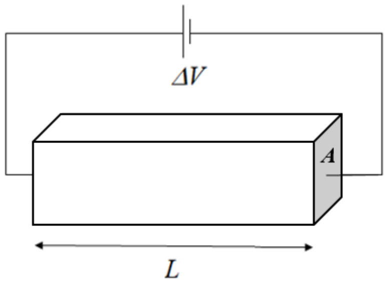
Name Surname: **Student No:** **Exam Duration: 110 mins.** **23.05.2022**

1) The tank made of a conductive material shown in the figure is filled with an aqueous solution of ions. Surface A on both sides of the tank is connected to the terminals of a battery as in the figure. The distance between these surfaces of the tank is L. Which of the following changes is made, the current through the structure will increase?



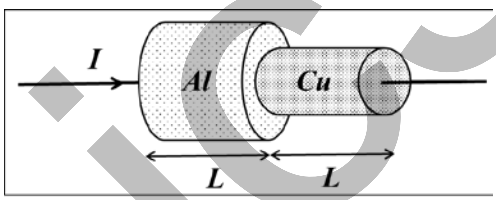
I) Increasing the distance L
II) Increasing the electric potential difference ΔV
III) Adding some additional ion solution to the solution
IV) Increasing the surface area A

a) I and III   b) II and IV   c) II, III, and IV   d) I, II, and IV   e) Only IV

2) When a voltage of 5 mV is applied to a copper bar at 20°C, the current through the bar becomes I_o. This current drops to $I_o/3$ when the rod is heated to a final temperature T_f. If the temperature coefficient of copper is $\alpha=4\times10^{-3}$ (1/°C), what is the final temperature of the bar in °C unit? (Assume the dimensions of the rod do not change during the heating process.)

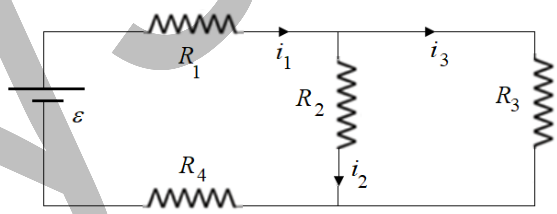
a) 400   b) 480   c) 500   d) 520   e) 620

3) Copper (Cu) and aluminum (Al) rods of the same length but different cross-sectional areas are connected in series as shown in the figure. The resistivities (ρ) and cross-sectional areas (A) of the rods are given by $\rho_{Cu}=1.75\times10^{-8}$ (Ω·m), $\rho_{Al}=2.75\times10^{-8}$ (Ω·m), $A_{Al}=0.4$ cm^2, and $A_{Cu}=0.2$ cm^2. Since the same constant current I flows through both rods, what is the ratio of the magnitude of electric field along the aluminum rod to that along the copper rod (E_{Al}/E_{Cu})?



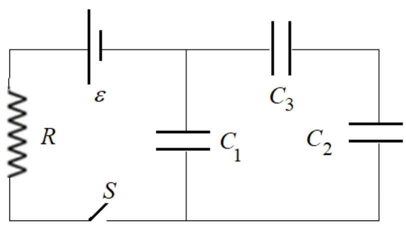
a) 11/14   b) 11/7   c) 14/11   d) 7/11   e)1/4

4) In the circuit in the figure, the resistance values of the resistors and the electromotive force of the battery are given by $R_1=8$ Ω, $R_2=20$ Ω, $R_3=30$ Ω, $R_4=40$ Ω, and $\varepsilon=30$ V. How many Ampers is the current flowing through the resistor R_3? (Assume that the battery has no internal resistance.)



a) 0.6   b) 0.5   c) 0.4   d) 0.3   e) 0.2

In the circuit in the figure, the capacitances of all three capacitors are the same ($C_1=C_2=C_3=C$). Ignore the internal resistance of the battery in the circuit Capacitors are initially uncharged. Switch S is closed at t = 0. Answer the following two questions (5-6) based on this information.



5) What is the time constant of the circuit?

a) RC b) $\frac{3}{2}RC$ c) $\frac{2}{3}RC$ d) $\frac{1}{3}RC$ e) $3RC$

6) Long after the switch S is closed, what is the energy stored in capacitor C_3 in terms of C and ε?

a) $2C\varepsilon^2$ b) $C\varepsilon^2$ c) $\frac{1}{2}C\varepsilon^2$ d) $\frac{1}{4}C\varepsilon^2$ e) $\frac{1}{8}C\varepsilon^2$

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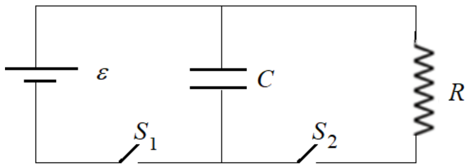
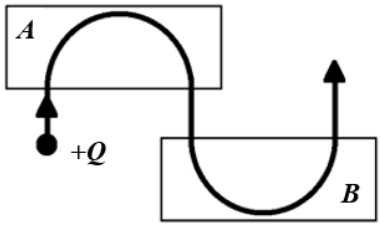
7) A capacitor of capacitance C is connected to a battery with $\varepsilon = 12$ V as shown in the figure. Initially, switch S_2 was open and switch S_1 is kept closed until the capacitor is fully charged. Then S_1 was opened and switch S_2 was closed. Since the voltage across the capacitor drops to 6 V after 4.2 ms, what is the capacitance of the capacitor? (ln0.5 ~ - 0.7)



