
PHYSICS

9702/42

Paper 4 A Level Structured Questions

March 2017

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the March 2017 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

Question	Answer	Marks
1(a)	work done per unit mass	M1
	bringing (small test) mass from infinity (to the point)	A1
1(b)(i)	$\Delta\phi = (GM/2R) - (GM/5R) = 3GM/10R$	A1
1(b)(ii)	change in GPE = $(3 \times 4.0 \times 10^{14} / 10R) \times 4.7 \times 10^4$	C1
	$(3 \times 4.0 \times 10^{14} / 10R) \times 4.7 \times 10^4 = (1.70 - 0.88) \times 10^{12}$ $R = 6.88 \times 10^6$	C1
	distance = $3 \times 6.88 \times 10^6$ = 2.1×10^7 m	A1

Question	Answer	Marks
2(a)	+ ΔU <u>increase</u> in internal energy + q heat (energy) transferred <u>to</u> the system / heating of system + w work done <u>on</u> system	B2
2(b)(i)	$W = p\Delta V$ = $5.2 \times 10^5 \times (5.0 - 1.6) \times 10^{-4}$ (=177 J)	B1
	$\Delta U = q + w$ = $442 - 177 = 265$ J	A1
2(b)(ii)	no (molecular) potential energy	B1
	internal energy decreases so (total molecular) kinetic energy decreases	B1
	(mean molecular) kinetic energy decreases so temperature decreases	B1

Question	Answer	Marks
2(b)(iii)	$\Delta U + 265 - 313 = 0$ $\Delta U = 48 \text{ J}$	A1
2(b)(iv)	$pV = NkT$ or $pV = nRT$ <u>and</u> $N = nN_A$	C1
	$5.2 \times 10^5 \times 1.6 \times 10^{-4} = N \times 1.38 \times 10^{-23} \times (273 + 227)$ or $5.2 \times 10^5 \times 1.6 \times 10^{-4} = n \times 8.31 \times (273 + 227)$ and $n = N / 6.02 \times 10^{23}$ $N = 1.2 \times 10^{22}$	A1

Question	Answer	Marks
3(a)	m is constant or k/m is constant <u>and</u> so acceleration / a proportional to displacement / x	B1
	negative sign shows that acceleration / a is in opposite direction to displacement / x or negative sign shows acceleration / a is towards fixed point	B1
3(b)	evidence of comparison to expression to $a = -\omega^2 x$	B1
	$\omega^2 = k/m$ or $\omega^2 = 4.0/m$ hence $\omega = 2.0/\sqrt{m}$	A1
3(c)	$E_K = \frac{1}{2} m \omega^2 x_0^2$ or $E_K = \frac{1}{2} m v^2$ <u>and</u> $v = \omega x_0$	C1
	$= \frac{1}{2} m (4.0/m) (3.0 \times 10^{-2})^2$	C1
	$= 1.8 \times 10^{-3} \text{ J}$	A1

Question	Answer	Marks
3(d)	$\text{new } x_0 = \sqrt{[(1.8 \times 10^{-3} / 2) \times (2 / m \times (m / 4.0))]}$ or $(E_K \propto x_0^2 \text{ so) new } x_0 = \sqrt{[1/2 \times (3.0 \times 10^{-2})^2]}$	C1
	$= 2.12 \times 10^{-2} \text{ m}$	A1
3(e)	flux linked to block changes / flux is cut by block which induces an e.m.f. in block	B1
	(eddy) currents induced in block cause heating	B1
	thermal / heat energy comes from (kinetic / potential) energy of oscillations / block	B1

Question	Answer	Marks
4	piezo-electric / quartz crystal / transducer	B1
	<u>alternating</u> p.d. applied across crystal / transducer	B1
	causes crystal to vibrate / resonate	B1
	crystal resonates at ultrasound frequencies / crystal's natural frequency is in the ultrasound range / alternating p.d. is in ultrasound frequency range	B1

