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Mark Scheme (Results)

January 2015

Pearson Edexcel International Advanced Level in Physics (WPH05) Paper 01

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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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

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] **3**
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

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.

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

Question Number	Answer	Mark
11	Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ **(1)** Use of $\omega = \frac{v}{r}$ **(1)** $\omega = 3.0 \times 10^{-6}$ rad s^{-1} **(1)** <u>Example of calculation</u> $v = c \times \frac{\Delta\lambda}{\lambda} = 3\times10^{8}\ \mathrm{m\,s^{-1}} \times \frac{3.4\times10^{-3}}{490} = 2.08\times10^{3}\ \mathrm{m\,s^{-1}}$ $\omega = \frac{v}{r} = \frac{2.08\times10^{3}\ \mathrm{m\,s^{-1}}}{0.7\times10^{9}\ \mathrm{m}} = 2.97\times10^{-6}\ \mathrm{rad\,s^{-1}}$	**3**
	Total for Question 11	**3**

Question Number	Answer	Mark
12(a)	Use of $pV = NkT$ **(1)** N = 2.3 × 10^{26} **(1)** <u>Example of calculation:</u> T = (18 + 273) = 291 K $N = \frac{pV}{kT} = \frac{0.11 \times 10^6 \text{ Pa} \times 8.5 \text{ m}^3}{1.38 \times 10^{-23} \text{ J K}^{-1} \times 291 \text{K}} = 2.33 \times 10^{26}$	**2**
***12(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Mean kinetic energy of molecules (in balloon) increases **(1)** Collision rate of molecules with balloon increases **Or** molecules collide with balloon more frequently **(1)** Greater change of momentum per collision (so greater force) **Or** rate of change of momentum increases (so greater force) **(1)**	**3**
	Total for Question 12	**5**

Question Number	Answer		Mark
13(a)	(kinetic) energy transferred (from ball to bat) so temperature increases	**(1)**	**1**
13(b)	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$	**(1)**	
	Conversion of temperature to K	**(1)**	
	$\Delta\lambda_{max} = 5 \times 10^{-10}$ m	**(1)**	**3**
	<u>Example of calculation</u> $\Delta\lambda_{max} = \frac{2.898 \times 10^{-3}\,\text{mK}}{(273+20)\text{K}} - \frac{2.898 \times 10^{-3}\,\text{mK}}{(273+20.015)\text{K}} = 5.06 \times 10^{-10}\,\text{m}$		
13(c)	Use of $\Delta E = mc\Delta\theta$	**(1)**	
	$\Delta E = 13$ J	**(1)**	**2**
	<u>Example of calculation:</u> $\Delta E = mc\Delta\theta = 15 \times 10^{-3}\text{ kg} \times 1700\text{ J kg}^{-1}\text{ K}^{-1} \times 0.5\text{ K} = 12.8\text{ J}$		
13(d)	Smaller temperature increase (at the point of impact)	**(1)**	
	Any sensible reason	**(1)**	**2**
	e.g. (compared to wood) the silicone tape may • be a better (thermal) conductor • have a higher (specific) heat capacity • cushion the impact, reducing the impact force		
	Total for Question 13		**8**

