2008 Physics Trial Exam 2 Solutions

Area of study 1 – Electric power

Q1 Current flows from high (+) to low (–) potential in the conducting loop. Use the right-hand grip rule to determine the direction of the magnetic field. I at P, J at Q and I at R.

Q2 Right-hand slap rule: I at U and J at V.

Q3 $I = \frac{V}{R} = \frac{0.20}{2.0} = 0.10$ A.
$F = BIL = (0.010)(0.10)(1\times10^{-3}) = 1.0\times10^{-6}$ N

Q4 A

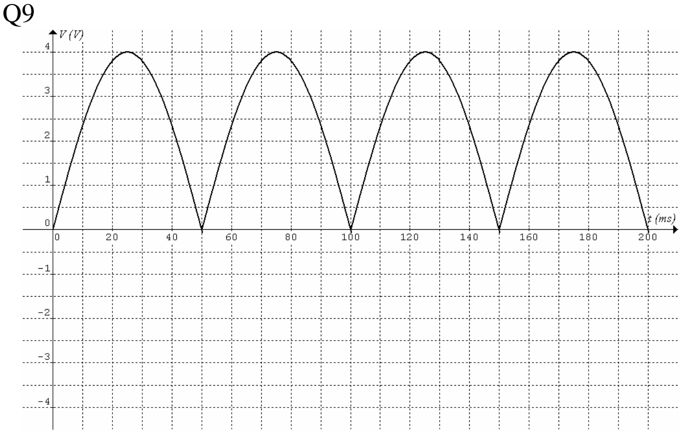
Q5 The current direction is reversed at the moment when the torque on the coil is zero momentarily. After passing through this stage of rotation, the direction of the torque remains the same due to the reversal of the current direction, and the coil continues its rotation without any opposing torque.

Q6 In the first t_1 seconds, the current in the left coil increases uniformly, $\therefore$ the magnetic field in the electromagnet increases uniformly and hence the magnetic flux through the closed loop increases uniformly. Between t_1 and t_2 the flux is constant, between t_2 and t_3 the flux decreases uniformly. B

Q7 The current directions in time intervals $0 \rightarrow t_1$ and $t_2 \rightarrow t_3$ are opposite. D

Q8 C

Q9



Q10 The modified dc generator at the higher frequency of rotation provides the same power as the original ac generator at the same higher frequency. $V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{4}{\sqrt{2}} \approx 2.83$ V

$\therefore$ a 3.0V battery will provide approximately the same power. B

Q11 The resistance of each globe $\approx \frac{V}{I} \approx \frac{240}{0.25} = 960\Omega$, which is very much greater than the resistance of the connecting wires. $\therefore$ the effect of the connecting wire resistance on the globe current is small. $\therefore$ currents in all the globes are about 0.25A.

For globe 1, voltage drop in the wires
$= IR \approx (0.25\times5)(5) = 6.25$ V,
$\therefore$ voltage across globe 1 $= 240 - 6.25 \approx 234$ V.

Total voltage drop in the wires connecting globe 5 to the power supply
$\approx (0.25\times5)(5) + (0.25\times4)(5) + (0.25\times3)(5) + (0.25\times2) + (5)(0.25\times1)(5)$
≈ 19 V
$\therefore$ voltage across globe 5 $= 240 - 19 \approx 221$ V.

Q12 Approximate total power loss $\approx$
$(0.25\times5)^2(5) + (0.25\times4)^2(5) + (0.25\times3)^2(5) + (0.25\times2)^2(5) + (0.25\times1)^2(5)$
≈ 18 W

Q13 Replacing all the wires with conducting wires of lower resistance.

Q14 $\frac{N_S}{N_P} = \frac{V_S}{V_P} = \frac{240}{11\times10^3} = 2.18\times10^{-2}$

Q15 B, because it is not 100% efficient.

Q16 Highest power at around 5.30 pm, $\therefore$ highest current in the transmission lines, $\therefore$ highest voltage drop.

Area of study 2 – Interactions of light and matter

Q1 Candle: Incoherent, continuous spectrum.
Laser: Coherent, discrete spectrum.
Sodium vapour lamp: Incoherent, discrete spectrum.

