



Cambridge
International
AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS**9702/23**

Paper 2 AS Level Structured Questions

October/November 2017

MARK SCHEME

Maximum Mark: 60

Published

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This document consists of **7** printed pages.

Question	Answer	Marks
1(a)(i)	work (done) / time (taken) or energy (transferred) / time (taken)	B1
1(a)(ii)	Correct substitution of base units of all quantities into any correct equation for power. Examples: $(P = E / t \text{ or } W / t \text{ gives}) \text{ kg m}^2 \text{ s}^{-2} / \text{s} = \text{kg m}^2 \text{ s}^{-3}$ $(P = Fs / t \text{ or } mgh / t \text{ gives}) \text{ kg m s}^{-2} \text{ m} / \text{s} = \text{kg m}^2 \text{ s}^{-3}$ $(P = \frac{1}{2}mv^2 / t \text{ gives}) \text{ kg (m s}^{-1})^2 / \text{s} = \text{kg m}^2 \text{ s}^{-3}$ $(P = Fv \text{ gives}) \text{ kg m s}^{-2} \text{ m s}^{-1} = \text{kg m}^2 \text{ s}^{-3}$ $(P = VI \text{ gives}) \text{ kg m}^2 \text{ s}^{-2} \text{ A}^{-1} \text{ s}^{-1} \text{ A} = \text{kg m}^2 \text{ s}^{-3}$	A1
1(b)(i)	units of A : m^2 and units of T : K	C1
	units of k : $\text{kg m}^2 \text{ s}^{-3} / \text{m}^2 \text{ K}^4$ $= \text{kg s}^{-3} \text{ K}^{-4}$	A1
1(b)(ii)	curve from the origin with increasing gradient	B1

Question	Answer	Marks
2(a)	$\rho = m / V$ or $\rho = m / Ah$	B1
	$p = F / A$ or $p = W / A$	B1
	$p = [\rho Ahg] / A$ or $p = [\rho Vg] / [V / h]$ (so) $p = \rho gh$	A1

Question	Answer	Marks
2(b)(i)	1. weight/gravitational (force) upthrust (force)/buoyancy (force) drag/viscous/frictional (force)/fluid resistance/resistance	B1
	2. weight = upthrust + viscous (force)	B1
2(b)(ii)	- decrease in (gravitational) potential energy (of sphere) due to decrease in height (since $E_p = mgh$) - increase in thermal energy due to work done against viscous force/drag - loss/change of (total) E_p equal to gain/change in thermal energy <i>Any 2 points.</i>	B2
2(c)(i)	atmospheric pressure = $9.1(0) \times 10^4$ Pa	A1
2(c)(ii)	$(\Delta)p = \rho g(\Delta)h$ $(9.15 - 9.10) \times 10^4 = \rho \times 9.81 \times (0.17 - 0.10)$	C1
	$\rho = 730$ (728) kg m^{-3}	A1

Question	Answer	Marks
3(a)	<u>sum/total</u> momentum (of system of bodies) is constant or <u>sum/total</u> momentum before = <u>sum/total</u> momentum after	M1
	for an isolated system/no (resultant) <u>external</u> force	A1
3(b)(i)	$p = mv$	C1
	$(4.0 \times 6.0 \times \sin \theta) - (12 \times 3.5 \times \sin 30^\circ) = 0$ or $(m_A v_A \times \sin \theta) - (m_B v_B \times \sin 30^\circ) = 0$	M1
	$\theta = 61^\circ$	A1

Question	Answer	Marks
3(b)(ii)	shows the horizontal <u>momentum</u> component of ball A or of ball B as $(4.0 \times 6.0 \times \cos \theta)$ or $(12 \times 3.5 \times \cos 30^\circ)$	C1
	$(4.0 \times 6.0 \times \cos 61^\circ) + (12 \times 3.5 \times \cos 30^\circ) = 4.0v$ so $v = 12 \text{ (ms}^{-1}\text{)}$	A1
3(b)(iii)	initial $E_K (= \frac{1}{2} \times 4.0 \times 12^2) = 290 \text{ (288) (J)}$	M1
	final $E_K (= \frac{1}{2} \times 4.0 \times 6.0^2 + \frac{1}{2} \times 12 \times 3.5^2) = 150 \text{ (145.5) (J)}$	M1
	(initial $E_K >$ final E_K) so inelastic [both M1 marks required to award this mark]	A1

