G12 Physics Mock 2023 - Paper 1 (Solutions)

MCQ

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	D	B	C	D	D	A	B	A	B	A	D	A	C	A	B	A	C
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
A	D	C	B	D	A	B	C	C	D	B	C	C	B	D			

Question 1 (8 marks)

(a) (Any TWO below)
- Use the thermometer to measure the room temperature. — 1A
- Put the copper rod inside the oven for 15 mins / a long enough time. — 1A
- Transfer the rod quickly from the oven to the beaker of water

(b) (Any ONE below) — 1A
The rod should be fully immersed in water.
The rod should be transferred quickly to minimize energy loss to surrounding.
Stir the water thoroughly.

(c) Energy loss by copper = Energy gain by beaker of water — 1M
$(0.5)(380)(T-33) = (1)(4200)(33-25) + 200(33-25)$ — 1M
$T = 218.26 \approx 218°C$ — 1A

(d) The hot air is a poor conductor of heat. Heat is transferred from air to his hand at a slower rate. The inside surface of the oven is a good conductor. When John touches it, heat is transferred at a faster rate and his hands get burnt. — 1A 1A

Question 2 (8 marks)

(a) $pV = nRT \Rightarrow p\mathcal{M} = \rho RT$ (where $n = \frac{M}{\mathcal{M}}$)

Slope $= \frac{p}{\rho} = \frac{RT}{\mathcal{M}} \Rightarrow \frac{1.25\times10^5 - 0}{1.5-0} = \frac{(8.31)(300)}{\mathcal{M}}$ — 1M

$\therefore \mathcal{M} = 0.029916 \text{ kg} \approx 29.9 \text{ g}$ (accept ± 0.005 kg) — 1A

(b) At T_2, slope $= \frac{p}{\rho} = \frac{RT}{\mathcal{M}}$

$\frac{1.5\times10^5 - 0}{1.0-0} = \frac{(8.31)T_2}{0.029916}$ — 1M

$\therefore T_2 = 540 \text{ K} = 267 \text{ °C}$ (accept ± 10 K) — 1A

(c) $pV = \frac{1}{3}Nm\overline{c^2} = \frac{1}{3}M\overline{c^2} \Rightarrow \frac{p}{\rho} = \frac{1}{3}\overline{c^2}$

$\therefore$ slope $= \frac{1}{3}\overline{c^2}$ — 1A

(d) At T_2, $\frac{1.5\times10^5 - 0}{1.0-0} = \frac{1}{3}\overline{c^2}$ — 1M

$\therefore \sqrt{\overline{c^2}} = 670.82 \approx 671 \text{ ms}^{-1}$ — 1A

OR $c_{rms} = \sqrt{\overline{c^2}} = \sqrt{\frac{3RT}{\mathcal{M}}}$

(e) Curve A: T_1 Curve B: T_2 (both correct) — 1A

Question 3 (10 marks)

(a) (i) $v_y = u_y + a_y t$

$0 = 6.5\sin\theta - 9.81t_1$ — 1M

$t_1 = \frac{6.5\sin\theta}{g}$ — 1A

(ii) $s_y = u_y t + \frac{1}{2}a_y t^2$

$-0.16 = 0 - \frac{1}{2}(9.81)t_2^2$ — 1M

$t_2 = 0.180609 \approx 0.181 \text{ s}$ — 1A

(iii) $t_1 + t_2 = 0.69$

$\frac{6.5\sin\theta}{g} + 0.180609 = 0.69$ — 1M

Solving gives $\theta = 50.2452 \approx 50.2°$

(b) From O to Q,

$s_y = u_y t + \frac{1}{2}a_y t^2 = 6.5\sin\theta(0.69) - \frac{1}{2}(9.81)(0.69)^2 = 1.1127 \text{ m}$ — 1M

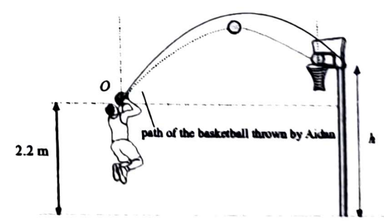
$h = 2.2 + 1.1127 = 3.3127 \approx 3.31 \text{ m}$ — 1M+1A

OR From O to P,

$s_y = \frac{1}{2}(u_y + v_y)t = \frac{1}{2}(6.5\sin\theta + 0)\left(\frac{6.5\sin\theta}{g}\right) = 1.2727 \text{ m}$ — (1M)

$h = 2.2 + 1.2727 - 0.16 = 3.3127 \approx 3.31 \text{ m}$ — (1M+1A)

(c)



Maximum height is higher than that of ball thrown by Aidan. 1A
The ball misses the net at a point higher than Q. 1A

Question 4 (8 marks)

