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Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE
in Physics (6PH05)
Paper 01R
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)	<u>Horizontal force of hinge on table top</u> 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] [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	B	**1**
2	B	**1**
3	D	**1**
4	D	**1**
5	D	**1**
6	A	**1**
7	D	**1**
8	C	**1**
9	C	**1**
10	A	**1**

Question Number	Answer	Mark
11	**MAX 3** Curve A: The system has a maximum amplitude at a particular frequency **(1)** This is an example of resonance **(1)** Resonance occurs when the forcing frequency is at (or near to) the natural frequency of the system **(1)** At resonance there is an efficient/maximum transfer of energy (to the mass-spring system) **(1)** **MAX 3** Curve B: B has a smaller amplitude than A (for a wide range of frequencies) **(1)** The modified system has (greater) damping **(1)** Energy is being removed from the system **(1)** The frequency at which resonance occurs is lower for the damped system **(1)**	**4**
	Total for question 11	**4**

Question Number	Answer	Mark
12(a)(i)	(Small mass) nuclei come very close together **Or** strong (nuclear) force acts on nuclei **(1)** Nuclei join to form a more massive nucleus **(1)**	**2**
12(a)(ii)	A very/extremely high temperature (plasma) is required **(1)** Plasma must not touch reactor walls, so strong magnetic fields are required **Or** If plasma touches the walls of the reactor its temperature falls (and fusion stops) **(1)**	**2**
12(b)	Mass of fused nucleus is less than sum of masses of fusing nuclei **(1)** Mass difference/deficit releases energy according to $\Delta E = c^2\Delta m$ **Or** Binding energy per nucleon is greater in the fused nucleus; **Or** Strong (nuclear) force binds the nucleons, lowering total energy of system. **(1)**	**2**
	Total for question 12	**6**

Question Number	Answer	Mark
***13**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Gravitational fields are regions in which a mass experiences a force due to its mass **(1)** Electric fields are regions in which a charge experiences a force due to its charge **(1)** Both types of field have an infinite range **(1)** In each type of field the force varies as an inverse square **(1)** The force between masses is always attractive whereas the force between charges can be attractive or repulsive **Or** electric fields can cancel or reinforce but gravitational fields always reinforce one another **(1)** The force between (unit) charges at a given separation is much stronger than the force between (unit) masses at the same separation **(1)**	**6**
	Total for question 13	**6**

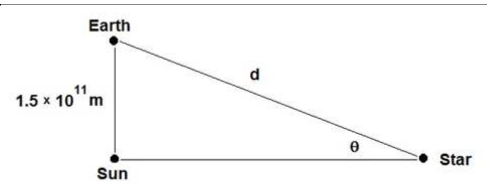
Question Number	Answer	Mark
14(a)(i)	Alpha particles ionise the air **Or** alpha particles strip electrons from air molecules **(1)** The ions/electrons move (in the electric field between the plates) **(1)**	**2**
14(a)(ii)	Smoke particles capture electrons (and reduce the free charge able to move) **Or** alpha particles collide with smoke particles and reduce amount of ionisation **(1)**	**1**
14(b)(i)	Random means we cannot identify which atom/nucleus will be the next to decay **Or** we cannot identify when an individual atom/nucleus will decay **Or** we cannot state exactly how many atoms/nuclei will decay in a set time **Or** we can only estimate the fraction that will decay in the next time interval **(1)** Spontaneous means that the decay cannot be influenced by any (external) factors. **(1)**	**2**
14(b)(ii)	${}_{95}\mathrm{Am} \rightarrow {}^{237}\mathrm{Np} + {}^{4}_{2}\alpha$ Top line correct **(1)** Bottom line correct **(1)**	**2**
	Total for question 14	**7**

Question Number	Answer	Mark
15(a)	The water molecules will have a greater average K.E. **Or** the water will be hotter **Or** less energy transferred to teapot **(1)**	**1**
15(b)(i)	Use of $\Delta E = mc\Delta\theta$ **(1)** ΔE = 15 000 J **(1)** <u>Example of calculation:</u> $\Delta E = mc\Delta\theta = 0.26 \text{ kg} \times 4200 \text{ J kg}^{-1} \text{ K}^{-1} \times (95 - 81) \text{ K} = 15\,300 \text{ J}$	**2**
15(b)(ii)	Assumption: no heat is lost to the surroundings **Or** all energy goes to the teapot **(1)** Use of ΔE value from (i) in $\Delta E = mc\Delta\theta$ **(1)** c = 600 (J kg^{-1} K^{-1}) **(1)** <u>Example of calculation:</u> $c = \frac{\Delta E}{m\Delta\theta} = \frac{15300 \text{ J}}{0.43 \text{ kg} \times (81-22) \text{ K}} = 603 \text{ J kg}^{-1} \text{ K}^{-1}$	**3**
15(b)(iii)	(The calculated value for the specific heat capacity has been overestimated) because energy is transferred to the surroundings (by heating) **(1)** so the energy gained by the teapot has been overestimated **(1)**	**2**
	Total for question 15	**8**

