Mark Scheme (Results)

January 2016

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. '<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] **3**
[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

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

Question Number	Answer	Mark
11(a)	The B.E. per nucleon for ^{4}He is greater/higher/larger (than other small nuclei) **Or** The B.E. per nucleon for ^{4}He is (relatively) large/high (1) (Hence) the energy released by the nucleus is greatest for alpha-decay **Or** The ^{4}He nucleus is the most stable (of the small nuclei) (1)	**2**
11(b)	The idea that some massive/heavy nuclei can undergo (induced) fission **Or** massive nuclei can be made to split into smaller nuclei (accept nuclei with large number of nucleons) (1) (The graph shows that) massive/heavy nuclei have less B.E.(per nucleon) than the (less massive) nuclei produced in the fission (1) (Hence) energy is released in the fission (1)	**3**
	Total for Question 11	**5**

Question Number	Answer		Mark
12(a)	Use of $\Delta E = mc\Delta T$ $\Delta E = 1.7 \times 10^7$ J <u>Example of calculation</u> $\Delta E = mc\Delta T = 275\,\text{kg} \times 3.59 \times 10^3\,\text{J kg}^{-1}\,\text{K}^{-1} \times (18.5 - 1.5)\,\text{K}$ $\Delta E = 1.68 \times 10^7\,\text{J}$	(1) (1)	**2**
12(b)	Use of $P = \frac{\Delta W}{\Delta t}$ Valid attempt at calculation of ΔT **Or** Valid attempt at calculation of "safe" time [t =3430 s if $\Delta\theta = 4\,^{o}$C] Conclusion that θ > 4 (^{o}C) (so meat may be unsafe to eat) **Or** "Safe" time less than 3600 s (so meat may be unsafe to eat) <u>Example of calculation</u> $\Delta W = Pt = 720\,\text{W} \times 3600\,\text{s} = 2.59 \times 10^6\,\text{J}$ $\Delta\theta = \frac{\Delta W}{mc} = \frac{2.59 \times 10^6\,\text{J}}{275\,\text{kg} \times 3.59 \times 10^3\,\text{Jkg}^{-1}\text{K}^{-1}} = 2.6\,\text{K}$	(1) (1) (1)	**3**
	Total for Question 12		**5**

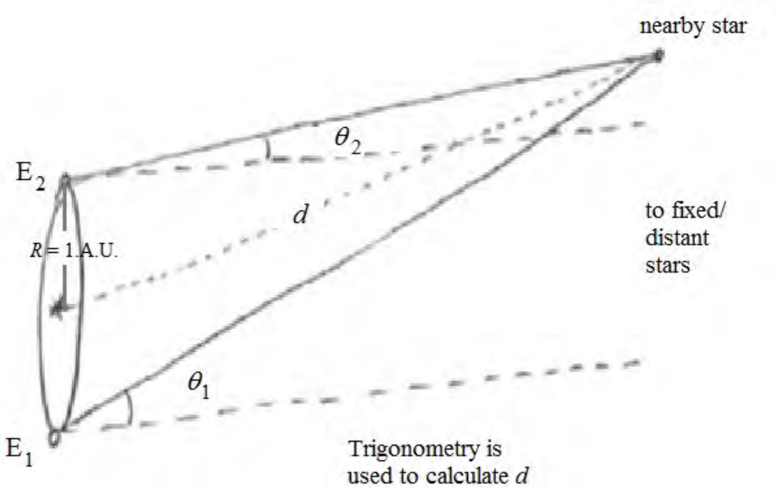
Question Number	Answer		Mark
13(a)	Idea that bridge is being forced/driven into oscillation At its natural frequency (accept "close to" for "at") Resulting in a maximum transfer of energy to the bridge **Or** Appropriate reference to resonance	(1) (1) (1)	**3**
13(b)	See $\lambda = 2l$ Use of $v = f\lambda$ v = 100 m s^{-1} <u>Example of calculation</u> $\lambda = 2l = 2\times91 = 182$ m $v = f\lambda = 0.55\,\text{Hz} \times 182\,\text{m} = 100.1\,\text{m s}^{-1}$	(1) (1) (1)	**3**
	Total for Question 13		**6**

