Pearson

Mark Scheme (Results)

January 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.

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.

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 e.g. '**and'** when two pieces of information are needed for 1 mark.

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 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a 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.

2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 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 mean that one mark will not be awarded. (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

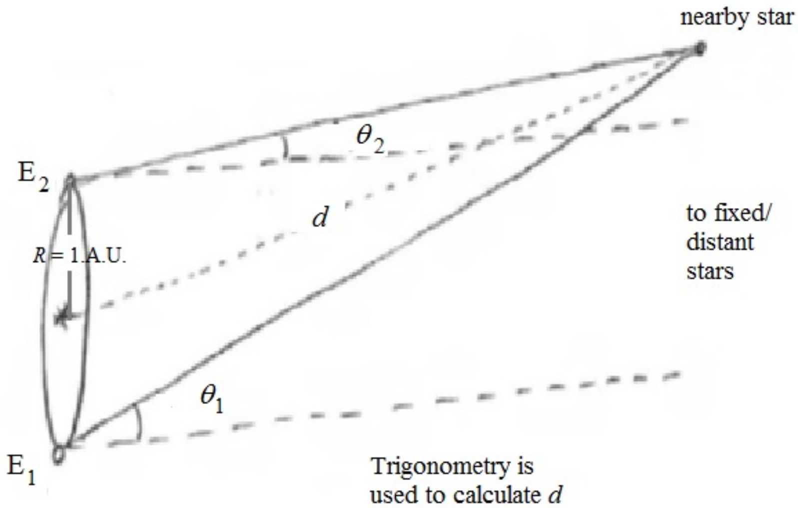
4.2 If a 'show that' question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

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.

Question Number	Answer	Mark
1	A is incorrect, as amplitude should stay the same or decrease upon reflection. **B is the correct answer** C is incorrect, as the speed of the radio waves is constant in a given medium. D is incorrect, as the wavelength decreases.	**1**
2	**C is the correct answer** as the gas obeys Boyle's law, $p \propto \frac{1}{V}$	**1**
3	**A is correct the correct answer** because red giant stars are cooler (Wien's law) and brighter (Stefan's law).	**1**
4	**B is correct** because dark matter has been postulated as a result of gravitational forces on galaxies being larger than predicted by the galaxies' mass.	**1**
5	A and B are incorrect because the mass increases when moving along the main sequence in the direction shown. **C is the correct answer** D is incorrect because the luminosity increases when moving along the main sequence in the direction shown.	**1**
6	A and B are incorrect because the molecular K.E. stays constant if the temperature stays constant, and the molecular P.E. increases. **C is the correct answer** D is incorrect because the molecular P.E. increases.	**1**
7	**C is correct** because $E_k \propto T$	**1**
8	**C is correct** because P and T increase when the current through the filament increases, so λ_{max} decreases (Wien's law).	**1**
9	**C is correct** because the total energy is constant.	**1**
10	**D is correct** because $T \propto \frac{1}{f}$	**1**

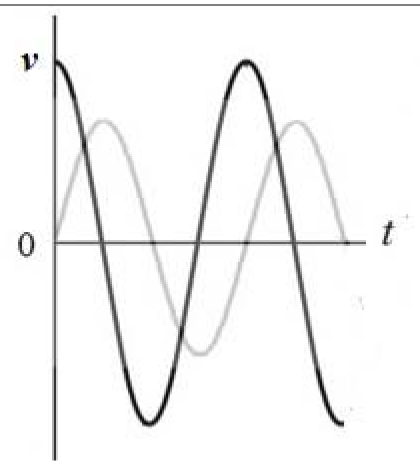
Question Number	Answer		Mark
11	The star is viewed from two positions at 6 month intervals **Or** The star is viewed from opposite ends of the Earth's orbit diameter about the Sun	**(1)**	
	The change in angular position of the star against backdrop of fixed stars is measured	**(1)**	
	Trigonometry is 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)**	**3**
	Full marks may be obtained from a suitably annotated diagram e.g  [Accept the symmetrical diagram seen in many text books]		
	Total for question 11		**3**

