Pearson Edexcel

Mark Scheme (Results)

January 2019

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

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January 2019
Publications Code WPH05_01_MS_1901

These instructions should be the first page of all mark schemes

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 $g = 10\ \mathrm{m\ s^{-2}}$ **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 B** ***A** is not correct because standard candles enable distances to be determined* ***C** is not correct because radiation flux depends upon distance and luminosity* ***D** is not correct because the surface temperature is not characteristic of a standard candle*	1

Question Number	Answer	Mark
2	**The only correct answer is B** ***A** is not correct because the proton number should decrease in an alpha decay* ***C** is not correct because the nucleon number should decrease if a neutron is emitted* ***D** is not correct because the proton number should decrease in a positron decay*	1

Question Number	Answer	Mark
3	**The only correct answer is A** ***B** is not correct because the energy radiated equals the increase in binding energy* ***C** is not correct because the force between nuclei is external to the nucleus* ***D** is not correct because binding energy relates to all the nucleons, not just one*	1

Question Number	Answer	Mark
4	**The only correct answer is D** ***A** is not correct because $E = ½m\omega^2A$, so $E \propto mA$* ***B** is not correct because $E = ½m\omega^2A$, so $E \propto mA$* ***C** is not correct because $E = ½m\omega^{2,} A$ so $E \propto mA$*	1

Question Number	Answer	Mark
5	**The only correct answer is D** ***A** is not correct because this would decrease the activity to 50%* ***B** is not correct because this would decrease the activity to 12.5%* ***C** is not correct because this would decrease the activity to 3.1%*	1

Question Number	Answer	Mark
6	**The only correct answer is C** ***A** is not correct because red shift does not indicate acceleration* ***B** is not correct because red shift does not indicate acceleration* ***D** is not correct because red shift implies moving away from the observer*	1

Question Number	Answer	Mark
7	**The only correct answer is B** ***A*** *is not correct because* $g = \frac{GM}{r^2}$ *and* $m = \rho V$ ***C*** *is not correct because* $g = \frac{GM}{r^2}$ *and* $m = \rho V$ ***D*** *is not correct because* $g = \frac{GM}{r^2}$ *and* $m = \rho V$	**1**

Question Number	Answer	Mark
8	**The only correct answer is C** ***A*** *is not correct because* $t = 1/H_0$*, and* H_0 *has increased by 20%* ***B*** *is not correct because* $t = 1/H_0$*, and* H_0 *has increased by 20%* ***D*** *is not correct because* $t = 1/H_0$*, and* H_0 *has increased by 20%*	**1**

Question Number	Answer	Mark
9	**The only correct answer is C** ***A*** *is not correct because this describes a flat universe* ***B*** *is not correct because this describes a closed universe* ***D*** *is not correct because the fate of the universe depends upon its average density*	**1**

Question Number	Answer	Mark
10	**The only correct answer is D** ***A*** *is not correct because* $L = \sigma AT^4$ *so* $L \propto T^4$ ***C*** *is not correct because* $L = \sigma AT^4$ *so* $L \propto T^4$ ***D*** *is not correct because* $L = \sigma AT^4$ *so* $L \propto T^4$	**1**

Question Number	Answer		Mark
11	Use of $t_{1/2} = \frac{\ln 2}{\lambda}$	(1)	
	Use of $\frac{\Delta N}{\Delta t} = (-)\lambda N$	(1)	
	$N = 1.86 \times 10^{15}$	(1)	**3**
	<u>Example of calculation</u> $\lambda = \frac{ln2}{t_{1/2}} = \frac{0.693}{8.02 \times 24 \times 3600\ \text{s}} = 1.00\times10^{-6}\ \text{s}^{-1}$ $N = (-)\frac{\Delta N/\Delta t}{\lambda} = \frac{1860 \times 10^{6}\ \text{s}^{-1}}{1.00 \times 10^{-6}\ \text{s}^{-1}} = 1.86\times10^{15}$		
	Total for question 11		**3**

