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Mark Scheme (Results)

Summer 2015

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.

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] ✓ **1**
[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.]

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 $g = 10\ \text{m s}^{-2}$ or $10\ \text{N kg}^{-1}$ instead of $9.81\ \text{m s}^{-2}$ or $9.81\ \text{N kg}^{-1}$ will be penalised by one mark (but not more than once per clip). Accept $9.8\ \text{m s}^{-2}$ or $9.8\ \text{N kg}^{-1}$

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:

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

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

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

$= 49.4\text{ N}$

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.

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

Question Number	Answer	Mark
11	Use of $pV = N\mathrm{k}T$ **(1)** Temperature conversion **(1)** $\Delta N = 5.1 \times 10^{23}$ **(1)** [allow use of $pV = nRT$ and use of $N = n \times N_A$ for mp1] Example of calculation: $\Delta N = \frac{V\Delta p}{\mathrm{k}T} = \frac{0.052\,\mathrm{m}^3 \times (2.0\times10^5 - 1.6\times10^5)\,\mathrm{Pa}}{1.38\times10^{-23}\,\mathrm{J\,K^{-1}}(273+22)\,\mathrm{K}} = 5.11\times10^{23}$	**3**
	Total for Question 11	**3**

Question Number	Answer	Mark
12	Use of $E_\mathrm{k} = ½mv^2$ **(1)** Use of 25% **(1)** Use of $\Delta E = mc\Delta\theta$ **(1)** $\Delta\theta = 39$ K [accept 39°C] **(1)** Example of calculation: $E_\mathrm{k} = \frac{1}{2}mv^2 = 0.5\times1200\,\mathrm{kg}\times(25\,\mathrm{m\,s^{-1}})^2 = 3.75\times10^5\,\mathrm{J}$ $\Delta\theta = \frac{\Delta E}{mc} = \frac{0.25\times3.75\times10^5\,\mathrm{J}}{5.3\,\mathrm{kg}\times450\,\mathrm{J\,kg^{-1}\,K^{-1}}} = 39.3\,\mathrm{K}$	**4**
	Total for Question 12	**4**

Question Number	Answer		Mark
13(a)(i)	Resonance / resonating / resonates	**(1)**	**1**
(a)(ii)	Loudspeaker/driving frequency close or equal to its natural frequency	**(1)**	
	so energy transfer is maximised/large **Or** energy transfer is very efficient	**(1)**	**2**
13(b)	Idea that energy would be transferred (from the glass) to the rubber band (as it deforms) **Or** work is done on the rubber band (by the glass)	**(1)**	
	Some of the (transferred) energy becomes internal energy of rubber band **Or** some of the (transferred) energy is dissipated in the rubber band	**(1)**	**2**
	Total for Question 13		**5**

Question Number	Answer		Mark
14(a)(i)	Use of $\omega = \dfrac{2\pi}{T}$	**(1)**	
	See $F = \dfrac{GMm}{r^2}$ **and** $F = m\omega^2 r$	**(1)**	
	$GM = 4.07 \times 10^{14}$ (m^3 s^{-2})	**(1)**	
	Or		
	Use of $v = \dfrac{2\pi r}{T}$	**(1)**	
	See $F = \dfrac{GMm}{r^2}$ **and** $F = \dfrac{mv^2}{r}$	**(1)**	
	$GM = 4.07 \times 10^{14}$ (m^3 s^{-2})	**(1)**	**3**
	[If reverse "show that" attempted, max 2]		
	Example of calculation:		
	$\omega = \dfrac{2\pi}{T} = \dfrac{2\pi \text{ rad}}{2.36 \times 10^6 \text{ s}} = 2.66 \times 10^{-6} \text{ rad s}^{-1}$		
	$\dfrac{GMm}{r^2} = m\omega^2 r$		
	$GM = \omega^2 r^3 = (2.66 \times 10^{-6} \text{ s}^{-1})^2 \times (3.86 \times 10^8 \text{ m})^3 = 4.07 \times 10^{14} \text{ m}^3 \text{ s}^{-2}$		
14(a)(ii)	Use of $g = \dfrac{GM}{R^2}$ with g = 9.81 N kg^{-1}	**(1)**	
	$R = 6.4 \times 10^6$ m [6.5×10^6 m if show that value used]	**(1)**	**2**
	Example of calculation:		
	$R = \sqrt{\dfrac{GM}{g}} = \sqrt{\dfrac{4.07 \times 10^{14} \text{ m}^3 \text{ s}^{-2}}{9.81 \text{ N kg}^{-1}}} = 6.44 \times 10^6 \text{ m}$		

