Mark Scheme (pre-standardisation)

January 2017

Pearson Edexcel
International Advanced Level
in Physics (WPH05) Paper 01
Physics from Creation to Collapse

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please visit our website at www.edexcel.com.

Our website subject pages hold useful resources, support material and live feeds from our subject advisors giving you access to a portal of information. If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

www.edexcel.com/contactus

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2016
Publications Code WPH05_MS_1701*

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.

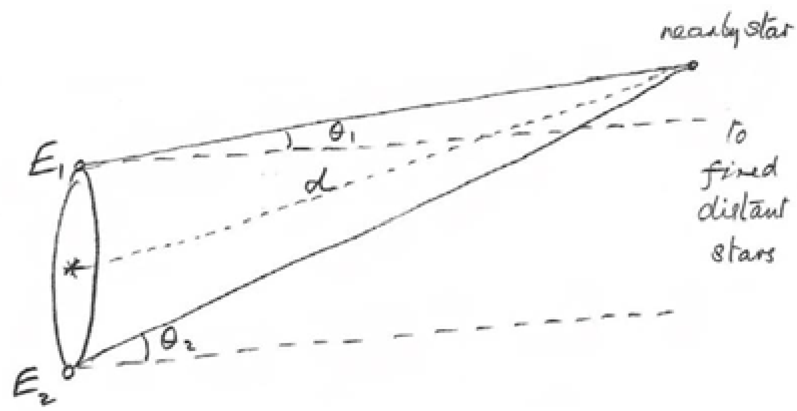
4.2 If a ‘show that’ question is worth 2 marks. then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

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

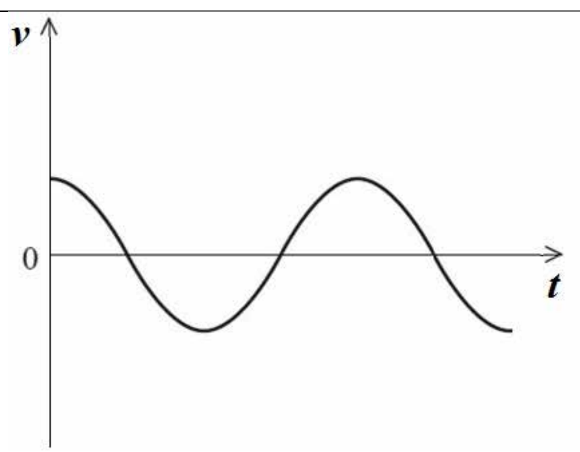
Question Number	Answer		Mark
11	The star is viewed from two positions at 6 month intervals/opposite ends of its orbit diameter about the Sun	**(1)**	
	The change in angular position of the star against backdrop of fixed stars is measured	**(1)**	
	Trigonometry is used to calculate the distance to the star [Do not accept Pythagoras] **Or** The diameter/radius of the Earth's orbit about the Sun must be known	**(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)	Average final temperature calculated [52.5 °C] **(1)** Use of $\Delta E = mc\Delta\theta$ **(1)** ΔE = 2920 J **(1)** Example of calculation $\Delta E = mc\Delta\theta$ $\therefore \Delta E = 22.5 \times 10^{-3}\text{ kg} \times 4190\text{ J kg}^{-1}\text{ K} \times (52.5 - 21.5) = 2920\text{ J}$	**3**
12(b)	Precaution **(1)** Corresponding reason **(1)** Example of answers: 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 Small thermometer bulb To reduce energy transfer to the bulb	**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%] **(1)** not all the energy supplied by the (burning) crisp is transferred to the water **Or** not all of the energy content of the crisps is released by burning **(1)**	**2**
	Total for question 12	**7**

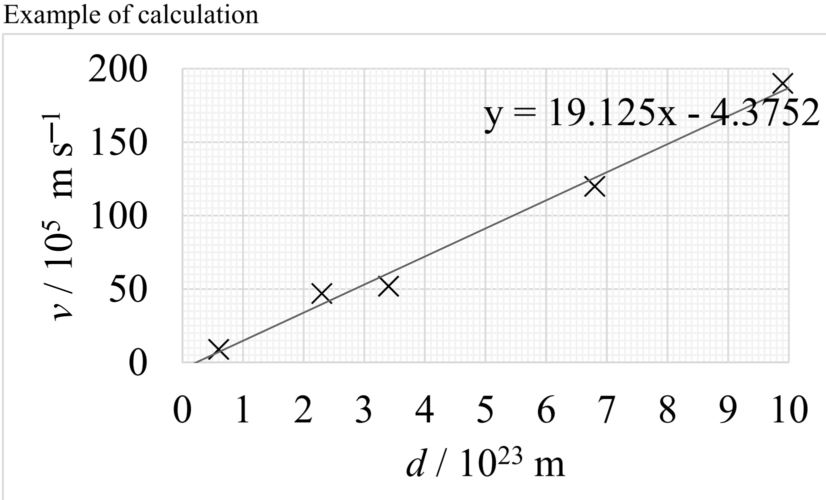
Question Number	Answer		Mark
13(a)	Equate $F = \frac{GMm}{r^2}$ and $F = mr\omega^2$ **Or** equate $F = \frac{GMm}{r^2}$ and $\frac{mv^2}{r}$	**(1)**	
	Use of $T = \frac{2\pi}{\omega}$ **Or** v = 2πr/T	**(1)**	
	T = 5550 s	**(1)**	**3**
	Example of calculation $mr\omega^2 = \frac{GMm}{r^2} \quad \therefore \ \omega^2 = \frac{GM}{r^3}$ $\omega = \sqrt{\frac{6.67\times10^{-11}\,\text{Nm}^2\text{kg}^{-2} \times 5.98\times10^{24}\,\text{kg}}{(6.37\times10^6\,\text{m} + 4.1\times10^5\,\text{m})^3}} = 1.13\times10^{-3}\,\text{rad}\,\text{s}^{-1}$ $T = \frac{2\pi}{\omega} = \frac{2\pi\, rad}{1.13\times10^{-3}\ rad\ s^{-1}} = 5550\,s$		
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 = $r\,\omega^2$	**(1)**	
	g = 8.7 N kg^{-1} [accept m s^{-2}]	**(1)**	**2**
	Example of calculation $g = \frac{GM}{r^2} = \frac{6.67\times10^{-11}\,\text{Nm}^2\text{kg}^{-2} \times 5.98\times10^{24}\,\text{kg}}{(6.37\times10^6\,\text{m} + 4.10\times10^5\,\text{m})^2} = 8.68\,\text{Nkg}^{-1}$		
13(c)	The orbiting spacecraft is effectively in free fall towards the Earth **Or** the gravitational force is equal to the required centripetal force	**(1)**	
	Hence there will be no reaction force on the astronauts, and so they will appear to be weightless.	**(1)**	**2**
	Total for question 13		**7**