Question Number	Answer	Mark
12(a)	Use of $pV = NkT$ (1) $N = 6.6 \times 10^{22}$ (1) <u>Example of calculation</u> $N = \frac{pV}{kT} = \frac{1.35\times10^{5}\,\text{Pa}\times2.0\times10^{-3}\,\text{m}^{3}}{1.38\times10^{-23}\,\text{J K}^{-1}\times(295)\,\text{K}} = 6.63\times10^{22}$	**2**
12(b)	Internal energy ∝ T (1) Conversion of temperature to kelvin (1) T = 570 K [Accept 297 °C] (1) <u>Example of calculation</u> Internal energy = N × mean molecular K.E. $T \propto$ (mean molecular K.E.) ∴ $T \propto$ (internal energy) So if the internal energy doubles, then the kelvin temperature doubles T = 2 × (273 +12) K = 570 K	**3**
	Total for question 12	**5**

Question Number	Answer	Mark
13(a)	Use of $P = VI$ (1) P = 1.55 × 10^3 (W) (1) <u>Example of calculation</u> $P = VI = 230\text{ V} \times 6.75\text{ A} = 1.55 \times 10^3\text{ W}$	**2**
13(b)(i)	Use of $\Delta E = mc\Delta\theta$ with $P = \frac{\Delta E}{\Delta t}$ (1) θ = 50 °C **Or** 323 K [ecf from (a)] (1) <u>Example of calculation</u> $P = \frac{m}{\Delta t} c\Delta\theta$ $\therefore 1550\text{ W} = 0.048\text{ kg s}^{-1} \times 1.01 \times 10^3\text{ J kg}^{-1} \times \Delta\theta$ $\therefore \Delta\theta = 32.0\ ^{\circ}\text{C}$ $\therefore \theta = (18.0 + 32.0)\ ^{\circ}\text{C} = 50.0\ ^{\circ}\text{C}$	**2**
13(b)(ii)	Idea that not all of the energy from the power supply will be used to increase the temperature of the air (1) e.g. Some (thermal) energy will be transferred/lost to the surroundings Some energy will heat the dryer Some energy will be used to drive the fan There will be heating in the cable/wires	**1**
	Total for question 13	**5**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>14(a)</td><td>Correct values [0.091 and 0.23] (1)

2 sf (1)

axes correctly labelled (1)

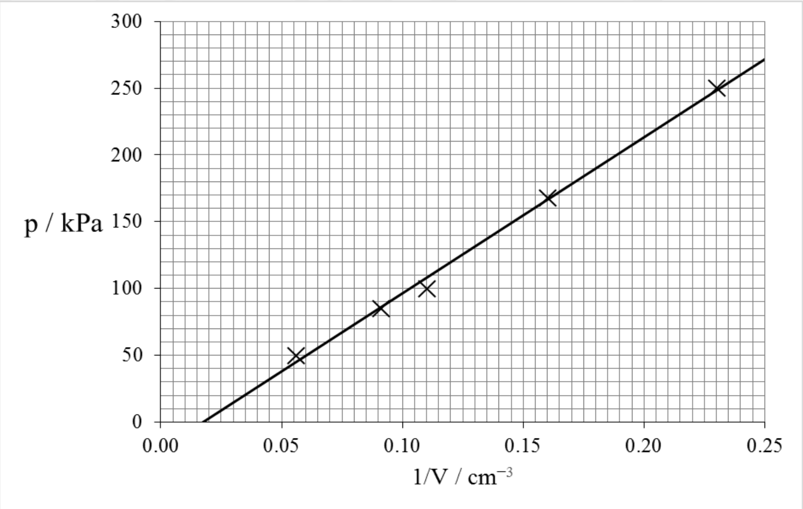
suitable scales (scales should go up in multiples of 1, 2, or 5 and at least half the graph grid must be used (1)

all points plotted correctly (1)

line of best fit drawn (best fit line should extend beyond plotted points to meet axis) (1)

<u>Example of calculation</u>

<table>
<tr><th>p / kPa</th><th>1/V / cm^{−3}</th></tr>
<tr><td>50</td><td>0.056</td></tr>
<tr><td>85</td><td>0.091</td></tr>
<tr><td>100</td><td>0.11</td></tr>
<tr><td>168</td><td>0.16</td></tr>
<tr><td>250</td><td>0.23</td></tr>
</table>


</td><td>6</td></tr>
<tr><td>14(b)</td><td>(If pressure is inversely proportional to volume) there should be a straight line passing through the origin (1)

