Pearson Edexcel

Mark Scheme (Results)

October 2018

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. 'resonance'
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	**The only correct answer is B** ***A*** *is not correct because if the half-life were 2.4 hours the activity would be* 150 Bq ***C*** *is not correct because if the half-life were 4.0 hours the activity would be* 600 Bq ***D*** *is not correct because if the half-life were 12 hours the activity would be* 2400 Bq	**1**

Question Number	Answer	Mark
2	**The only correct answer is B** ***A*** *is not correct because standard candles enable distances to be determined* ***C*** *is not correct because the age of the universe is not related to the Planck constant* ***D*** *is not correct because the age of the universe is not simply related to the temperature of deep space*	**1**

Question Number	Answer	Mark
3	**The only correct answer is C** ***A*** *is not correct because the smaller the number of nuclei the lower the activity* ***B*** *is not correct because the larger the half-life of the source the lower the activity* ***D*** *is not correct because the larger the half-life of the source the lower the activity*	**1**

Question Number	Answer	Mark
4	**The only correct answer is A** ***B*** *is not correct because* P *is further away with a greater flux, so luminosity is greater* ***C*** *is not correct because a smaller parallax angle indicates a greater distance* ***D*** *is not correct because a smaller parallax angle indicates a greater distance*	**1**

Question Number	Answer	Mark
5	**The only correct answer is C** ***A*** *is not correct because nuclear decay releases only a small fraction of the total energy* ***B*** *is not correct because nuclear emission is another way to describe nuclear decay* ***D*** *is not correct because uranium fuel does not undergo fusion*	**1**

Question Number	Answer	Mark
6	**The only correct answer is D** ***A*** *is not correct because deep space is a few degrees above absolute zero* ***B*** *is not correct because nitrogen liquefies at a much higher temperature* ***C*** *is not correct because we have not yet attained absolute zero in an experiment*	**1**

Question Number	Answer	Mark
7	**The only correct answer is A** ***B*** *is not correct because the size of the universe is also important* ***C*** *is not correct because the time elapsed is not related to the density of the universe* ***D*** *is not correct because this temperature is not related to the density of the universe*	**1**

Question Number	Answer	Mark
8	**The only correct answer is B** ***A*** *is not correct because elastic deformations return energy to the oscillation* ***C*** *is not correct because stiff materials require large stresses to deform* ***D*** *is not correct because strong materials withstand large stresses without breaking*	**1**

Question Number	Answer	Mark
9	**The only correct answer is C** ***A*** *is not correct because the temperature should decrease from X to Y* ***B*** *is not correct because the temperature should decrease from X to Y* ***D*** *is not correct because the temperature should decrease logarithmically from X to Y*	**1**

Question Number	Answer	Mark
10	**The only correct answer is B** ***A*** *is not correct because this graph shows a proportional relationship between p and V* ***C*** *is not correct because this shows p remaining constant as V is increased* ***D*** *is not correct because this shows a linear relationship between p and V*	**1**

Question Number	Answer		Mark
11a	(A standard candle is a stellar) object of known luminosity	**(1)**	**1**
***11b**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** A standard candle is identified in the galaxy The (radiation) flux (from the candle) received (on Earth) is measured The inverse square law is used to determine the distance using the (known) luminosity of the candle [accept references to use of $F = \frac{L}{4\pi d^2}$, but only if symbols *F* and *L* are defined]	**(1)** **(1)** **(1)**	**3**
11c	Because the distance is too large **Or** the angular displacement is too small (to measure) **Or** trigonometric parallax is only suitable for nearby stars	**(1)**	**1**
			5