Question	Answer	Marks
4(a)	displacement of particles/vibration(s)/oscillation(s) is parallel to/along the direction of energy/propagation	B1
4(b)	period = $1 / 800 (= 1.25 \times 10^{-3} \text{ s})$	C1
	time-base setting = $1.25 \times 10^{-3} / 2.5$	C1
	$= 5.0 \times 10^{-4} \text{ s cm}^{-1}$	A1
4(c)(i)	$I \propto A^2$	C1
	$(I_X / I_Y =) [r_Y / r_X]^2 = [A_X / A_Y]^2$	C1
	ratio $A_Y / A_X = 120 / 30$ $= 4.0$	A1

Question	Answer	Marks
4(c)(ii)	1. $v = f\lambda$	C1
	minimum $\lambda = 330 / (800 + 16) = 0.40 \text{ m}$	A1
	2. $f_o / f_s = v / (v - v_s)$ $816 / 800 = 330 / (330 - v_s)$	C1
	$v_s = 6.5 \text{ m s}^{-1}$	A1

Question	Answer	Marks
5(a)	force <u>per</u> unit positive charge	B1
5(b)(i)	$s = \frac{1}{2}at^2$	C1
	$a = (2 \times 0.045) / (1.5 \times 10^{-7})^2 = 4(.0) \times 10^{12} \text{ m s}^{-2}$	A1
5(b)(ii)	$F = 1.67 \times 10^{-27} \times 4.0 \times 10^{12} = 6.7 (6.68) \times 10^{-15} \text{ N}$	A1
5(b)(iii)	1. $E = F / Q$	C1
	$= 6.68 \times 10^{-15} / 1.6 \times 10^{-19}$ $= 4.2 (4.18) \times 10^4 \text{ NC}^{-1}$	A1
	2. $E = V / d$	C1
	$V = 4.18 \times 10^4 \times 0.045$ $= 1.9 \times 10^3 \text{ V}$	A1

Question	Answer	Marks
5(c)	$a = Eq / m$ or $F = ma$ and $F = Eq$	C1
	$\text{ratio} = \frac{(2 \times 1.6 \times 10^{-19}) \times (1.67 \times 10^{-27})}{(1.6 \times 10^{-19}) \times (4 \times 1.66 \times 10^{-27})} \text{ or } \frac{2 \times 1}{1 \times 4}$ $= 0.50$	A1

Question	Answer	Marks
6(a)(i)	$P = VI$	C1
	$I = 30 / 120$ $= 0.25 \text{ A}$	A1
6(a)(ii)	$Q = 0.25 \times 3.0 \times 3600 (= 2700)$	C1
	$\text{number} = (0.25 \times 3.0 \times 3600) / 1.60 \times 10^{-19}$ $= 1.7 \times 10^{22}$	A1
6(b)	$R = V / I$ or $R = P / I^2$ or $R = V^2 / P$	C1
	$= 120 / 0.25$ or $= 30 / 0.25^2$ or $= 120^2 / 30$ $= 480 \Omega$	A1

Question	Answer	Marks
6(c)	$R = \rho l / A$	C1
	$A = (6.1 \times 10^{-7} \times 580 \times 10^{-3}) / 480 (= 7.37 \times 10^{-10})$	C1
	$d = [(4 \times 7.37 \times 10^{-10}) / \pi]^{1/2}$ $= 3.1 \times 10^{-5} \text{ m}$	A1
6(d)	temperature decreases and so resistance decreases	B1

Question	Answer	Marks
7(a)	nucleons = 23	B1
	neutrons = 11	B1
7(b)	similarity: same (rest) mass or equal (magnitude of) charge	B1
	difference: opposite (sign of) charge or one is matter and one is antimatter or one is an electron and one is an antielectron	B1