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PHYSICS **9702/42**

Paper 4 A Level Structured Questions **May/June 2017**

MARK SCHEME

Maximum Mark: 100

Published

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Question	Answer	Marks
1(a)	force per unit mass	**B1**
1(b)(i)	$g = GM / r^2$ $= (6.67 \times 10^{-11} \times 1.0 \times 10^{13}) / (3.6 \times 10^3)^2$	**C1**
	$= 5.1 \times 10^{-5}$ N kg^{-1}	**A1**
1(b)(ii)	mass = (960 / 9.81) kg weight on comet = $(960 / 9.81) \times 5.1 \times 10^{-5}$	**C1**
	$= 5.0 \times 10^{-3}$ N	**A1**
1(c)	similarity: e.g. both attractive/pointed towards the comet e.g. same order of magnitude	**B1**
	difference: e.g. radial/non-radial e.g. same (over surface)/varies (over surface)	**B1**

Question	Answer	Marks
2(a)(i)	mean/average square speed/velocity	**B1**
2(a)(ii)	$pV = NkT$ **or** $pV = nRT$	**B1**
	$\rho = Nm / V$ **or** $\rho = nN_Am / V$ **and** $k = nR / N$	**B1**
	$E_K = ½ m\langle c^2\rangle$ with algebra to $(3/2)kT$	**B1**
2(b)(i)	no (external) work done **or** $\Delta U = q$ **or** $w = 0$	**B1**
	$q = N_A \times (3/2)k \times 1.0$	**M1**
	$N_Ak = R$ so $q = (3/2)R$	**A1**
2(b)(ii)	specific heat capacity $= \{(3/2) \times R\} / 0.028$	**C1**
	$= 450\ \text{J kg}^{-1}\,\text{K}^{-1}$	**A1**

Question	Answer	Marks
3(a)(i)	e.g. period = 6 / 2.5	**C1**
	frequency = 0.42 Hz	**A1**
3(a)(ii)	energy = ½ $m \times 4\pi^2 f^2 y_0^2$	**C1**
	= ½ × 0.25 × $4\pi^2 \times 0.42^2 \times (1.5 \times 10^{-2})^2$	**C1**
	= 2.0×10^{-4} J	**A1**
3(b)(i)	(induced) e.m.f. proportional to rate of	**M1**
	change of magnetic flux (linkage) **or** cutting of magnetic flux	**A1**
3(b)(ii)	coil cuts flux/field (of moving magnet) <u>inducing</u> e.m.f. in coil	**B1**
	(induced) current in resistor causes heating (effect)	**M1**
	thermal energy/heat derived from energy of oscillations (of magnet)	**A1**

Question	Answer	Marks
4(a)	pulse (of ultrasound)	**B1**
	* produced by quartz crystal/piezo-electric crystal	
	* gel/coupling medium (on skin) used to reduce reflection at skin	
	reflected from boundaries (between media)	**B1**
	reflected pulse/wave detected by (ultrasound) transmitter	**B1**
	reflected wave processed and displayed	**B1**
	* intensity of reflected pulse/wave gives information about boundary	
	* time delay gives information about depth of boundary	
	max. 2 of additional detail points marked *	**B2**
4(b)	$I_T = I_0 \exp(-\mu x)$	**C1**
	$2.9 = \exp(4.6\mu)$	**C1**
	$\mu = 0.23\ \text{cm}^{-1}$	**A1**

Question	Answer	Marks
5(a)	any two reasonable suggestions e.g. • signal can be regenerated/noise removed (not “no noise”) • circuits more reliable • circuits cheaper to produce • multiplexing (is possible) • error correction/checking • easier encryption/better security	**B2**
5(b)(i)	samples the analogue signal	**M1**
	at regular intervals and converts it (to a digital number)	**A1**
5(b)(ii)	**1.** smaller step depth	**B1**
	2. smaller step height	**B1**

Question	Answer	Marks
6(a)	force proportional to product of charges and inversely proportional to the square of the separation	**M1**
	reference to point charges	**A1**
6(b)(i)	(near to each sphere,) fields are in opposite directions **or** point (between spheres) where fields are equal and opposite **or** point (between spheres) where field strength is zero	**M1**
	so same (sign of charge)	**A1**
6(b)(ii)	(at x = 5.0 cm,) $E = 3.0 \times 10^{3}$ V m^{-1} **and** $a = qE / m$	**C1**
	$E = (1.60 \times 10^{-19} \times 3.0 \times 10^{3}) / (1.67 \times 10^{-27})$	**C1**
	$= 2.9 \times 10^{11}$ m s^{-2}	**A1**
6(c)	field strength or E is potential gradient **or** field strength is rate of change of (electric) potential	**M1**
	(field strength) maximum at x = 6 cm	**A1**

