İzmir Kâtip Çelebi University
Department of Engineering Sciences
Phy102 Physics II
Final Examination
June 30, 2025 08:30 – 10:00
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:

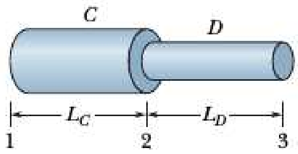
DURATION: 90 minutes

◇ **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		20
5		15
TOTAL		100

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

1. A) Wire C and wire D are made from different materials and have length $L_C = L_D = 1.2\ m$. The resistivity and diameter of wire C are $2.6 \times 10^{-6}\ \Omega m$ and 1.40 mm, and those of wire D are $1.4 \times 10^{-6}\ \Omega m$ and 0.50 mm. The wires are joined as shown in Figure, and a current of 2.7 A is set up in them.



What is the electric potential difference between

i points 1 and 2,

ii points 2 and 3?

What is the rate at which energy is dissipated between

i points 1 and 2,

ii points 2 and 3?

$L_C = L_D = 1.2\,m$

$\rho_C = 2.6\times10^{-6}\ \Omega m$

$\rho_D = 1.4\times10^{-6}\ \Omega m$

$d_C = 1.4\times10^{-3}\ m$

$d_D = 0.5\times10^{-3}\ m$

same currents at both segments, $R = \rho\frac{\ell}{A} = \frac{V}{I}$

$R_C = \rho_C\, L_C/\pi\left(\frac{d_C}{2}\right)^2 = 2.6\times10^{-6}\ \Omega m\ \frac{1.2m}{\pi(0.7\times10^{-3}\,m)^2} = 2.03\Omega$ (3)

$R_D = \rho_D\, L_D/\pi\left(\frac{d_D}{2}\right)^2 = 1.4\times10^{-6}\ \Omega m\ \frac{1.2m}{\pi(0.25\times10^{-3}\,m)^2} = 8.56\Omega$ (3) (3)

$(V_2-V_1) = V_C = R_C\, i = 2.03\Omega \times 2.7A = \boxed{5.5V}$ (1.5)

$(V_3-V_2) = V_D = R_D\, i = 8.56\Omega \times 2.7A = \boxed{23.1V}$ (1.5)

$P_C = i^2 R_C = (2.7A)^2\, 2.03\Omega = \boxed{14.8\,W}$ (1.5)

$P_D = i^2 R_D = (2.7A)^2\, 8.56\Omega = \boxed{62.4\,W}$ (1.5)

B) A 15.0 $k\Omega$ resistor and a capacitor are connected in series and then a 12.0 V potential difference is suddenly applied across them. The potential difference across the capacitor rises to 5.0 V in 1.30 μs.

a) Calculate the time constant of the circuit.

b) Find the capacitance of the capacitor.

Charging capacitor: $q = C\mathcal{E}(1-e^{-t/RC})$ & $\tau = RC$ (2)

$V(t) = \mathcal{E}(1-e^{-t/RC})$ (3)

i) $V(t) = \mathcal{E}(1-e^{-t/RC}) \Rightarrow 5V = 12V\left(1-e^{-\frac{1.3\times10^{-6}s}{15\times10^{3}\Omega C}}\right)$ (3)

$15\times10^{3}\Omega C = \tau$

$e^{-1.3\times10^{-6}s/\tau} = 1 - 5/12 \rightsquigarrow \ln e^{-1.3\times10^{-6}/\tau} = \ln 7/12$

$\rightsquigarrow -1.3\times10^{-6}s/\tau = \ln 7/12 \rightsquigarrow \tau = \frac{-1.3\times10^{-6}s}{\ln 7/12} = \frac{-1.3\times10^{-6}s}{-0.54}$ (3)

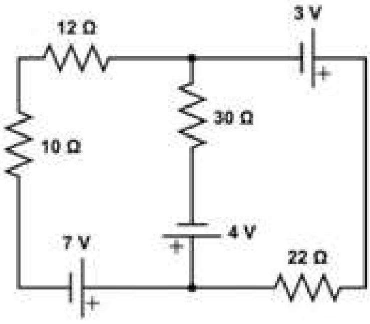
$\Rightarrow \tau = 2.41\,\mu s$ (2)

ii) $\tau = RC \rightsquigarrow C = \frac{\tau}{R} = \frac{2.41\times10^{-6}s}{15\times10^{3}\Omega} = 1.61\times10^{-10}F$

$= 0.161\,nF$

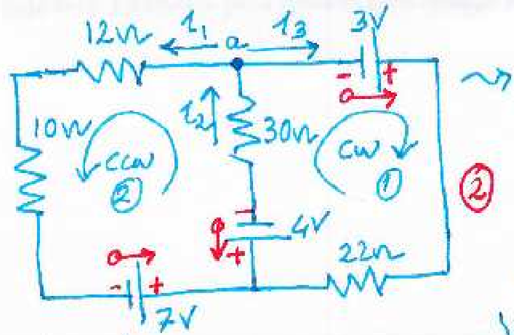
$= 162\,pF$ (2)

2. A circuit is assembled as shown at the figure. If $R_1 = 10\ \Omega$, $R_2 = 12\ \Omega$, $R_3 = 30\ \Omega$, $R_4 = 22\ \Omega$, $\xi_1 = 7\ V$, $\xi_2 = 4\ V$, and $\xi_3 = 3\ V$;



i What is the magnitude of the current through the 30 Ω resistor?

ii How much power is drawn by the 7 V battery?