Question Number	Answer		Mark
12(a)	Evidence of calculation of average temperature [52.5 °C] Use of $\Delta E = mc\Delta\theta$ ΔE = 2920 (J) <u>Example of calculation</u> $\Delta E = mc\Delta\theta$ $\therefore \Delta E = 22.5 \times 10^{-3}\,\text{kg} \times 4190\,\text{J kg}^{-1}\,\text{K} \times (52.5 - 21.5) = 2920\,\text{J}$	**(1)** **(1)** **(1)**	**3**
12(b)	Precaution Corresponding reason [dependent mark] <u>Example of answers:</u> Water should be stirred So water is all at the same temperature No draughts So that all the energy from the crisp is transferred to the test tube Light crisp close to test tube So that all the energy from the crisp is transferred to the test tube Keep crisp close to test tube To reduce the heat dissipated to surroundings Small thermometer bulb To reduce energy transfer to the bulb Use test tube of low specific heat capacity To reduce energy transferred to the test tube Read thermometer at eye level To avoid parallax error leading to incorrect temperature	**(1)** **(1)**	**2**
12(c)	The energy value calculated (from the experimental data) is much less (than the value stated on the crisp packet) [accept a ratio e.g. 13%] not all the energy (from the crisp) is transferred to the water **Or** not all of the energy content of the crisps is released by burning [do not accept a bald statement “energy transferred to surroundings”]	**(1)** **(1)**	**2**
	Total for question 12		**7**

Question Number	Answer		Mark
13(a)	Equate $F = \frac{GMm}{r^2}$ and $F = mr\omega^2$ **Or** equate $F = \frac{GMm}{r^2}$ and $\frac{mv^2}{r}$ Use of $T = \frac{2\pi}{\omega}$ **Or** v = 2πr/T T = 5550 s Example of calculation $mr\omega^2 = \frac{GMm}{r^2} \quad \therefore \ \omega^2 = \frac{GM}{r^3}$ $\omega = \sqrt{\frac{6.67\times10^{-11}\,\mathrm{Nm^2kg^{-2}}\times5.98\times10^{24}\,\mathrm{kg}}{(6.37\times10^6\,\mathrm{m}+4.1\times10^5\,\mathrm{m})^3}} = 1.13\times10^{-3}\,\mathrm{rad\,s^{-1}}$ $T = \frac{2\pi}{\omega} = \frac{2\pi\,\mathrm{rad}}{1.13\times10^{-3}\,\mathrm{rad\,s^{-1}}} = 5550\,\mathrm{s}$	 **(1)** **(1)** **(1)**	**3**
13(b)	Use of $g = \frac{GM}{r^2}$ [may be by using a ratio] **Or** use of $g\,r^2$ = constant **Or** use of g = $r\,\omega^2$ g = 8.7 N kg^{-1} [accept m s^{-2}] Example of calculation $g = \frac{GM}{r^2} = \frac{6.67\times10^{-11}\,\mathrm{Nm^2kg^{-2}}\times5.98\times10^{24}\,\mathrm{kg}}{(6.37\times10^6\,\mathrm{m}+4.10\times10^5\,\mathrm{m})^2} = 8.68\,\mathrm{Nkg^{-1}}$	**(1)** **(1)**	**2**
13(c)	The orbiting astronaut/spacecraft is effectively in free fall towards the Earth **Or** the gravitational force equals/provides the required centripetal force (Hence) there will be no reaction force on the astronauts (and so they will appear to be weightless).	**(1)** **(1)**	**2**
	Total for question 13		**7**