14(b)	Force varies with distance (from the Earth) according to inverse square law $F \propto \frac{1}{r^2}$ **(1)** so force (on these asteroids) is (very) small **(1)** **Or** Gravitational field strength varies with distance (from the Earth) according to inverse square law $g \propto \frac{1}{r^2}$ **(1)** so gravitational field strength is (very) weak at this distance **(1)** [Accept idea that since the asteroids are much further from the Earth (than the moon) they are only weakly bound (to the Earth) for max 1 mark]		**2**
	Total for Question 14		**7**

Question Number	Answer		Mark
15(a)	Activity is the rate of decay of (unstable) nuclei **Or** activity is the number of (unstable) nuclei that decay in unit time	**(1)**	**1**
15(b)(i)	Background radiation/count will increase the recorded count **Or** background count must be subtracted from the recorded count **Or** background radiation contributes systematic error to the count [Do not accept "to correct for background radiation"]	**(1)**	**1**
15(b)(ii)	Radioactive decay is a random process (so count for a fixed period will vary) [Ignore references to spontaneous, accurate, reliable] Idea that repeating enables a mean/average value to be calculated	**(1)** **(1)**	**2**
15(b)(iii)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ Use of $A = A_0 e^{-\lambda t}$ [allow 2.5 Bq for A_0 here; allow use of $N = N_0 e^{-\lambda t}$] A = 0.47 Bq [Allow calculation of number of half lives elapsed and use of $A = A_0 \left(\frac{1}{2}\right)^{t/t_{1/2}}$ for mp1 and mp2] <u>Example of calculation:</u> $\lambda = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{8.0\,\text{d}} = 0.0866\,\text{d}^{-1}$ $A = A_0 e^{-\lambda t} = 6.38 \times \text{e}^{-0.0866\,\text{d}^{-1} \times 30\,\text{d}} = 6.38\,\text{Bq} \times 0.074 = 0.47\,\text{Bq}$	**(1)** **(1)** **(1)**	**3**
15(b)(iv)	Idea that people have to be close to or ingest seaweed for any degree of risk **Or** β particles are moderately ionising **Or** β particles can enter body through the skin The half-life is short **Or** after a month the activity has decayed to negligible levels **Or** the radioisotope doesn't remain in the seaweed for very long	**(1)** **(1)**	**2**
	Total for Question 15		**9**

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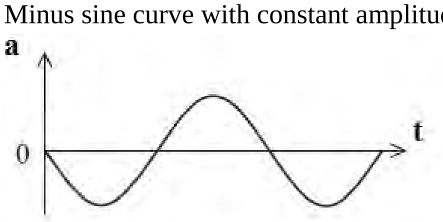
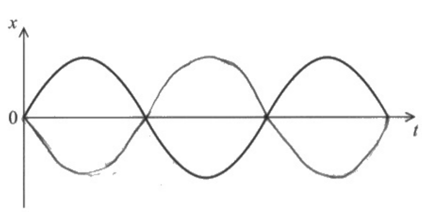
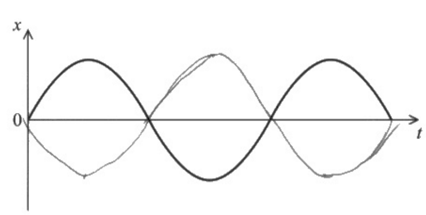
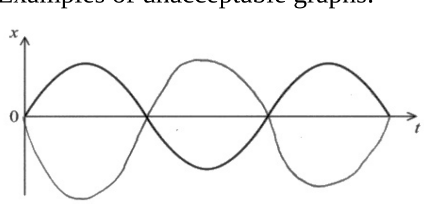
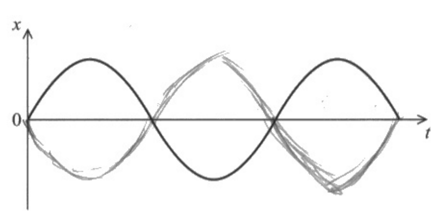
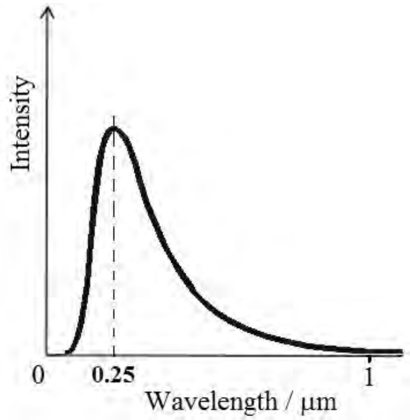
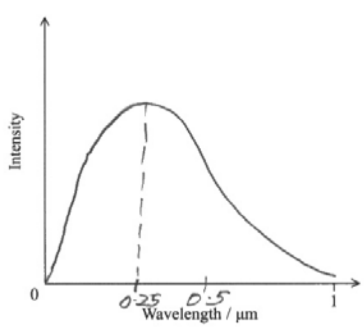
Question Number	Answer		Mark
***16(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Current carrying conductor in a magnetic field Coil experiences a force Current is alternating, so force changes direction with current (same frequency) **Or** Current in coil causes a magnetic field Current is alternating so field changes direction with current (same frequency) Field interacts with permanent magnet's field so coil experiences oscillating force	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
16(b)(i)	Acceleration is: • proportional to displacement from equilibrium position • (always) acting towards the equilibrium position **Or** idea that acceleration is in the opposite direction to displacement **Or** Force is: • proportional to displacement from equilibrium position • (always) acting towards the equilibrium position **Or** idea that force is a restoring force e.g. "in the opposite direction" [accept undisplaced point/fixed point/central point for equilibrium position] [An equation with symbols defined correctly is a valid response for both marks. e.g. $a \propto -x$ **or** $F \propto -x$]	 **(1)** **(1)** **(1)** **(1)**	**2**
16(b)(ii)	Minus sine curve with constant amplitude  Examples of acceptable graphs:  Examples of unacceptable graphs: 	**(1)**	**1**