Question Number	Answer		Mark
14(a)	Use of $F = \frac{GMm}{r^2}$ **Or** $g = \frac{GM}{r^2}$ **and** $W = mg$ F = 267 N <u>Example of calculation</u> $F = \frac{GMm}{r^2} = \frac{6.67\times10^{-11}\,\text{N m}^2\,\text{kg}^{-2}\times6.42\times10^{23}\,\text{kg}\times72\,\text{kg}}{(0.5\times6.79\times10^{6}\,\text{m})^2} = 267\,\text{N}$	**(1)** **(1)**	**2**
14(b)(i)	See gravitational force expression equated to centripetal force expression Use of $\omega = \frac{2\pi}{T}$ **Or** $v = \frac{2\pi r}{T}$ r = 2.3 × 10^{11} (m) <u>Example of calculation</u> $\omega = \frac{2\pi}{T} = \frac{2\pi\,\text{rad}}{5.94\times10^{7}\,\text{s}} = 1.06\times10^{-7}\,\text{rad s}^{-1}$ $\frac{GMm}{r^2} = m\omega^2 r$ $r = \sqrt[3]{\frac{6.67\times10^{-11}\,\text{N m}^2\,\text{kg}^{-2}\times1.99\times10^{30}\,\text{kg}}{(1.06\times10^{-7}\,\text{m})^2}} = 2.28\times10^{11}\,\text{m}$	**(1)** **(1)** **(1)**	**3**
14(b)(ii)	10% of average radius calculated **Or** 0.9r and 1.1r used Use of $F = \frac{L}{4\pi d^2}$ **Or** $F \propto \frac{1}{d^2}$ $\frac{F_1}{F_2} = 1.5$ <u>Example of calculation</u> $F = \frac{L}{4\pi r^2}$ $\therefore \frac{F_1}{F_2} = \frac{r_2^2}{r_1^2} = \frac{(2.28\times10^{11}\,\text{m} + 0.228\times10^{11}\,\text{m})^2}{(2.28\times10^{11}\,\text{m} - 0.228\times10^{11}\,\text{m})^2} = 1.49$	**(1)** **(1)** **(1)**	**3**
	Total for Question 14		**8**

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Question Number	Answer		Mark
15(a)(i)	Top line correct Bottom line correct $$\text{Al} + {}^{4}_{2}\alpha \rightarrow \text{P} + {}^{1}_{0}\text{X}$$ X is a neutron	**(1)** **(1)** **(1)**	**3**
15(a)(ii)	Attempt at calculation of mass difference Use of $\Delta E = c^2 \Delta m$ Conversion of ΔE to MeV **Or** conversion of kinetic energy of alpha to J E_k = 1.6 MeV **Or** 2.6×10^{-13} J Example of calculation $\Delta m = (26.98154 + 4.001506 - 29.97831 - 1.008665)\text{u}$ $\therefore \Delta \text{m} = -0.003929\text{u}$ $\Delta m = -0.003929\ \text{u} \times 1.66 \times 10^{-27}\ \text{kg} = -6.52 \times 10^{-30}\ \text{kg}$ $\Delta E = c^2 \Delta m = (3 \times 10^8\ \text{m s}^{-1})^2 \times (-6.52 \times 10^{-30}\ \text{kg}) = -5.87 \times 10^{-13}\ \text{J}$ $\Delta E = \dfrac{-5.87 \times 10^{-13}\ \text{J}}{1.6 \times 10^{-13}\ \text{J MeV}^{-1}} = -3.67\ \text{MeV}$ Kinetic energy of particle X = (5.3 MeV–3.7 MeV) = 1.6 MeV	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)	A positron is the antiparticle to the electron **Or** a positron is an anti-electron **Or** a positron has the same mass as an electron but the opposite charge Idea that positron emission increases the number of neutrons in the nucleus	 **(1)** **(1)**	**2**

15(c)(i)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ Use of $A = -\lambda N$ A = 1.0 × 10^{14} Bq <u>Example of calculation</u> $\lambda = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{150\,\text{s}} = 4.62 \times 10^{-3}\,\text{s}^{-1}$ $A = -\lambda N = 4.62 \times 10^{-3}\,\text{s}^{-1} \times 2.2 \times 10^{16} = 1.02 \times 10^{14}\,\text{Bq}$	**(1)** **(1)** **(1)**	**3**
15(c)(ii)	Conversion of time into s Use of $A = A_0 e^{-\lambda t}$ A = 1.6 × 10^{12} Bq **Or** 6 half lives elapsed use of A/2^n A = 1.6 × 10^{12} Bq (ecf answer from (c)(i)) <u>Example of calculation</u> 15 min = 15 × 60 s = 900 s $A = A_0 e^{-\lambda t} = 1.0 \times 10^{14}\,\text{Bq} \times \text{e}^{-4.62 \times 10^{-3}\,\text{s}^{-1} \times 900\,\text{s}} = 1.56 \times 10^{12}\,\text{Bq}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question 15		**15**