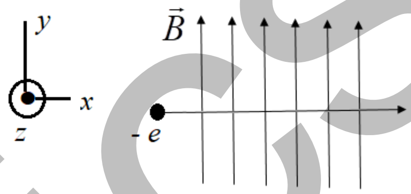
a) 1 mF b) 6 mF c) 1 μF d) 6 μF e) 7 F

8) There are uniform magnetic fields perpendicular to the page plane in regions *A* and *B* indicated by the box. Since a positively (+) charged particle follows the trajectory shown in the figure in these regions, what are the directions of the magnetic fields in regions *A* and *B*?



a) *A*: Out of the page plane *B*: Out of the page plane
b) *A*: Out of the page plane *B*: Into the page plane
c) *A*: Into the page plane *B*: Out of the page plane
d) *A*: Into the page plane *B*: Into the page plane
e) Nothing definite can be said.

9) In a given region, there is a uniform magnetic field in the +y-direction and a uniform electric field in an unknown direction. An electron moves to the right in this region with a constant velocity, without deviating from its path as shown in the figure. What is the direction of the electric field in this region?



a) $-\hat{i}$ b) $-\hat{j}$ c) $\hat{k}$ d) $-\hat{k}$ e) $\hat{j}$

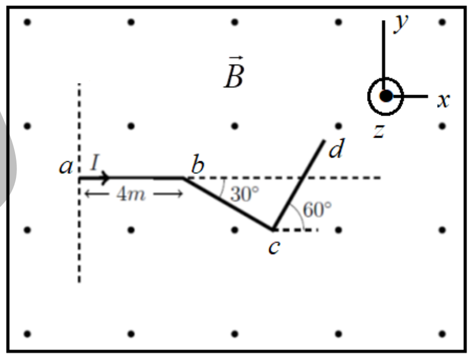
10) In the same uniform magnetic field, two electrons orbit in a circular orbit (Ignore the interaction between electrons). If the ratio of their speeds is $\frac{\upsilon_1}{\upsilon_2} = 4$, what is the ratio of their frequencies ($\frac{f_1}{f_2}$)?

a) 4 b) 1/4 c) 2 d) 1 e) 1/2

The *ad* wire shown in the figure carries a current of I = 4 A and is in a uniform magnetic field of B = 0.5 T. Each piece of wire is 4 m long.

(sin 30°=cos60°=$\frac{1}{2}$ and cos 30°=sin60°=$\frac{\sqrt{3}}{2}$)

Answer the following three questions (11-13) based on this information.



11) What is the magnetic force vector acting on the *ab* part of the wire in N unit?

a) $4\hat{i}+4\hat{j}$ b) $-2\hat{i}+4\hat{j}$ c) $4\hat{j}$ d) $-8\hat{j}$ e) $-12\hat{j}$

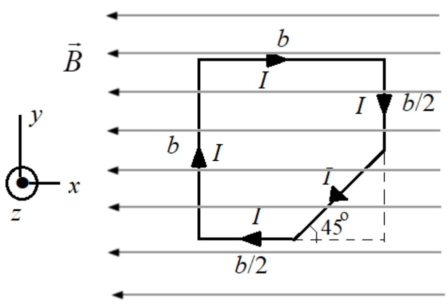
12) What is the magnetic force vector acting on the *bc* part of the wire in N unit?

a) $-4\hat{i}-4\sqrt{3}\hat{j}$ b) $-2\sqrt{3}\hat{i}+4\hat{j}$ c) $4\left(3-\sqrt{3}\right)\hat{k}$ d) $-4\left(1+\sqrt{3}\right)\hat{i}-\sqrt{3}\hat{j}$ e) $4\hat{i}-8\sqrt{3}\hat{j}$

13) What is the magnetic force vector acting on the *cd* part of the wire in N unit?

a) $4\sqrt{3}\hat{i}+4\sqrt{3}\hat{j}$ b) $-2\sqrt{3}\hat{i}+4\sqrt{3}\hat{j}$ c) $4\left(3+\sqrt{3}\right)\hat{k}$ d) $4\left(3+\sqrt{3}\right)\hat{j}$ e) $4\sqrt{3}\hat{i}-4\hat{j}$

A current of I=2 A flows through the closed conducting loop shown in the figure. (b= 2 m). This loop is placed in a uniform magnetic field of B= 3 T. (Ignore the magnetic field created by the loop itself.)
Answer the following three questions (14-16) based on this information.



