Useful Information

(a) Physical Constants

$h = 6.626 \times 10^{-34}$ J . S

$hc = 1.242 \times 10^{-6}$ eV.m

$R = 1.097 \times 10^{7}$ 1/m (Rydberg constant)

$\mu_o = 4\pi \times 10^{-7}$ Wb/(A.m)

$N_A = 6.02 \times 10^{23}$ 1/mole (Avogadro Number)

$m_e = 9.11 \times 10^{-31}$ kg

$K = 9 \times 10^{9}$ N . m^2/C^2 (Coulomb constant)

(b) Atomic Masses

Z	A	Element	Atomic Mass
1	1	H	1.007825
0	1	n	1.008665
13	27	Al	26.981541
14	27	Si	26.986721

Q. X-ray of wavelength $\lambda = 0.180$ nm are scattered by electrons from a block of carbon. The scattered X-rays are observed at an angle of 45° with respect to the incident beam:

(a) The kinetic energy of the recoil electrons is (in eV) :

☐ 54 ☐ 27 ☐ 80 ☐ 180

☐ none of the above, my answer is ________________

(b) The maximum energy that a recoil electron can achieve is (in eV)

☐ 54 ☐ 80 ☐ 181 ☐ 27

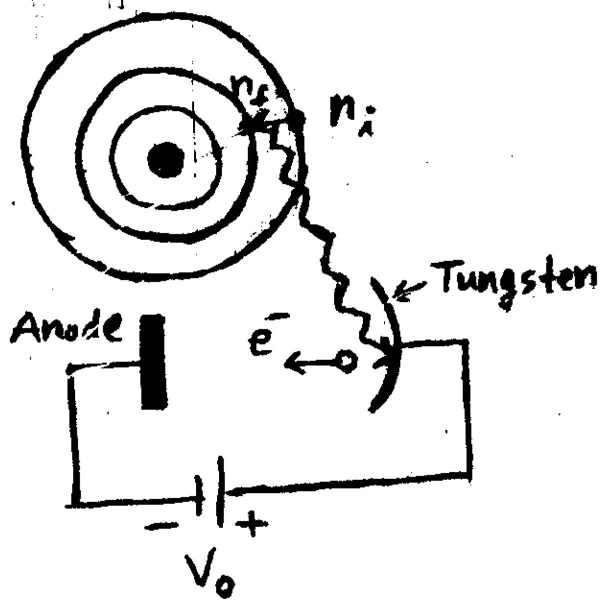
☐ none of the above, my answer is ________________

Q. The estimated wavelength of the K_β X-ray emitted from a Nickel target (Z = 28) is (in nm) :

☐ 0.50 ☐ 0.035 ☐ 0.35 ☐ 0.25 ☐ 0.028

☐ none of the above, my answer is:________________

Q. An electron in the hydrogen atom "jumps" from some initial Bohr orbit (n_i) to some final orbit (n_f). The photon emitted is capable of ejecting photoelectrons from a tungsten target (see Figure), whose work function is 4.58 eV.



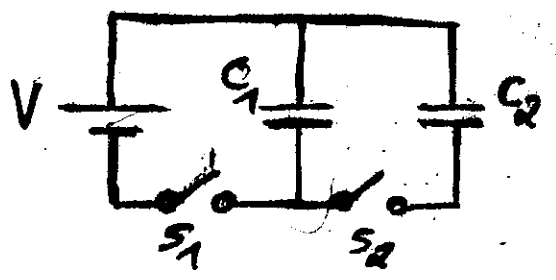
(a) The value of n_f is :

n_f = ________________

(b) If the stopping potential is v_o = 7.51 V, then the value of n_i is:

n_i = ________________

Q. In the figure below:
V = 20V, C_1 = 6μF,
C_2 = 3μF. The capacitor C_1 is first charged by closing the switch S_1. Switch S_1 is then opened and switch S_2 is closed.



(a) The final charge on capacitor C_1 is (in μC):

☐ 120 ☐ 20 ☐ 60 ☐ 80 ☐ 40

☐ none of the above, my answer is ______________

(b) The final charge on capacitor C_2 is (in μC):

☐ 120 ☐ 60 ☐ 40 ☐ 80 ☐ 20

☐ none of the above, my answer is ______________

Q. Two long parallel conductors carry currents $I_1 = I_2 = 3$ A. Both currents are directed into the page (see Figure).

(a) The magnitude of the resultant magnetic field at point P is (in μT):

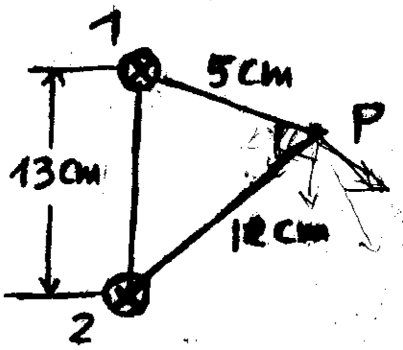
☐ 10.5 ☐ 12.4 ☐ 13.0

☐ 15.0 ☐ none of the above, my answer is ______________

(b) The direction of the resultant magnetic field is :

☐ upward ☐ to the left ☐ to the right

☐ downward



$\Phi = EA.$

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$q,\ 2q,\ 4q,\ 8q,\ 16q$

$E = k_e \frac{q}{r^2}$

$= \frac{8.99\times10^9 \times 31q}{r^2}$

$\phi = \frac{8.99\times10^9 \times 31q}{r^2} \times 4\pi r^2$

$\phi = 8.99\times10^9 \times 31q$

Q. Five charges are placed in a closed box. Each charge, has a magnitude which is twice that of the previous one placed in the box. All charges are positive. After placing all the charges in the box, the net electric flux is ϕ_o.

