Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2016

Physics

Standard level

Paper 2

12 pages

Subject Details: Physics SL Paper 2 Markscheme

Mark Allocation

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.

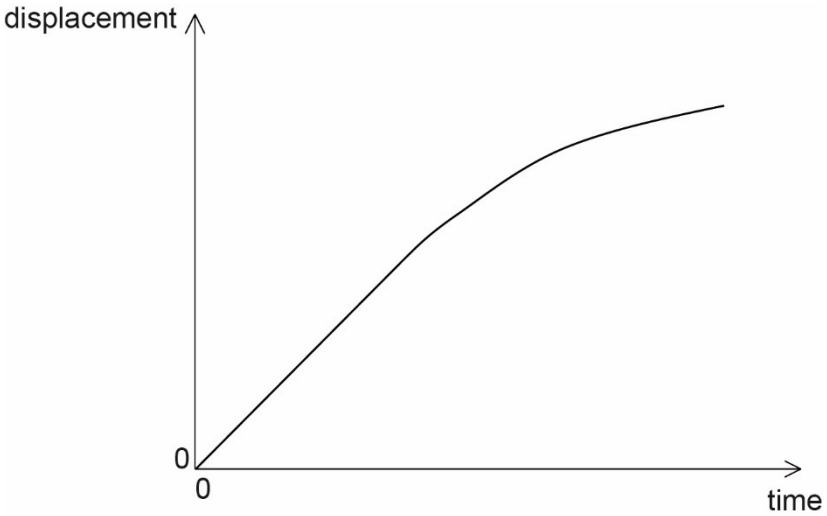
6. An alternative answer is indicated in the "Answers" column by "***OR***" between the alternatives. Either answer can be accepted.

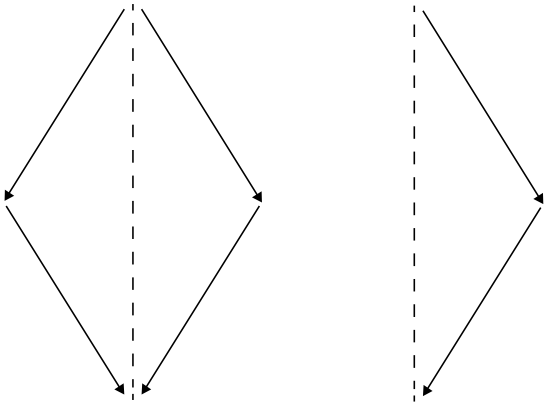
7. Words in angled brackets « » in the "Answers" column are not necessary to gain the mark.

8. Words that are <u>underlined</u> are essential for 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.

Question			Answers	Notes	Total
1	a	i	$«E_{el} =» \frac{1}{2}mv^2 + mgh$ ***OR*** $«E_{el} =» E_P + E_K$ ✓ $«E_{el} =» \frac{1}{2}\times 55 \times 0.90^2 + 55 \times 9.8 \times 1.2$ ***OR*** 669 J ✓ $«E_{el} = 669 \approx 670\,\text{J}»$	*Award **[1 max]** for use of $g = 10\ \text{N kg}^{-1}$, gives 682 J.*	**2**
	a	ii	$\frac{1}{2}\times 55 \times v^2 = 670\ \text{J}$ ✓ $v = «\sqrt{\frac{2\times 670}{55}} =» \ 4.9\ \text{m s}^{-1}$ ✓	*If 682 J used, answer is $5.0\ \text{m s}^{-1}$.*	**2**
	b	i	no force/friction on the block, hence constant motion/velocity/speed ✓		**1**
	b	ii	force acts on block ***OR*** gravity/component of weight pulls down slope ✓ velocity/speed decreases ***OR*** it is slowing down ***OR*** it decelerates ✓	*Do not allow a bald statement of "N2" or "F = ma" for MP1.* *Treat references to energy as neutral.*	**2**

Questions			Answers	Notes	Total
1	c		straight line through origin for at least one-third of the total length of time axis **covered by candidate line** ✓ followed by curve with decreasing positive gradient ✓  	*Ignore any attempt to include motion before A.* *Gradient of curve must always be less than that of straight line.*	**2**
	d		$F = \left(\frac{\Delta p}{\Delta t}\right) = \frac{55 \times 4.9}{0.42}$ ✓ $F = 642 \approx 640$ N ✓	*Allow ECF from (a)(ii).*	**2**
	e		«energy supplied by motor =» $120 \times 6.8 \times 1.5$ ***or*** 1224 J ***OR*** «power supplied by motor =» 120×6.8 ***or*** 816 W ✓ e = 0.55 ***or*** 0.547 ***or*** 55% ***or*** 54.7% ✓	*Allow ECF from earlier results.*	**2**

Question			Answers	Notes	Total
2	a		$g = \frac{GM}{r^2} = \frac{6.67\times10^{-11}\times2.0\times10^{30}}{\left(6.0\times10^{11}\right)^2}$ ***OR*** $3.71\times10^{-4}\text{Nkg}^{-1}$ ✓		1
	b		«g_{net} = 2cos34» 2g ***OR*** $g$cos34 ***OR*** $g$sin56 ***OR*** vector addition diagram shown ✓  $g_{net} = \text{«}2\times3.7\times10^{-4}\times\cos34^{\circ} =\text{»}\ 6.1\times10^{-4}\ \text{Nkg}^{-1}$ ✓		2

