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PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

Published

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1	**(a)**	acceleration = change in velocity / time (taken) or rate of change of velocity	B1	[1]
	(b) (i)	$v = 0 + at$ or $v = at$	C1	
		(a = 36 / 19 =) 1.9 (1.8947) m s^{-2}	A1	[2]
	(ii)	$s = ½(u + v)t$ or $s = v^2 / 2a$ or $s = ½at^2$		
		= ½ × 36 × 19 = 36^2 / (2 × 1.89) = ½ × 1.89 × 19^2		
		= 340 m (342 m / 343 m / 341 m)	M1	[1]
	(iii)	**1.** (ΔKE =) ½ × 95 × (36)^2	C1	
		= 62 000 (61 560) J	A1	[2]
		2. (ΔPE =) 95 × 9.81 × 340 sin 40° or 95 × 9.81 × 218.5	C1	
		= 200 000 J	A1	[2]
	(iv)	work done (by frictional force) = ΔPE – ΔKE *or* work done = 200 000 – 62 000 (values from **1b(iii) 1.** and **2.**)	C1	
		(frictional force = 138 000 / 340 =) 410 (406) N [420 N if full figures used]	A1	[2]
	(v)	$-ma = mg$ sin 20° $- f$ or $ma = -mg$ sin 20° $+ f$	C1	
		–95 × 3.0 = 95 × 3.36 – f		
		f = 600 (604) N	A1	[2]
2	**(a)**	$p = F / A$	M1	
		use of $m = \rho V$ and use of $V = Ah$ and use of $F = mg$	M1	
		correct substitution to obtain $p = \rho gh$	A1	[3]
	(b) (i)	(when h is zero the pressure is not zero due to) <u>pressure</u> from the air/atmosphere	B1	[1]
	(ii)	gradient = ρg or $P - 1.0 \times 10^5 = \rho gh$	C1	
		e.g. $\rho g = 1.0 \times 10^5 / 0.75$ (= 133333)		
		ρ = 133 333 / 9.81		
		= 14 000 (13 592) kg m^{-3}	A1	[2]

3	**(a)**	Young modulus = stress / strain	B1	[1]
	(b) (i)	$E = (F \times l)/(A \times e)$ or $e = (F \times l)/(A \times E)$	B1	
		$e \propto 1/E$ *or* ratio $e_C/e_S = E_S/E_C$ or $(1.9 \times 10^{11})/(1.2 \times 10^{11})$ or 19/12	C1	
		(ratio =) 1.6 (1.58)	A1	[3]
	(ii)	two straight lines from (0,0) with **S** having the steepest gradient	B1	[1]
4	**(a)**	longitudinal: vibrations/oscillations (of the particles/wave) are parallel to the direction **or** in the same direction (of the propagation of energy)	B1	
		transverse: vibrations/oscillations (of the particles/wave) are perpendicular to the direction (of the propagation of energy)	B1	[2]
	(b)	LHS: intensity = power / area units: $kg\,m\,s^{-2} \times m \times s^{-1} \times m^{-2}$ or $kg\,m^2 s^{-3} \times m^{-2}$	B1	
		RHS: units: $m\,s^{-1} \times kg\,m^{-3} \times s^{-2} \times m^2$	M1	
		LHS and RHS both $kg\,s^{-3}$	A1	[3]
	(c) (i)	change/difference in the observed/apparent frequency when the source is moving (relative to the observer)	B1	[1]
	(ii)	wavelength increases/frequency decreases/red shift	B1	[1]
	(d)	observed frequency = $vf_S/(v - v_S)$	C1	
		$550 = (340 \times 510)/(340 - v_S)$	C1	
		$v_S = 25\ (24.7)\ m\,s^{-1}$	A1	[3]
5	**(a)**	diffraction: spreading/diverging of waves/light (takes place) at (each) slit/element/gap/aperture	B1	
		interference: overlapping of waves (from coherent sources at each element)	B1	
		path difference λ/phase difference of 360(°)/2π (produces the first order)	B1	[3]
	(b)	$d \sin\theta = n\lambda$ or $\sin\theta = Nn\lambda$	C1	
		$d = (2 \times 486 \times 10^{-9})/\sin 29.7°$ (= 1.962×10^{-6})	C1	
		number of lines = 510 (509.7) mm^{-1}	A1	[3]