Question	Answer	Marks
7(a)	equal and opposite charges on the plates so no resultant charge	**B1**
	+ve and –ve charges separated so energy stored	**B1**
7(b)	charge / potential difference	**M1**
	reference to charge on one plate and p.d. between plates	**A1**
7(c)	energy = $\frac{1}{2}CV^2$ **or** energy = $\frac{1}{2}QV$ **and** $C = Q / V$	**C1**
	$(1 / 16) \times \frac{1}{2}CV_0^2 = \frac{1}{2}CV^2$ $V = \frac{1}{4}V_0$	**A1**

Question	Answer	Marks
8(a)(i)	circle around both diodes	**B1**
8(a)(ii)	indicates (whether) temperature	**M1**
	(is) above or below a set value	**A1**
8(b)(i)	(when resistance of C > R_V,) $V^- > V^+$ **or** $V^+ < 3\,V$ **or** p.d. across R_V < p.d. across R/Y/3 V **or** p.d. across C > p.d. across R/ X/3 V	**M1**
	op-amp output is negative	**M1**
	(only) green	**A1**
8(b)(ii)	resistance of C becomes less than R_V **or** $V^- < V^+$	**B1**
	green (LED) goes out	**A1**
	blue (LED) comes on	**A1**
8(c)	changes/determines <u>temperature</u> at which LEDs switch	**B1**

Question	Answer	Marks
9(a)(i)	Hall voltage depends on thickness of slice	**C1**
	thinner slice, larger Hall voltage	**A1**
9(a)(ii)	Hall voltage depends on current in slice	**B1**
9(b)	sinusoidal wave, one cycle	**B1**
	at $\theta = 0$ and at $\theta = 360°$, $V_H = V_{MAX}$	**B1**
	at $\theta = 180°$, $V_H = -V_{MAX}$	**B1**

Question	Answer	Marks
10(a)	two from: • frequency below which electrons not ejected • maximum energy of electron depends on frequency • maximum energy of electrons does not depend on intensity • instantaneous emission of electrons	B2
10(b)(i)	(λ_0 is the) threshold wavelength **or** wavelength corresponding to threshold frequency **or** maximum wavelength for emission of electrons	B1
10(b)(ii)1.	intercept = $1/\lambda_0 = 2.2 \times 10^6\,\text{m}^{-1}$ $\lambda_0 = 4.5 \times 10^{-7}$ m or 450 nm	A1
10(b)(ii)2.	gradient = hc	C1
	gradient = 2.0×10^{-25} or correct substitution into gradient formula	C1
	$h = (2.0 \times 10^{-25}) / (3.0 \times 10^8) = 6.7 \times 10^{-34}$ J s	A1
10(c)	line: same gradient	B1
	straight line, positive gradient, intercept at greater than 2.2×10^6 when candidate's line extrapolated	B1

Question	Answer	Marks
11(a)	loss of (electric) potential energy = gain in kinetic energy **or** $qV = ½mv^2$ **or** $E_K = p^2 / 2m = qV$	**B1**
	$p = mv$ with algebra leading to $p = \sqrt{(2mqV)}$	**B1**
11(b)(i)	particle/electron has a wavelength (associated with it)	**B1**
	dependent on its momentum **or** when/because particle is moving	**B1**
11(b)(ii)	$p = (2 \times 9.11 \times 10^{-31} \times 1.60 \times 10^{-19} \times 120)^{1/2}$	**C1**
	$\lambda = (6.63 \times 10^{-34}) / (5.91 \times 10^{-24})$	**C1**
	$= 1.12 \times 10^{-10}$ m	**A1**
11(c)	wavelength is similar to separation of atoms	**M1**
	so diffraction observed	**A1**

Question	Answer	Marks
12(a)	$7\,{}^{0}_{-1}\mathrm{e}$	**A1**
12(b)(i)	$E = mc^2$	**C1**
	$= 1.66 \times 10^{-27} \times (3.00 \times 10^8)^2$	**M1**
	$= 1.494 \times 10^{-10}$ J division by 1.60×10^{-13} clear to give 934 MeV	**A1**
12(b)(ii)	Δm = (82 × 1.00863u) + (57 × 1.00728u) – 138.955u = (–) 1.16762 (u)	**C1**
	energy = 1.16762 × 934	**C1**
	energy per nucleon = (1.16762 × 934) / 139 = 7.85 MeV	**A1**
12(c)	above *A* = 56, binding energy per nucleon decreases as *A* increases	**B1**
	U-235 has larger nucleon number	**M1**
	so less (binding energy per nucleon)	**A1**
	or	
	fission takes place with uranium	**(B1)**
	fission reaction releases energy	**(M1)**
	binding energy per nucleon less (for uranium than for products)	**(A1)**