2225 – 6724M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2025

Physics

Standard level

Paper 2

15 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. For numerical answers, a correct answer with no working is awarded full marks UNLESS stated otherwise in the “Notes”. For correct numerical answers with working the working must be checked. If the working contains minor omissions or errors full marks are awarded. If the working contains wrong Physics or wrong method the correct answer obtained will be the result of numerical coincidence. In that case the answer is penalized.
6. An alternative wording is indicated in the “Answers” column by a slash (/). Either wording can be accepted.
7. An alternative answer is indicated in the “Answers” column by “OR” between the alternatives. Either answer can be accepted.
8. Words in angled brackets « » in the “Answers” column are not necessary to gain the mark.
9. The order of marking points does not have to be as in the “Answers” column, unless stated otherwise in the “Notes” column.
10. 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.
11. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
12. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in a marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then error carried forward (ECF) marks should be awarded. When marking, indicate this by adding ECF on the script. When ECF is not to be applied “Do not allow ECF” will be displayed in the “Notes” column.
13. Do not penalize candidates for errors in units or significant figures, unless it is specifically referred to in the “Notes” column.
14. Allow alternative formats such as c for rad or use of E for scientific notation.

Question			Answers	Notes	Total
1.	a		It is a ratio between two forces therefore units cancel out. ***OR*** μ = Ff/N, therefore units cancel out. ✓		**1**
1.	b		uses the static coefficient ✓ F = 0.36 x 1.2 x 9.8 = 0.36 x 11.76 ***OR*** F = 4.2 «N» ✓	*Must see full substitution OR answer to 2 (or more) significant figures for MP2.*	**2**

1.	**c**		**ALT 1** F_f = 0.28 x 1.2 x 9.8 = 3.29 «N» ✓ W done over 0.35 m = (14 -3.29) x 0.35 = 3.75 «J»✓ d = «3.75 J / 3.29 N = » 1.14 «m» ✓ ***ALT 2*** a = (14 - 0.28 x 1.2 x 9.8)/1.2 = 8.92 «m s^{-2}» ✓ v = $\sqrt{(2)(8.92)(0.35)}$ = 2.50 «m s^{-1}» ✓ d = «2.5^2/(2x0.28x9.8) = » 1.14 «m» ✓	*Allow ECF from MP1* *Only award marks from one ALT.*	**3**

Question			Answers	Notes	Total
2.	**a**	**i**	Wavelength = 0.68 «m» ✓ Period = 0.002 «s» ✓	*Accept 0.67 – 0.70 m for wavelength.*	**2**
2.	**a**	**ii**	v = «λ/T = 0.68 / 0.002 = » 340 «m s^{-1}» ✓	*Allow ECF from 2ai* *Allow v = 335 – 350* m s^{-1}	**1**
2.	**b**	**i**	440 Hz because the frequency heard <<by the driver>> will be higher OR 440 Hz because the <<apparent>> wavelength decreases. ✓		**1**

2.	**b**	**ii**	Use of $\frac{v}{c} = \frac{\Delta\lambda}{\lambda} = \frac{(659x10^{-9}) - (656.1x10^{-9})}{(656.1x10^{-9})}$ ✓ v = 1.33 x 10^{6} «m s^{-1}» **OR** 0.00442 c ✓		**2**

Question			Answers	Notes	Total
3.	a	i	86 ✓		1
3.	a	ii	**ALT 1** mass defect = 226.02540 – 222.01757 – 4.00260 = 0.00523 «u» ✓ 0.00523 x 931.5 = 4.87 «MeV» ✓ **ALT 2** initial energy = (226.02540)(931.5) = 210542.66 «MeV» ***OR*** final energy = (222.01757 + 4.00260)(931.5) = 210537.79 «MeV» ✓ 210542.66 - 210537.79 = 4.87 «MeV» ✓	*Must see full substitution or answer to at least 2 significant figures.*	2
3.	a	iii	$p_{\alpha} = p_{Rn}$ ✓ «Use of $KE = p^2/2m$ to get KE_{α}/KE_{Rn} =222/4 so» KE_{α} = 222/226 OR 0.982 ✓		2
3.	b	i	«a few» alpha particles bounce back from the foil ✓ «most» alpha particles pass through «undeflected» ✓ «some» alpha particles were scattered/deviated from their path ✓		2 max
3.	b	ii	«nucleus is» small ***AND*** dense ✓ «nucleus is» positively charged ***OR*** a nucleus «is postulated» ✓		2