Question	Answer	Marks
5(a)	any three from: <ul style="list-style-type: none"> • greater bandwidth • does not suffer from (e.m.) interference / can be used in (e.m.) ‘noisy’ environments • no/less power/energy radiated/better security/less cross-talk • less attenuation/fewer repeaters/amplifiers needed • less weight/easier to handle/cheaper/occupy less space 	B3
5(b)(i)	attenuation / gain = $10 \log P_1 / P_2$	C1
	$0.50 \times 57 = 10 \log (15 \times 10^{-3} / P)$ so $P = 2.1 \times 10^{-5} \text{ W}$ <i>or</i> $-(0.50 \times 57) = 10 \log (P / 15 \times 10^{-3})$ so $P = 2.1 \times 10^{-5} \text{ W}$	A1
5(b)(ii)	<i>either</i>	
	(calculation of S/N ratio at receiver) S/N ratio = $10 \log (2.1 \times 10^{-5} / 9.0 \times 10^{-7})$ or S/N ratio = 14	M1
	$14 < 24$ or S/N ratio < minimum S/N ratio	A1
	so not able to distinguish signal from noise	A1
	<i>or</i>	
	(calculation of minimum acceptable power at receiver) $24 = 10 \log (P / 9.0 \times 10^{-7})$ or $P = 2.3 \times 10^{-4}$	(M1)
	$2.1 \times 10^{-5} < 2.3 \times 10^{-4}$ or power < minimum power	(A1)
so not able to distinguish signal from noise	(A1)	

Question	Answer	Marks
6(a)	similarity: lines are radial/greater separation of lines with increased distance from the sphere	B1
	difference: gravitational lines directed towards sphere <u>and</u> electric lines directed away from sphere	B1
6(b)(i)	$E = Q / 4\pi\epsilon_0 r^2$ or $E = kQ / r^2$ with k defined/substituted in	C1
	$4.1 \times 10^{-5} = [Q / (4\pi \times 8.85 \times 10^{-12} \times 0.025^2)] - [Q / (4\pi \times 8.85 \times 10^{-12} \times 0.075^2)]$	C1
	$Q = 3.2 \times 10^{-18} \text{ C}$	A1
6(b)(ii)	smooth curve with gradient decreasing starting at $(0, 4.1 \times 10^{-5})$ to d -axis at $(2.5, 0)$	B1
	smooth curve with gradient increasing from $(2.5, 0)$ ending at $(5, -4.1 \times 10^{-5})$	B1
6(b)(iii)	acceleration decreases (to zero at mid-point)	B1
	then acceleration increases in the opposite direction/increasing negative acceleration	B1

Question	Answer	Marks
7(a)	correct grid shape (of wire)	B1
	fine wire/foil strip	B1
	plastic/insulating envelope containing the wire	B1
7(b)(i)	$2.00 / 6.00 = 153.0 / (R + 153.0)$ or $4.00 / 6.00 = R / (R + 153.0)$ (so $R = 306.0$)	C1
	$\Delta R = 306.0 - 300.0 = 6.0 \text{ } (\Omega)$	C1
	so $\Delta L = 8(.0) \times 10^{-5} \text{ m}$	A1

Question	Answer	Marks
7(b)(ii)	R or ΔR increases	B1
	$V^+ < V^-$ or $V_A < 2.00$ or V^+ / V_A decreases	M1
	output is negative / $-5V$	A1
	diode X emits light / is 'on'	A1

Question	Answer	Marks
8(a)	region (of space) where there is a force	M1
	produced by / on a magnet / magnetic pole / <u>moving</u> charge / current-carrying conductor	A1
8(b)(i)	out of (the plane of) the paper / page	B1
8(b)(ii)	the force on the particle is (always) perpendicular to the velocity / perpendicular to the direction of travel / towards the centre of path	B1
	no work is done by the force on the particle / there is no acceleration in the direction of the velocity / the acceleration is (always) perpendicular to the velocity	B1
8(b)(iii)	$F = Bqv$ or $F = mv^2 / r$	C1
	$mv^2 / (d/2) = Bqv$ so $d = 2mv / Bq$	A1
8(b)(iv)	time = distance / speed $T_{(F)} = \pi d / 2v$	C1
	$T_{(F)} = (\pi / 2v) \times (2mv / Bq)$ $T_{(F)} = \pi m / Bq$ and so $T_{(F)}$ independent of v	A1