14) What is the magnetic dipole moment of the loop in (A·m^2) unit?

a) $-7\hat{k}$ b) $7\hat{k}$ c) $-\frac{7}{4}\hat{k}$ d) $\frac{7}{4}\hat{k}$ e) $-\frac{7}{8}\hat{k}$

15) What is the torque acting on the loop in (N·m) unit?

a) $-21\hat{j}$ b) $\frac{21}{4}\hat{j}$ c) $-\frac{21}{4}\hat{j}$ d) $\frac{21}{8}\hat{j}$ e) $21\hat{j}$

16) What is the energy of magnetic dipole moment in J unit?

a) 21/4 b) -21/4 c) 0 d) -21 e) 21

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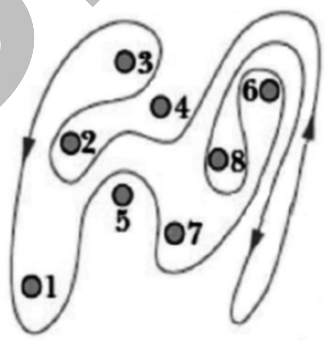
17) **"**The potential energy of a magnetic dipole is minimum when it is …………….. to the magnetic field and maximum when it is ………….. to the magnetic field.”

Which option should replace the spaces in the sentence?

a) antiparallel, parallel
b) perpendicular, parallel
c) parallel, antiparallel
d) parallel, perpendicular
e) perpendicular, antiparallel

18) Eight wires (1-8) cut the page plane perpendicularly at the points shown in the figure. All wires carry the same current of 2 A. While in wires 1, 3, 5 and 7, current flows out of the page plane, in wires 2, 4, 6 and 8, current flows into the page plane.What is the result of the integral $\oint \vec{B}\cdot d\vec{s}$ along the closed path in the direction shown in the figure? (π~3)



a) 8×10^{-7} T·m b) 16×10^{-7} T·m c) 32×10^{-7} T·m
d) 48×10^{-7} T·m e) 64×10^{-7} T·m

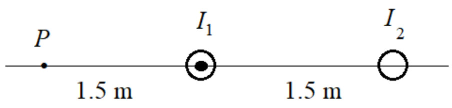
19) The magnetic field formed in the center of a ring carrying a current is 24 T. If the magnitude of the current in the ring is tripled and the radius of the ring is doubled, what is the magnetic field at the center of the ring in T units?

a) 36 b) 18 c) 12 d) 24 e) 72

20) A long solenoid is formed by winding 20 turns/cm. How many A must the current be to create a 12 mT magnetic field inside the solenoid? (π~3)

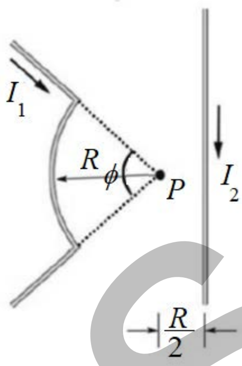
a) 12 b) 6 c) 5 d) 8 e) 4

21) The figure shows cross-section of two long straight wires. The wire on the left carries current I_1=5 A, directed out of the page. What must be the magnitude and direction of the current I_2 so that the net magnetic field at point P is zero?



a) I_2=10 A, out of the page
b) I_2=10 A, into the page
c) I_2=2.5 A, out of the page
d) I_2=2.5 A, into the page
e) I_2= 5A, into the page

22) The figure shows two wires carrying currents I_1 and I_2. One of the wires consists of a circular arc of radius R and two radial lengths and carries a current I_1=1.8 A in the direction shown in the figure. The second wire is a long straight wire located at R/2 distance from the center of the arc and carrying a current of I_2=0.45 A. If the net magnetic field created by the wires at point P is zero, what is the angle ϕ in rad unit?



a) 5 b) 4 c) 3 d) 2 e) 1

23) Which of the following statements is/are false?

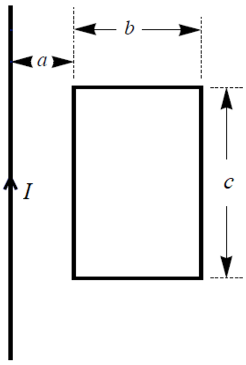
I) A magnetic field is produced by the motion of charged particles.
II) Magnetic field lines around a current-carrying wire form a series of concentric circles.
III) A neutron moving perpendicular to a magnetic field experiences a force.
IV) A current-carrying wire experiences a force when it is placed perpendicular to a magnetic field.
V) The magnetic pole in the Northern Hemisphere coincides with the geographic North Pole.

a) only III b) III and V c) I and V d) II, III, and IV e) only IV

24) The model that explains the transport properties of electrons in metals is known as ……… model.

a) Faraday b) Gauss c) Ampere d) Maxwell e) Drude

25) There is a long wire carrying current I next to a rectangular conducting loop as shown in the figure. What is the magnetic flux through the rectangular loop due to the current in the wire?



a) $\frac{\mu_0 cI}{2\pi}\ln\left(\frac{a+b}{a}\right)$ b) $\frac{\mu_0 I}{2\pi c}\ln\left(\frac{a+b}{a}\right)$ c) $\frac{\mu_0 cI}{2\pi}\ln\left(\frac{b}{a}\right)$

d) $\frac{\mu_0 I}{4\pi c}\ln\left(\frac{a}{a+b}\right)$ e) $\frac{\mu_0 cI}{2\pi}\ln\left(\frac{a}{b}\right)$