Pearson Edexcel

Mark Scheme (Final)

October 2020

Pearson Edexcel International Advanced Subsidiary/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.

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 questions set in a practical context.
- 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 because background radiation is produced by a variety of radioisotopes present in the environment. A, B and C are all incorrect because they only identify one of the 3 types of radiation contributing to background radiation.	**1**
2	The only correct answer is A because • spontaneous processes occur without input from an external source, • random means it is impossible to know which nucleus will decay next. B, C and D are incorrect because they confuse the meanings of these terms.	**1**
3	The only correct answer is C because when the person is not in contact with the trampoline their acceleration is constant (and equal to *g*). A, B and D are incorrect because they are all examples of S.H.M.	**1**
4	The only correct answer is C because kinetic energy (E_k) is a maximum and potential energy (E_p) is zero at the equilibrium position. A is incorrect because E_p is a max and E_k is zero at the max displaced position. B and D are incorrect because in between the equilibrium position and the maximum displace position there is a mixture of E_k and E_p.	**1**
5	The only correct answer is C because this uses the value of *g* at the surface of the Earth in the expression$g = (-)\frac{GM}{r^2}$. A is incorrect because the calculation omits the square root. B is incorrect because the square root of *g* is not taken. D is incorrect because the equation is incorrectly re-arranged.	**1**
6	The only correct answer is C because *v* is given by the gradient of the *x-t* graph. So the gradient of the d *x-t* graph must be zero initially, and then become positive. A is incorrect because the *x-t* graph gradient is zero initially, then negative. B and D are incorrect because the *x-t* graph gradient is non-zero initially.	**1**
7	The only correct answer is C because $L = 4\pi r^2 T^4$, and so $r = R \times \sqrt{\frac{L}{16L} \times \left(\frac{T}{5T}\right)^2} = R \times \frac{1}{4} \times \frac{1}{25} = \frac{R}{100}$ A, B and D are incorrect because the equation is used incorrectly.	**1**
8	The only correct answer is B. A is incorrect because alpha radiation cannot penetrate the skin. C is incorrect because gamma radiation has negligible absorption in paper D is incorrect because gamma radiation does not produce significant ionisation	**1**
9	The only correct answer is D. A is incorrect because this is the increase in B.E./nucleon B is incorrect because this is the B.E./nucleon for $^{235}_{92}U$ C is incorrect because this would be the energy released for only 92 nucleons	**1**
10	The only correct answer is D A is incorrect because we cannot know this from the graph. B is incorrect because energy must be supplied if heavy nuclei undergo fusion C is incorrect because we cannot know this from the graph	**1**

Question Number	Answer	Mark
11(a)	resistant to scratching/denting (1)	**1**
11(b)(i)	Use of $\Delta E = mc\Delta\theta$ (1) Thermal energy transfer from steel = thermal energy transfer to oil (1) T = 32 ºC (1) <u>Example of calculation</u> $0.40 \text{ kg} \times 450 \text{ J kg}^{-1} \text{ K}^{-1} \times (560 - \theta)\text{K}$ $= 4.4 \text{ kg} \times 1800 \text{ J kg}^{-1} \text{ K}^{-1} \times (\theta - 20)\text{K}$ 100800 – 180θ = 7920T – 158400 259200 = 8100θ θ = 32 ºC	**3**
11(b)(ii)	Assumed thermal energy transfer from steel = thermal energy gain by oil **Or** not all thermal energy would be transferred to the oil (1) Final T would be less (1) **MAX 2 marks from any pair** Assumed all the oil heated to the same temperature (1) The oil nearer the bar would be at a higher temperature than calculated (1) **OR** Oil is not stirred (1) Temperature of oil is not uniform (1) **OR** Assumed no vaporisation/boiling of oil (1) If some oil vapourised then the overall temperature of the mixture will be less (1)	**4**
	Total for question 13	**8**

Question Number	Answer	Mark
12(a)i	Use of $\omega = 2\pi f$ (1) Use of $a = (-)A\omega^2(\cos \omega t)$ (1) $A = 6.9 \times 10^{-3}$ m (1) Example of Calculation: $100 \times 9.81 \text{ m s}^{-2} = -A(2\pi \times 60\ s^{-1})^2$ $A = 6.9 \times 10^{-3}$ m	3
12(a)ii	MAX 2 from Particles no longer receive energy from the sound wave (1) Energy from the particles is transferred to the liquid **Or** damping occurs (1) Amplitude decreases as (kinetic) energy of particles decreases (1)	2
*12(b)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Oscillations are forced at a frequency equal to the natural frequency (of the system) (1) There is a maximum energy transfer **Or** there is an efficient energy transfer (1) The amplitude of oscillation is maximum (1)	3
	Total for question 12	**8**