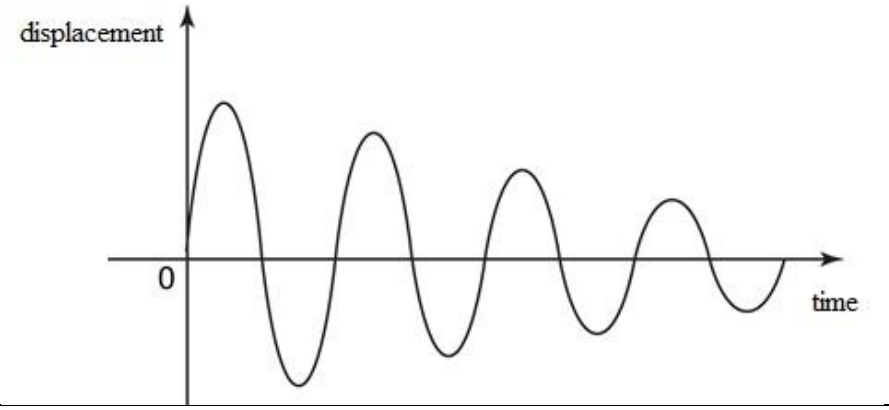
Question Number	Answer		Mark
12a	Use of $\Delta E = mc\Delta\theta$ $\Delta E = 2.6 \times 10^6$ (J) <u>Example of calculation</u> $\Delta E = 18\ \text{kg} \times 4200\ \text{J kg}^{-1}\ \text{K}^{-1} \times (50\text{-}16)\ \text{K} = 2.57 \times 10^6\ \text{J}$	**(1)** **(1)**	**2**
12b	Use of $P = \frac{\Delta W}{\Delta t}$ $\Delta t = 1400$ s [ecf value of ΔE from (a)] <u>Example of calculation</u> $\Delta t = \frac{\Delta W}{P} = \frac{2.57 \times 10^6\text{J}}{1800\ \text{W}} = 1430\ \text{s}$	**(1)** **(1)**	**2**
12c	All the energy supplied is used to heat the water **Or** no energy transfer to the surroundings	**(1)**	**1**
	Total		**5**

Question Number	Answer		Mark
13ai	Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ λ_o = 485.8 nm Example of calculation $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ $\therefore \frac{486\text{ nm} - \lambda}{486\text{ nm}} = \frac{120 \times 10^3\text{ m s}^{-1}}{3.0 \times 10^8\text{ m s}^{-1}}$ $\therefore \lambda_o = 485.8\text{ nm}$ **Or** $\Delta\lambda = \frac{120 \times 10^3\text{m s}^{-1}}{3.00 \times 10^8\text{m s}^{-1}} \times 486\text{ nm} = 0.194\text{ nm}$ $\therefore \lambda_o = 486\text{ nm} - 0.194\text{ nm} = 485.8\text{ nm}$	**(1)** **(1)**	**2**
13aii	There are different (Doppler) shifts for light from stars in either arm Because the stars in the arms are moving relative to the centre **Or** because the stars in the arms have an additional velocity component	**(1)** **(1)**	**2**
13b	There must be matter (in the galaxy) that is not emitting electromagnetic radiation So dark matter must be present (in the galaxy)	**(1)** **(1)**	**2**
			6

Question Number	Answer		Mark
14ai	Use of $pV = NkT$ p = 1.39 × 10^5 (Pa) Example of calculation $\frac{p}{T}$ = a constant $\therefore p = \frac{(38.5+273)\text{ K}}{(22.5+273)\text{ K}} \times 1.32\times10^5\text{ Pa} = 1.39\times10^5\text{ Pa}$	**(1)** **(1)**	**2**
14aii	The volume (of the volleyball) remains constant **Or** no air escapes (from the volleyball) **Or** the number of (air) molecules (in the volleyball) remains constant **Or** the mass of air (in the volleyball) remains constant	**(1)**	**1**
14b	Calculation of volume of volleyball Use of $pV = NkT$ ΔN = 8.4 × 10^{21} (allow ecf from (a)(i)) Example of calculation $V = \frac{4\pi}{3} \times \left(\frac{0.214\text{ m}}{2}\right)^3 = 5.13\times10^{-3}\text{m}^3$ $N = \frac{pV}{kT}$ $\therefore \Delta N = \Delta p \times \frac{V}{kT}$ $\Delta N = \left(1.39\times10^5 - 1.32\times10^5\right)\text{Pa} \times \frac{5.13\times10^{-3}\text{ m}^3}{1.38\times10^{-23}\text{J K}^{-1}\times(38.5+273)\text{ K}}$ $\therefore \Delta N = 8.36\times10^{21}$	**(1)** **(1)** **(1)**	**3**
			6