<u>If their line passes through the origin:</u>
Boyle's law is obeyed (1)

<u>If their line doesn't pass through the origin:</u>
Boyle's law is not obeyed
Or there may have been a systematic error (1)</td><td>2</td></tr>
<tr><td></td><td>Total for question 14</td><td>8</td></tr>
</table>

Question Number	Answer		Mark
15(a)	Acceleration 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 **Or** force 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"	(1) (1) (1) (1)	**2**
15(b)(i)	Amplitude = 3.6 m – 3.8 m Time period = 12.3 hour – 12.7 hour <u>Example of calculation</u> Amplitude = (9.0 −1.6) m /2 = 3.65 m Time period = (18 − 5.5) hour = 12.5 hour	(1) (1)	**2**
15(b)(ii)	Use of $\omega = \frac{2\pi}{T}$ Use of $v = \omega A$ v = 1.9 (m hour^{-1}) [ecf value of A from (i)] **Or** Tangent drawn to graph at steepest point Gradient of tangent determined v = 1.9 (m hour^{-1}) <u>Example of calculation</u> $\omega = \frac{2\pi}{T} = \frac{2\pi}{12.5 \text{ hour}} = 0.503 \text{ hour}^{-1}$ $v = \omega A = 0.503 \text{ hour}^{-1} \times 3.7 \text{ m} = 1.86 \text{ m hour}^{-1}$	(1) (1) (1) (1) (1) (1)	**3**
15(b)(iii)	Sinusoidal graph with same period as water level variation and constant amplitude [not necessarily the displacement amplitude] Velocity graph leading the displacement graph by about ¼ of a cycle	(1) (1)	**2**
	Total for question 15		**9**

Question Number	Answer		Mark
***16**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)**		
	(Very) high temperatures are needed to give hydrogen/nuclei/protons enough kinetic energy to overcome the electrostatic repulsion	(1)	
	High densities enable a high enough collision rate (of nuclei to sustain the fusion reactions)	(1)	
	(A star is the ideal place for fusion because) the large gravitational forces (in a star) produce high temperatures and densities in the stars' core	(1)	
	(On Earth) there are containment problems for a material undergoing fusion and strong magnetic fields are required	(1)	
	If the material/plasma undergoing fusion (on Earth) were to touch the container the temperature would decrease and fusion would stop **Or** If the material/plasma undergoing fusion (on Earth) were to touch the container then the container would melt (and containment cease)	(1)	**5**
	Total for question 16		**5**

Question Number	Answer		Mark
17(a)	Alpha particles have only a small range in air (so the detector must be very close to the source)	(1)	
	The distance must be fixed, because: The fraction of alpha particles detected depends upon the distance from the source to the detector. **Or** the count rate depends upon the distance from the source to the detector	(1)	**2**
17(b)	Background radiation increases her count/reading	(1)	
	(So) measure the background count (rate) and subtract (from her count)	(1)	
	The random nature of radioactive decay introduces uncertainties	(1)	
	(So) take measurement for a longer time **Or** repeat the measurement to calculate an average	(1)	**4**
	Total for question 17		**6**