Question			Answers	Notes	Total
3	a		use of $m \times c \times \theta$ with correct substitution for either original water ***or*** water from melted ice ✓ energy available to melt ice = «8820 – 1260 =» 7560 J ✓ equates 7560 to mL ✓ 3.02×10^5 J kg^{-1} ✓ ***FOR EXAMPLE*** $0.35 \times 4200 \times (18 - 12)$ ***OR*** $0.025 \times 4200 \times 12$ ✓ 7560 J ✓ $L = \frac{7560}{0.025}$ ✓ 3.02×10^5 J kg^{-1} ✓	*Award **[3 max]** if energy to warm melted ice as water is ignored (350 kJ kg^{-1}).* *Allow ECF in MP3.*	**4**
	b	i	no change in temperature/no effect, the energies exchanged are the same ✓		**1**
	b	ii	the time will be less/ice melts faster, because surface area is greater ***or*** crushed ice has more contact with water ✓		**1**

Question			Answers	Notes	Total
4	a		a wave where the displacement of particles/oscillations of particles/movement of particles/vibrations of particles is parallel to the direction of energy transfer/wave travel/wave movement ✓	*Do not allow "direction of wave".*	1
	b	i	***ALTERNATIVE 1*** «distance travelled by wave =» 0.30 m ✓ $v = \text{«}\frac{\text{distance}}{\text{time}} \text{=»} 340\ \text{m s}^{-1}$ ✓ ***ALTERNATIVE 2*** evaluates $T = \frac{0.882 \times 10^{-3} \times 1.6}{0.3} \text{«=} 4.7\,\text{ms»}$ to give $f = 210$ ***or*** 212 Hz ✓ uses $\lambda = 1.6$ m with $v = f\lambda$ to give 340 m s^{-1} ✓		2

Question			Answers	Notes	Total
4	b	ii	***ALTERNATIVE 1*** $\lambda = 1.60\,\text{m}$ ✓ $f = \frac{340}{1.60} = 212$ ***or*** $213\,\text{Hz}$ ✓ ***ALTERNATIVE 2*** $T = \frac{0.882\times10^{-3}\times1.6}{0.3}$ «$= 4.7\,\text{ms}$» ✓ $F = \text{«}\frac{1}{T}\text{=»}\,210\,\text{Hz}$ ✓		**2**
	c	**i**	the displacement of the particle decreases ***OR*** «on the graph» displacement is going in a negative direction ***OR*** on the graph the particle goes down ✓ to the left ✓	*Do not allow "moving downwards" unless accompanied by reference to graph.*	**2**
	c	**ii**	molecules to the left of the particle have moved left and those to the right have moved right ✓ «hence» the particle is at the centre of a rarefaction ✓		**2**

Question			Answers	Notes	Total
5	a		infinite resistance ***OR*** draws no current from circuit/component ***OR*** has no effect on the circuit ✓	*Do not allow "very high resistance".*	**1**
	b	i	«vertical intercept = emf» $= 8.8 - 9.2$ V ✓		**1**
	b	ii	attempt to evaluate gradient of graph ✓ $= 0.80\,\Omega$ ✓	*Accept other methods leading to correct answer, eg using individual data points from graph.* *Allow a range of 0.78 – 0.82 Ω.* *If $\varepsilon = I(R + r)$ is used then the origin of the value for R must be clear.*	**2**
	c		$3.5 = 2.4\times10^{28}\times\pi\left(1.2\times10^{-3}\right)^2\times1.6\times10^{-19}\times v$ «$\Rightarrow v = 2.0\times10^{-4}\,\text{ms}^{-1}$» ✓		**1**
	d		F = «$qvB = 1.6\times10^{-19}\times2.0\times10^{-4}\times0.25$ =» 8.1×10^{-24} N ✓ directed down ***OR*** south ✓		**2**

Question			Answers	Notes	Total
6	a		«energy/mass difference =» 8.450 – 8.398 «= 0.052 MeV» ✓ $Q = 1.7$ ***or*** 1.66 ***or*** 1.664 MeV ***OR*** 2.66×10^{-13} J ✓		**2**
	b		11 – 12 days ✓		**1**
	c		quark theory is simpler ***OR*** Occam's razor example ***OR*** simple model explains complex observations ✓ quotes experiment that led to quark theory, eg deep inelastic scattering ***or*** electron scattering ✓ model incorporates strong/weak interactions/forces between protons and neutrons ✓ model incorporates conservation rules ✓ model explains differences between neutrons and protons ***OR*** explains decay of neutron to proton ✓		**3 max**

Question			Answers	Notes	Total
7	a		$I = \frac{\sigma A T^4}{4\pi d^2}$ ✓ $= \frac{5.67\times10^{-8}\times\left(7.0\times10^{8}\right)^2\times5800^4}{\left(1.5\times10^{11}\right)^2}$ ***OR*** $\frac{5.67\times10^{-8}\times4\pi\times\left(7.0\times10^{8}\right)^2\times5800^4}{4\pi\times\left(1.5\times10^{11}\right)^2}$ ✓ $I = 1397\ \text{W m}^{-2}$ ✓	*In this question we must see 4SF to award MP3.* *Allow candidate to add radius of Sun to Earth–Sun distance. Yields 1386 W m^{-2}.*	**2 max**
	b		«transmitted intensity =» 0.70×1400 «= 980 W m^{-2}» ✓ $\frac{\pi R^2}{4\pi R^2}\times 980\ \text{W m}^{-2}$ ✓ $245\ \text{W m}^{-2}$		**2**
	c		$5.67\times10^{-8}\times T^4 = 245$ ✓ $T = 256\ \text{K}$ ✓		**2**