İzmir Kâtip Çelebi University
Department of Engineering Sciences
Phy102 Physics II
Final Examination
June 08, 2026 10:20 – 11:50
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		20
4		15
5		15
TOTAL		100

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1. A) A 24.0 m length of 2.0 mm diameter cylindrical conducting wire carries a 140 A current when 28.0 V is applied to its ends.

   i Calculate the resistance R and resistivity ρ of the conducting wire.

   ii Find the current density J and electric field E inside the conducting wire.

   iii If the current is maintained in the conductor for 3 hours, calculate the dissipated energy in the conducting wire.

i) $R = \frac{V}{I}$ & $R = \rho \frac{L}{A} \rightsquigarrow \rho = \frac{A}{L} R$, $A = \pi r^2$

$R = \frac{28V}{140A} = \underline{\underline{0.2\,\Omega}}$

$= \underline{\frac{\pi (2\times 10^{-3} m/2)^2}{24 m}} 0.2\,\Omega$

$= \underline{\underline{2.6\times 10^{-8}\,\Omega m}}$

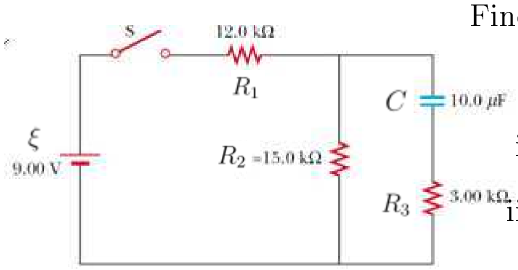
ii) $J = \frac{I}{A} = \frac{140 A}{\pi (10^{-3} m)^2} = \underline{\underline{4.5\times 10^{7}\, A/m^2}}$

$E = \rho J = (2.6\times 10^{-8}\,\Omega m)(4.5\times 10^{7} A/m^2) = \underline{\underline{1.2\ V/m}}$

iii) $\frac{\Delta U}{\Delta t} = P = i^2 R \rightsquigarrow \Delta U = i^2 R \Delta t$

$\rightsquigarrow \Delta U = (140A)^2 (0.2\,\Omega)(3\times 60\times 60 s) = \underline{\underline{4.2\times 10^{7}\, J}}$

B) A circuit is assembled as shown at the figure. If $R_1 = 12\ k\Omega$, $R_2 = 15\ k\Omega$, $R_3 = 3\ k\Omega$, $C = 10\ \mu F$ and $\xi = 9\ V$. 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.

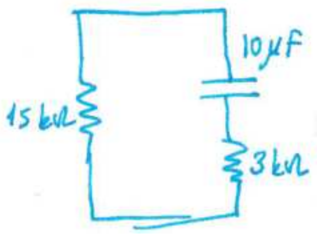
sufficiently long time interval ⇝ C becomes broken wire (steady-state) 2

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; $(\Delta V)_C$

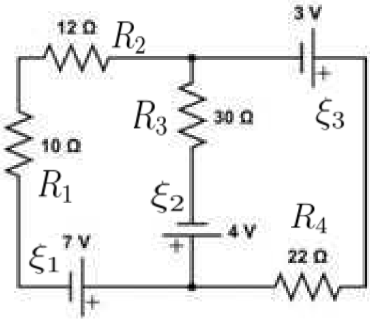


$I_{t=0}=\frac{(\Delta V)_C}{(R_2+R_3)}=\frac{IR_2}{R_2+R_3}=\frac{(333\mu A)(15k\Omega)}{(15k\Omega+3k\Omega)}=278\mu A=I_i$ 2

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

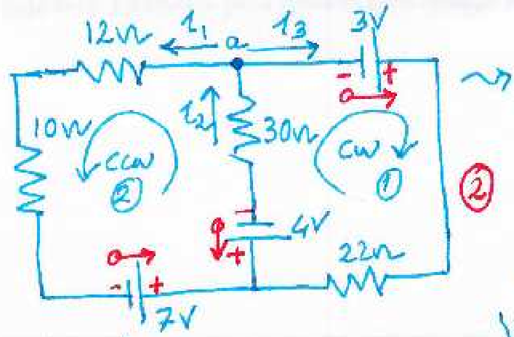
$\boxed{I_{R_2}=I_i e^{-t/\tau}=(278\mu A)e^{-t/0.180s}}$ for $t>0$ 1

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)

$\Rightarrow i_1 = 0.103\,A$ (1)

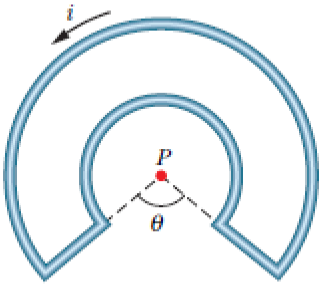
$i_3 = -\frac{1}{52} - \frac{30}{52} i_1 = -0.078\,A$ (1) (1)

$\boxed{i_2 = 0.0244\,A}$ i) (1) (1)

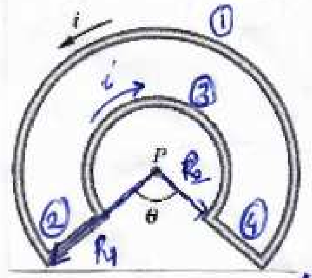
ii) $P = iV = i_1 7V$ (1)

$= (0.103A)(7V) = \boxed{0.72W}$ (1) (1)

3. In figure given below, a closed loop carries current $i = 200\ mA$. The loop consists of two radial straight wires and two concentric circular arcs of radii 2.00 m and 4.00 m. The angle θ is $\pi/4\ rad$.



