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PHYSICS **9702/23**

Paper 2 AS Level Structured Questions **October/November 2016**

MARK SCHEME

Maximum Mark: 60

Published

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1	**(a)** (density =) mass / volume	B1	[1]
	(b) **(i)** $d = [(6 \times 7.5)/(\pi \times 8100)]^{1/3}$		
	$= 0.12(1)$ m	A1	[1]
	(ii) percentage uncertainty = (4 + 5) / 3 (= 3%) *or* fractional uncertainty = (0.04 + 0.05) / 3 (= 0.03)	C1	
	absolute uncertainty (= 0.03 × 0.121) = 0.0036	C1	
	$d = 0.121 \pm 0.004$ m	A1	[3]
2	**(a)** force per unit positive charge	B1	[1]
	(b) **(i)** time $= 5.9 \times 10^{-2} / 3.7 \times 10^{7}$ $= 1.6 \times 10^{-9}$ s (1.59×10^{-9} s)	A1	[1]
	(ii) $E = V / d$	C1	
	$= 2500 / 4.0 \times 10^{-2}$		
	$= 6.3 \times 10^{4}$ N C^{-1} (6.25×10^{4} or 62500 N C^{-1})	A1	[2]
	(iii) $a = Eq / m$ *or* $F = ma$ <u>*and*</u> $F = Eq$	C1	
	$= (6.3 \times 10^{4} \times 1.60 \times 10^{-19}) / 9.11 \times 10^{-31} = 1.1 \times 10^{16}$ m s^{-2}	A1	[2]
	(iv) $s = ut + ½at^2$		
	$= ½ \times 1.1 \times 10^{16} \times (1.6 \times 10^{-9})^2$	C1	
	$= 1.4 \times 10^{-2}$ (m)	C1	
	distance from plate = 2.0 – 1.4 = 0.6 cm (*allow 1 or more s.f.*)	A1	[3]
	(v) electric force ≫ gravitational force (on electron)/weight *or* acceleration due to electric field ≫ acceleration due to gravitational field	B1	[1]
	(vi) v_X–t graph: horizontal line at a non-zero value of v_X	B1	
	v_Y–t graph: straight line through the origin with positive gradient	B1	[2]

3	(a)	force/load is proportional to extension/compression (provided proportionality limit is not exceeded)	B1	[1]
	(b) (i)	$k = F / x$ *or* k = gradient	C1	
		$k = 600\,\text{N}\,\text{m}^{-1}$	A1	[2]
	(ii)	$(W =)\ \frac{1}{2}kx^2$ *or* $(W =)\ \frac{1}{2}Fx$ *or* $(W =)$ area under graph	C1	
		$(W =)\ 0.5 \times 600 \times (0.040)^2 = 0.48\,\text{J}$ *or* $(W =)\ 0.5 \times 24 \times 0.040 = 0.48\,\text{J}$	A1	[2]
	(iii)	**1.** $(E_K =)\ \frac{1}{2}mv^2$	C1	
		$= \frac{1}{2} \times 0.025 \times 6.0^2$		
		$= 0.45\,\text{J}$	A1	[2]
		2. (work done against resistive force =) 0.48 – 0.45 [= 0.03(0) J]	C1	
		average resistive force = 0.030 / 0.040	C1	
		= 0.75 N	A1	[3]
	(iv)	efficiency = [useful energy out / total energy in] (×100)	C1	
		= [0.45 / 0.48] (×100)		
		= 0.94 *or* 94%	A1	[2]
4	(a)	the number of oscillations per unit time	M1	
		of the source/of a point on the wave/of a particle (in the medium)	A1	[2]
		or		
		the number of wavelengths/wavefronts per unit time	(M1)	
		passing a (fixed) point	(A1)	
	(b)	T or period = 2.5 × 250 (μs) (= 625 μs)	M1	
		frequency = $1 / (6.25 \times 10^{-4})$ or $1 / (2.5 \times 250 \times 10^{-6}) = 1600\,\text{Hz}$	A1	[2]
	(c) (i)	for maximum frequency: $f_o = f_s v / (v - v_s)$		
		$1640 = (1600 \times 330) / (330 - v_s)$	C1	
		$v_s = 8(.0)\,\text{m}\,\text{s}^{-1}$ $(8.049\,\text{m}\,\text{s}^{-1})$	A1	[2]
	(ii)	loudspeaker moving towards observer causes rise in/high<u>er</u> frequency	B1	
		loudspeaker moving away from observer causes fall in/low<u>er</u> frequency	B1	[2]
		or		
		<u>repeated</u> rise and fall/higher and then lower frequency	(M1)	
		caused by loudspeaker moving towards and away from observer	(A1)	

5	**(a)**	wave incident on/passes by or through an aperture/edge	B1	
		wave spreads (into geometrical shadow)	B1	[2]
	(b)	$n\lambda = d\sin\theta$	C1	
		substitution of $\theta = 90°$ *or* $\sin\theta = 1$	C1	
		$4 \times 500 \times 10^{-9} = d \times \sin 90°$		
		line spacing = 2.0×10^{-6} m	A1	[3]
	(c)	wavelength of red light is long<u>er</u> (than 500 nm)	M1	
		(each order/fourth order is now at a greater angle so) the fifth-order maximum cannot be formed/not formed	A1	[2]
6	**(a)**	$\dfrac{\text{work done or energy (transformed) (from electrical to other forms)}}{\text{charge}}$	B1	[1]
	(b)	**(i)** **1.** $V = IR$ *or* $E = IR$	C1	
		$I = 14/6.0$ $= 2.3\ (2.33)$ A	A1	[2]
		2. total resistance of parallel resistors = 8.0 Ω	C1	
		current = 14 / (6.0 + 8.0) = 1.0 A	A1	[2]
		(ii) $P = EI$ (*allow* $P = VI$) *or* $P = V^2/R$ *or* $P = I^2R$	C1	
		change in power = $(14 \times 2.33) - (14 \times 1.0)$ *or* $(14^2 / 6.0) - (14^2/14)$ *or* $(2.33^2 \times 6.0) - (1.0^2 \times 14)$		
		= 19 W (18 W if 2.3 A used)	A1	[2]
	(c)	$I = Anvq$		
		ratio = $(0.50n/n) \times (1.8A/A)$ or ratio = 0.50×1.8	C1	
		= 0.90	A1	[2]

7	(a)		hadron not a fundamental particle/lepton is fundamental particle *or* hadron made of quarks/lepton not made of quarks *or* strong force/interaction acts on hadrons/does not act on leptons	B1	[1]
	(b)	(i)	proton: up, up, down / uud neutron: up, down, down / udd	B1 B1	 [2]
		(ii)	composition: 2(uud) + 2(udd) = 6 up, 6 down / 6u, 6d	B1	[1]
	(c)	(i)	<u>most</u> of the atom is empty space *or* the nucleus (volume) is (very) small <u>compared to the atom</u>	B1	[1]
		(ii)	<u>nucleus</u> is (positively) charged	B1	
			the mass is concentrated in (very small) nucleus/small region/small volume/small core *or* the majority of mass in (very small) nucleus/small region/small volume/small core	B1	[2]