Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

Specimen paper

Physics

Standard level

Paper 2

11 pages

International Baccalaureate®
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Subject Details: Physics SL Paper 2 Markscheme

Candidates are required to answer **all** questions. Maximum total = **55 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.

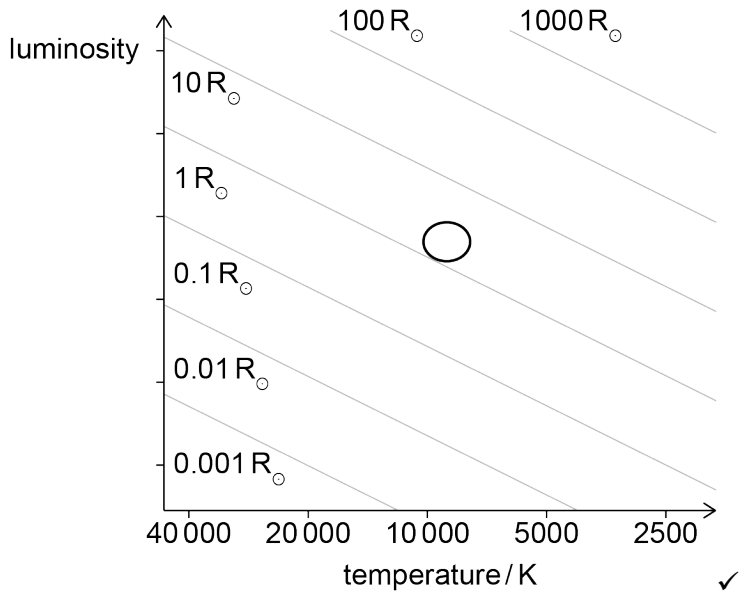
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	**a**		static friction force «between blocks» **AND** directed to the right✓		**1**
1.	**b**		$F = 60a$ ✓ $F_f = 0.6 \times 15 \times 9.8$ «$= 88.2$N» ✓ $88.2 = 15 \times \frac{F}{60} \Rightarrow F = 350$«N» ✓	*Allow use of* $a = 0.6g$ *leading to 353 N.*	**3**

Question			Answers	Notes	Total
2.	**a**		standing waves form «in the oven» by superposition / constructive interference✓ energy transfer is greatest at the antinodes «of the standing wave pattern»✓		**2**
2.	**b**		$\lambda = 12.2$ «cm» ✓ f «$= \frac{c}{\lambda}$» $= \frac{3.0 \times 10^{8}}{1.22 \times 10^{-1}}$ ✓ $f = 2.46$ GHz ✓ correct answer only including power of ten	*Allow* $\lambda \pm 2$ *mm.* *Condone power of ten error in MP2 only.*	**3**

Question			Answers	Notes	Total
3.	**a**		arrow normal to the orbit towards the Earth ✓		**1**
3.	**b**	**i**	use of $v_{\text{orbital}} = \frac{2\pi r}{T}$ AND either $v_{\text{orbital}} = \sqrt{\frac{GM}{r}}$ or $\frac{mv_{\text{orbital}}^2}{r} = \frac{GMm}{r^2}$ correctly manipulated✓ «to yield $T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$»	*Allow use of* ω.	**1**
3.	**b**	**ii**	$r = \sqrt[3]{\frac{GMT^2}{4\pi^2}} = \sqrt[3]{\frac{6.67\times10^{-11}\times5.97\times10^{24}\times(5620)^2}{4\pi^2}}$ ✓ $= 6.83\times10^6$ «m» height $=$ «$6.83\times10^6 - 6.37\times10^6 =$» 4.6×10^5 «m» ✓		**2**