Question Number	Answer		Mark
16(a)(i)	resultant force (of magnitude) kx acts on car, where x is displacement from equilibrium position	**(1)**	
	(Appling Newton's 2nd Law) $ma = -k\,x$	**(1)**	
	Identifies $\omega^2 = \dfrac{k}{m}$ (from $a = -\omega^2 x$)	**(1)**	
	Use of $\omega = 2\pi f$ leading to $f = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}}$	**(1)**	**4**
16(a)(ii)	Use of mg = (–)kΔx	**(1)**	
	k = 30.3 (kN m^{-1})	**(1)**	**2**
	Example of calculation $k = \dfrac{mg}{\Delta x} = \dfrac{85.0\,\text{kg} \times 9.81\,\text{N kg}^{-1}}{27.5 \times 10^{-3}\,\text{m}} = 3.03 \times 10^4\,\text{Nm}^{-1}$		
16(a)(iii)	Use of $f = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}}$	**(1)**	
	f = 0.79 Hz	**(1)**	**2**
	Example of calculation $f = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}} = \dfrac{1}{2\pi} \times \sqrt{\dfrac{3.03 \times 10^4\,\text{Nm}^{-1}}{(1130 + 85)\text{kg}}} = 0.7948\,\text{Hz}$		
***16(b)(i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)		
	Idea that damping is the transfer of energy (from the oscillating system)	**(1)**	
	(Damping is desirable because) it reduces amplitude of vibration	**(1)**	
	So that oscillations die away quickly **Or** so that it prevents transfer of energy to oscillation of car body	**(1)**	**3**
16(b)(ii)	Cosine variation (constant time period; frequency of 2 graphs should be approximately equal)	**(1)**	
	Amplitude decreasing with time (dependent upon mp1)	**(1)**	**2**
	Total for Question 16		**13**

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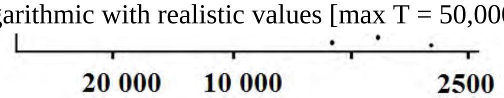
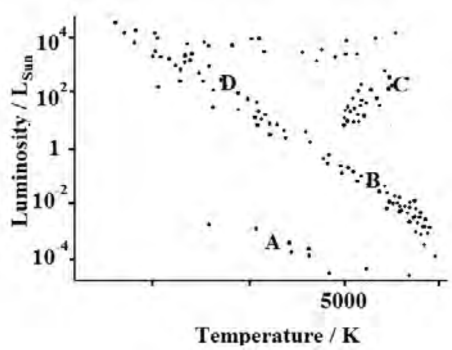
Question Number	Answer		Mark
17(a)(i)	(Extremely dense) to maintain a sufficiently high collision rate (At a very high temperature) to give the nuclei/protons enough energy to overcome the (electrostatic) repulsion **Or** (At a very high temperature) to bring the nuclei/protons close enough to experience the strong (nuclear) force	**(1)** **(1)**	**2**
17(a)(ii)	Gravitational potential energy decreases (as cloud collapses) Decrease in (gravitational) potential energy equals increase in internal energy	**(1)** **(1)**	**2**
17(a)(iii)	Mass is converted to energy according to $\Delta E = c^2 \Delta m$, where Δm is the mass deficit/lost Although energy released per fusion is small, fusion rate is very large	**(1)** **(1)** **(1)**	**3**
17(b)(i)	Reverse scale Logarithmic with realistic values [max T = 50,000 K, min T = 2500 K]  e.g.	**(1)** **(1)**	**2**
17(b)(ii)	A white dwarf B C D main sequence [accept blue giant]	**(1)** **(1)**	**2**
17(b)(iii)	 4 correct labels 2 marks 3 correct labels 1 mark 2 correct labels 1 mark 1 correct label 0 marks	**(2)**	**2**
17(c)(i)	A standard candle is a star of known luminosity	**(1)**	**1**

*17(c)(ii)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) If Polaris were closer, Its ("known") luminosity would be less than had been thought **(1)** Idea that distances to other astronomical bodies would be less than had been thought **(1)** So the Hubble constant would be greater than had been thought **Or** appropriate reference to $v = H_0 d$ **(1)** As age = $1/H_0$, the universe would not be as old as had been thought. **(1)**	**4**
	Total for Question 17	**18**