Q2 Dark fringe P is the third one from the centre of the pattern.
$\therefore b - a = \frac{5}{2}\lambda = 1.47\times10^{-6}$ m.

Q3 A, D.

Q4 Coherent light from the laser *diffracts* around the circular disk and *interferes constructively* to form the bright spot.

Q5 Work function
$\phi = hf_{threshold} = (6.63\times10^{-34})(8.2\times10^{14}) = 5.4\times10^{-19}$ J

Q6 $E_{max} = \frac{hc}{\lambda} - \phi$
$= \frac{(6.63\times10^{-34})(3.0\times10^{8})}{340\times10^{-9}} - 5.4\times10^{-19} = 4.5\times10^{-20}$ J

Q7 C

Q8 Image I has higher resolution. Electrons accelerated by a higher voltage have higher kinetic energy E_k, $\therefore \lambda = \frac{h}{\sqrt{2mE_k}}$ is shorter, $\therefore$ there is less diffraction because the extent of diffraction is $\propto \lambda$. Hence the resolution is higher.

Q9 2.0 eV $= 2\times1.60\times10^{-19} = 3.2\times10^{-19}$ J
For a 2.0 eV electron,
$p = \sqrt{2mE_k} = \sqrt{2(9.11\times10^{-31})(3.2\times10^{-19})} = 7.6\times10^{-25}$ kg ms^{-1}.
For a 2.0 eV photon,
$p = \frac{E}{c} = \frac{3.2\times10^{-19}}{3.0\times10^{8}} = 1.1\times10^{-27}$ kg ms^{-1}.
The momentum of a 2.0 eV electron is greater than the momentum of a 2.0 eV photon.

Q10 Fig. 1, $n = 3$; fig. 2, $n = 1$.

Q11 Energy of emitted photon $= 13.6 - 1.5 = 12.1$ eV.
$\lambda = \frac{hc}{E} = \frac{(4.14\times10^{-15})(3.0\times10^{8})}{12.1} = 1.03\times10^{-7} = 103\times10^{-9}$ m
$= 103$ nm

Detailed study 3 – Sound

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

Q1 A sound wave carries energy from one place to another by the vibrations of air molecules parallel to the direction of the energy flow, hence longitudinal. The vibrations of the air molecules create regions of high (compression) and low (rarefaction) air pressure, hence pressure waves. A

Q2 The frequency remains constant. λ and v are directly proportional to each other. C

Q3 $\frac{I_f}{I_i} = 10^{\frac{\Delta L}{10}} = 10^{\frac{10}{10}} = 10$, $\therefore I_f = 10 I_i$. D

Q4 For sounds of the same frequency, loudness is related to intensity $I = \frac{P}{4\pi r^2}$. $\frac{I_{II}}{I_I} = \frac{P_{II} r_I^2}{P_I r_{II}^2} = \frac{(20)(5)^2}{(10)(10)^2} = \frac{1}{2}$.
$\therefore I_I = 2I_{II}$. A

Q5 From the graph, $\lambda = 1$ m. $f = \frac{v}{\lambda} = \frac{330}{1} = 330$ Hz. A

Q6 From the graph, amplitude $= 0.1$ Nm^{-2}. A

Q7 The terms 'pressure nodes' and 'pressure antinodes' are used to describe respectively points where air pressure remains constant and points where air pressure varies the most in a standing wave. D

Q8 Microphone C gives a flat response over a wide frequency range.

Q9 The curves are equal loudness curves. The one above shows sounds louder than those in the lower curve. Sound Y is closer to the top curve than sound X, $\therefore$ sound Y is louder than sound X. C

Q10 Extent of sound diffraction $\propto \frac{\lambda}{w}$, where λ is the wavelength and w is the diameter of a loudspeaker. In this case w is constant. $\therefore$ sound from the tweeter (high frequency, short wavelength) is more directional, i.e. diffracts less than sound from the woofer (low frequency, long wavelength). D

Q11 D

Q12 The fundamental (lowest) resonance frequency of the closed pipe is $\frac{v}{4L} \approx \frac{340}{4\times0.34} = 250$ Hz. C

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

