Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2019

Physics

Standard level

Paper 2

11 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.

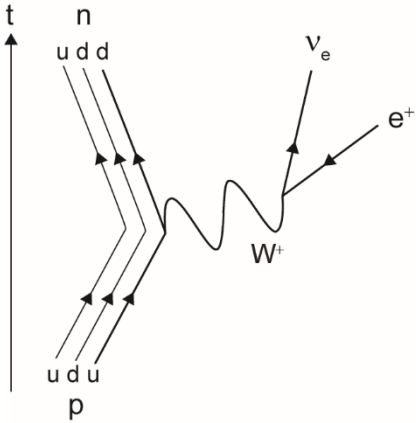
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	a	i	time taken $\frac{2.0\times10^4}{7}$ **«**$= 2860$ s**»** $= 2900$**«**s**»** ✓	*Must see at least two s.f.*	**1**
1.	a	ii	use of $E = qV$ ***OR*** energy $= 4.3\times10^3\times16$ **«**$= 6.88\times10^5$ J**»** ✓ power $= 241$ **«**W**»** ✓	*Accept 229 W – 241 W depending on the exact value of t used from ai.* *Must see at least three s.f.*	**2**
1.	a	iii	use of power = force x speed ***OR*** *force x distance = power x time* ✓ 34 **«**N**»** ✓	*Award **[2]** for a bald correct answer.* *Accept 34 N – 36 N.*	**2**
1.	b	i	$66\,g\sin(3°) = 34$ **«**N**»** ✓		**1**
1.	b	ii	total force 34 + 34 = 68 **«**N**»** ✓ 3.5 **«**ms^{-1}**»**✓	*If you suspect that the incorrect reference in this question caused confusion for a particular candidate, please refer the response to the PE.* *Look for ECF from aiii and bi.* *Accept 3.4 – 3.5 **«**ms^{-1}**»**.* *Award **[0]** for solutions involving use of KE.* *Award **[0]** for $v = 7\ ms^{-1}$.* *Award **[2]** for a bald correct answer.*	**2**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	c		«maximum» distance will decrease ***OWTTE*** ✓ because opposing/resistive force has increased ***OR*** because more energy is transferred to GPE ***OR*** because velocity has decreased ***OR*** increased mass means more work required «to move up the hill» ✓		**2**
1.	d		4 V dropped across battery ***OR*** $R_{circuit} = 1.85\ \Omega$ ✓ so internal resistance $= \frac{4.0}{6.5} = 0.62$ «Ω» ✓	*For MP1 allow use of internal resistance equations that leads to 16V – 12V (=4V).* *Award **[2]** for a bald correct answer.*	**2**
1.	e	i	$\frac{16}{5} = 3.2$ «V» ✓		**1**
1.	e	ii	***ALTERNATIVE 1:*** $2.5r = 0.62$ ✓ $r = 0.25$ «Ω» ✓ ***ALTERNATIVE 2:*** $\frac{0.62}{5} = 0.124$ «Ω» ✓ $r = 2(0.124) = 0.248$ «Ω» ✓	*Allow ECF from (d) and/or e(i).*	**2**

Question			Answers	Notes	Total
2.	a	i	$^{30}_{15}\text{P} \rightarrow \left(^{30}_{14}\text{Si}\right)$ ✓ $+^{0}_{+1}\text{e} + \nu_e$ ✓	*Subscript on neutrino not necessary to award MP2.* *Allow the use of β for e.* *Do not allow an anti-neutrino for MP2.*	2
2.	a	ii	 correct change of either u to d ✓ W^+ shown ✓ correct arrow directions for positron and electron neutrino ✓	*Allow ECF from MP2 in ai for MP3.*	3
2.	a	iii	quarks cannot be directly observed as free particles/must remain bound to other quarks/quarks cannot be isolated ✓ because energy given to nucleon creates other particles rather than freeing quarks/***OWTTE*** ✓		2

(continued…)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**b**		models need testing/new information may change models/new technology may bring new information/Models can be revised***/OWTTE ✓***	*Look for responses that suggest changes/improvements to models.* *Don't accept answers specifically about the Standard Model.* *Don't accept answers about simply proving the model correct.*	**1**

Question			Answers	Notes	Total
3.	a		two waves superpose/mention of superposition/mention of «constructive» interference ✓ they arrive in phase/there is a path length difference of an integer number of wavelengths ✓	*Ignore references to nodes/antinodes.*	2
3.	b		path difference = 0.062 «m» ✓ so wavelength = 0.031 «m» ✓ frequency = 9.7×10^9 «Hz» ✓	*If no unit is given, assume the answer is in Hz. Accept other prefixes (eg 9.7 GHz)* *Award **[2 max]** for 4.8×10^9 Hz.*	3
3.	c		intensity varies with distance ***OR*** points are different distances from the slits ✓	*Accept "Intensity is modulated by a single slit diffraction envelope".*	1

Question			Answers	Notes	Total
4.	a		weight of cylinder $= Ahg\rho$ ✓ pressure $= \frac{F}{A} = \frac{Ahg\rho}{A}$ ✓	*Allow use of $A = \pi r^2$ in MP1.*	**2**
4.	b	i	use of PV = nRT and V = Area × (0.190) seen ✓ substitution of $P = p_o + p_m$ «re-arrangement to give answer»✓		**2**
4.	b	ii	recognition that $\frac{nRT}{A}$ is constant ***OR*** $190p_o + 190p_m = 208p_0 - 208p_m$ ***OR*** $p_0 = \frac{398}{18}p_m$ ✓ pressure due to mercury $p_m = 0.035 \times 1.36 \times 10^4 \times 9.81 (= 4.67 \times 10^3 \text{Pa})$ ✓ 1.03×10^5 ✓ Pa ***OR*** Nm^{-2} ***OR*** $kgm^{-1}s^{-2}$ ✓	*Do not award for a bald correct answer. Working must be shown to award MP3.* *Award MP4 for any correct unit of pressure (eg "mm of mercury / Hg").*	**4**
4.	b	iii	same number of particles to collide with a larger surface area ***OR*** greater volume with constant rms speed decreases collision frequency ✓	*Look for a correct statement that connects pressure to molecular movement/collisions.*	**1**

Question			Answers	Notes	Total
5.	a		0.40 «m s^{-1}» ✓		1
5.	b		initial energy 24 mJ and final energy 12 mJ ✓ energy is lost/unequal /change in energy is 12 mJ ✓ inelastic collisions occur when energy is lost ✓		3
5.	c		maximum GPE at extremes, minimum in centre ✓		1

Question			Answers	Notes	Total
6.	a	i	$T = \left(\frac{1360}{\sigma}\right)^{0.25}$ ✓ 390 «K» ✓	*Must see 1360 (from data booklet) used for MP1.* *Must see at least 2 s.f.*	2
6.	a	ii	energy/Power/Intensity lower at B ✓ connection made between energy/power/intensity and temperature of blackbody ✓		2
6.	b		(28%) of sun's energy is scattered/reflected by earth's atmosphere ***OR*** only 72% of incident energy gets absorbed by blackbody ✓	*Must be clear that the energy is being scattered by the atmosphere.* *Award **[0]** for simple definition of "albedo".*	1
6.	c	i	gravitational attraction/force/field «of the planet/Moon» ✓	*Do not accept "gravity".*	1
6.	c	ii	the force/field and the velocity/displacement are at 90° to each other ***OR*** there is no change in GPE of the moon ✓	*Award **[0]** for any mention of no net force on the satellite.* *Do not accept acceleration is perpendicular to velocity.*	1