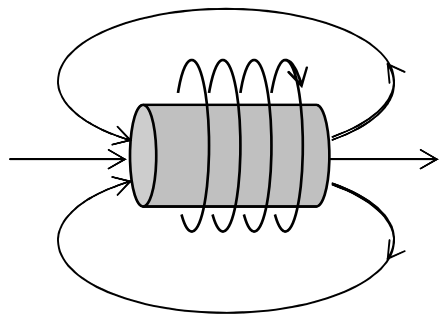
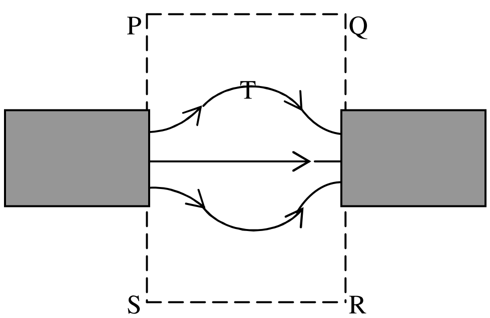
2010 Physics Trial Exam 2 Solutions

Area of study 1 – Electric power

Q1



Q2



Q3 B

Q4 $F = nBIL = (20)(0.50)(30\times10^{-3})(5.0\times10^{-2}) = 0.015\,\text{N}$

Q5 F

Q6 The magnetic forces on *AB* and *CD* are equal, opposite and aligned. The magnetic forces on *AD* and *BC* are also equal, opposite and aligned. .: zero net force and torque on the coil. .: the coil remains at rest.

Q7 $\phi = BA = (0.50)(0.050\times0.10) = 0.0025$ Wb

Q8 (i) flux decreases, .: induced current flows in the direction ADCBA according to Lenz's law. The same direction and explanation apply for (ii).

Q9 $|\xi_{av}| = n\left|\frac{\Delta\phi}{\Delta t}\right|$, $0.25 = 20\frac{|0.0025\cos60° - 0.0025|}{\Delta t}$, $\Delta t = 0.10$ s.

Q10 Without the commutators, $T = \frac{1}{f} = \frac{1}{20} = 0.050\,\text{s} = 50$ ms.

With the commutators, $T = \frac{1}{2}\times50 = 25\,\text{ms}$.

Q11 B

Q12 $rms\ V_{OUT} = \frac{V_{peak}}{\sqrt{2}} = \frac{0.50}{\sqrt{2}} \approx 0.35\,\text{V}$

Q13 D

Q14 $P_{IN,av} = \frac{P_{OUT,av}}{0.95} \approx 12.6\,\text{W}$

Q15 $V_{drop} = 6 - 3.8 = 2.2\,\text{V}$. $I = \frac{V_{drop}}{R} = \frac{2.2}{1.2} \approx 1.8\,\text{A}$

Q16 $\frac{P_{loss}}{P_{\sup ply}} = \frac{V_{drop}I}{VI} = \frac{V_{drop}}{V} = \frac{2.2}{6} \approx 0.37 = 37\%$

Q17 Light globe is rated 6V20W. $I = \frac{P}{V} = \frac{20}{6} \approx 3.3\,\text{A}$.
$V_{drop} = IR \approx 3.3\times1.2 \approx 4\,\text{V}$
.: increase power pack voltage to 10 V ($4 + 6 = 10\,\text{V}$) would ensure a voltage of 6 V across the light globe.

Area of study 2 – Interactions of light and matter

Q1 To ensure the lights from S_1 and S_2 are coherent enough for interference pattern to form on the viewing screen.

Q2 Point P is on the *second* dark fringe from the central bright fringe. $\therefore PS_1 - PS_2 = 1\frac{1}{2}\lambda = \frac{3}{2}\times630 = 945\,\text{nm} = 9.45\times10^{-7}$ m.