What are the magnitude and direction (into or out of the page) of the *net magnetic field* at the center of curvature P?



$i = 200mA = 0.2A$

$R_1 = 4m$ & $R_2 = 2m$

$\vec{B}_{net,P} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 + \vec{B}_4$

$|\vec{B}_2| = 0, |\vec{B}_4| = 0 \Big\} \vec{i} \parallel d\vec{s}$ (2) (2)

$\Big\{ B = \frac{\mu_0 i}{4\pi r}\phi$ (3)

$\phi = 2\pi - \frac{\pi}{4} = 7\pi/4$ (3)

$B_1 = \frac{\mu_0 i}{4\pi R_1}\phi \odot \rightsquigarrow B_1 = \frac{\mu_0 i}{4\pi R_1}\frac{7\pi}{4}$ (2)

$B_3 = \frac{\mu_0 i}{4\pi R_2}\phi \otimes \rightsquigarrow B_3 = \frac{\mu_0}{4\pi R_2}\frac{7\pi}{4}$ (2)

(2)

$\Big\} \vec{B}_{net,P} = \frac{\mu_0 i}{4\pi R_1}\frac{7\pi}{4}\hat{k} + \frac{\mu_0 i}{4\pi R_2}\frac{7\pi}{4}(-\hat{k})$

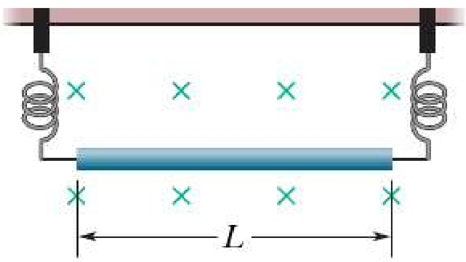
$= \frac{\mu_0 i 7}{16}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)\hat{k}$

$\rightsquigarrow |\vec{B}_{net,P}| = \frac{7}{16}\left(4\pi \times 10^{-7}\frac{Tm}{A}\right)(0.2A)\left(\frac{1}{4} - \frac{1}{2}\right)$

$= 2.7 \times 10^{-8}T \rightsquigarrow \vec{B}_{net,P} = 2.7 \times 10^{-8}T(-\hat{k})$ into the page

(2) (2)

4. A 13.0 g wire of length L=62.0 cm is suspended by a pair of flexible leads in a uniform magnetic field of magnitude 0.440 T (see Figure below).



What are the

i magnitude

ii direction (left or right, why?)

of the current required to remove the tension in the supporting leads?

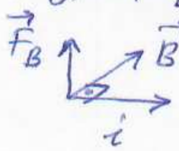
Hint: Remove the tension means $\Sigma\vec{F}_{net} = 0 = \vec{F}_g + \vec{F}_B$

y, x suspension $\Rightarrow \Sigma\vec{F}_{net} = 0 = \vec{F}_g + \vec{F}_B$

$i\ell B = F_B$
~COM
$mg = F_g$

so that $\vec{F}_B$ should be upward

i) $|\vec{F}_g| = |\vec{F}_B| \rightsquigarrow mg = i\ell B \sin 90°$



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$$i = \frac{mg}{\ell B} = \frac{(13.0\times10^{-3}\,kg)(9.8\,m/s^2)}{(0.620\,m)(0.440\,T)} = \boxed{0.467\,A}$$

3 2

ii) $\vec{F}_B$ should be upward. so RHR & towards right

5

5. A uniform magnetic field B is perpendicular to the plane of a circular loop of diameter 10 cm formed from wire of diameter 2.5 mm and resistivity 1.69×10^{-8} Ωm. At what rate must the magnitude of B change to induce a 10 A current in the loop?

$$R = \frac{V}{I} \overset{(2)}{=} \rho \frac{L}{A} = 1.69\times10^{-8}\,\Omega m \, \frac{\pi(0.10\,m)}{\pi\left(\frac{2.5\times10^{-3}\,m}{2}\right)^2} = \underline{\underline{1.08\times10^{-3}\,\Omega}}$$
(1) (1)

$$\text{where } L: 2\pi r \;\&\; A = \pi r^2$$

$$\varepsilon_{ind} \overset{(2)}{=} \frac{d\Phi_B}{dt} = \frac{d(BA)}{dt} \overset{(1)}{=} A\frac{dB}{dt} \;\&\; i_{ind} = \frac{\varepsilon_{ind}}{R} \; (1)$$

$$\rightsquigarrow i_{ind} R \overset{(2)}{=} A\frac{dB}{dt} \;\overset{(2)}{\rightsquigarrow}\; \frac{dB}{dt} = \frac{i_{ind} R}{A} = \frac{i_{ind} R}{\pi r^2}$$

$$\rightsquigarrow \left|\frac{dB}{dt}\right| = \frac{(10\,A)(1.08\times10^{-3}\,\Omega)}{\pi(0.10/2\,m)^2} = \boxed{1.377\ T/s}$$
(2) (1)