(2)

Junction rule: $i_1+i_3=i_2$ (3)

loop1: $-12i_1-10i_1+7-4-30i_2=0$ (3)

loop2: $3-22i_3-4-30i_2=0$ (3)

$22i_1+30i_2=3$

$-30i_2-22i_3=1$

$22i_1+30(i_1+i_3)=3$

$-30(i_1+i_3)-22i_3=1$

$52i_1+30i_3=3$

$-30i_1-52i_3=1$

$52i_1+30\left(\frac{-1-30i_1}{52}\right)=3$ (1)

$\Rightarrow i_1=0.103A$ (1)

$i_3=-\frac{1}{52}-\frac{30}{52}i_1=-0.078A$ (1) (1)

$i_2=0.0244A$ (1) (1) i)

ii) $P=iV=i_1 7V$ (1)

$=(0.103A)(7V)=0.72W$ (1) (1)

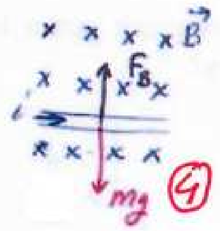
3. A 0.1 T uniform magnetic field is horizontal and parallel to the floor. A straight segment of 1.0 mm diameter copper wire,also parallel to the floor, is perpendicular to the magnetic field. What current through the wire, and in which direction, will allow the wire to float (not falling to the floor)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

$B = 0.1T$ (uniform)

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

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

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



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

$i l B \sin 90 = mg$

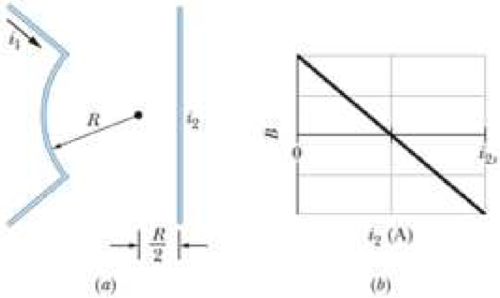
$i l (0.1T) = (\rho V) g$

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

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

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

4. Figure(a) shows two wires, each carrying a current. Wire 1 consists of a circular arc of radius R and two radial lengths; it carries current $i_1 = 3.0\ A$ in the direction indicated. Wire 2 is long and straight; it carries a current i_2 that can be varied; and it is at distance R/2 from the center of the arc. The net magnetic field B due to the two currents is measured at the center of curvature of the arc.



Figure(b) is a plot of B in the direction perpendicular to the figure as a function of current i_2. The horizontal scale is set by $i_{2s} = 2.00\ A$. **What is the angle subtended by the arc?**

$i_1 = 3A$, R
i_2: variable, R/2

net magnetic field at point P

$$B_P = \frac{\mu_0 i_1}{4\pi R}\phi - \frac{\mu_0 i_2}{2\pi R/2}$$ (5) (5)

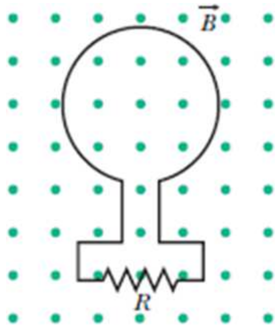
circular arc (out of page) — straight wire (into page)

at $i_2 = 1A \rightsquigarrow B_P = 0 \rightsquigarrow \frac{\mu_0 3A}{4\pi R}\phi = \frac{\mu_0 1A}{\pi R}$ (5)

$\rightsquigarrow \phi = \frac{4}{3}$ radians $= 76.4^0$ (3) (2)

(3.14 rad $\rightsquigarrow$ 180°)

5. In Figure given below, the magnetic flux through the loop increases according to the relation $\Phi_B = 6.0t^2 + 7.0t$, where Φ_B is in miliwebers and t is in seconds.



i What is the magnitude of the emf (ϵ) induced in the loop when $t = 2.0\ s$?

ii Is the direction of the current through R to the right or left? Explain.

Increasing magnetic flux → induced emf in the loop (1)

i) $|\mathcal{E}| = \left|\frac{d\Phi_B}{dt}\right|$ (3) $\rightarrow \mathcal{E}\Big|_{t=2s} = \frac{d}{dt}(6.0t^2+7.0t)\Big|_{t=2s}$ (2) $= 12t+7\Big|_{t=2s}$ (2)

$\rightarrow \boxed{\mathcal{E} = 31\ mV}$ (2)

ii) Increasing flux ↔ induced emf should create a magnetic flux to oppose (to decrease external field)

To have an inward (induced) B, we should have a clockwise current at the loop. (3)

→ **Left through R** (2)