Cambridge International Examinations
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PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **March 2017**

MARK SCHEME

Maximum Mark: 60

Published

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

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Question	Answer	Marks
1(a)	scalars: kinetic energy, power, work	**A1**
	vectors: acceleration, force, momentum	**A1**
1(b)(i)	mass = volume × density *or* $m = V \times \rho$ = 4/3 π $(23 \times 10^{-2})^3 \times 82$	**C1**
	weight = 4/3 π $(23 \times 10^{-2})^3 \times 82 \times 9.8$ = 41 N	**A1**
1(b)(ii)	vertical component of tension = 290 sin75° or 290 cos15° (= 280)	**C1**
	upthrust = 290 sin75° + 41 = 320 (321) N	**A1**
1(b)(iii)	the water pressure is greater than the air pressure *or* the pressure on lower surface (of sphere) is greater than the pressure on upper surface (of sphere)	**B1**

Question	Answer	Marks
2(a)	<u>sum</u> / <u>total</u> momentum of bodies is constant *or* <u>sum</u> / <u>total</u> momentum of bodies before = <u>sum</u> / <u>total</u> momentum of bodies after	**M1**
	for an isolated / closed system / no (resultant) external force	**A1**
2(b)(i)	EPE = area under graph or ½Fx or ½kx^2 <u>and</u> $F = kx$	**C1**
	energy = ½ × 12.0 × 8.0 × 10^{-2} = 0.48 J *or* energy = ½ × 150 × (8.0 × 10^{-2})^2 = 0.48 J	**A1**
2(b)(ii)1	4.0 v_A = 6.0 v_B	**C1**
	$E_K = ½mv^2$	**C1**
	ratio $= \dfrac{0.50 \times 4.0}{0.50 \times 6.0}\left(\dfrac{6.0}{4.0}\right)^2 = 1.5$ *or* ratio $= \dfrac{1}{1.5} \times (1.5)^2 = 1.5$	**A1**
2(b)(ii)2	0.48 = E_K of A + E_K of B = E_K of A + (E_K of A / 1.5) = 5/3 × E_K of A	**C1**
	E_K of A = 0.29 (0.288) J	**A1**
2(b)(iii)	curve starts from origin and has decreasing gradient	**M1**
	final gradient of graph line is zero	**A1**

Question	Answer	Marks
3(a)	change of displacement / time (taken)	B1
3(b)(i)	constant velocity, so resultant force is zero	M1
	(so car is) in (dynamic) equilibrium	A1
3(b)(ii)	$F_D = 0.40$ (kN) or 0.40×10^3 (N)	C1
	component of weight $= 2.0 \times 10^3 - 0.40 \times 10^3$ $= 1.6 \times 10^3$ N	A1
3(b)(iii)	$P = Fv$	C1
	$= 2.0 \times 10^3 \times 9.0 = 1.8 \times 10^4$ W	A1
3(b)(iv)	(driving) force $= 1.8 \times 10^4 / 15$ $(= 1.2 \times 10^3)$	C1
	$F_D = 0.66$ (kN) or 0.66×10^3 (N)	C1
	acceleration $= (1.2 \times 10^3 - 0.66 \times 10^3) / 850$ $= 0.64$ (0.635) m s^{-2}	A1

Question	Answer	Marks
4(a)	change in frequency when source moves relative to observer	M1
	refers to 'change in <u>observed</u> / <u>apparent</u> frequency'	A1
4(b)(i)	f = (950 × 330) / (330 – 7.5)	C1
	= 970 (972) Hz	A1
4(b)(ii)	frequency decreases	M1
	from greater than 950 Hz / from 970 (972) Hz / to less than 950 Hz / to 930 (929) Hz / by 40 (43) Hz	A1

Question	Answer	Marks
5(a)	to the right / from the left / from A to B / in the same direction as electron velocity	B1
5(b)	$v^2 = u^2 + 2as$ $a = (1.5 \times 10^7)^2 / (2 \times 2.0 \times 10^{-2})$ Other alternative calculations for the C1 mark: e.g. $a = 1.5{\times}10^7 / 2.67{\times}10^{-9}$ e.g. $a = [(1.5{\times}10^7 \times 2.67{\times}10^{-9}) - 2.0{\times}10^{-2}] \times [2 / (2.67{\times}10^{-9})^2]$ e.g. $a = (2.0{\times}10^{-2} \times 2) / (2.67{\times}10^{-9})^2$	C1
	$= 5.6 \times 10^{15}\,\mathrm{m\,s^{-2}}$	A1
5(c)	$E = F / Q$	C1
	$= (9.1 \times 10^{-31} \times 5.6 \times 10^{15}) / 1.6 \times 10^{-19}$	C1
	$= 3.2 \times 10^4\,\mathrm{V\,m^{-1}}$	A1
5(d)	straight line with negative gradient starting at an intercept on the *v*-axis and ending at an intercept on the *t*-axis.	B1

Question	Answer	Marks
6(a)	$I = I_1 + I_2 + I_3$	B1
	$(V / R) = (V / R_1) + (V / R_2) + (V / R_3)$ *or* $(I / V) = (I_1 / V) + (I_2 / V) + (I_3 / V)$ <u>and</u> (so) $1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3$	A1
6(b)(i)	e.m.f. is total energy available per unit charge	B1
	energy is dissipated in the internal resistance / resistor / r	B1
6(b)(ii)1	Energy $= EQ$	C1
	$= 6.0 \times 2.5 \times 10^3$ $= 1.5 \times 10^4$ J	A1
6(b)(ii)2	number $= 2.5 \times 10^3 / 1.6 \times 10^{-19}$ $= 1.6 \times 10^{22}$ (1.56×10^{22})	A1
6(b)(iii)	$1 / 4.8 = 1 / 12 + 1 / R_X$ $R_X = 8.0\,\Omega$	A1
6(b)(iv)	$P = V^2 / R$ *or* $P = VI$ <u>and</u> $V = IR$	C1
	ratio $= (V^2 / 8) / (V^2 / 12) = 12 / 8$ $= 1.5$	A1
6(b)(v)	(total) current, *or* I, increases <u>and</u> $P = EI$ *or* $P = 6I$ *or* $P \propto I$ *or* total (circuit) resistance decreases <u>and</u> $P = E^2 / R$ *or* $P = 36 / R$ or $P \propto 1 / R$	B1

Question	Answer	Marks
7(a)	number of protons = 83 and number of neutrons = 129	**A1**
7(b)	$\lambda = 3.8 \times 10^{-12}$	**C1**
	$f = 3.0 \times 10^{8} / 3.8 \times 10^{-12}$	**C1**
	$f = 7.9 \times 10^{19}$ (7.89×10^{19}) Hz	**A1**
7(c)	use an electric field (at an angle to the beam)	**M1**
	α is deflected <u>and</u> γ is undeflected	**A1**
7(d)	*either*	
	energy $= 9.3 \times 10^{-13} / 1.8 \times 10^{5}$ $(= 5.17 \times 10^{-18}$ J)	**C1**
	$= 5.17 \times 10^{-18} / 1.6 \times 10^{-19}$ $= 32$ (32.3) eV	**A1**
	or	
	energy $= 9.3 \times 10^{-13} / 1.6 \times 10^{-19}$ $(= 5.81 \times 10^{6}$ eV)	**(C1)**
	$= 5.81 \times 10^{6} / 1.8 \times 10^{5}$ $= 32$ (32.3) eV	**(A1)**