Cambridge International AS & A Level

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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** $\rho = nN_A m / V$ **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**
	$N_A k = R$ 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 $= \frac{1}{2} m \times 4\pi^2 f^2 y_0^2$	C1
	$= \frac{1}{2} \times 0.25 \times 4\pi^2 \times 0.42^2 \times (1.5 \times 10^{-2})^2$	C1
	$= 2.0 \times 10^{-4}$ 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 = ½ CV^2 **or** energy = ½ QV **and** $C = Q / V$	C1
	$(1 / 16) \times ½ CV_0^2 = ½ CV^2$ $V = ¼ V_0$	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 • <u>maximum</u> energy of electron depends on frequency • <u>maximum</u> 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** $qV = ½ mv^2$ **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)	$7\ {}^{0}_{-1}e$	**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)**