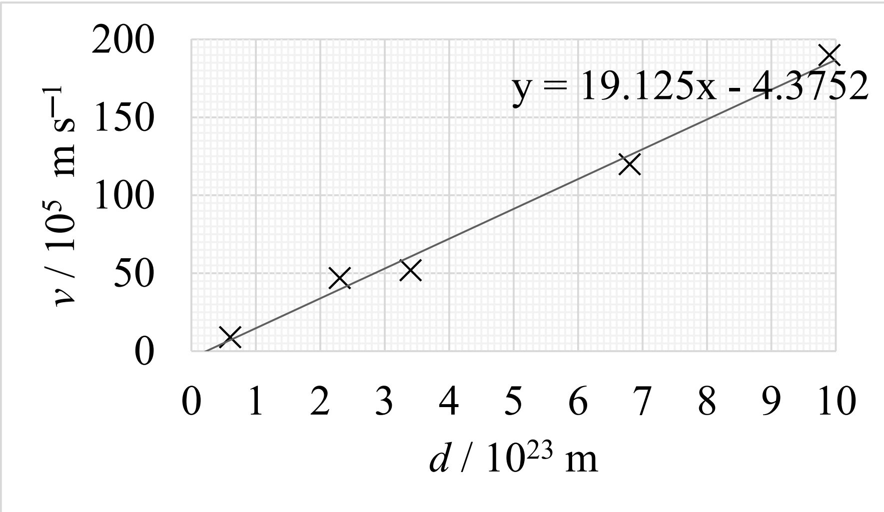
Question Number	Answer		Mark
14(a) **G**	The rate of decay of (unstable) nuclei (accept disintegration for decay and ignore reference to mean/average) [there must be a reference to nucleus/nuclei to get the mark]	**(1)**	**1**
***14(b)**	(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) (With no source present) record the background count (Handling the source with tongs) fix one source close to the GM-tube Introduce a sheet of paper/aluminium between the source and the GM-tube If paper/aluminium reduces the count rate to background levels it is the americium source If paper causes no change in the count rate it is the strontium source **Or** If thin aluminium causes a small change in the count rate it is the strontium source If paper reduces the count rate but the count rate is still above background levels it is the radium source **Or** If thin aluminium causes a large change in the count rate it is the radium source	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
14(c)	Use of $\lambda t_{1/2} = \log_e 2$ Use of $N = N_0 e^{-\lambda t}$ ($A = A_0 e^{-\lambda t}$) t = 15 years <u>Example of calculation</u> $\lambda = \frac{\log_e 2}{t_{1/2}} = \frac{0.693}{5.26\,\text{year}} = 0.132\,\text{years}^{-1}$ $25.7\,\text{kBq} = 185\,\text{kBq} \times (\text{e}^{-0.132\text{years}^{-1} \times t})$ $\therefore t = \frac{\log_e\left(\frac{25.7\,\text{kBq}}{185\,\text{kBq}}\right)}{-0.132\,\text{years}^{-1}} = 15.0\,\text{years}$	**(1)** **(1)** **(1)**	**3**
	Total for question 14		**10**

Question Number	Answer	Mark
15(a)(i) **GEN**	$\mathrm{U} + {}_{0}\mathrm{n} \rightarrow {}_{56}\mathrm{Ba} + {}^{92}\mathrm{Kr} + 3\times\ \mathrm{n}$ 92 and 56 in correct places **(1)**	**1**
15(a)(ii)	(total) mass of the products is less than the initial mass **(1)** The decrease in mass (Δm) results in a release of energy (ΔE) according to the equation $\Delta E = c^2 \Delta m$ **(1)**	**2**
15(a)(iii)	Initial momentum is zero **(1)** So in order to conserve momentum the products must be travelling in different directions **(1)**	**2**
15(b)(i) **G**	${}^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$ [order is unimportant] Nuclei on correct sides of equation **(1)** Bottom line correct **(1)**	**2**
15(b)(ii)	Mass difference calculation **(1)** Conversion to J **(1)** $\Delta E = 2.7 \times 10^{-12}$ (J) **(1)** <u>Example of calculation</u> $\Delta m = [(1875.1 + 2807.9) - (3726.4 + 939.6)]\ \mathrm{MeV/c^2} = 17.0\ \mathrm{MeV/c^2}$ $\Delta \mathrm{m} = 17.0 \times 10^{6} \times 1.6 \times 10^{-19}\ \mathrm{J\ eV^{-1}} = 2.72 \times 10^{-12}\ \mathrm{J}$	**3**
15(b)(iii)	So that nuclei have sufficient <u>kinetic</u> energy to overcome electrostatic repulsion **(1)** So that they come close enough (for fusion) **(1)**	**2**
15(c)	Advantage: Virtually unlimited fuel supply for fusion, but limited fuel for fission. **(1)** Hardly any radioactive waste for fusion, but significant radioactive waste for fission [accept "no" for "hardly any"] **(1)** (If two correct advantages for fusion given without a reference to fission, 1 mark maximum)	**2**
	Total for question 15	**14**