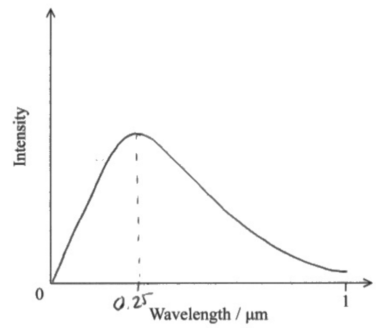
16(c)(i)	Identification of weight and force from cone, F_c, as the two forces acting on the sand **(1)** Weight − $F_c = m\omega^2 x$ **(1)** So as x increases, F_c decreases, sand loses contact with cone when $F_c = 0$ **(1)**		**3**
16(c)(ii)	Resultant force equated to weight **Or** acceleration equated to g **(1)** Use of $\omega = 2\pi f$ **(1)** f = 32 Hz **(1)** <u>Example of calculation:</u> $mg = m\omega^2 x_0$ $\omega = \sqrt{\frac{g}{x_0}} = \sqrt{\frac{9.81\,\mathrm{m\,s^{-2}}}{0.25\times10^{-3}\,\mathrm{m}}} = 198\,\mathrm{rad\,s^{-1}}$ $f = \frac{\omega}{2\pi} = \frac{198}{2\pi} = 31.5\,\mathrm{Hz}$		**3**
	Total for Question 16		**12**

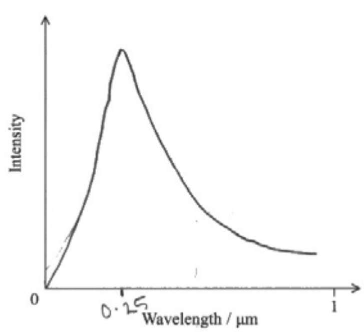
Question Number	Answer		Mark
17(a)	Curve with peak at 0.25μm (labelled or in correct position)	**(1)**	
	Shape must be an asymmetric curve and must not have intensity at $\lambda = 0$	**(1)**	**2**

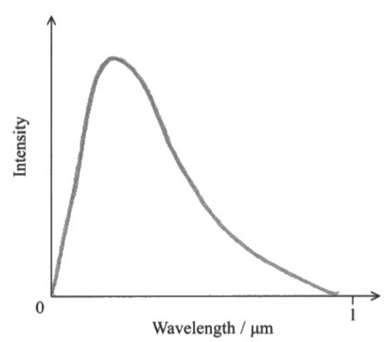


Examples of acceptable shapes:

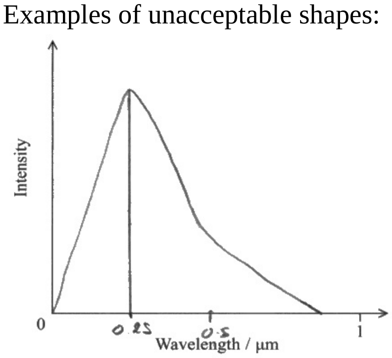


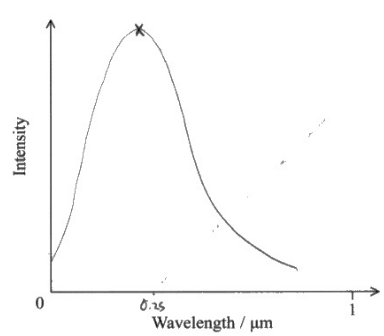




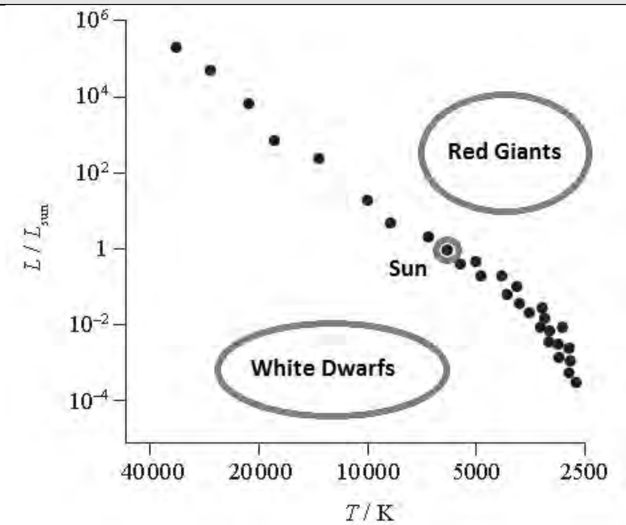


Examples of unacceptable shapes:





17(b)(i)	T = 11 500 K (allow 11 250 K to 11 750 K) **(1)**	**1**
17(b)(ii)	At least 2 pairs of values read from graph **(1)** Use of $\lambda_{max}T$ = constant **(1)** Use values to show $\lambda_{max}T$ = a constant **(1)** <u>Example of calculation:</u> $\lambda_{max}T = 0.25\times10^{-6}\times11500 = 2.9\times10^{-3}$ $\lambda_{max}T = 0.5\times10^{-6}\times5800 = 2.9\times10^{-3}$	**3**
17(c)(i)	A standard candle is a (stellar) object of known luminosity	**1**
***17(c)(ii)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Standard candle's flux/ brightness (on Earth) is measured/determined **(1)** Use inverse square law [Reference to $F=L/4\pi d^2$ with symbols defined] **(1)** (Hence) distance to standard candle is calculated/determined **(1)** [do not accept "measure" or "find" for "calculate"] [accept star/cluster for standard candle] [accept a re-arrangement of $F=L/4\pi d^2$ with d as subject as indication that d is calculated]	**3**
17(c)(iii)	Idea that trigonometric parallax is the change in position of a star against the background of more distant stars **Or** parallax angle is the angle subtended at the star by the radius of the Earth's orbit **(1)** [Mark can be obtained from a fully labelled diagram] If star is too distant the angle is too small to measure **(1)**	**2**
	Total for Question 17	**12**

Question Number	Answer		Mark
18(a)			
(i)	Sun's position identified [single point identified]	**(1)**	
(ii)	White dwarf region Red giant region	**(1)** **(1)**	**3**
*18(a)(iii)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) White dwarf stars have: high temperature *T* (because λ_{max} is small) low luminosity *L* $L = \sigma A T^4$ linked to a determination of the surface area	 **(1)** **(1)** **(1)**	**3**
18(b)	The star cools, so temperature *T* reduces The star contracts (under gravitational forces), so area *A* reduces $L = \sigma A T^4$ hence L is reduced (mark dependent upon either mp1 or mp2)	**(1)** **(1)** **(1)**	**3**
18(c)(i)	$^{7}_{3}\text{Li} + {}^{1}_{1}\mathbf{X} \rightarrow 2\times {}^{4}_{2}\text{He}$ X is a proton [Accept X is hydrogen/H]	**(1)** **(1)**	**2**
18(c)(ii)	Attempt at calculation of mass difference Use of 1 MeV = 1.60×10^{-13} J $\Delta E = 2.77 \times 10^{-12}$ (J) <u>Example of calculation:</u> $\Delta m = 6533.8\text{MeV/c}^2 + 938.3\text{MeV/c}^2 - (2\times 3727.4\text{MeV/c}^2) = 17.3\text{MeV/c}^2$ $\Delta E = 17.3\text{MeV}$ $\Delta E = 17.3\text{MeV}\times 1.60\times 10^{-13}\,\text{J MeV}^{-1} = 2.768\times 10^{-12}\,\text{J}$	**(1)** **(1)** **(1)**	**3**

18(d)	**Max 4** • Extremely high temperature and density needed **(1)** • High temperature because nuclei need high <u>energy</u> to overcome the (electrostatic) repulsive force **(1)** • Since nuclei must come very close for fusion to occur **Or** since nuclei must come close enough for (strong) nuclear force to act **(1)** • Very high density is needed to maintain a sufficient collision rate **(1)** • Reference to extreme conditions leading to containment problems **(1)**	**4**
	Total for Question 18	**18**

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