Q3 C

Q4 C

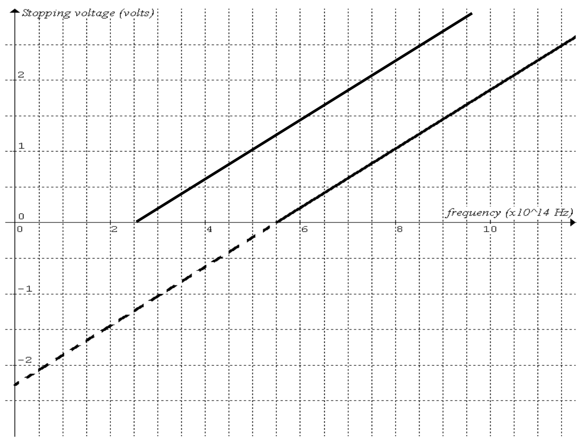
Q5 Max. kinetic energy $= qV_o = (1.6\times10^{-19})(2.3) \approx 3.7\times10^{-19}\,\text{J}$

Q6 The stopping voltage for L_2 is higher than that for L_1. .: the frequency of L_2 is higher than the frequency of L_1. If the threshold frequency of the metal is lower than both frequencies, L_1 and L_2 will both produce photoelectrons. If the threshold frequency is between the two frequencies, only L_2 produces photoelectrons. If the threshold frequency is higher than both frequencies, no photoelectrons will be produced.

Q7 2.25 eV (Read from graph)

Q8 Max. $E_k = hf - w$
$= (6.63\times10^{-34})(10.1\times10^{14}) - (1.6\times10^{-19})(2.25) \approx 3.1\times10^{-19}$ J
The range is 0 to 3.1×10^{-19} J approximately.

Q9



Q10 $w = 0.8$ nm, de Broglie $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{(9.1\times10^{-31})(1.2\times10^{6})}$
$\approx 6\times10^{-10}\text{ m} = 0.6\text{ nm}$
.: $\lambda \approx w$. Hence significant diffraction will occur.

Q11 Ionisation of the mercury atom can occur because the photon energy (11.3 eV) is greater than the ionisation energy (10.4 eV). The electron emitted will have $11.3 - 10.4 = 0.9$ eV of kinetic energy.

Q12 Shortest wavelength $\Rightarrow$ highest frequency $\Rightarrow$ highest photon energy $\Rightarrow$ from $n = 3$ to $n = 1$.
.: photon energy $= 10.4 - 3.7 = 6.7$ eV.
$E = \frac{hc}{\lambda}$, .: $\lambda = \frac{hc}{E} = \frac{(4.14\times10^{-15})(3.0\times10^{8})}{6.7} \approx 1.9\times10^{-7}$ m

Detailed study 3 – Sound

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

Q1 Read from graph, $\lambda = 4.0$ m. $\therefore f = \frac{v}{\lambda} = \frac{338}{4.0} \approx 84.5$ Hz. B

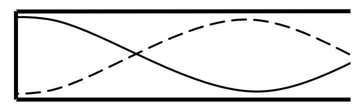
Q2 D

Q3 C

Q4 $\frac{I_B}{I_A} = \frac{0.05}{0.45} = \frac{1}{9} = \frac{r_A^{\,2}}{r_B^{\,2}}$, .: $r_B = 3r_A$, $r_A + 20 = 3r_A$.
.: $r_A = 10$ m B

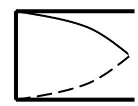
Q5 $\Delta L = 10\log_{10}\left(\frac{1}{9}\right) = -9.54$ dB B

Q6 $\lambda = \frac{v}{f} = \frac{338.4}{564} = 0.6$ m
$\frac{\ell}{\lambda} = \frac{0.45}{0.6} = \frac{3}{4}$.
.: $\ell = \frac{3}{4}\lambda$



Third harmonic of the 45 cm tube D

Q7 When the tube is 15 cm long, it will also resonate at 564 Hz but as its fundamental frequency. A



Q8 When the 45-cm tube resonates at its fundamental frequency, $\lambda = 0.45\times4 = 1.8$ m, $f = \frac{v}{\lambda} = \frac{338.4}{1.8} = 188$ Hz.
Third harmonic: $188\times3 = 564$ Hz
Fifth harmonic: $188\times5 = 940$ Hz
Seventh harmonic: $188\times7 = 1316$ Hz C

Q9 High frequency sound is more directional than low frequency sound. .: Low frequency sound will arrive at point Y at higher intensity. B

Q10 Low frequency sound diffracts more through the opening. .: its intensity at point Z is lower. C

Q11 Both A and B are on the same equal-loudness curve. C

Q12 The lowest intensity level is required for the same perceived loudness in the range 1000 – 4000 Hz. C

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