$\phi = \varepsilon_o 31q$

(a) The magnitude of the smallest charge in the box is:

☐ $13\phi_o/\varepsilon_o$ ☐ $25\phi_o/\varepsilon_o$ ☐ $\phi_o/25\,\varepsilon_o$

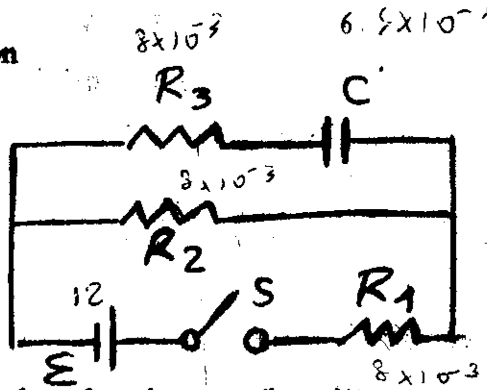
☐ $\phi_o/30\varepsilon_o$ ☐ none of the above, my answer is ____________________

(b) If the size of the box is doubled, the magnitude of the smallest charge:

☐ will be doubled ☑ will remain the same

☐ I cannot determine, without further information

Q. In the circuit shown below:
$\varepsilon = 12V$, $C = 6.50\ \mu F$,
$R_1 = R_2 = R_3 = 8 \times 10^3\Omega$.
The capacitor is initially <u>uncharged</u>, and the switch S is suddenly closed.



(a) For the time t = 0, the magnitudes the currents through each resistor are (in mA):

I_1	I_2	I_3

(b) For $t \to \infty$, the magnitudes of the currents through each resistor are (in mA):

I_1	I_2	I_3

(c) At $t \to \infty$, the charge on the capacitor is:

Q = ____________________ μC

Q. A series RLC circuit contains $R = 100\ \Omega$, $L = 12$ mH, $C = 2.4\ \mu F$ which are connected to an alternating source of an amplitude 80 V and a variable frequency ω.

(a) The maximum current in the circuit at resonance is (in a)

☐ 0.1 ☐ 0.2 ☐ 0.50 ☐ 0.35

☐ none of the above, my answer is ~~1.13A~~ 0.8

(b) The average power dissipated in the circuit at resonance is (in J)

☐ 3.2 ☐ 32 ☐ 0.45 ☐ 0.92

☐ none of the above, my answer is 64 J

(c) What is the phase angle ϕ between the current and the applied voltage ? (at $\omega = 500$ rad/s)

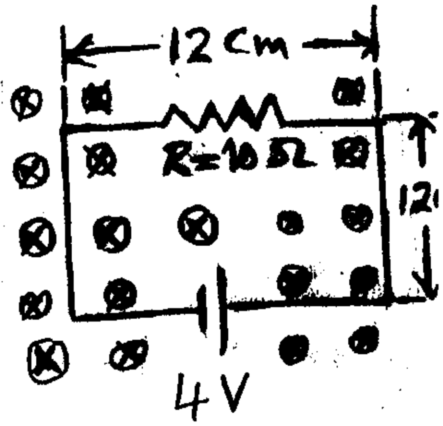
Answer : 0

Q. Transforms can be used for impedance matching. Given the impedance $Z_2 = 30\Omega$

$N_1 = 2000$, and $N_2 = 100$

The impedance Z_1 is then :

Answer: ________________



Q. The circuit shown in the Figure is placed in a uniform magnetic field which point into the page. The magnetic field is decreasing at a rate 150 T/S.

(a) The current in the circuit is (in A):

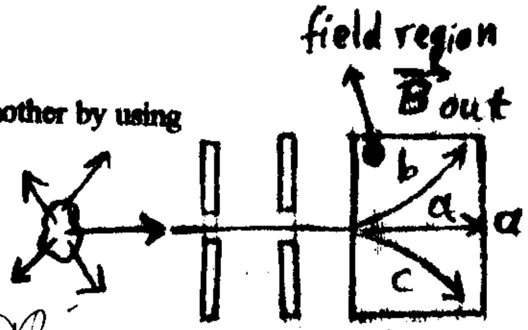
☐ 0.22 ☐ 0.18 ☑ 0.40 ☐ 0.62

☐ none of the above, my answer is ________________

b) ↓

c) [illegible]

Q. Consider distinguishing the three emissions (α, β^-, γ) from one another by using a magnetic field as shown in the Figure.(out of the Page).



