107 \times 10^{-6}\,\text{m}^3}{1.38 \times 10^{-23}\,\text{JK}^{-1} \times (273+20)\text{K}} = 4.82 \times 10^{21}$ $\Delta E_k = \frac{3}{2}k\Delta T$ $\Delta E_{\text{k,total}} = 4.82 \times 10^{21} \times 1.5 \times 1.38 \times 10^{-23}\,\text{J K}^{-1} \times (299 - 293)\text{K} = 0.599\text{J}$	**(1)** **(1)** **(1)** **(1)**	**4**
17(b)(iv)	Less <u>kinetic</u> energy after bounce, **so** bounce height less (than release height) Energy is dissipated during bounce (Idea that not all thermal energy will return to kinetic energy of the ball)	**(1)** **(1)**	**2**
	Total for Question 17		**14**

Question Number	Answer		Mark
18(a)(i)	Can't say when a nucleus will decay **Or** which nucleus will decay next	**(1)**	**1**
18(a)(ii)	Cannot influence when a nucleus will decay	**(1)**	**1**
18(b)(i)	Top line correct Bottom line correct $^{210}Po \rightarrow _{82}Pb + _{2}\alpha$	**(1)** **(1)**	**2**
18(b)(ii)	Use of $\frac{1}{2}mv^2$ $v = 1.6 \times 10^7$ (m s^{-1}) <u>Example of calculation</u> $\frac{1}{2}mv^2 = 8.5 \times 10^{-13}$ J $v = \sqrt{\frac{2 \times 8.5 \times 10^{-13} \text{ J}}{6.64 \times 10^{-27} \text{ kg}}} = 1.60 \times 10^7 \text{ m s}^{-1}$	**(1)** **(1)**	**2**
18(b)(iii)(1)	momentum is conserved **Or** total momentum is constant Polonium/Final /initial momentum is zero	**(1)** **(1)**	**2**
18(b)(iii)(2)	Use of $m_{Pb}v_{Pb} = m_\alpha v_\alpha$ $v_{Pb} = 3.9 \times 10^5$ m s^{-1} (use of $v_\alpha = 1.6 \times 10^7$ gives $v_{Pb} = 3.1 \times 10^5$ m s^{-1} scores both marks) <u>Example of calculation</u> $v_{Pb} = \frac{m_\alpha}{m_{Pb}} \times v_{Pb} = \frac{4\text{ u}}{206\text{ u}} \times 2 \times 10^7 \text{ m s}^{-1} = 3.88 \times 10^5 \text{ m s}^{-1}$	**(1)** **(1)**	**2**

18(b)(iv)	Although the alpha has a smaller mass it has a bigger velocity/speed **(1)** And velocity/speed is squared in the energy expression **(1)** **Or** Both particles have the same momentum **(1)** $E_k = p^2/2m$ so alpha has more energy, since it has a smaller mass **(1)**		**2**
18(c)(i)	Use of $P = E \times \frac{\Delta N}{\Delta t}$ **(1)** P = 69 (W) **(1)** <u>Example of calculation</u> $P = E \times \frac{\Delta N}{\Delta t} = 8.5 \times 10^{-13}\,\mathrm{J} \times 8.1 \times 10^{13}\,\mathrm{s}^{-1} = 68.9\,\mathrm{W}$		**2**
18(c)(ii)	Use of $t_{1/2} = \frac{\ln 2}{\lambda}$ **(1)** $t_{1/2}$ = 139 days **(1)** links (short) half life to activity/ power (dependent mark) **(1)** **Or** use exponential equation to find activity/power after at least one year **(1)** Decay constant and time in complementary units **(1)** The idea that the activity/power is too small (dependent mark) **(1)** <u>Example of calculation</u> $t_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{5.0 \times 10^{-3}\,\mathrm{day}^{-1}} = 138.6\,\mathrm{day}$		**3**
	Total for Question 18		**17**

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