Mark Scheme (Results)

October 2017

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.

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.

Physics Specific Marking Guidance

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:

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.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

Mark scheme format

- Bold lower case will be used for emphasis.
- Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
- Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

Unit error penalties

- A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
- Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
- 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.
- The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
- 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.
- The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

Significant figures

- 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.
- Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
- Using $g = 10\ m\ s^{-2}$ will be penalised.

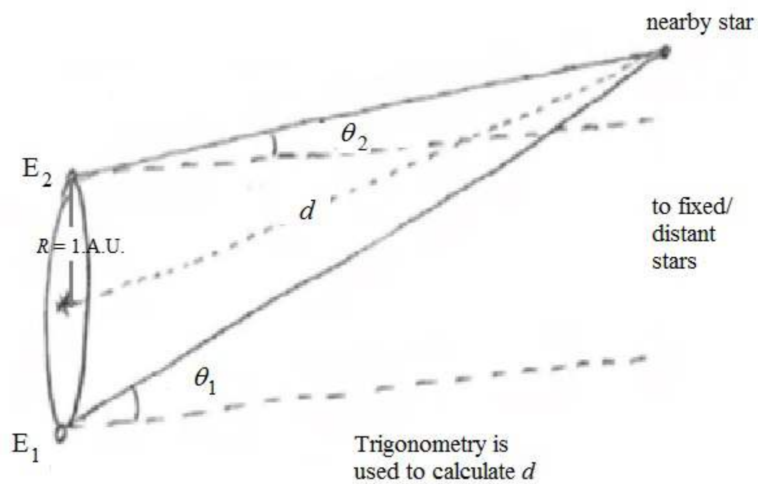
Calculations

- Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
- Rounding errors will not be penalised.
- 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.
- 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.
- Recall of the correct formula will be awarded when the formula is seen or implied by substitution.
- The mark scheme will show a correctly worked answer for illustration only.

Question Number	Answer	Mark
1	**The only correct answer is D** *A is not correct because α particles would be absorbed by the aluminium* **B** *is not correct becauseß particles would be absorbed by the aluminium* *C is not correct becauseß particles would be absorbed by the aluminium*	**1**
2	**The only correct answer is C** *A is not correct becauseMore than 50% will remain after < 1 half lifetime* *B is not correct because50% will remain after 1 half lifetimes* *D is not correct because12.5% will remain after 3 half lifetimes*	**1**
3	**The only correct answer is B** *A is not correct because:* $\sqrt{m_A/m_B} = 0.5$ *C is not correct because:* $m_B / m_A = 0.5$ *D is not correct because:* $\sqrt{m_B/m_A} = 0.5$	**1**
4	**The only correct answer is C** *A is not correct because pressure would increase* *B is not correct because pressure would increase* *D is not correct because pressure would increase*	**1**
5	**The only correct answer is A** *B is not correct because this is half the field strength at O due to one of the stars* **C** *is not correct because this is the field strength at O due to one of the stars* *D is not correct because this is the field strength at O ignoring the direction of the fields*	**1**
6	**The only correct answer is C** *A is not correct because this would change the frequency of vibration of the string* *B is not correct because this would change the frequency of vibration of the string* *D is not correct because this would change the frequency of vibration of the string*	**1**
7	**The only correct answer is A** *B is not correct because the Frequency received would be lower* *C is not correct because the Frequency received would be lower* *D is not correct because it would have a Negligible effect on the received frequency*	**1**

8	**The only correct answer is A** ***B*** *is not correct because pV stays constant so temperature stays constant* ***C*** *is not correct because pV decreases so temperature decreases* ***D*** *is not correct because pV stays constant so temperature stays constant*	**1**
9	**The only correct answer is D** ***A*** *is not correct because Many stars have become red giants and white dwarfs* ***B*** *is not correct because Most stars have become red giants and white dwarfs* ***C*** *is not correct because Some stars have left the main sequence and become red giants*	**1**
10	**The only correct answer is A** ***B*** *is not correct because Many red giants have become white dwarfs* ***C*** *is not correct because No red giants have become white dwarfs* ***D*** *is not correct because No red giant stars have formed yet*	**1**
	Total for multiple choice questions	**10**