Question			Answers	Notes	Total
4.	**a**		$^{241}_{95}\text{Am}$ ✓ $^{237}_{93}\text{Np} + {}^{4}_{2}\alpha$ ✓		**2**
4.	**b**		Alpha particles only travel a few cm in air / penetration of alpha particles is poor (and will not escape the chamber) ✓	*OWTTE*	**1**
4.	**c**		Each alpha gives rise to $\frac{5.5\times10^{6}}{15} = 3.67\times10^{5}$ ion pairs ✓ So $\frac{3.67\times10^{5}\times42000}{3} = 5.13\times10^{9}$ ion pairs per second ✓ current $= 1.6\times10^{-19}\times5.13\times10^{9} = 0.82\times10^{-9}$ «A» ✓		**3**

Question			Answers	Notes	Total
5.	**a**		correct substitution into $\lambda_{max} = \frac{2.9 \times 10^{-3}}{T}$ OR 9350 K ✓		**1**
5.	**b**		Attempted use of $L = 4\pi bd^2$ ✓ use of $r = \sqrt{\frac{L}{4\pi\sigma T^4}}$ ✓ $r = 1.4\,\text{Gm}$ ✓	*Accept a range of values between 1.3 to 1.5 Gm*	**3**
5.	**c**		Shows $r \approx 2R_\odot$ ✓ Correct position on diagram  ✓	*[use of 9000 K gives $2.2R_\odot$]*	**2**

Question			Answers	Notes	Total
6.	**a**		$(0.030\times0.7\times10^3\times5)+(0.030\times220\times10^3)+(0.030\times2.13\times10^3)(T-47)$ $=(0.150\times2.13\times10^3)(240-T)$ One heat capacity term correctly substituted ✓ latent heat correctly substituted $(0.030\times220\times10^3)$ ✓ $T=190$«°C» ✓		**3**
6.	**b**		Experimental temperature will be lower ✓ Heat loss to the environment ✓		**2**

Question			Answers	Notes	Total
7.	**a**	**i**	equally spaced arrows «by eye» all pointing down ✓ edge effects also shown with arrows ✓		**2**
7.	**a**	**ii**	$E = \frac{V}{d} = \frac{960}{8.0 \times 10^{-3}}$ ✓ $E = 1.2 \times 10^{5}$ «NC^{-1}» ✓		**2**
7.	**b**		friction transfers electron(s) to or from drop ***AND*** through collisions/ interaction with air molecules in the tube OR through collisions/interaction with wall of tube ✓		**1**
7.	**c**	**i**	weight of oil drop is $\rho_o gV$ ✓ $\frac{F_b}{W} = \frac{\rho_a gV}{\rho_o gV} = \frac{\rho_a}{\rho_o}$ ✓ «$\frac{F_b}{W} = \frac{1}{730}$ =»1.4×10^{-3} ***OR*** Ratio of F_b to W is much less than 1 ✓		**3**

7.	**c**	**ii**	Weight vertically down ***AND*** electric force vertically up ✓ Of equal length «by eye» ✓		**2**
7.	**c**	**iii**	Mass of drop is $\rho_0 V$ ✓ $qE = (\rho_0 V)g$ ✓ «hence answer»	*MP1 must be shown implicitly for credit.*	**2**
7.	**c**	**iv**	Negative ✓		**1**
7.	**d**	**i**	Net force is zero ✓ Acceleration of the oil drop is zero ✓ ***OR*** For terminal velocity drag must equal weight ✓ weight $= \rho_0 gV$ **and** drag $= 6\pi\eta rv$ ✓		**2**

7.	**d**	**ii**	$q = \frac{6\pi\eta rv}{E}$ ✓ $q = \frac{6\pi \times 1.60 \times 10^{-5} \times 1.36 \times 10^{-6} \times 1.40 \times 10^{-4}}{1.2 \times 10^{5}}$ ✓ $q = 4.79 \times 10^{-19}$ «C» ✓	*Answer must be shown to 3+ sf.*	**3**
7.	**d**	**iii**	charge is quantized ✓ so, the charges must be 1e and 2e ✓		**2**