(a) $F\cos\theta = 1200\cos 25°$ ...(1) 1A
$F\sin\theta = 1200\sin 25° + 70(9.81)$ ...(2) 1A

(b) (2)/(1), we have

$\tan\theta = \frac{1200\cos 25°}{1200\sin 25° + 70(9.81)}$ 1M

$\theta = 47.66702083 \approx 47.7°$ 1M

Put it in (1) or (2) gives $F = 1614.95 \approx 1610$ N 1A

(c) Yes, I agree. 1A
When the rope is released, there is no tension acting on the parascender with a vertically downward direction. 1M
The vertical component of F is greater than his weight. 1M

Question 5 (7 marks)

(a) (i) The distance is at maximum when u is the smallest.
$\frac{1}{u}+\frac{1}{v}=\frac{1}{f} \Rightarrow \frac{1}{51}+\frac{1}{v}=\frac{1}{50} \Rightarrow v = 2550 \text{ mm} = 2.55 \text{ m}$ 1M 1A

(ii) The image is real and inverted. 1A

(iii) $m = \frac{v}{u} = \frac{2550}{51} = 50$ 1M
Area $= (0.035\times 50)(0.025\times 50) = 2.1875 \text{ m}^2 \approx 2.19 \text{ m}^2$ 1A

(b) 45 mm is the possible focal length. 1A
If the focal length is 55 mm, the object distance u (51-54 mm) is smaller than f. The image is virtual and cannot be projected on screen. 1A

Question 6 (8 marks)

(a) $d = \frac{1}{400}\text{ mm} = \frac{10^{-3}}{400}\text{ m} = 2.5\times 10^{-6}\text{ m}$ 1A

(b) $d\sin\theta = m\lambda \Rightarrow 2.5\times 10^{-6}\sin\theta_2 = 2(400\times 10^{-9}) \Rightarrow \sin\theta_2 = 0.32$ 1M

$\tan\theta_2 = \frac{y_2}{D} \Rightarrow \tan 18.663° = \frac{y_2}{0.8} \Rightarrow y_2 = 0.270 \text{ m}$ 1A

(c) The equation holds only when the small angle approximation is valid. 1A
The angle θ_2 in *part (b)* is very large (18.7°) and it does not satisfy the small angle approximation. 1A

(d) Applying $\sin\theta = \frac{m\lambda}{d}$,

(i) $\sin\theta_{2r} = \frac{2(650\times 10^{-9})}{2.5\times 10^{-6}} \Rightarrow \theta_{2r} = 31.3°$ 1A

(ii) $\sin\theta_{3v} = \frac{3(400\times 10^{-9})}{2.5\times 10^{-6}} \Rightarrow \theta_{3v} = 28.7°$ 1A

(e) The third order of violet light is closer. 1A

Question 7 (6 marks)

(a) The electric forces acting on A and B form an action-and-reaction pair. Accoding to Newton's third law, they are of equal magnitude. 1A

(b) $Q_1 - Q_2 = 10\times 10^{-6}$ ...(1) 1M
$\frac{Q_1 Q_2}{4\pi\varepsilon_0}\left(\frac{1}{3^2}\right) = 0.075$ ...(2) 1M
Solving gives $Q_1 = 1.5\times 10^{-5}$ C and $Q_2 = 5\times 10^{-6}$ C. 1A

(c) Place X near A. 1A
- Touch X momentarily with a finger (OR Earth X momentarily). 1A
- Remove the finger / Earth wire before removing X from A. (any 1)

Question 8 (6 marks)

(a) From the graph, the current through the LED is 6 mA when the voltage across it is 1.5 V. — 1M

$R_{LED} = \frac{1.5}{6\times10^{-3}} = 250\ \Omega$ — 1A

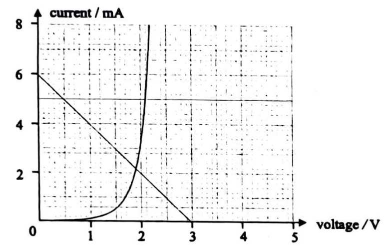
(b) (i) $\varepsilon = V_R + V_{LED}$

$3 = 50I + V$ — 1M

Divide both sides by 50 and rearranging gives

$I = 0.06 - 0.02V$ — 1A

(ii)



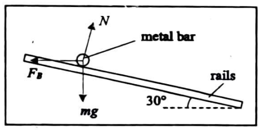
1A

$I = 22$ mA — 1A

Question 9 (8 marks)

(a) (i) 0.2 A — 1A

(ii) downwards — 1A



2A (1A for 1 or 2 correct)

(iii) $F_B \cos 30° = mg \sin 30°$ — 1M

$F_B = IBL$

$B = \frac{\left[\left(\frac{20}{1000}\right)(9.81)(\tan 30°)\right]}{(0.2)(0.5)} = 1.13276 \approx 1.13\text{ T}$ — 1M+1A