Question Number	Answer		Mark
11	This is the equilibrium position	(1)	**3**
	So the mass is moving fastest at this position [accept mass has max speed/velocity or KE at this point] **Or** the mass is nearest this point for the shortest time	(1)	
	So the value for the time period is more precise [accept "accurate"] **Or** uncertainty is determining when the mass passes this point is least	(1)	
	OR		
	The centre point is fixed whereas amplitude reduces over time	(1)	
	Because there is damping **Or** energy transfer (from system)	(1)	
	Hence the mass may not pass the chosen point	(1)	
	[Accept idea that at max displacement the mass changes direction which is difficult to judge for max 1 mark]		
	Total for Question 11		**3**

Question Number	Answer	Mark
12(a)	The star is viewed from two positions at 6 month intervals **Or** The star is viewed from opposite ends of the Earth's orbit diameter about the Sun (1) The change in angular position of the star against backdrop of fixed stars is measured (1) Trigonometry is used to calculate the distance (to the star) [Do not accept Pythagoras] **Or** The diameter/radius of the Earth's orbit (about the Sun) must be known **Or** The distance to the Sun is 1AU (1) Full marks may be obtained from a suitably annotated diagram e.g  [Accept the symmetrical diagram seen in many text books]	**3**
12(b)	Reference to $F = \frac{L}{4\pi r^2}$ with F and L identified **Or** reference to inverse square law for radiation flux [accept brightness] **Or** statement that the brightness of a star depends upon its luminosity and distance away from the observer (1) The stars have the same brightness, so F is constant (1) Hence one star may have a greater luminosity but be more distant (1) [accept converse statement] [Ignore references to temperature and size of the stars]	**3**
	Total for question 12	**6**

Question Number	Answer	Mark
13(a)	Use of $\Delta E = mc\Delta\theta$ (1) Use of $P = \frac{\Delta E}{\Delta t}$ (1) $P = 7.0 \times 10^3$ W (1) <u>Example of calculation</u> $P = \frac{\Delta E}{\Delta t} = \frac{mc\Delta\theta}{\Delta t} = \frac{0.25\ \text{kg} \times 4200\ \text{J kg}^{-1}\text{K}^{-1} \times (85 - 22)\ \text{K}}{9.4\ \text{s}}$ =7037 W	**3**
13(b)	Idea that not all of the energy from the heater will be used to increase the temperature of the water in the cup e.g. Some of the energy from the heater will be transferred to the surroundings [accept heat, accept lost to the surroundings] **Or** some liquid evaporates from the surface **Or** some energy heats the cup/dispenser. (1) Hence the heater power may be greater (than the value calculated in (a)) (1)	**2**
	Total for question 13	**5**

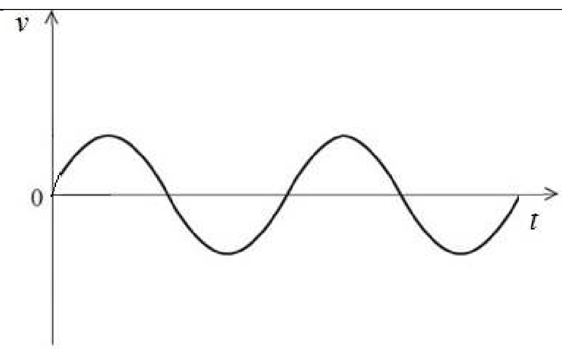
Question Number	Answer	Mark
***14**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** **MAX 5** The vacuum pump removes air molecules from the bell <u>jar</u> (1) Reducing the number of air molecules decreases the rate of collision of air molecules with the surface of the balloon (1) Since the temperature is unchanged, the average speed of the molecules is also unchanged [accept average kinetic energy is unchanged] (1) (Hence) the (rate of) change of momentum (at the surface of the balloon) is less (1) So a smaller force is exerted on the surface of the <u>balloon</u> (1) Pressure inside the balloon is unchanged, and so there is a net force outwards and the balloon expands **Or** pressure outside the balloon is reduced and this causes the balloon to expand (1)	**5**
	Total for question 14	**5**

