Mock Exam M1

PHYSICS | **9702**
Paper 4 A Level Structured Questions | **2 hours 15 minutes**
MARK SCHEME
Maximum Mark: 123

Published

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1

Question	Answer	Marks
a	acceleration perpendicular to velocity	**B1**
b	decreases	**B1**
c	(acceleration of) 9.8 $m s^{-2}$ is caused by weight of car **or** centripetal force must be greater than weight of car	**B1**
	(acceleration > 9.8 $m s^{-2}$) requires contact <u>force</u> from track **or** (centripetal force > weight) requires contact <u>force</u> from track	**B1**
d	$\frac{1}{2}mv_Y^2 = \frac{1}{2}mv_X^2 - mgh$	**C1**
	$a = v^2 / r$	**C1**
	$v_Y^2 = 3.8^2 - 2 \times 9.81 \times 0.62$ so $v_Y = 1.5\ m s^{-1}$ $a = 1.5^2 / 0.31 = 7.3\ m s^{-2}$ (which is less than 9.8 $m s^{-2}$) so no	**A1**
	or	
	$v_Y = \sqrt{(9.81 \times 0.31)} = 1.74\ m s^{-1}$ so $v_X^2 = 1.74^2 + 2 \times 9.81 \times 0.62$ $v_X = 3.9\ m s^{-1}$ (which is greater than 3.8 $m s^{-1}$) so no	**(A1)**
e	acceleration is independent of mass so makes no difference **or** mass cancels in the equation so makes no difference	**B1**

2

Question	Answer	Marks
(a)	(thermal) energy per unit mass (to cause temperature change)	**B1**
	(thermal) energy per unit <u>change</u> in temperature	**B1**
(b)(i)	$(T =)\ pV / Nk$	**B1**
(b)(ii)	$(pV =)\ NkT = \frac{1}{3}Nm<c^2>$ **or** $pV = NkT$ **and** $pV = \frac{1}{3}Nm<c^2>$	**M1**
	leading to $\frac{1}{2}m<c^2> = (3/2)kT$ and $\frac{1}{2}m<c^2> = E_K$	**A1**
(b)(iii)	internal energy = ΣE_K (of molecules) + ΣE_P (of molecules) **or** no forces between molecules	**B1**
	potential energy of molecules is zero	**B1**
(c)(i)	increase in internal energy = Q + work done	**B1**
	constant volume so no work done	**B1**
(c)(ii)	$c = Q / Nm\Delta T$	**C1**
	$= [N \times (3/2)k\Delta T] / (Nm\Delta T) = 3k / 2m$	**A1**
(d)	(as it expands) gas does work (against the atmosphere/external pressure)	**B1**
	for same temperature rise) more (thermal) energy needed, so larger specific heat capacity	**B1**

3

Question	Answer	Marks
2(a)(i)	(vertically) downwards	B1
2(a)(ii)	magnetic force (on sphere) is perpendicular to its velocity	B1
	magnetic force perpendicular to velocity is the centripetal force **or** magnetic force perpendicular to velocity causes centripetal acceleration **or** acceleration perpendicular to velocity is centripetal (acceleration) **or** magnetic force does not change the speed of the sphere **or** magnetic force has constant magnitude	B1
2(b)	$mg = Eq$	C1
	$E = (1.6 \times 10^{-10} \times 9.81) / (0.27 \times 10^{-9})$ $= 5.8\ \text{N C}^{-1}$	A1
2(c)	centripetal force = magnetic force **or** $Bqv = mv^2 / r$	B1
	$B = mv / qr$	C1
	$= (1.6 \times 10^{-10} \times 0.78) / (0.27 \times 10^{-9} \times 3.4) = 0.14\ \text{T}$	A1