Question			Answers	Notes	Total
4.	a		g = $\frac{G\,M}{(1.50x10^{11})^2}$ ✓ g =0.0059 ≪N kg^{-1} or m/s^2≫ ✓		2
4.	b	i	A planet orbits a star describing an elliptical path with the Sun/star at one of the foci ✓		1
4.	b	ii	**ALT 1** One component of the gravitational force creates an acceleration <<that acts in the same direction of the velocity>> ✓ Therefore KE increases ✓ **ALT 2** According to Kepler's second law, the Earth sweeps out equal areas in equal times ✓ Therefore, the Earth moves slower/less KE when far from the sun ✓		2

Question			Answers	Notes	Total
5.	a		ALT 1 $4kq / r_1^2 = kq / r_2^2$ used to give $r_1 = 2 r_2$. ✓ Since $r_1 = 2 r_2$ therefore $r_1 = 2/3$ d. ✓ ALT 2 $k \cdot q/(d-x)^2 = k \cdot 4q/x^2$ ✓ Rearrange to show x = 2/3d ✓		2
5.	b	i	The charge will be attracted/net force towards q therefore it will accelerate to the right ✓		1
5.	b	ii	The net force will be downwards so it will return towards the axis ≪and continue an oscillation around X≫ ✓		1

Question			Answers	Notes	Total
6.	a	i	Weight and Buoyancy drawn in proper directions (by eye) and correctly identified ✓	*Allow any sensible identification of the forces (e.g. mg for F_g)* *Do not allow "gravity" for weight.*	**1**
6.	a	ii	Weight = $\rho_c \cdot A \cdot H \cdot g$ ***OR*** Buoyancy = $\rho_w \cdot A \cdot D \cdot g$ ✔ $\rho_c \cdot A \cdot H \cdot g = \rho_w \cdot A \cdot D \cdot g$ ✔ ≪algebraic manipulation to show the relationship≫		**2**

6.	**b**		When cork is released, upthrust/buoyant force is larger than weight ***OR*** buoyant force is increased when cork submerged. ✓ «net» force/acceleration is proportional to displacement ***OR*** quotes a = «-» ω^2x OR a $\propto$«-» x ✓ «net» force/acceleration is in opposite direction of displacement ***OR*** «net» force/acceleration is directed towards equilibrium ✓		2 max

6.	**c**	**i**	solid state volume is less than liquid state ***OR*** molecules/particles/atoms are closer in solids so volume is smaller ✓ Same mass in smaller volume «so larger density» ***OR*** More mass per unit volume ✓		**2**
6.	**c**	**ii**	4 «ºC» ✓	*Allow 3.9 ºC - 4.1 ºC.* *Accept answer in Kelvin (e.g. 277 K) if proper unit shown.*	**1**
6.	**d**	**i**	«(H -32) / H = 920 / 1030 so» H = 300 «m» ***OR*** D = 268 «m» ✓ m = 920 x 300 x 4200 ***OR*** 1.16×10^9 «kg» ✓	*Must see either full substitution or answer to 3 or more significant figures.*	**2**
6.	**d**	**ii**	$\frac{1}{40} m\ 12 = (\frac{1}{40} m + m)v$ ✓ v = 0.29 «m s^{-1}» ✓		**2**

6.	**e**	**i**	use of ΔT = 6 «ºC» ✓ $\frac{\Delta Q}{\Delta t\ A} = \ll \frac{2.3\ \cdot 6}{0.019} = \gg$ 730 «W m^{-2}» ✓		**2**
6.	**e**	**ii**	m = (ρA)(22) = (1000)(A)(22) = 22000A ***AND*** ΔT = 2 «ºC» ✓ Q/A = «mcΔT» = (22)(1000)(4200 * 2) =1.85x10^8 «J m^{-2}» ***OR*** Q/A = «mL» = (22)(1000)(330000) = 7.26x10^9 «J m^{-2}» ✓ Q/A = 7.4x10^9 «J m^{-2}» ✓		**3**
6.	**e**	**iii**	«the thicker the layer the» lower the rate of transfer ✓		**1**

6.	**e**	**iv**	if solid water were denser than liquid, ice layer would sink ***OR*** water at 4ºC sinks to bottom ✓ ice layer «would isolate water below ice to» maintain conditions «above freezing » ✓ this insulates the lake ***OR*** prevents the lake from freezing completely ✓		**2 max**