İzmir Kâtip Çelebi University
Department of Engineering Sciences
Phy102 Physics II
Final Examination
January 14, 2026 14:10 – 15:40
Good Luck!

NAME-SURNAME:

SIGNATURE:

◇ **I declare hereby that I fulfilled the requirements for the attendance according to the University regulations and I accept that my examination will not be valid otherwise.**

ID:

DEPARTMENT:

INSTRUCTOR:

DURATION: 90 minutes

◇ **Answer all the questions.**
◇ **Write the solutions explicitly and clearly. Use the physical terminology.**
◇ **You are allowed to use Formulae Sheet.**
◇ **Calculator is allowed.**
◇ **You are not allowed to use any other electronic equipment in the exam.**

Question	Grade	Out of
1A		15
1B		15
2		20
3		15
4		15
5		20
TOTAL		100

This page is intentionally left blank. Use the space if needed.

1. A) A wire 4.00 m long and 6.00 mm in diameter has a resistance of 15.0 $m\Omega$. A potential difference of 23.0 V is applied between the ends.

   i What is the current in the wire?

   ii What is the magnitude of the current density?

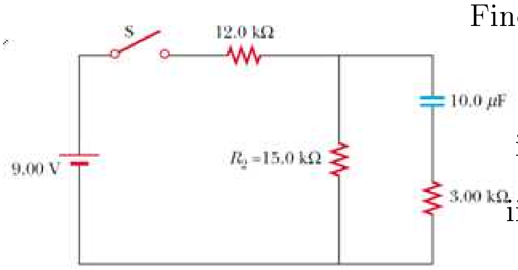
   iii Calculate the resistivity of the wire material.

i) $i = ?$ (3) $i = V/R = 23V / 15\times10^{-3}\,\Omega = \boxed{1.53\times10^{3} A}$ (1) (1)

ii) $J = ?$ (3) $J = i/A = 1.53\times10^{3} A / \pi(3\times10^{-2} m)^2 = \boxed{5.41\times10^{7} A/m^2}$ (1) (1) (1) (1)

iii) $\rho = ?$ (3) $R = \rho \frac{L}{A} \rightsquigarrow \rho = R\frac{A}{L} = \frac{15\times10^{-3}\,\Omega\, \pi(3\times10^{-3} m)^2}{4m} = \boxed{10.6\times10^{-8}\,\Omega m}$

B) In figure, suppose the switch has been closed for a time interval sufficiently long for the capacitor to become fully charged.



Find

i the steady-state current in each resistor

ii the charge Q on the capacitor

iii The switch is now opened at t=0. Write an equation for the current in R_2 as a function of time.

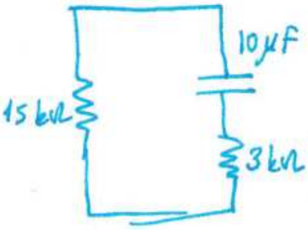
sufficiently long time interval ⇝ C becomes broken wire (steady-state) (2)

i) $\boxed{I_{R_3}=0}$ since C is acting as broken wire

$I_{R_1} = I_{R_2} = I = \frac{\mathcal{E}}{(R_1+R_2)} = \frac{9V}{(12k\Omega + 15k\Omega)} = \boxed{333\,\mu A}$ (2) (1) (1)

ii) $C = \frac{Q}{V} \sim Q = CV = C(IR_2) = (10\mu F)(333\mu A)(15k\Omega) = \boxed{50\,\mu C}$ (2) (1) (1)

iii) switch is opened ($t=0$), C behaves as a battery; $(\Delta V)_C$

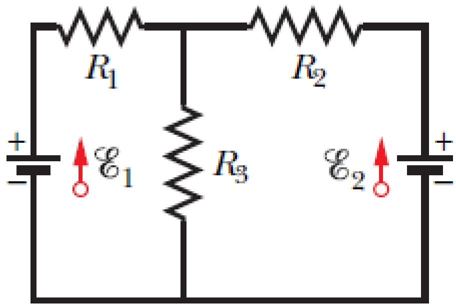


$I_{t=0} = \frac{(\Delta V)_C}{(R_2+R_3)} = \frac{IR_2}{R_2+R_3} = \frac{(333\mu A)(15k\Omega)}{(15k\Omega + 3k\Omega)} = 278\,\mu A = I_i$ (2)

Time Constant: $\tau = (R_2+R_3)C = (18k\Omega)(10\mu F) = 0.180 s$ (2)

$\boxed{I_{R_2} = I_i e^{-t/\tau} = (278\mu A)\, e^{-t/0.180s}}$ for $t>0$ (1)

2. In figure given below, the ideal batteries have emfs $\varepsilon_1 = 10.0V$ and $\varepsilon_2 = 5.0V$, and the resistances are $R_1 = R_2 = R_3 = 4.00\ \Omega$.

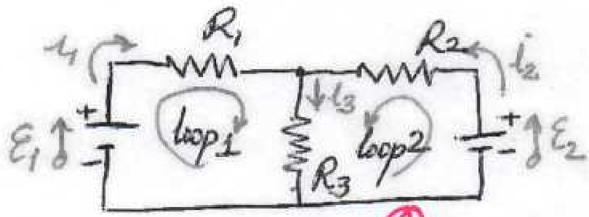


What are

i the direction and magnitude of the **current in resistor 3**?

ii the energy dissipated in **resistor 2**?

iii the power of **battery 1**?