(b) $a = g \sin\theta = (9.81)(0.5) = 4.905\text{ m s}^{-2}$ — 1A

Question 10 (7 marks)

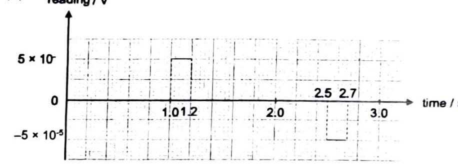
(a) (i) Induced e.m.f. $= \frac{N(\Delta\Phi)}{\Delta t} = \frac{[(50)(5\times10^{-4})(0.02\times0.02)]}{1.2-1.0}$ — 1M

$= 5\times10^{-5}$ V — 1A

OR Induced e.m.f. $= Bvl = (5\times10^{-4})(0.1)(0.02\times50)$ — (1M)

$= 5\times10^{-5}$ V — (1A)

(ii)



(accept negative reading from t = 1.0 s to t = 1.2 s and positive reading from t = 2.5 s to t = 2.7 s)

$V = 5\times10^{-5}$ V from t = 1.0 s to t = 1.2 s — 1A

$V = -5\times10^{-5}$ V from t = 2.5 s to t = 2.7 s — 1A

V = 0 V in other time periods — 1A

(b) Move the coil faster. — 1A

Use a pair of stronger magnets. — 1A

Question 11 (8 marks)

(a) (i) Fig 2 - β radiation; Fig 3 - α radiation — 1A 1A

(ii) Helium gas — 1A

(iii) The cloud chamber is placed inside a magnetic field or electric field. — 1A

(b) (i) ${}^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\beta$ — 1A

(ii) $A = A_0\left(\frac{1}{2}\right)^n$ where $n = \frac{t}{t_{1/2}}$

$15 = 80\left(\frac{1}{2}\right)^{t/5700} \Rightarrow \ln\frac{15}{80} = \frac{t}{5700}\ln\frac{1}{2}$ — 1M

$t = 13765.7 \approx 13800$ yrs — 1A

(iii) There will large percentage error in dating results because 150 years is too short compared to the half-life of C-14 <u>OR</u> change in activity A is not significant. — 1A

Section E2: Atomic World

Multiple-choice questions

1	2	3	4	5	6	7	8
C	A	D	B	A	B	C	D

Structured question

(a)		- Orbiting electron emit radiation while accelerating and losing energy continuously - Electrons would spiral into nucleus and collapse. - Orbital radius, velocity and frequency can take continuous range of values. (Any ONE)	1A
(b)		Angular momentum is equal to multiple integrals of $\frac{h}{2\pi}$.	1A
(c)	(i)	$E_n = -\frac{13.6}{n^2} = -\frac{13.6}{4^2} = -0.85$ eV	1A
	(ii)	It is the sum of kinetic energy and electrical potential energy.	1A
	(iii)	$mvr_n = \frac{nh}{2\pi} \Rightarrow mv = \frac{nh}{2\pi r_n} = \frac{(4)(6.63\times10^{-34})}{2\pi(5.31\times10^{-11})(4^2)} \approx 4.97\times10^{-25}$ kgms^{-1}	1M 1A
(d)	(i)	electrical potential energy: increase	1A
	(ii)	kinetic energy: decrease	1A
(e)	(i)	from n=4 to n=2	1A
	(ii)	$E_\infty - E_2 = 0-(-\frac{13.6}{2^2}) = 3.4$ eV	1A

Section E3: Energy and Use of Energy

Multiple-choice questions

1	2	3	4	5	6	7	8
B	C	A	B	C	A	A	C

Structured question

(a)	(i)	When the LED is connected in forward bias / when electrons and holes move towards the PN junction,	1A
		electrons combine with holes, electrons moves from a higher energy level to a lower energy level. energy is release in the form of an EM wave.	1A (any 1)
	(ii)	Incandescent lap emits light in a wide range of frequency (including IR). More energy is lost as heat.	1A
		LED emits light monochromatically. Less energy is lost as heat.	1A
(b)		Efficacy = $\frac{600}{6}$ = 100 lm W^{-1}	1M+1A
(c)	(i)	$\cos\theta = \frac{2}{\sqrt{2^2+0.8^2}}$	1M
		$E = \frac{\Phi\cos\theta}{4\pi r^2} = \frac{6\times600}{4\pi(\sqrt{2^2+0.8^2})}\frac{2}{\sqrt{2^2+0.8^2}}$	1M
		$E = 57.3252 \approx 57.3$ lx	1A
	(ii)	- Tilt the menu such that the light falls on it normally - Move the menu towards X or the lamp.	1A (any 1)