Question number	Answer		Mark
18(a)	Evidence of using multiple cycles to find T Use of $f = \frac{1}{T}$ f = 0.75 (Hz) <u>Example of calculation</u> Reading from graph, $T = \frac{(14.9 - 1.5)\text{ s}}{10} = 1.34\text{ s}$ $f = \frac{1}{1.34\text{ s}} = 0.75\text{ Hz}$	(1) (1) (1)	3
18(b)(i)	Use of $\omega = 2\pi f$ Use of $v = \omega r$ v = 3.5×10^9 m s^{-1} **Or** Use of $T = 1/f$ Use of $v = 2\pi r/T$ v = 3.5×10^9 m s^{-1} <u>Example of calculation</u> $\omega = 2\pi\text{ rad} \times 0.8\text{ s}^{-1} = 5.03\text{ rad s}^{-1}$ $v = 5.03\text{ rad s}^{-1} \times 1.4 \times 10^9\text{ m} /2 = 3.52 \times 10^9\text{ m s}^{-1}$	(1) (1) (1) (1) (1) (1)	3
18(b)(ii)	Speed (of extreme positions of Sun) is greater than the speed of light	(1)	1
18(c)(i)	Light from A is observed to have a lower frequency as the source is receding from the observer **Or** light from B is observed to have a higher frequency as the source is approaching the observer Because there is a Doppler shift.	(1) (1)	2
18(c)(ii)	Use of $\frac{v}{c} = \frac{\Delta\lambda}{\lambda}$ So wavelength difference between light from A & B = 1.6×10^{-11} m <u>Example of calculation</u> $\Delta\lambda = \left(\frac{4.00 \times 10^3\text{ m s}^{-1}}{3.00 \times 10^8\text{ m s}^{-1}}\right) \times 5.9 \times 10^{-7}\text{m} = 7.87 \times 10^{-12}\text{ m}$ Difference between A and B = $2 \times 7.87 \times 10^{-12}$ m = 1.57×10^{-11} m	(1) (1)	2
	Total for question 18		**11**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>19(a)</td><td>Parallax is the (apparent) change in position (of a star/object) relative to the background (owing to a change in position of the observer)</td><td>(1)</td><td>1</td></tr>
<tr><td>19(b)</td><td>When the stars are viewed from two positions at 6 month intervals
Or when the stars are viewed from opposite ends of the Earth's orbit diameter about the Sun
(Accept a labelled diagram as evidence for MP1)

The change in angular position of star A is (about) half of that of star B
Or
The parallax angle for A would be (about) half of that of star</td><td>(1)

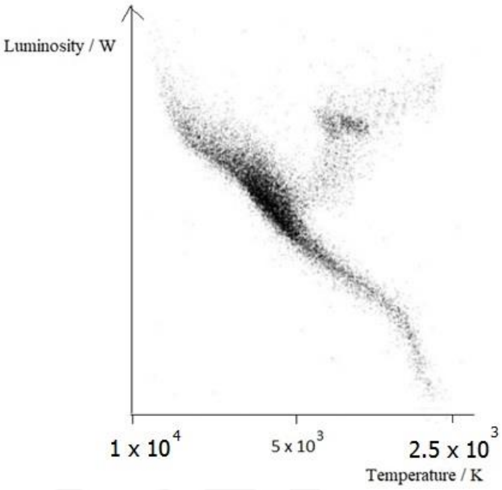
(1)</td><td>2</td></tr>
<tr><td>19(c)(i)</td><td>Communicating with the satellite would be easier
Or satellite would be found at the same location always

Because the satellite would always be above the same point on the Earth's surface Or the satellite would be a geostationary orbit</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>19(c)(ii)</td><td>Use of $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ Or with $F = \frac{mv^2}{r}$
Use of $\omega = \frac{2\pi}{T}$ Or use of $v = \frac{2\pi r}{T}$
$r = 4.23 \times 10^7$ m
$h = 3.6 \times 10^7$ m

<u>Example of calculation</u>
$m\omega^2 r = \frac{GMm}{r^2}$
$\therefore \left(\frac{2\pi}{T}\right)^2 = \frac{GM}{r^3}$
$\therefore r = \sqrt[3]{\frac{GMT^2}{4\pi^2}} = \sqrt[3]{\frac{6.67\times10^{-11} \times 6.00\times10^{24}\ \text{kg} \times (8.64\times10^4\ \text{s})^2}{4\pi^2}}$
$\therefore r = 4.23\times10^7$ m
$h = r - R_E = 4.23\times10^7\ \text{m} - 6.4\times10^6\ \text{m} = 3.59\times10^7$ m</td><td>(1)
(1)
(1)
(1)

(1)
(1)
(1)
(1)</td><td>4</td></tr>
</table>

19(d)(i)	Reverse scale Power/log scale Example of labelling: 	(1) (1)	**2**
19(d)(ii)	These red giant stars have a high luminosity But they have a low temperature $L = \sigma T^4 A$ with L, T and A defined, therefore (surface) area must be (very) large (MP3 dependent upon MP1 **and** MP2)	(1) (1) (1)	**3**
***19(d)(iii)**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** All/most the stars would be on the main sequence in a young cluster There are red giant stars so the cluster cannot be very young Red giant stars evolve into white dwarf stars There are no white dwarf stars so the cluster cannot be very old	 (1) (1) (1) (1)	4
	Total for question 19		**18**

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