Question Number	Answer		Mark
16(a)	Activity is the rate of <u>decay</u> (of radioactive nuclei) **Or** the number of <u>decays</u> in a second	**(1)**	**1**
16(b)	Use of $\lambda t_{1/2} = 0.693$ Use of $A = -\lambda N$ $N = 1.9 \times 10^{12}$ <u>Example of calculation:</u> $\lambda = \dfrac{0.693}{3.89 \times 10^{8}\ \text{s}} = 1.78 \times 10^{-9}\ \text{s}^{-1}$ $N = \dfrac{3450\ \text{s}^{-1}}{1.78 \times 10^{-9}\ \text{s}^{-1}} = 1.94 \times 10^{12}$	**(1)** **(1)** **(1)**	**3**
16(c)(i)	Use of $A = A_0 e^{-\lambda t}$ Conversion between seconds and years t = 41 (years) <u>Example of calculation:</u> $0.1 = e^{-(1.78\times10^{-9} s^{-1})t}$ $t = 1.29 \times 10^{9}$ s $t = 1.29 \times 10^{9}$ s /(365×24×3600 s y^{-1}) = 41 y	**(1)** **(1)** **(1)**	**3**
16(c)(ii)	This is a very long time and so: The sample's activity will stay approx. constant for the procedure **Or** tritium may be in the body long enough for damage to be caused **Or** the sample can be prepared well in advance of the procedure	 (1) (1) (1)	**1**
	Total for question 16		**8**

Question Number	Answer	Mark
17(a)(i)	See $F = GMm/r^2$ **(1)** Equated to mg to give required expression **Or** use of g = F/m **(1)**	2
17(a)(ii)	Use of $g = \omega^2 r$ OR $g = v^2/r$ **(1)** Use of $\omega = 2\pi/T$ OR $v = 2\pi r/T$ **(1)** Correct algebra leading to expression given **(1)** <u>Example of calculation:</u> $\omega^2 r = \frac{GM}{r^2}$ $\left(\frac{2\pi}{T}\right)^2 = \frac{GM}{r^3}$ $r^3 = \frac{GMT^2}{4\pi^2}$	3
17(a)(iii)	See T = 24 hours **(1)** T converted into s **(1)** $r = 4.2 \times 10^7$ m **(1)** <u>Example of calculation:</u> $T = 24 \times 60 \times 60 \text{ s} = 86\,400 \text{ s}$ $r^3 = \frac{GMT^2}{4\pi^2} = \frac{6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \times 6.0 \times 10^{24} \text{ kg} \times (86400 \text{ s})^2}{4\pi^2} = 7.57 \times 10^{22} \text{ m}^3$ $r = \sqrt[3]{7.57 \times 10^{22} \text{ m}^3} = 4.23 \times 10^7 \text{ m}$	3
17(b)	The satellite must rotate with the Earth **Or** the satellite must be in a geosynchronous orbit **Or** any non-equatorial orbit would cause the satellite to move N-S	1
	Total for question 17	**9**

Question Number	Answer	Mark
18(a)	Force (or acceleration): • proportional to displacement from equilibrium/undisplaced/rest position **(1)** • always acting towards the equilibrium/undisplaced/rest position **Or** always in the opposite direction to the displacement **(1)**	**2**
18(b)(i)	Acceleration is a maximum at an extreme position (towards X) **(1)** Acceleration decreases to zero at X **(1)**	**2**
18(b)(ii)	**Max 3** Total energy remains constant **(1)** (Elastic) potential energy is transferred to kinetic energy as string moves towards X **(1)** Kinetic energy is zero at an extreme position and a maximum at X **(1)** (Elastic) potential energy is a maximum at an extreme position and a minimum at X **(1)**	**3**
18(c)	Use of $\lambda = 2l$ **(1)** Use of $v = f\lambda$ **(1)** $f = 250$ Hz **(1)** <u>Example of calculation:</u> $\lambda = 2 \times 0.53 \text{ m} = 1.06 \text{ m}$ $f = v/\lambda = 270 \text{ m s}^{-1}/1.06 \text{ m} = 254.7 \text{ Hz}$	**3**
	Total for question 18	**10**

Question Number	Answer		Mark
19(a)	**Max 6**		
	The young star cluster consists (mainly) of main sequence stars	**(1)**	
	The old star cluster has a truncated main sequence	**(1)**	
	The old star cluster has lost its heaviest main sequence stars	**(1)**	
	The old star cluster has (many) red giant stars	**(1)**	
	The old star cluster has (some) white dwarf stars	**(1)**	
	Massive main sequence stars are the first stars (to deplete sufficient hydrogen in their core) to evolve into red giant stars.	**(1)**	
	Some red giant stars have evolved into white dwarf stars in the old cluster	**(1)**	**6**
19(b)(i)	Star A is closer to Earth than Star B	**(1)**	**1**
19(b)(ii)			
	Use of appropriate trigonometric relationship	**(1)**	
	$d = 4.0 \times 10^{16}$ m	**(1)**	**2**
	<u>Example of calculation:</u> $\sin\theta = \frac{1.5\times10^{11}\text{ m}}{d}$ $d = 4.01 \times 10^{16}$ m		
19(c)	$\lambda_{max} = 1.0 \times 10^{-6}$ m	**(1)**	
	Use of $\lambda_{max} T = 2.9 \times 10^{-3}$	**(1)**	
	$T = 2900$ K	**(1)**	**3**
	<u>Example of calculation:</u> $T = 2.9 \times 10^{-3}$ m K/1.0×10^{-6} m = 2900 K		
	Total for question 19		**12**

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