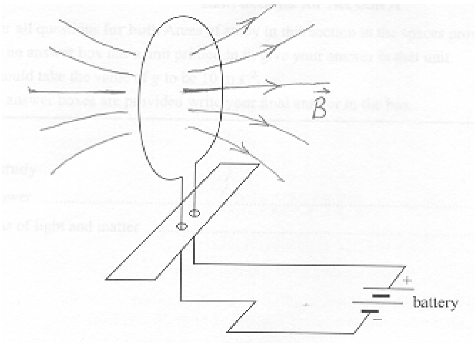
2008 VCAA Physics Exam 2 Solutions

Area of study 1 – Electric power

Q1

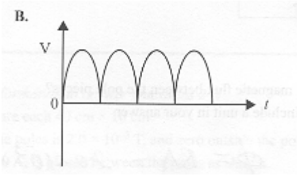


Q2 By right-hand slap rule: AB

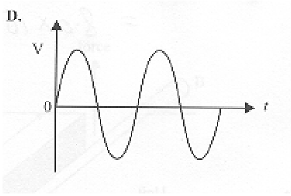
Q3 $F = BIL = (2.0\times10^{-3})(5.0)(0.40) = 4.0\times10^{-3}$ N

Q4 $\phi = BA = (2.0\times10^{-3})(0.40\times0.10) = 8.0\times10^{-5}$ wb

Q5 Graph B

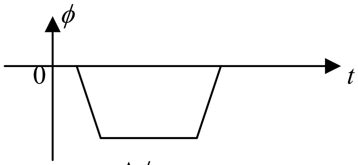


Q6 Graph D

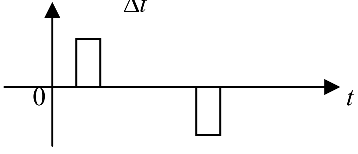


Q7 $V_{pp} = 8.0$ v, $V_p = 4.0$ v, $V_{RMS} = \frac{V_p}{\sqrt{2}} = \frac{4.0}{\sqrt{2}} = 2.8$ v

Q8 Flux vs time:



Output emf vs time: $\xi = -\frac{\Delta\phi}{\Delta t}$



Q9 $\xi_{av} = -\frac{\Delta\phi}{\Delta t} = -\frac{0-(4.0\times10^{-3})(0.020\times0.020)}{1.0} = 1.6\times10^{-6}$ v

Q10 As the square loop moves out of the magnetic field, the magnetic flux (into the page) through the square loop decreases. According to Lenz's law a current is induced in the square loop, which opposes the decrease in magnetic flux by increasing the magnetic field through the square loop (into the page). This happens only when the induced current flows in the square loop from Q to P.

Q11 $P_{av} = \frac{(V_{RMS})^2}{R} = \frac{12^2}{3.0} = 48$ W

Q12 Total resistance $R_T = 0.5 + 3.0 + 0.5 = 4.0\ \Omega$

$I_{RMS} = \frac{V_{RMS}}{R_T} = \frac{12}{4.0} = 3.0$ A

Voltage across the floodlight:

$V_{RMS} = I_{RMS}R_{floodlight} = 3.0\times3.0 = 9.0$ V

Q13 Total resistance $R_T = 0.50 + \frac{1}{\frac{1}{3.0}+\frac{1}{3.0}} + 0.50 = 2.5\Omega$

$I_{RMS} = \frac{V_{RMS}}{R_T} = \frac{12}{2.5} = 4.8$ A

Q14 $\frac{N_P}{N_S} = \frac{V_{RMS,P}}{V_{RMS,S}}$, $N_P = \frac{N_S V_{RMS,P}}{V_{RMS,S}} = \frac{30\times240}{18} = 400$

Q15 $P_{av} = V_{RMS,P}I_{RMS,P}$, $40 = 240 I_{RMS,P}$, $I_{RMS,P} = 0.17$ A

Area of study 2 – Interactions of light and matter

Q1 When an electric current flows through the filament, the electrons gain a wide range of energy from thermal excitation. These electrons return to lower energy states by emitting light (electromagnetic radiation) of a wide range of frequencies.

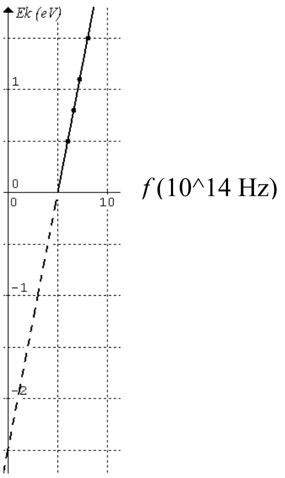
Q2 Incandescent light globe gives a continuous wide spectrum of visible light and beyond, whilst a mercury vapour lamp gives a spectrum that consists of a discrete set of frequencies of light.

Q3 $S_1Z - S_2Z = \frac{3}{2}\lambda = \frac{3}{2}\times3.0 = 4.5$ cm.

Q4 The microwaves from S_1 and S_2 arrives at point Y (the 1st maximum) in phase because the path difference is a whole number multiple of the wavelength. Constructive interference occurs and a maximum is detected.