(2)

$i_1 + i_2 = i_3$

loop 1: $\mathcal{E}_1 - i_1 R_1 - i_3 R_3 = 0$ (3)

loop2: $\mathcal{E}_2 - i_2 R_2 - i_3 R_3 = 0$ (3)

$10 = 4 i_1 + 4 i_3$

$5 = 4 i_2 + 4 i_3$

$10 = 4 i_1 + 4 i_1 + 4 i_2$

$5 = 4 i_2 + 4 i_1 + 4 i_2$

$10 = 8 i_1 + 4 i_2$

$-2 /\ 5 = 4 i_1 + 8 i_2$

$0 = -12 i_2 \rightsquigarrow$ $\boxed{i_2 = 0 A}$

$\rightsquigarrow i_1 = 5/4\ A \rightsquigarrow$ $\boxed{i_1 = 1.25 A}$

(2) $\boxed{i_3 = 1.25 A}$ (1)

i) $i_3 = 1.25 A$ & downward (1)

ii) (2) $P = i_2^2 R_2 = \Delta U / \Delta t \rightsquigarrow U = i_2^2 R_2 t = \boxed{0}$ since $i_2 = 0$ (2)

iii) (2) $P = i_1 \mathcal{E}_1 = (1.25A)(10V) = \boxed{12.5 W}$ (1)(1)

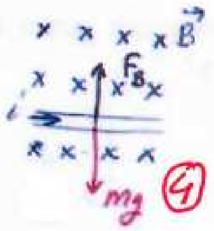
3. A 0.1 T uniform magnetic field is horizontal and parallel to the floor. A straight segment of 1.0 mm diameter copper wire,also parallel to the floor, is perpendicular to the magnetic field. What current through the wire, and in which direction, will allow the wire to float (not falling to the floor) in the magnetic field. Take $\rho = 8920\ kg/m^3$ as the density of copper and $\rho = mass/Volume$.

$B = 0.1\,T$ (uniform)

$d = 1\times10^{-3}\,m$

$\rho = 8920\ kg/m^3 = \frac{m}{V}$

$V = (\pi d^2 l)$



(4)

$|\vec{F}_B| = |\vec{F}_g|$ (5)

$i l B \sin 90 = mg$

$i l (0.1T) = (\rho V) g$

$i l (0.1T) = (8920\ \frac{kg}{m^3})(\pi (\frac{d}{2})^2 l)(9.8\ m/s^2)$

$\rightsquigarrow i = \frac{\rho \pi (d/2)^2 g}{B}$

$\rightsquigarrow i = \frac{(8920\ kg/m^3)(\pi (1\times10^{-3} m/2)^2)(9.8\ m/s^2)}{0.1\,T} = 0.686\,A$ (4) (1) (1)

4. A circular coil of 160 turns has a radius of 1.90 cm.

   i **Calculate the current** that results in a magnetic dipole moment of magnitude 2.30 $A.m^2$

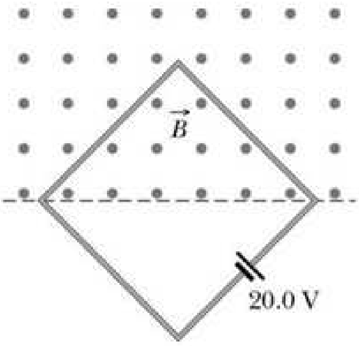
   ii Find the **maximum magnitude of the torque** that the coil, carrying this current, can experience in a uniform 35.0 T magnetic field.

i) $\mu = NiA$ (3) $\rightarrow i = \frac{\mu}{NA} = \frac{\mu}{N\pi R^2}$ (2) $= \frac{2.30\ Am^2}{(160)\pi(1.90\times10^{-2}m)^2} = \boxed{12.7A}$ (1) (1)

ii) (3) $\vec{\tau} = \vec{\mu}\times\vec{B} \Rightarrow \tau = |\mu||B|\sin\theta$ (1) $\sim \tau_{max} = \mu B \sin 90°$ (2)

$\rightarrow \tau_{max} = (2.30\ Am^2)(35\ T) = \boxed{80.5\ Nm}$ (1) (1)

5. A square wire loop with 3.00 m sides and resistance 3 Ω is perpendicular to a uniform magnetic field, with half the area of the loop in the field as shown in figure. The loop contains an ideal battery with emf (ε) 20.0 V. The magnitude of the field varies with time according to $B = 0.0420 - 0.3870t$, with B in teslas and t in second.



i Find the value and direction of the induced ε.

ii What is the net emf in the circuit?

iii Find the magnitude and the direction of the net current around the loop?

Hint: Magnetic field is decreasing.

$l = 2.00\,m$
$R = 3\,\Omega$
$\varepsilon_B = 20.0\,V$
$B = 0.0420 - 0.870t$
$A = L^2/2$ (1)

i) $\varepsilon_i = -\frac{d\Phi_B}{dt}$ (2) $= -\frac{d(BA)}{dt}$ (1) $= -\frac{L^2}{2}\frac{dB}{dt} = -\frac{L^2}{2}\frac{d(0.0420 - 0.3870t)}{dt}$ (2)

$= -\frac{L^2}{2}(-0.3870\,T/s) = \frac{(3.00\,m)^2}{2}(0.3870\,T/s)$

$\varepsilon_i = 1.74\,V$ (2) $\because$ B is out of page and DECREASING. (3)

→ Induced emf should support the external magnetic field ⇒ ccc: direction of induced emf (current,

⇒ same direction with the battery → $\varepsilon_{total} = \varepsilon_B + \varepsilon_i = 20.0\,V + 1.74\,V$ (3)

ii) $= 21.74\,V$ (2)

iii) Current is in the ccw. (2) $i = \frac{V}{R} = \frac{\varepsilon_{total}}{R} = \frac{21.74\,V}{3\,\Omega} = 7.23\,A$ (2)