Question Number	Answer		Mark
14(a)(i)	Standard candle has a known luminosity	(1)	
	(Radiation) flux/brightness of standard candle is measured at the Earth	(1)	
	Inverse square law used to calculate distance **Or** reference to $F = \dfrac{L}{4\pi d^2}$ with L and F identified as luminosity and radiation flux	(1)	**3**
14(a)(ii)	Idea that (radiation) flux/brightness/intensity is too small to measure (for more distant galaxies) (accept idea of not enough light arriving)	(1)	**1**
***14(b)**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)**		
	Doppler shift formula used to calculate velocities (accept $\dfrac{\Delta\lambda}{\lambda} = \dfrac{v}{c}$ **Or** $\dfrac{\Delta f}{f} = \dfrac{v}{c}$ **Or** $z = \dfrac{v}{c}$ for "Doppler shift formula")	(1)	
	Nebulae/galaxies were moving away from the Earth	(1)	
	The further away the galaxy the faster it was moving (from the Earth) **Or** correct reference to the Hubble equation, $v = H_0 d$ with symbols defined	(1)	
	Therefore <u>all</u> galaxies are moving away from each other (so universe must be expanding)	(1)	**4**
	Total for Question 14		**8**

Question Number	Answer		Mark
15(a)	Use of $pV = NkT$	(1)	
	Conversion of temperature to K	(1)	
	Number of breaths = 135 (reverse calculation starting with 140 breaths gives $V = 6.79 \times 10^{-2}$ m^3 2 marks max here)	(1)	**3**
	<u>Example of calculation</u> $N = \frac{pV}{kT} = \frac{1.05\times10^5\,Pa\times6.55\times10^{-2}\,m^3}{1.38\times10^{-23}\,JK^{-1}\times(273+22)K} = 1.69\times10^{24}$ $\text{Number of breaths} = \frac{1.69\times10^{24}}{1.25\times10^{22}} = 135$		
15(b)	Use of $pV = NkT$	(1)	
	$p = 1.08 \times 10^5$ Pa	(1)	**2**
	(Only penalise Kelvin conversion once in (a) & (b) accept $p = 1.43 \times 10^5$ Pa if temperature not converted to K and this error already penalised in (a))		
	<u>Example of calculation</u> $\frac{p_2}{p_1} = \frac{T_2}{T_1}$ $p_2 = 1.05\times10^5\,\text{Pa}\times\frac{(273+30)\text{K}}{(273+22)\text{K}} = 1.078\times10^5\,\text{Pa}$		
15(c)	(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)		
	(Average) <u>kinetic</u> energy of molecules/atoms is greater **Or** molecules/atoms move faster	(1)	
	Collision rate with walls of container is greater	(1)	
	There is more momentum/impulse (exchanged) per collision **Or** the rate of change of momentum is greater	(1)	
	Therefore a greater force on the container walls (dependent upon MP2 or MP3)	(1)	**4**
	Total for Question 15		**9**

Question Number	Answer		Mark
16(a)	see $g = \frac{GM}{r^2}$ with an attempt to use equation Use of ratio **Or** Calculate value for GM or M **and** use equation again g_2 = 8.3 (N kg^{-1}) (full credit can be given to candidates who correctly recall the mass of the Earth) <u>Example of calculation</u> $\frac{g_1}{g_2} = \frac{r_2^2}{r_1^2}$ $g_1 = 9.81\,\text{N kg}^{-1} \times \frac{(6.36\times10^3\,\text{km})^2}{(6.36\times10^3\,\text{km} + 569\,\text{km})^2} = 8.26\,\text{N kg}^{-1}$	(1) (1) (1)	3
16(b)	Use of *mg* **Or** use of *GMm/r*^{2} Use of $m\omega^2 r$ **Or** $\frac{mv^2}{r}$ (seeing $mg = m\omega^2 r$ or $mg = \frac{mv^2}{r}$ with no substitution scores 1 mark) Use of $\omega = \frac{2\pi}{T}$ **Or** v = 2πr/T *T* = 5760 s (1.6 h) (show that value → 5850 s; accept any value that correctly uses a value of g that would round to 8) <u>Example of calculation</u> $mg = m\omega^2 r$ $\omega = \sqrt{\frac{g_1}{r}} = \sqrt{\frac{8.26\,\text{N kg}^{-1}}{(6.36\times10^6\,\text{m} + 5.69\times10^5\,\text{m})}} = 1.09\times10^{-3}\,\text{rad s}^{-1}$ $T = \frac{2\pi}{\omega} = \frac{2\pi\,\text{rad}}{1.09\times10^{-3}\,\text{rad s}^{-1}} = 5755\,\text{s}$	(1) (1) (1) (1)	4
16(c)	**Max 2** Orbit must be higher (to increase orbital time) Has an orbital time of 24 hours (so that satellite orbits with the Earth) The orbit must be in a equatorial plane (so that satellite orbits with the Earth)	 (1) (1) (1)	2
	Total for Question 16		**9**