Question Number	Answer		Mark
13(a)(i)	The object must be a black body (radiator)	(1)	**1**
13(a)(ii)	Use of $\lambda_{max}T = 2.898 \times 10^{-3}$m K $\lambda_{max} = 1.3 \times 10^{-6}$ (m) This is infrared/IR (radiation), so most intensity at IR range **Or** this is not in visible range, so low(er) intensity at visible wavelength <u>Example of calculation</u> $\lambda_{max} \times 2200$ K $= 2.898 \times 10^{-3}$ m K $\lambda_{max} = 1.3 \times 10^{-6}$ m	(1) (1) (1)	**3**
13(b)	Use of luminosity of lamp = efficiency × power Use of $F = \frac{L}{4\pi d^2}$ F = 0.044 W m^{-2} <u>Example of calculation</u> $F = \frac{0.0500 \times 100 \text{ W}}{4\pi(3.00)^2 \text{ m}^2}$ F = 0.044 W m^{-2}	(1) (1) (1)	**3**
	Total for question 13		**7**

Question Number	Answer		Mark
14(a)(i)	x axis reverse temp Temp values should be approximately logarithmic	(1) (1)	**2**
14(a)(ii)	W in upper left Y in bottom right	(1) (1)	**2**
14(b)(i)	There is maximum (radiation) flux when the stars are side by side **Or** there is maximum (radiation) flux for diagrams A and C There is a decrease in flux when one star is in front of the other **Or** there is a decrease in flux for diagrams B and D The larger decrease in flux is when star Y is in front of star W **Or** the larger decrease in flux is when the dimmer star is in front of the brighter star	(1) (1) (1)	**3**
14(b)(ii)(1)	Period of orbit (T) = 70 hours Use of $v = \omega r$ and $T = 2\pi/\omega$ $v = 1.9 \times 10^5$ (m s^{-1}) <u>Example of calculation</u> $v = \frac{2\pi \times 7.6 \times 10^9 \text{m}}{70 \times 3600 \text{ s}}$ $v = 1.9 \times 10^5$ m s^{-1}	(1) (1) (1)	**3**
14(b)(ii)(2)	Use of $F = \frac{GMm}{r^2}$ Use of $F = \frac{mv^2}{r}$ Mass of star W is 3.1 solar masses <u>Example of calculation</u> $\frac{GMm}{(9.3 \times 10^9)^2 \text{ m}^2} = \frac{mv^2}{7.6 \times 10^9 \text{ m}}$ $\frac{GM}{(9.3 \times 10^9)^2 \text{ m}^2} = \frac{(1.9 \times 10^5)^2}{7.6 \times 10^9 \text{ m}}$ $M = 6.13 \times 10^{30}$ kg Number of solar masses $= \frac{6.13 \times 10^{30} \text{kg}}{2.0 \times 10^{30} \text{ kg}}$ = 3.1 solar masses	(1) (1) (1)	**3**
	Total for question 14		**13**

Question Number	Answer		Mark
15(a)	A standard candle is identified in the galaxy The (radiation) flux from the candle/star received (on Earth) is measured The inverse square law is used to determine the distance using the (known) luminosity (of the candle) [Accept reference to $F = L/4\pi d^2$ with symbols defined]	(1) (1) (1)	**3**
***15(b)**	(QWC Spelling of technical terms must be correct and the answer must be organised in a logical sequence) Frequency of a line in the spectrum emitted by the galaxy is measured Difference between this frequency and the same line in a lab source is determined The Doppler equation is used to determine the velocity of the galaxy (relative to the Earth) [Accept explanations in terms of wavelength] **OR** The distance to the galaxy is determined (suing a standard candle) Hubble's law is used [accept reference to $v = H_o d$] The value of the Hubble constant must be known	(1) (1) (1) (1) (1) (1)	**3**
15(c)(i)	Line of best fit drawn Gradient determined Light years converted to m $H_o = 2.1 \times 10^{-18}\ \text{s}^{-1} \rightarrow 2.4 \times 10^{-18}\ \text{s}^{-1}$ <u>Example of calculation</u> $\text{Grad} = \dfrac{(26000 - 1000) \times 10^3\ \text{m s}^{-1}}{(1200 - 0) \times 10^6\ \text{light year}} = 0.0208\ \text{m s}^{-1}\text{light year}^{-1}$ $H_o = \dfrac{0.0208\ \text{m s}^{-1}\ \text{light year}^{-1}}{(3.00 \times 10^8\ \text{m s}^{-1} \times 3.15 \times 10^7\ \text{s})\ \text{light year}^{-1}}$ $H_o = 2.2 \times 10^{-18}\ \text{s}^{-1}$	(1) (1) (1) (1)	**4**