Question Number	Answer		Mark
15(a)(i)	Mass difference calculation Use of $\Delta E = c^2 \Delta m$ Conversion to MeV B.E. = 8.52 (MeV) [Check masses of p and n are used correctly before awarding this mark] <u>Example of calculation</u> $\Delta m = [(2 \times 1.675\ 40 + 1.673\ 09) - 5.008\ 75] \times 10^{-27}$ kg $= 1.514 \times 10^{-29}$ kg $\Delta E = (3 \times 10^{8}$ m s$^{-1})^{2} \times 1.514 \times 10^{-29}$ J $= 1.363 \times 10^{-12}$ J $\Delta m = 1.363 \times 10^{-12} / 1.6 \times 10^{-19}$ J eV$^{-1} = 8.516 \times 10^{6}$ eV	(1) (1) (1) (1)	**4**
15(a)(ii)	(from the data) hydrogen-3 is the more stable, as it has the larger binding energy (per nucleon) [Stated or implied by number values] [A bald statement that H-3 is more stable without reference to binding energy does not get a mark] Hence, the more energy required to release a nucleon from the nucleus [Accept to break (up) the nucleus]	(1) (1)	**2**
15(b)	When uranium nuclei undergo fission they disintegrate into (two or more) less massive nuclei (together with the release of neutrons) [Do not accept "smaller nuclei", but smaller nucleon number is okay] The binding energy per nucleon increases (so energy is released) The large number of nucleons/nuclei means that the energy output is large.	(1) (1) (1)	**3**
	Total for question 15		**9**

Question Number	Answer		Mark
16(a)	Use of $\lambda_{\max}T = 2.898 \times 10^{-3}$ T = 5800 (K) <u>Example of calculation</u> $T = \frac{2.898 \times 10^{-3}\ m\ K}{0.50 \times 10^{-6}\ m} = 5796\ K$	(1) (1)	**2**
16(b)	very high temperature very high density [accept pressure] [at least one "very" for 2 marks] [max 1 mark awarded if "very" omitted completely]	(1) (1)	**2**
16(c)	Use of $L = 4\pi r^2 \sigma T^4$ Temperature conversion to kelvin $\frac{L_2}{L_1} = 2010$ (increase) <u>Example of calculation</u> $\frac{L_2}{L_1} = \frac{r_2^2 T_2^4}{r_1^2 T_1^4} = \left(\frac{1.26 \times 10^{11}\ \text{m}}{6.96 \times 10^{8}\ \text{m}}\right)^2 \times \left(\frac{(2700+273)\ \text{K}}{(5700+273)\ \text{K}}\right)^4 = 2012$	(1) (1) (1)	**3**
***16(d)**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** Large mass stars have (much) higher gravitational forces Hence there is a (much) greater density in the core [accept greater pressure] (Hence) large mass stars have a much larger rate of fusion (than low mass stars) **Or** large mass stars use up their (available) hydrogen much more quickly So high mass stars have a shorter main sequence lifetime	(1) (1) (1) (1)	**4**
	Total for question 16		**11**

Question Number	Answer	Mark
17(a)	Top line correct (1) Bottom line correct (1) $^{239}_{93}\text{Np} \rightarrow ^{239}_{94}\text{Pu} + ^{0}_{-1}\beta^-$	**2**
17(b)(i)	The rate of decay of the neptunium nuclei is proportional to the number of neptunium nuclei **Or** $\frac{\Delta N}{\Delta t} \propto (-)N$ with symbols defined (1) Hence the number of neptunium nuclei decaying per second increases over time (1)	**2**
17(b)(ii)	When the rate of decay of neptunium nuclei is equal to the rate of production of neptunium nuclei (1)	**1**
17(b)(iii)	Use of $\lambda t_{1/2} = \log_e 2$ (1) Use of $A = (-)\lambda N$ (1) $N = 5.44 \times 10^{12}$ [may see 5.45×10^{12} depending upon rounding] (1) <u>Example of calculation</u> $\lambda = \frac{\log_e 2}{t_{1/2}} = \frac{0.693}{2.04 \times 10^5 \text{ s}} = 3.39 \times 10^{-6} \text{ s}^{-1}$ $1.85 \times 10^7 s^{-1} = (-)3.39 \times 10^{-6} N$ $\therefore N = \frac{1.85 \times 10^7 \text{ s}^{-1}}{3.39 \times 10^{-6} \text{ s}^{-1}} = 5.44 \times 10^{12}$	**3**
17(c)	The decay products of the fission are radioactive **Or** the decay products emit (very) penetrating radiation (1) Neutrons can only be stopped by large thicknesses of concrete [accept γ-radiation for neutrons] (1)	**2**
	Total for question 17	**10**