Question Number	Answer		Mark
14(a)	The rate of decay of (unstable) nuclei (accept disintegration for decay and ignore reference to mean/average)	**(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 between the source and the GM-tube If the count rate reduces to background levels it is the americium source Having identified the americium source, introduce 5 mm of aluminium (as well as the paper) between each of the other sources and the GM-tube If the count rate reduces almost to background levels it is the strontium source	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**
14(c)	Use of $\lambda t_{1/2} = \log_e 2$ Use of $A = A_0 e^{-\lambda t}$ t = 15 years <u>Example of calculation</u> $\lambda = \frac{\log_e 2}{t_{1/2}} = \frac{0.693}{5.26\,\text{year}} = 0.132\,\text{years}^{-1}$ $25.7\,\text{kBq} = 185\,\text{kBq} \times (e^{-0.132\text{years}^{-1} \times t})$ $\therefore t = \frac{\log_e\left(\frac{25.7\,\text{kBq}}{185\,\text{kBq}}\right)}{-0.132\,\text{years}^{-1}} = 15.0\,\text{years}$	**(1)** **(1)** **(1)**	**3**
	Total for question 14		**10**

Question Number	Answer	Mark
15(a)(i)	$\text{U} + {}_{0}\text{n} \rightarrow {}_{56}\text{Ba} + {}^{92}\text{Kr} + 3\times\ \text{n}$ 92 and 56 in correct places **(1)**	**1**
15(a)(ii)	Energy is released in the reaction since the (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)	Momentum must be conserved **(1)** So in order to conserve momentum the products must be travelling in different directions **(1)**	**2**
15(b)(i)	${}^{2}_{1}\text{H} + {}^{3}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + {}^{1}_{0}\text{n}$ Top line correct **(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> $\Delta m = [(1875.1 + 2807.9) - (3726.4 + 939.6)]\ \text{MeV/c}^2 = 17.0\ \text{MeV/c}^2$ $\Delta \text{m} = 17.0 \times 10^6 \times 1.6 \times 10^{-19}\ \text{J eV}^{-1} = 2.72 \times 10^{-12}\ \text{J}$	**3**
15(b)(iii)	Extremely high temperatures so that nuclei have sufficient kinetic energy to overcome electrostatic repulsion **(1)** so that they come close enough for fusion **Or** close enough to feel the strong (nuclear) force **(1)**	**2**
15(c)	Advantage: Hardly any radioactive waste for fusion, but significant radioactive waste for fission **(1)** Virtually unlimited hydrogen fuel supply for fusion, but uranium is a limited resource for fission. **(1)**	**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 m s^{-1} Example of calculation: $v = A\omega \sin\omega t = 2.5\times10^{-3}\,\text{m}\times 2\pi\times 100\,\text{s}^{-1}\times 1 = 1.57\,\text{ms}^{-1}$	**(1)** **(1)** **(1)**	**3**
16(a)(iii)	 Cosine graph [maximum velocity at t = 0, same period as displacement] Constant amplitude [not necessarily the displacement amplitude]	**(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) **(1)**	**3**
16(b)(ii)	Reference to damping **(1)** Damping linked to removal of energy from the unit **(1)**	**2**
16(c)	**Max 2** High frequency oscillation involves large accelerations **Or** the tweeter has to move at high frequency **(1)** So the tweeter requires a small mass / inertia **(1)** **Or** The woofer must be large to set a large volume of air into oscillation **(1)**	**2**
	Total for question 16	**14**

Question Number	Answer		Mark
17(a)	Light from these galaxies was shifted to a longer wavelength [accept red shifted] A suitable reference to "Doppler effect" (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	**(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 of graph determined Reciprocal of gradient determined **Or** Age of the universe = H^{-1} stated Age of universe = 5.2×10^{16} (s) 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 **(1)** Hence the gradient should not be as steep as in Hubble's graph **(1)** **Or** (Rate of) expansion of universe is accelerating **(1)** Speed was smaller in the past, so galaxies took longer to go distance d **(1)**	2
17(c)(iii)	More distant galaxies are being seen as they were in the past **(1)** (For a given atomic transition) the photons would have been less energetic in the past **(1)** Hence a lower frequency [longer wavelength] would be emitted by distant galaxies. **(1)**	3
	Total for question 17	**15**