Question Number	Answer		Mark
16(a)(i)	**Either** (For simple harmonic motion the) acceleration (of the cone) is: • (directly) proportional to displacement from equilibrium position • (always) acting towards the equilibrium position **Or** idea that acceleration is in the opposite direction to displacement [accept undisplaced point/fixed point/central point for equilibrium position] **Or** (For simple harmonic motion the resultant) force (on the cone) is: • (directly) 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 towards 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(a)(ii)	Use of $v = A\omega(\sin\omega t)$ Use of $\omega = 2\pi f$ $v = 1.6 \text{ m s}^{-1}$ Example of calculation: $v = A\omega\sin\omega t = 2.5\times10^{-3}\text{m}\times2\pi\times100\text{s}^{-1}\times1 = 1.57\text{ms}^{-1}$	**(1)** **(1)** **(1)**	**3**
16(a)(iii)	 Cosine graph [maximum velocity at t = 0,] Constant amplitude with same period as displacement [dependent mark] [If a minus cosine graph is drawn with same period as displacement and a constant amplitude, then max 1 mark]	**(1)** **(1)**	**2**

***16(b)(i)**	(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.) This is an example of resonance **(1)** The unit is driven/forced into oscillation at its natural frequency **(1)** This results in a maximum energy transfer (from speaker to unit) **Or** this results in a more efficient energy transfer **(1)**	**3**
16(b)(ii) **G**	Reference to damping [Description of damping without specific use of the term could gain mark] **(1)** Damping linked to removal of energy from the unit **(1)**	**2**
16(c)	Tweeter has to move at high frequency/acceleration **(1)** So the tweeter requires a small mass **(1)** **Or** Woofer has to set a large volume of air into oscillation **(1)** Because it produces low frequency sounds **(1)** [Bald statement that tweeter has high frequency or woofer has low frequency for 1 mark maximum]	**2**
	Total for question 16	**14**

Question Number	Answer		Mark
17(a)	Light from these galaxies was shifted to a longer wavelength [accept there is a red shift] [accept reference to lower frequency] A suitable reference to "Doppler effect" [e.g. by the Doppler effect they must be receding] (accept $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ **Or** $\frac{\Delta f}{f} = \frac{v}{c}$ **Or** $z = \frac{v}{c}$ for "Doppler effect")	**(1)** **(1)**	**2**
17(b)(i)	The distance of Pegasus is similar to that of Pisces However its speed is (significantly) less than that of Pisces [Bald statement that the data for distance and speed for Pegasus fits between that of Virgo and Pisces supporting data in the table for 1 mark maximum]	**(1)** **(1)**	**2**
17(b)(ii)	A source of known luminosity (in Pegasus) is identified [accept "standard candle" for "source of known luminosity"] The radiation flux of this source is measured (at the Earth) [accept "brightness" for "radiation flux"] The (radiation) flux obeys an inverse square law (hence the distance can be calculated) **Or** $F = \frac{L}{4\pi d^2}$, where L is the luminosity and *d* the distance to the source (hence the distance can be calculated)	**(1)** **(1)** **(1)**	**3**

17(c)(i)	Gradient calculation attempted Reciprocal of gradient determined **Or** Age of the universe = H^{-1} stated Age of universe = 5.2×10^{16} (s) [Accept values in the range 5.0 – 5.3] Example of calculation  Gradient = 1.9×10^{-17} s^{-1} Age of universe = $1/(1.9 \times 10^{-17}$ s$^{-1}) = 5.2 \times 10^{16}$ s	**(1)** **(1)** **(1)**	**3**
17(c)(ii)	**Either** The distances to the galaxies must have been underestimated Hence the gradient should not be as steep as in Hubble's graph **Or** (Rate of) expansion of universe is accelerating Speed was smaller in the past, so galaxies took longer to go distance d	**(1)** **(1)** **(1)** **(1)**	**2**
17(c)(iii)	More distant galaxies are being seen as they were in the past (For a given atomic transition) the photons would have been less energetic in the past Hence a lower frequency [longer wavelength] would be emitted by distant galaxies. [A bald statement that stars from an earlier period of the universe's evolution ["older stars"] emitted lower frequency radiation for 1 mark maximum]	**(1)** **(1)** **(1)**	**3**
	Total for question 17		**15**

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