(a) Which emission correspond to each of the paths shown ?

Path a : ___γ___ Path b :___α___ Path c :___β___

Q. How many different sets of quantum numbers are possible for an electron which has (a) n = 1, (b) n = 5 ?

Answer: a:___2___

b:___18___

Q. An electron travelling with a speed v in a circle of radius r is equivalent to a current of:

☐ ev/2 ☐ ev/r ☐ ev/2πr ☐ 2π ev/r

☐ none of the above, my answer is ______________

Q. A by-product of fission reactors is the radioactive isotope ^{239}Pu, which is an alpha-emitter and has a half-life of 2.4×10^4 years. Consider a sample of 1 kg of pure ^{239}Pu at t = 0.

(a) The initial activity of the sample is (in Bq):

☐ 1.23×10^3 ☐ 3.46×10^3 ☐ 1.10×10^6

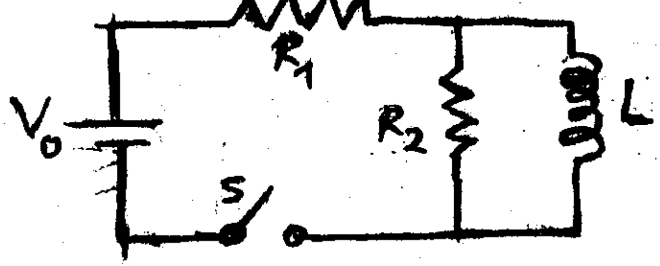
☐ 5.86×10^{12} ☐ none of the above, my answer is: ______________

(b) The time needed for this radioactive material to reduce its activity to the level of 0.10 Bq is (in years) :

☐ 3.46×10^3 ☐ 1.10×10^6 ☐ 5.86×10^{12}

☐ 1.23×10^3 ☐ none of the above, my answer is ______________.

Q. Immediately after the swich S is closed in the circuit shown, the current is:



☐ zero ☐ V_0/R_2

☐ $V_0/(R_1 + R_2)$ ☐ $V_0 \dfrac{(R_1 + R_2)}{R_1 R_2}$

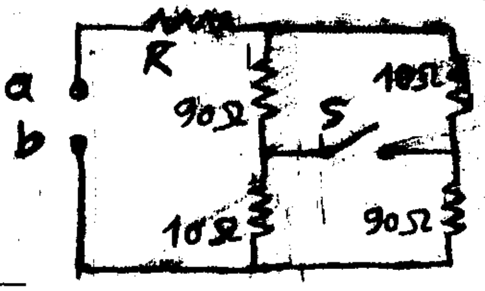
☐ none of the above, my answer is ____________________

(b) After a long time, the switch is opened.
Immedialtely after the switch is opned, the current in the inductor is

☐ V_0/R_1 ☐ V_0/R_2 ☐ $V_0/(R_1 + R_2)$ ☐ $V_0 \dfrac{(R_1 + R_2)}{R_1 R_2}$

☐ zero ☐ none of the above, my answer is ____________________

Q. In the circuit shown in the Figure, when the switch S is closed, the resistance between points a and b drops to one-half of its initial value (before S is closed).



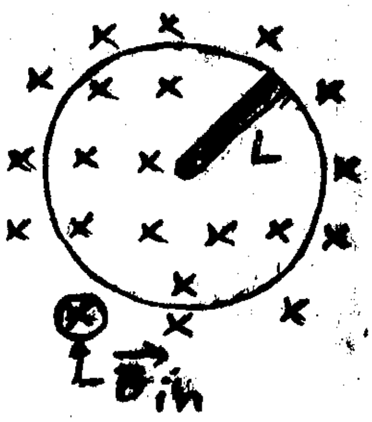
(a) The value of the resistor R is (in Ω):

☐ 10 ☐ 12 ☐ 19 ☐ 14 ☐ 28

☐ none of the above, my answer is ____________________

Q. A copper rod of length L rotates at angular velocity ω in a uniform magnetic field.

(a) The emf (ε) induced between the two ends of the rod is:



☐ zero ☐ $1/2\, B^2 \omega L$ ☐ $1/2\, B \omega L^2$ ☐ $1/2\, B^2 \omega L^2$

☐ none of the above, my answer is ____________________

Q. A beam of 6.61 MeV protons is incident on a $^{27}_{13}Al$ target. The protons which collide with the target will produce the reaction $^{27}_{13}Al + p \rightarrow ^{27}_{14}Si + n$

Neglecting the recoil energy of Si, the kinetic energy of the emitted neutrons is (in MeV):

☐ 2.0 ☐ 0.50 ☐ 1.50 ☐ 2.50

☐ none of the above, my answer is ________________

Q. The electric potential energy of four identical point charges of magnitude Q = 5 μC placed at the corners of a square of side a = 30 cm is (in Joules):

☐ 4.1 ☐ 3.0 ☐ 3.5 ☐ 5.5

☐ none of the above, my answer is ________________