Question Number	Answer		Mark
15ai	This is the average/mean kinetic energy per molecule (in the gas)	**(1)**	**1**
15aii	This is the internal energy (of the gas) **Or** the total kinetic energy (of the molecules in the gas)	**(1)**	**1**
15b	Use of $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ $\langle c^2\rangle = 3.7 \times 10^6\ \text{m}^2\ \text{s}^{-2}$ <u>Example of calculation</u> $\langle c^2\rangle = \frac{3\times1.38\times10^{-23}\ \text{J K}^{-1}\times(25+273)\text{K}}{3.3\times10^{-27}\text{kg}} = 3.74\times10^6\text{m}^2\text{s}^{-2}$	**(1)** **(1)**	**2**
***15c**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** (As the volume of the container decreases) the rate of collision of molecules/atoms with the walls of the container increases Since the temperature is unchanged, the (root mean square) speed of the molecules/atoms is also unchanged [Accept "kinetic energy", "momentum", for "root mean square speed"] The rate of change of momentum of the molecules/atoms when colliding with the container walls increases Hence the force on the container walls increases and the pressure exerted by the gas increases (since p = F/A) [Dependent upon MP3]	**(1)** **(1)** **(1)** **(1)**	**4**
			8

Question Number	Answer		Mark
16ai	Pair of values for ΔE_{el} and x read from graph	**(1)**	
	Use of $\Delta E_{el} = \frac{1}{2} F \Delta x$ and $F = k\Delta x$	**(1)**	
	k = 120 (N m^{-1})	**(1)**	**3**
	<u>Example of calculation</u> ΔE_{el} = 0.38 J when x = 0.08 m $\Delta E_{el} = \frac{1}{2}(k\Delta x)\Delta x = \frac{1}{2}k(\Delta x)^2$ $\therefore k = \frac{2 \times 0.38 \text{ J}}{(0.08 \text{ m})^2} = 119 \text{ N m}^{-1}$		
16aii	Use of $F = kx$ with $F = m\omega^2 x$	**(1)**	
	Use of $\omega = 2\pi f$	**(1)**	
	f = 2.6 Hz	**(1)**	**3**
	<u>Example of calculation</u> $kx = m\omega^2 x$ $\therefore \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{120 \text{ N m}^{-1}}{0.45 \text{ kg}}} = 16.3 \text{ rad s}^{-1}$ $f = \frac{\omega}{2\pi} = \frac{16.3 \text{ rad s}^{-1}}{2\pi \text{ rad}} = 2.60 \text{ Hz}$		
16bi	The pan would (be displaced below its equilibrium position and then begin to) oscillate with (gradually) decreasing amplitude	**(1)**	
	Because energy would be removed from the system **Or** because energy would be dissipated **Or** because energy would be transferred to the surroundings as thermal energy	**(1)**	**2**

16bii	Sinusoidal graph with decreasing amplitude over at least 2 cycles (Accept any displacement at $t = 0$) **(1)** Constant time period for oscillations **(1)** [Must be drawn over at least 2 cycles] <u>Example of graph:</u>  	**2**
		10

Question Number	Answer	Mark
17ai	Use of $F = \frac{GMm}{r^2}$ with $F = mg$ **(1)** Algebra to show $g = \frac{GM}{r^2}$ **(1)**	**2**
17aii	Use of $g = \frac{GM}{r^2}$ **(1)** g_v = 8.9 N kg^{-1} [accept m s^{-2}] **(1)** <u>Example of calculation</u> $g_v = \frac{6.67\times10^{-11}\text{N m}^2\text{ kg}^{-2}\times4.9\times10^{24}\text{kg}}{(6050\times10^3\text{m})^2} = 8.93\text{ N kg}^{-1}$	**2**
17b	Use of $F = \frac{L}{4\pi d^2}$ **Or** Use of $F \propto \frac{1}{d^2}$ **(1)** Use of ratios **(1)** F_v = 2600 W m^{-2} **(1)** <u>Example of calculation</u> $\frac{F_v}{F_E} = \frac{\frac{L}{4\pi d_v^2}}{\frac{L}{4\pi d_E^2}}$ $\therefore F_v = F_E \times \frac{d_E^2}{d_v^2} = 1370\text{ W m}^{-2}\times\left(\frac{1}{0.72}\right)^2 = 2640\text{ W m}^{-2}$	**3**
17ci	Use of $L = 4\pi r^2\sigma T^4$ **(1)** L = 7.4 × 10^{18} W **(1)** <u>Example of calculation</u> $L = 5.67\times10^{-8}\text{ W m}^{-2}\text{ K}^{-4}\times4\pi\times(6050\times10^3\text{m})^2\times(730\text{ K})^4$ $\therefore L = 7.41\times10^{18}$ W	**2**