Question	Answer	Marks
9(a)(i)	increase flux linkage (with secondary coil) / to reduce flux loss	B1
9(a)(ii)	e.m.f. (induced only) when flux (in core/coil) is changing	B1
	constant / direct voltage gives constant flux / field	B1
9(b)(i)	$N_S / N_P = V_S / V_P$	C1
	$N_S = (52 / 150) \times 1200$ = 416 turns	A1
9(b)(ii)	0 ms or 7.5 ms or 15.0 ms or 22.5 ms	A1
9(c)(i)	<i>either</i>	
	mean power = $V^2 / 2R$ and $V = 52$ (V)	C1
	$R = 52^2 / (2 \times 1.2)$ = 1100 (1127) Ω	A1
	<i>or</i>	
	mean power = V^2 / R and $V = 52 / \sqrt{2}$ (= 36.8 V)	(C1)
	$R = 36.8^2 / 1.2$ = 1100 Ω	(A1)
9(c)(ii)	sinusoidal shape with troughs at zero power	B1
	only 3 'cycles'	B1
	each 'cycle' is 2.4 W high and zero power at correct times	B1

Question	Answer	Marks
10(a)	packet/ quantum of energy	M1
	of electromagnetic radiation	A1
10(b)(i)	light is re-emitted in all directions /only part of the re-emitted light is in the direction of the beam	B1
10(b)(ii)	an arrow between -3.40 eV and -1.51 eV <u>and</u> an arrow between -3.40 eV and -0.85 eV	B1
	all arrows shown point 'upwards'	B1
10(b)(iii)	$E = hc / \lambda$ or $E = hf$ <u>and</u> $c = f\lambda$	C1
	$2.60 \times 1.60 \times 10^{-19} = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$	C1
	$\lambda = 4.8 \times 10^{-7}$ m	A1

Question	Answer	Marks
11	any five from: <ul style="list-style-type: none">• electrons need energy to enter conduction band (from valence band)• (positively-charged) holes are left in valence band• moving charge carriers/holes/electrons are current• (increase of temperature leads to) more (positive and negative) charge carriers/more holes/more electrons so more current• more charge carriers/holes/electrons gives rise to less resistance• (increase of temperature causes) greater (amplitude of) vibrations of atoms/ions/lattice• effect of more charge carriers/holes/electrons is greater than effect of greater vibrations (and so resistance decreases)	B5

Question	Answer	Marks
12(a)	<i>either</i>	
	(minimum) energy required / work done to separate the nucleons (in a nucleus)	M1
	to infinity	A1
	<i>or</i>	
	energy released when nucleons come together (to form a nucleus)	(M1)
	from infinity	(A1)
12(b)(i)	(total) binding energy of thorium and helium (nuclei) greater than binding energy of uranium (nucleus)	B1
12(b)(ii)1	change in mass = $238.05076 - (234.04357 + 4.00260)$ = $4.59 \times 10^{-3} \text{ u}$	A1
12(b)(ii)2	<i>either</i>	
	$E = mc^2$	C1
	= $4.59 \times 10^{-3} \times 1.66 \times 10^{-27} \times (3.00 \times 10^8)^2$	
	= $6.9 \times 10^{-13} \text{ J}$	A1
	<i>or</i>	
	1u = 931 MeV $E = 4.59 \times 10^{-3} \times 931 \times 10^6 \times 1.6 \times 10^{-19}$	(C1)
	= $6.8 \times 10^{-13} \text{ J}$	(A1)
12(b)(iii)	Th nucleus / He nucleus / product nucleus has kinetic energy	M1
	energy of gamma photon must be less than energy released	A1