Question Number	Answer		Mark
18(a)	Use of $F = \frac{GMm}{r^2}$ and $F = \frac{mv^2}{r}$ Algebra leading to $v = \sqrt{\frac{GM}{r}}$ <u>Example of calculation:</u> $\frac{GMm}{r^2} = \frac{mv^2}{r}$ $\therefore \frac{GM}{r^2} = \frac{v^2}{r}$ $\therefore v = \sqrt{\frac{GM}{r}}$	(1) (1)	2
18(b)	$v^2 \propto \frac{M}{r}$ Or $v \propto \sqrt{\frac{M}{r}}$ Dark matter increases the total mass, *M* (of the centre) of the galaxy If *M* increases as *r* increases then *v* may stay constant [accept may be larger than predicted]	(1) (1) (1)	3
18(c)	Dark matter increases the density of the universe The fate of the universe depends upon its density (compared with a critical density value) If the density of the universe is greater than the critical density then the universe will reach a maximum size and then start to contract [or other correct comparison between density of universe and critical density] [accept universe will be closed, but do not accept references to a "big crunch"]	(1) (1) (1)	3
	Total for question 18		**8**

Question Number	Answer	Mark
19(a)	(For simple harmonic motion the) acceleration (of the cone) is: • (directly) proportional to displacement from equilibrium position (1) • (always) acting towards the equilibrium position **Or** idea that acceleration is in the opposite direction to displacement (1) [accept undisplaced point/fixed point/central position/point for equilibrium position] **Or** (For simple harmonic motion the resultant) force (on the cone) is: • (directly) proportional to displacement from equilibrium position (1) • (always) acting towards the equilibrium position **Or** idea that force is a restoring force e.g. "in the opposite direction" (1) [accept undisplaced point/fixed point/central position/point for equilibrium position] [An equation with symbols defined correctly is a valid response for both marks. e.g $a \propto -x$ or $F \propto -x$]	**2**
19(b)	Use of $a = \omega^2 x$ (1) Use of $\omega = 2\pi f$ (1) a = 1700 m s^{-2} (1) Example of calculation $a = \omega^2 x = (2\pi \times 120\text{s}^{-1})^2 \times 3.0 \times 10^{-3}\text{m} = 1710\text{ms}^{-2}$	**3**
19(c)	 Sine graph [zero velocity at t = 0, same period as displacement] (1) Constant amplitude [not necessarily the displacement amplitude] (1) [Only award MP2 if candidate has attempted a sine or a minus sine graph]	**2**

19(d)	If the natural frequency of the casing is about 120 Hz, the casing will be forced into resonance (1) This results in a maximum energy transfer (from speaker to casing) (1) This produces large vibrations of the casing **Or** this produces damage to the casing (1) **OR** This avoids the frequency of the sound produced by the bass speaker being close to the natural frequency of the casing [120 Hz] (1) [Accept reference to resonance] This prevents maximum energy transfer (from speaker to casing) (1) And avoids large vibrations of the casing **Or** avoids damage to the casing (1)	**3**
19(e)	(Damping is) the removal/dissipation of energy from an oscillation (1) This prevents an increasing amplitude of vibration (at particular frequencies) (1) which would distort the sound output (1) **Or** damage the casing [dependent upon an attempt on MP2]	**3**
	Total for question 19	**13**

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