17cii	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$ **(1)** $\lambda_{max} = 4.0 \times 10^{-6}$ m **(1)** Example of calculation $\lambda_{max} = \frac{2.898 \times 10^{-3} \text{ m K}}{730 \text{ K}} = 3.97 \times 10^{-6}$ m	**2**
17ciii	Infra-red (Ecf from wavelength in cii)	**1**
		12

Question Number	Answer		Mark
18ai	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$	**(1)**	**3**
	Use of $\frac{\Delta N}{\Delta t} = -\lambda N$	**(1)**	
	$\frac{\Delta N}{\Delta t} = (-)3.65 \times 10^{10}$ (Bq)	**(1)**	
	<u>Example of calculation</u> $\lambda = \frac{0.693}{(66 \times 3600)\ s} = 2.92 \times 10^{-6}\ s^{-1}$ $\frac{\Delta N}{\Delta t} = -2.92 \times 10^{-6} \times 1.25 \times 10^{16} = 3.65 \times 10^{10}$ Bq		
18aii	Use of $\left(\frac{\Delta N}{\Delta t}\right) = \left(\frac{\Delta N}{\Delta t}\right)_0 e^{-\lambda t}$	**(1)**	**2**
	$t = 1.2 \times 10^5$ s (ecf from 18ai)	**(1)**	
	<u>Example of calculation</u> 2.6×10^{10} Bq $= 3.65 \times 10^{10}$ Bq $\times e^{-2.92 \times 10^{-6}\ s^{-1} \times t}$ $\therefore t = \frac{\ln\left(\frac{2.6}{3.6}\right)}{-2.92 \times 10^{-6}\ s^{-1}} = 1.16 \times 10^5$ s		
***18b**	**(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence.)** **MAX 4**		**4**
	Gamma radiation can penetrate the body	**(1)**	
	Both half-lives are long enough to allow the procedure to be done	**(1)**	
	Thallium has a longer half-life so will continue to decay for longer	**(1)**	
	Thallium has a smaller decay constant so more nuclei needed to produce the required/same activity	**(1)**	
	Thallium would pose a greater radiation exposure risk to the patient	**(1)**	
	[Allow converse statement about technetium in MP3 → MP5. MP5 must be awarded for full marks]		
			9

Question Number	Answer		Mark
19a	Isotopes (of an element) have the same proton number but different nucleon numbers	**(1)**	
	A numerical reference to the two isotopes of He shown on the graph	**(1)**	**2**
19b	Binding energy per nucleon for ^{4}He read off graph [7 Mev]	**(1)**	
	Calculation of binding energy of ^{4}He nucleus	**(1)**	
	Use of 1.60 x 10^{-19} to convert eV to J	**(1)**	
	Use of $\Delta E = c^2 \Delta m$	**(1)**	
	Δm = 5.0 × 10^{-29} (kg)	**(1)**	**5**
	<u>Example of calculation</u> ΔE = 4 × 7 × 10^{6} eV × 1.6 × 10^{-19} J eV^{-1} = 4.48 × 10^{-12} J $\Delta m = \frac{\Delta E}{c^2} = \frac{4.48\times10^{-12}\text{J}}{(3\times10^{8}\ \text{m s}^{-1})^2} = 4.98\times10^{-29}$ kg		
19c	**Either** The binding energy (per nucleon) is (much) greater for a nucleus of ^{4}He	**(1)**	
	Hence more energy is released by forming a nucleus of ^{4}He	**(1)**	
	Or The binding energy (per nucleon) is (much) less for a nucleus of ^{3}He	**(1)**	
	Hence less energy is released by forming a nucleus of ^{3}He	**(1)**	**2**
			9

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