15(c)(ii)	The gradient of the graph is constant The graph shows the greater the distance the greater the velocity **Or** velocity is directly proportional to distance This means the distance between galaxies is increasing So each unit of distance in the universe expands by the same proportion in a fixed period of time **Or** the rate of increase of distance is the same everywhere	(1) (1) (1) (1)	**4**
15(d)	Dark matter (has mass therefore) increases the (average) density of the universe (So the average) density is more likely to be greater than the critical density which would lead to a closed universe. **Or** (so the average) density is more likely to be equal to the critical density which would lead to a flat universe	(1) (1)	**2**
	Total for question 15		**16**

Question Number	Answer		Mark
16(a)(i)	Use of $V = \pi r^2 h$ Use of $pV = NkT$ Number of atoms = 7.8×10^{21} <u>Example of calculation</u> $V = \pi \times (0.060\ \text{m})^2 \times 0.028\ \text{m} = 3.2 \times 10^{-4}\ \text{m}^3$ $N = \dfrac{1 \times 10^5\ \text{Pa} \times 3.2 \times 10^{-4}\ \text{m}^3}{1.38 \times 10^{-23}\ \text{JK}^{-1} \times 293\ \text{K}} = 7.8 \times 10^{21}$	(1) (1) (1)	**3**
16(a)(ii)	Use of $E_K = \frac{3}{2}kT$ Recognises that internal energy is the total E_k for all the molecules Uses 80% of total number of molecules Final T = 244 K <u>Example of calculation</u> Internal energy = $\frac{3}{2} 1.38 \times 10^{-23}\ \text{JK}^{-1} \times 293\ \text{K} \times 7.8 \times 10^{21}$ = 47.3 J 20% removed so Internal energy = 37.8 J reduced by 6.3 J so new internal energy = 31.5 J 31.5 J = $\frac{3}{2} 1.38 \times 10^{-23}\ \text{JK}^{-1} \times T\text{K} \times 6.24 \times 10^{21}$ T = 244 K	(1) (1) (1) (1)	**4**
*16b	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Any**TWO** pairs of statements: Visible tracks so alpha is charged Tracks are thick As alpha radiation is strongly ionising Tracks are short As alpha particles can penetrate only a few cm in air Tracks all same length As alpha particles all have the same [similar] energy	(1) (1) (1) (1) (1) (1) (1) (1)	**4**

16c	Use of $\lambda t_{½} = \ln 2$ Use of $N = N_o e^{-\lambda t}$ and $dN/dt = -\lambda N$ Activity = 3680 Bq <u>Example of calculation</u> $\lambda = 0.693/(1600\ \text{year}) = 4.33 \times 10^{-4}\ \text{year}^{-1}$ $A = 3700\ \text{Bq} \times e^{-4.33\times10^{-4}\times10}$ $A = 3684$ Bq	(1) (1) (1)	**3**
16d	Determines mass difference Use of u = 1.66×10^{-27} kg Use of $\Delta E = c^2 \Delta m$ E = 4.9 (MeV) <u>Example of calculation</u> $\Delta m = 226.025402\ \text{u} - (222.017570\ \text{u} + 4.002600\ \text{u}) = 5.23 \times 10^{-3}\ \text{u}$ $E = 5.23 \times 10^{-3}\ u \times 1.66 \times 10^{-27}\ \frac{\text{kg}}{\text{u}} \times (3 \times 10^8\ \text{m s}^{-1})^2 = 7.81 \times 10^{-13}\ \text{J}$ $E = \frac{7.81\times10^{-13}\ \text{J}}{1.6\times10^{-13}\ \text{J/MeV}} = 4.9\ \text{MeV}$	(1) (1) (1) (1)	**4**
	Total for question 16		**18**

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