Q5 The pattern of maxima and minima becomes wider because the separation between a maximum and its neighbour minimum is *inversely* proportional to the separation of S_1 and S_2.

Q6 Maximum kinetic energy $E_k = QV_S$.



Q7 $h = \text{gradient} = \dfrac{1.5}{3.0\times10^{14}} = 5.0\times10^{-15}$ eVs

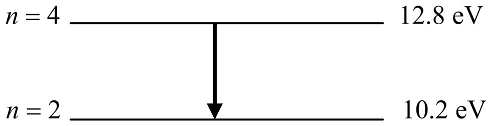
Q8 2.5 eV from graph.

Q9 $\lambda = \dfrac{h}{mv} = \dfrac{6.63\times10^{-34}}{(9.1\times10^{-31})(2.0\times10^{7})} = 0.036\times10^{-9}$ m $= 0.036$ nm

Q10 $\lambda = 410$ nm, read from diagram.

$E = \dfrac{hc}{\lambda} = \dfrac{(4.14\times10^{-15})(3.0\times10^{8})}{410\times10^{-9}} = 3.0$ eV

Q11



Q12 Shortest wavelength → highest energy, $\therefore$ from $n = 4$ to $n = 1$, $\therefore E = 12.8 - 0 = 12.8$ eV.

$\lambda = \dfrac{hc}{E} = \dfrac{(4.14\times10^{-15})(3.0\times10^{8})}{12.8} = 97\times10^{-9}$ m $= 97$ nm.

Detailed study 1 – Synchrotron and its applications

1	2	3	4	5	6	7	8	9	10	11	12	13
B	C	A	C	A	C	A	D	C	B	B	C	B

Q1 $\frac{1}{2}mv^2 = QV$, $\frac{1}{2}(9.1\times10^{-31})v^2 = (1.6\times10^{-19})(5000)$,

$v \approx 4.2\times10^{7}$ ms^{-1}

Q2

$F = QvB = (1.6\times10^{-19})(4.00\times10^{7})(7.60\times10^{-4}) \approx 4.86\times10^{-15}$ N

Q3 $F = \dfrac{mv^2}{r}$, $r = \dfrac{mv^2}{F} = \dfrac{(9.1\times10^{-31})(4.00\times10^{7})^2}{4.86\times10^{-15}} \approx 0.30$ m

Q8 $E = \dfrac{hc}{\lambda} = \dfrac{(4.14\times10^{-15})(3.0\times10^{8})}{0.115\times10^{-9}} \approx 10.8\times10^{3}\text{ eV} = 10.8\text{ keV}$

Q9 $n\lambda = 2d\sin\theta$,

$d = \dfrac{n\lambda}{2\sin\theta} = \dfrac{1\times0.115\times10^{-9}}{2\sin 9.6^\circ} \approx 3.45\times10^{-10}\text{ m} = 0.345\text{ nm}$

Detailed study 2 – Photonics

1	2	3	4	5	6	7	8	9	10	11	12	13
D	B	C	C	C	B	B	C	C	A	C	C	A

Q2 $\lambda = \dfrac{hc}{E} = \dfrac{(4.14\times10^{-15})(3.0\times10^{8})}{1.80} \approx 690\times10^{-9}\text{ m} = 690\text{ nm}$

Q5 $\theta = \sin^{-1}\left(\dfrac{1.41}{1.48}\right) \approx 72^\circ$

Q6 $1.00\sin\alpha = 1.50\sin 30^\circ$, $\alpha = \sin^{-1}(0.75) \approx 48.6^\circ$

Q7 $1.33\sin\alpha = 1.50\sin 30^\circ$, $\alpha = \sin^{-1}\left(\dfrac{0.75}{1.33}\right) \approx 34.3^\circ < 48.6^\circ$

Q8 $\Delta P = 50 - 20 = 30$ mW

Attenuation $= 2.5$ mW/km at $\lambda = 1300$ nm

Maximum length $= \dfrac{30}{2.5} = 12$ km

Detailed study 3 – Sound

1	2	3	4	5	6	7	8	9	10	11	12	13
B	B	B	C	B	B	C	C	C	C	A	B	D

Q3 $\lambda = \dfrac{v}{f} = \dfrac{330}{220} = 1.5$ m

Q4 $L = 10\log_{10}\left(\dfrac{1.0\times10^{-3}}{10^{-12}}\right) = 90$ dB

Q5 The distance is 3 times the original, I drops to $\frac{1}{9}$ of the original intensity, i.e. 1.1×10^{-4} Wm^{-2}.

Q8 $\lambda = \dfrac{v}{f} = \dfrac{333}{256} \approx 1.3$ m

Q9 Interpret the 'second harmonic' as the next harmonic with $n = 3$. $f = 3\times256 = 768$ Hz.

Q11 Length of closed pipe $= \dfrac{1}{4}\lambda = \dfrac{1}{4}\times0.325 \approx 0.081$ m

Please inform physicsline@itute.com re conceptual, mathematical and/or typing errors