Markscheme

May 2023

Physics

Standard level

Paper 2

10 pages

Subject Details: Physics SL Paper 2 Markscheme

Candidates are required to answer **all** questions. Maximum total = **50 marks**.

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative wording is indicated in the "Answers" column by a slash (*/*). Either wording can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading ***ALTERNATIVE 1*** *etc*. Either alternative can be accepted.

8. Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

11. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script. "ECF acceptable" will be displayed in the "Notes" column.

14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	a		***ALTERNATIVE 1*** Attempt to count squares ✓ Area of one square found ✓ 7.2 **«**m**»** (accept 6.4 – 7.4 m) ✓ ***ALTERNATIVE 2*** Uses area equation for either triangle ✓ Correct read offs for estimate of area of triangle ✓ 7.2 **«**m**»** (accept 6.4 – 7.4) ✓		**3**
1.	b		Attempt to calculate gradient of line at t = 1.2 s ✓ «–» 9.8 «m s^{-2}**»** (accept 9.6 - 10.0) ✓		**2**
1.	c	i	Attempt to evaluate KE ratio as $\left(\frac{v_{\text{final}}}{v_{\text{initial}}}\right)^2$ ✓ **«**$\left(\frac{4.5}{10}\right)^2$ =**»** 0.20 ***OR*** 20 % ***OR*** $\frac{1}{5}$ ✓	*Accept ± 0.5 velocity values from graph*	**2**
1.	c	ii	Attempt to use force = momentum change ÷ time ✓ «= $\frac{(4.5+10)\times 0.027}{85\times 10^{-3}}$ = 4.6» Force = «4.6 + 0.3» 4.9 «N» ✓ Any answer to 2sf ✓	*Accept ± 0.5 velocity values from graph*	**3**

Question			Answers	Notes	Total
1.	d		***ALTERNATIVE 1*** $\omega = 2\pi(0.35)$ «=2.20 rad s^{-1}» ✓ Use of $v = 0.14\omega$ ✓ 0.31 «m s^{-1}» ✓ ***ALTERNATIVE 2*** $T = \frac{1}{0.35}$ **«**$= 2.9$ s**»** ✓ $v = \frac{2\pi(0.14)}{T}$ ***OR*** $\frac{v^2}{0.14} = \frac{4\pi^2(0.14)}{T^2}$ ✓ $v = 0.31$ «m s^{-1}» ✓	***Award [3]*** *for* ***BCA***	**3**
1.	e		Mass «leaving the bottle per second» will be larger for air–water ✓ the momentum change/force is greater ✓	*Allow opposite argument for air only*	**2**

Question			Answers	Notes	Total
2.	**a**		kg m^2 s^{-2} ✓		**1**
2.	**b**		***ALTERNATIVE* 1** Graph shown is a straight line/linear ***OR*** expected graph should be a straight line/linear ✓ If ideal then T intercept must be at T = -273 °C ✓ Use of $y = mx+c$ to show that x = -273°C when y = 0 ✓ (hence ideal) ***ALTERNATIVE* 2** Calculates $\frac{pV}{T}$ for two different points ✓ Obtains 1.50 **«**J K^{-1}**»** for both ✓ States that for ideal gas $\frac{pV}{T} = nR$ which is constant and concludes that gas is ideal ✓		**3**
2.	**c**		Use of $n = \frac{pV}{RT}$ ***OR*** $N = \frac{pV}{kT}$ ✓ Mass of gas = n x N_A x mass of molecule ***OR*** Mass of gas = N x mass of molecule ✓ 5.1 **«**g**»** ✓		**3**

Question			Answers	Notes	Total
3.	**a**		Mention of interference / superposition ✓ Bright fringe occurs when light from the slits arrives in phase ✓ Dark fringe occurs when light from the slits arrives 180°/ π out of phase ✓		**3**
3.	**b**		$s = \frac{0.15}{8}$ ***OR*** $= 0.0188$ **«**m**»** ✓ use of $\lambda = \frac{ds}{D}$ ✓ 450 **«**nm**»** ✓		**3**
3.	**c**		Blue fringe is unchanged ✓ Red fringes are farther apart than blue ✓ By a factor of 1.5 ✓ At some point/s the fringes coincide/are purple ✓		**3 max**

Question			Answers	Notes	Total
4.	a		$I = \sqrt{\frac{P}{R}}$ **«=»** 1.9 **«**A**»** ✓		1
4.	b	i	***ALTERNATIVE* 1** (Calculation of length) Read off from graph [2.8 - 3.2 x10^{-5} Ω m] ✓ Use of $I = \frac{RA}{\rho}$ ✓ l = 1.3 - 1.4 **«**m**»** ✓ ***ALTERNATIVE* 2** (Calculation of area) Read off from graph [2.8 - 3.2 x10^{-5} Ω m] ✓ Use of $A = \rho\frac{l}{R}$ ✓ A = 8.3 - 9.5 x 10^{-6} **«**m^2**»** ✓ ***ALTERNATIVE* 3** (Calculation of resistance) Read off from graph [2.8 - 3.2 x10^{-5} Ω m] ✓ Use of $R = \rho\frac{l}{A}$ ✓ R = 3.6 - 4.2 **«**Ω**»** ✓ ***ALTERNATIVE* 4** (Calculation of resistivity) Use of $\rho = \frac{RA}{l}$ ✓ ρ = 3.2 x 10^{-5} **«**Ωm**»** ✓ Read off from graph 260 – 280 K ✓		3

Question			Answers	Notes	Total
4.	**b**	**ii**	**«**Resistivity and hence**»** resistance will decrease ✓ **«**Pd across pad will not change because internal resistance is negligible**»** Current will increase ✓		**2**
4.	**c**	**i**	**«**The force is**»** away from PQ/repulsive/to the right ✓		**1**
4.	**c**	**ii**	The magnetic fields **«**due to currents in PQ and TU**»** are in opposite directions ***OR*** There are two **«**repulsive**»** forces in opposite directions ✓ Net force is zero ✓		**2**
4.	**d**		Air is a poor **«**thermal**»** conductor ✓ Lack of convection due to air not being able to move in material ✓ Appropriate statement about energy transfer between the pet, the resistor and surroundings ✓ The rate of thermal energy transfer to the top surface is greater than the bottom «due to thinner material**»** ✓	*Accept air is a good insulator*	**3 max**

Question			Answers	Notes	Total
5.	**a**		$^{27}_{12}Mg \rightarrow {}^{27}_{13}Al + {}^{0}_{-1}\beta^{-}$ **«**+ $\bar{\nu}_e$ **»** ✓ **«**Electron**»** anti-neutrino specified ✓	*Accept any other valid symbol for the electron, e.g. e, e^- (with or without numbers), β^- (without numbers)*	**2**
5.	**b**		Neutron → proton ✓ d quark → u quark ✓		**2**
5.	**c**		Strong force is short range & electromagnetic force is long range ✓ Strong force is attractive between nucleons/neutrons & protons ✓ Electromagnetic force is repulsive between protons ✓ Overall, the strong force dominates ✓		**3 max**