4

Question	Answer	Marks
2(a)	$pV = NkT$	C1
	$N = (1.8 \times 10^{-3} \times 3.3 \times 10^5) / (1.38 \times 10^{-23} \times 310) = 1.4 \times 10^{23}$	A1
	or	
	$pV = nRT$ **and** $nN_A = N$	(C1)
	$N = (1.8 \times 10^{-3} \times 3.3 \times 10^5 \times 6.02 \times 10^{23}) / (8.31 \times 310) = 1.4 \times 10^{23}$	(A1)
2(b)	speed of molecule decreases on impact with moving piston	B1
	mean square speed (directly) proportional to (thermodynamic) temperature **or** mean square speed (directly) proportional to kinetic energy (of molecules) **or** kinetic energy (of molecules) (directly) proportional to (thermodynamic) temperature	B1
	kinetic energy (of molecules) decreases (so temperature decreases)	B1
2(c)(i)	$\Delta U = 3/2 \times k \times \Delta T \times N$	C1
	$= 3/2 \times 1.38 \times 10^{-23} \times (288 - 310) \times 1.4 \times 10^{23}$	C1
	$= -64\ \text{J}$	A1
2(c)(ii)	decrease in internal energy is less than work done by gas	M1
	(thermal energy is) transferred <u>to</u> the gas (during the expansion)	A1

5

Question	Answer	Marks
(a)	acceleration in opposite <u>direction</u> to displacement shown by – sign	**B1**
	g / L is constant	**M1**
	(so) acceleration is (directly) proportional to displacement	**A1**
(b)	$\omega^2 = g / L$	**C1**
	$\omega = 2\pi / T$ **or** $\omega = 2\pi f$ **and** $f = 1 / T$	**C1**
	$(2\pi / T)^2 = 9.81 / 0.18$ $T = 0.85$ s	**A1**
(c)	energy $\propto x_0^2$	**C1**
	(after 3 cycles,) amplitude $= (0.94)^3 x_0$ $= 0.83 x_0$	**C1**
	ratio final energy / initial energy $= 0.83^2$ $= 0.69$	**A1**

6

Question	Answer	Marks
(a)	work done per unit charge	**B1**
	(work done on charge) moving positive charge from infinity	**B1**
(b)(i)	$(2.0 \times 10^{-9}) / 4\pi\varepsilon_0(4.0 \times 10^{-2}) + Q / 4\pi\varepsilon_0(8.0 \times 10^{-2}) = 0$	**C1**
	$Q = 4.0 \times 10^{-9}$ C	**A1**
	Q given with negative sign	**B1**
(b)(ii)	change = 1200 V	**A1**
(c)	$½mv^2 = qV$	**C1**
	$½ \times 4 \times 1.66 \times 10^{-27} \times v^2 = 2 \times 1.60 \times 10^{-19} \times 1200$	**C1**
	$v = 3.4 \times 10^5$ m s^{-1}	**A1**

7

Question	Answer	Marks
(a)	force acting between two masses **or** force on mass due to another mass **or** force on mass in a gravitational field	**B1**
(b)	arc length $= r\theta$ $d = 1.5 \times 10^{17} \times 1.2 \times 10^{-5} = 1.8 \times 10^{12}$ m	**A1**
(c)(i)	$\omega = 2\pi / T$	**C1**
	$= 2\pi / (44.2 \times 365 \times 24 \times 3600)$ $= 4.5 \times 10^{-9}$ rad s^{-1}	**A1**
(c)(ii)	gravitational forces are equal **or** centripetal force about P is the same	**C1**
	$M_1 x\omega^2 = M_2(d - x)\omega^2$ so $M_1 / M_2 = (d - x) / x$	**A1**
(c)(iii)	$x = 0.4d$	**C1**
	$6.67 \times 10^{-11} \times M_1 = (1.0 - 0.4) \times (1.8 \times 10^{12})^3 \times (4.5 \times 10^{-9})^2$	**C1**
	$M_1 = 1.1 \times 10^{30}$ kg	**A1**

8

Question	Answer	Marks
(a)	(magnetic) flux density × area × number of turns	M1
	area is perpendicular to (magnetic) field	A1
(b)	use of t = 1.2 s	C1
	$\varepsilon = \frac{\Delta BAN}{\Delta t}$ $= \frac{0.250 \times \pi \times 0.030^2 \times 540}{1.2}$	C1
	$= 0.32 V$	A1
(c)(i)	light damping	B1