6 **(a)** at least six horizontal lines equally spaced and arrow to the right B1 [1]

(b) charge used 2*e* C1

gain in KE = $15 \times 1.6 \times 10^{-19} \times 10^{3} = 2 \times 1.6 \times 10^{-19} \times V$ (p.d.across plates)
or
F (= W/d) = $15 \times 1.6 \times 10^{-19} \times 10^{3} / 16 \times 10^{-3}$ C1

(hence V = 7500 V or $F = 1.5 \times 10^{-13}$ N)

$E = V/d$ or $E = F/Q$ C1

$E = (7500/16 \times 10^{-3})$ or $E = (1.5 \times 10^{-13}/3.2 \times 10^{-19})$

$E = 4.7 \times 10^{5}$ (468 750) V m^{-1} A1 [4]

or

KE (= ½mv^2) = $15 \times 10^{3} \times 1.6 \times 10^{-19}$

$v = [(2 \times 15 \times 10^{3} \times 1.6 \times 10^{-19})/(6.68 \times 10^{-27})]^{1/2} = 8.5 \times 10^{5}$ m s^{-1} (C1)

a (= $v^2/2s$) = $(8.5 \times 10^{5})^2/2 \times 16 \times 10^{-3} = 2.25 \times 10^{13}$ m s^{-2}

F (= $6.68 \times 10^{-27} \times 2.25 \times 10^{-13}$) = 1.5×10^{-13} N

$E = F/Q$ (C1)

$Q = 2e$ (C1)

$E = 4.7 \times 10^{5}$ V m^{-1} (A1)

7	**(a)**		charge exists only in discrete amounts	B1	[1]
	(b)	**(i)**	$E = I(R + r)$ or $V = IR$	C1	
			(total resistance =) 2.7 + 0.30 + 0.25 (= 3.25 Ω)	M1	
			$I = 9.0 / (2.7 + 0.30 + 0.25)$ or $9.0 / 3.25 = 2.8$ A	A1	[3]
		(ii)	$V = IR_{ext}$ $= 2.77 \times 3.0$ or 2.8×3.0	C1	
			or		
			$V = E - Ir$ $= 9.0 - 2.77 \times 0.25$ or $9.0 - 2.8 \times 0.25$	(C1)	
			$V = 8.3$ (8.31) V or 8.4 V	A1	[2]
	(c)	**(i)**	$I = nevA$		
			$v = 2.77 / (8.5 \times 10^{29} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-6})$	M1	
			$= 8.1\ (8.147) \times 10^{-6}\ \text{m s}^{-1}$ or $8.2 \times 10^{-6}\ \text{m s}^{-1}$	A1	[2]
		(ii)	*A* reduces by a factor 4 (1/4 less) or resistance <u>of Z</u> goes up by 4×	M1	
			current goes down but by <u>less than</u> a factor of 4 (as total resistance does not go up by a factor of 4) so drift speed goes up	A1	[2]
8	**(a)**		both electron and neutrino: lepton(s)	B1	
			both neutron and proton: hadron(s)/baryon(s)	B1	[2]
	(b)	**(i)**	${}^{1}_{1}\text{p} \rightarrow {}^{1}_{0}\text{n} + {}^{0}_{1}\beta + {}^{0}_{0}\nu$		
			correct symbols for particles	M1	
			correct numerical values (allow no values on neutrino)	A1	[2]
		(ii)	up up down or uud → up down down or udd	B1	[1]
		(iii)	weak (nuclear)	B1	[1]