Question Number	Answer		Mark
17(a)(i)	Peak wavelength is in the middle of the visible region of the electromagnetic spectrum	(1)	**1**
17(a)(ii)	Curve A because λ_{max} is smaller **Or** curve A because peak is shifted left	(1)	**1**
17(a)(iii)	(The curve peaks at a smaller wavelength so) the star emits more blue/UV radiation The area under the curve is larger so the star has a greater power output (per unit surface area of the star) **Or** the peak of the curve is higher so the star has a greater power output (per unit surface area of the star) (credit can be given for candidates who incorrectly identify curve C.)	(1) (1)	**2**
17(b)	We need to know/determine the star's luminosity *(L)* and it's (surface) temperature (*T*) *r* is calculated using Stefan's Law [accept reference to $L = 4\pi r^2 \sigma T^4$ if *L* and *T* defined] **Or** *L* and *T* plotted on Hertzsprung-Russell diagram and star type identified	(1) (1) (1)	**3**

17(c)	The star is viewed from two positions at 6 month intervals **Or** the star is viewed from opposite ends of the diameter of the Earth's orbit about the Sun	(1)	
	The change in angular position of the star against backdrop of distant/fixed stars is measured	(1)	
	Trigonometry is used to calculate the distance to the star [Do not accept Pythagoras]	(1)	
	The diameter/radius of the Earth's orbit about the Sun must be known	(1)	**4**
	Full marks may be obtained from a suitably annotated diagram  [Accept the symmetrical diagram seen in many text books]		
	Total for Question 17		**11**

Question Number	Answer		Mark
18(a)	Top line correct Bottom line correct $\text{Pb} \rightarrow {}^{212}_{83}\text{Bi} + {}^{0}_{-1}\beta^{-}$	(1) (1)	**2**
18(b)(i)	Half life is the average/mean time taken for half of the (unstable) nuclei/atoms to decay **Or** Half life is the average/mean time taken for the rate of decay of (unstable) nuclei/atoms to fall to half of its original value	(1) (1)	**1**
18(b)(ii)	Use of $\lambda t_{1/2} = \ln(2)$ $\lambda = 1.8 \times 10^{-5}$ (s^{-1}) Use of $N = N_0 e^{-\lambda t}$ **Or** a calculation of the number of half-lives and use of the halving rule $N/N_0 = 0.21$ (0.18 if “show that” value used) Example of calculation $\lambda = \frac{0.693}{3.83 \times 10^4 \text{s}} = 1.81 \times 10^{-5} \text{s}^{-1}$ $\frac{N}{N_0} = \text{e}^{-1.8\times10^{-5}\text{s}^{-1}\times86400\,\text{s}} = 0.208$	(1) (1) (1) (1)	**4**
18(b)(iii)	Use of $\Delta E = c^2 \Delta m$ $\Delta m = 1.0 \times 10^{-30}$ kg Example of calculation $\Delta m = \frac{\Delta E}{c^2} = \frac{9.12 \times 10^{-14}\,\text{J}}{(3 \times 10^8\,\text{m}\,\text{s}^{-1})^2} = 1.01 \times 10^{-30}\,\text{kg}$	(1) (1)	**2**
18(c)	An indication of increased/greater activity (from bismuth) Due to presence of beta particles (as Alpha particles cannot penetrate the bean plant)	(1) (1)	**2**
18(d)	The idea that the material, by absorbing neutrons, reduces the number of neutrons available to cause further fission.	(1)	**1**

18(e)	Fusion reactors use hydrogen as their fuel which is very abundant whereas the fuel for fission reactors is limited (1) Fusion reactors would produce less radioactive waste than fission reactors **Or** helium produced which isn't radioactive unlike products of fission. (Do not accept references to "greener", "more environmentally friendly" or "safer". (1) Fusion requires very high temperatures (and densities) (1) These extreme conditions lead to confinement problems (1) So very strong magnetic fields are required **Or** contact with container causes temperature to fall and fusion to cease **Or** at the moment input energy would be greater than output energy. (1)	**5**
	Total for Question 18	**17**