Question	Answer	Marks
(c)(ii)	sheet cuts (magnetic) flux and causes induced emf	B1
	(induced) emf causes (eddy) currents (in sheet)	B1
	either currents (in sheet) cause resistive force or currents (in sheet) dissipate energy	B1
	smaller currents in Y or larger currents in X, so dashed line is X	B1

9

Question	Answer	Marks
(a)(i)	electrons are accelerated (by an applied p.d.)	B1
	electrons hit target	B1
	X-rays produced when electrons decelerate	B1
(a)(ii)	images of the multiple sections are combined to create a 3-D image	B1
(b)(i)	$I = I_0 \exp(-\mu x)$	C1
	$= I_0 \exp(-0.89 \times 5.6)$ $= 0.0068\ I_0$	A1
(b)(ii)	$I = I_0 \exp(-2.4 \times 3.4) \times \exp(-0.89 \times 3.2)$	C1
	$= 1.7 \times 10^{-5}\ I_0$	A1
(c)	comparison of intensities or values in **(b)** leading to conclusion consistent with these values	B1

10

Question	Answer	Marks
(a)	(particle is) stationary/not moving	B1
	(particle is) moving parallel to the (magnetic) field	B1
(b)	magnetic field around each coil is circular **or** each coil is normal to magnetic field due to adjacent coils	B1
	current in coil interacts with (magnetic) field to exert force (on coil)	B1
	force is normal to both coil and magnetic field **or** force parallel to axis (of coil)	B1
	forces between coils are attractive so spring contracts	B1
(c)	(oscillating) coils cut magnetic flux **or** as separation of coils changes, magnetic flux changes	B1
	cutting flux causes induced e.m.f. in coils	B1
	changing (induced) e.m.f. causes changing current (in coil)	B1

11

Question	Answer	Marks
(a)	magnetic field normal to current	**B1**
	newton per ampere	**B1**
	newton per metre	**B1**
(b)(i)	current in wire QL gives rise to a force **or** wire QL is perpendicular to the magnetic field	**B1**
	force on wire QL is vertical	**B1**
	force does not act through the pivot	**B1**
(b)(ii)	forces act through the same line **or** forces are horizontal	**B1**
	forces are equal (in magnitude) and opposite (in direction)	**B1**
(c)(i)	change $= mg \times (\Delta)L$	**C1**
	$= 1.3 \times 10^{-4} \times 9.81 \times 2.6 \times 10^{-2} = 3.3 \times 10^{-5}$ N m^{-1}	**A1**
(c)(ii)	change $= B \times (\Delta)I \times L \times x$	**C1**
	$3.3 \times 10^{-5} = B \times 1.2 \times 0.85 \times 10^{-2} \times 5.6 \times 10^{-2}$	**C1**
	$B = 0.058$ T	**A1**

12

Question	Answer	Marks
(a)(i)	energy required to separate nucleons (of nucleus)	**M1**
	to infinity	**A1**
(a)(ii)	a (single) large nucleus <u>divides</u> to form (smaller) nuclei	**B1**
	any one point from: • initiated by neutron bombardment • resulting nuclei are of similar size • binding energy per nucleon increases • total binding energy increases • neutrons released • combined mass of smaller nuclei is less than mass of large nucleus	**B1**
(b)	binding energy per nucleon is a maximum at around $A = 56$	**B1**
	products of splitting a ^{56}Fe nucleus must have a lower total binding energy	**B1**
	(reaction would require) a net input of energy	**B1**

13

Question	Answer	Marks
(a)	wavelength of maximum intensity is inversely proportional to (thermodynamic) temperature	**B1**
(b)(i)	$\lambda_{MAX} = 0.50$ μm for A **and** 0.65 μm for B	**C1**
	$T = 5800 \times (0.50 / 0.65)$ $= 4500$ K	**A1**
(b)(ii)	(star B has) greater peak / average wavelength	**B1**
	(star B looks) redder	**B1**
(c)(i)	apparent wavelength is greater **or** wavelength is greater than known value	**B1**
	(due to) movement of star away (from observer)	**B1**
(c)(ii)	by examining the (lines in the) spectrum (of light from the star)	**B1**
	and comparing with known spectrum	**B1**