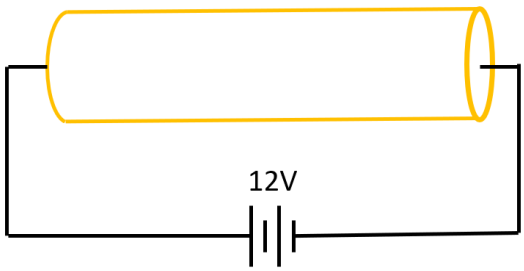
Physics 1320 - Calculus-based Physics II
Summer 2022
Midterm Exam II

Question 1 (15 pts)

Consider a segment of AWG 12 (diameter = 2.052mm) copper wire in a circuit that is $20m$ long. The potential difference from one end to the end of the wire is $12V$.



Material	Conductivity, σ $(\Omega \cdot \mathrm{m})^{-1}$	Resistivity, ρ $(\Omega \cdot \mathrm{m})$
Conductors		
Silver	6.29×10^7	1.59×10^{-8}
Copper	5.95×10^7	1.68×10^{-8}
Gold	4.10×10^7	2.44×10^{-8}
Aluminum	3.77×10^7	2.65×10^{-8}
Tungsten	1.79×10^7	5.60×10^{-8}

A What is the resistance of this segment of wire?

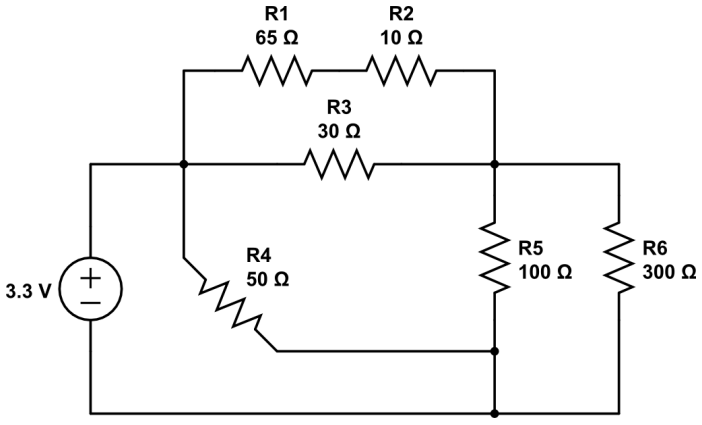
B For an aluminum wire of the same length, what diameter is required to match the resistance of the copper wire?

C How much energy is used by this segment of wire?

D Where does this energy go?

Question 2 (15 pts)

Consider the below circuit:



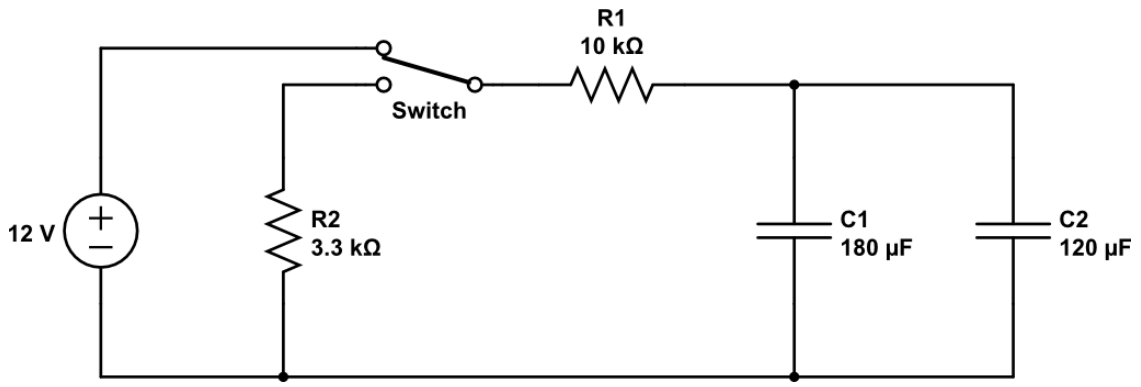
A What is the total current flowing from the power supply?

B What is the voltage across resistor R_2?

C What is the current through resistor R_6?

Question 3 (20 pts)

Consider the circuit below with a power supply $V = 12V$, $R_1 = 10k\Omega$, $R_2 = 3.3k\Omega$, $C_1 = 180\mu F$, and $C_2 = 120\mu F$.



Assume that the switch starts open (connected neither to the power supply nor the resistor R_2). It closes to the power supply at time = 5 seconds. And, then at time = 14 seconds it switch over to connect to the resistor R_2.

A What is the charge on capacitor C_2 at time = 11 seconds?

B What is the voltage across capacitor C_1 at time = 20 seconds?

Question 4 (15 pts)

Consider a magnetic field of magnitude $2.73T$ that is parallel to the positive z-axis. For each of the following situations, calculate the force vector acting upon the particle.

A An electron moving in the negative y direction with a velocity of $4.2\frac{m}{s}$.

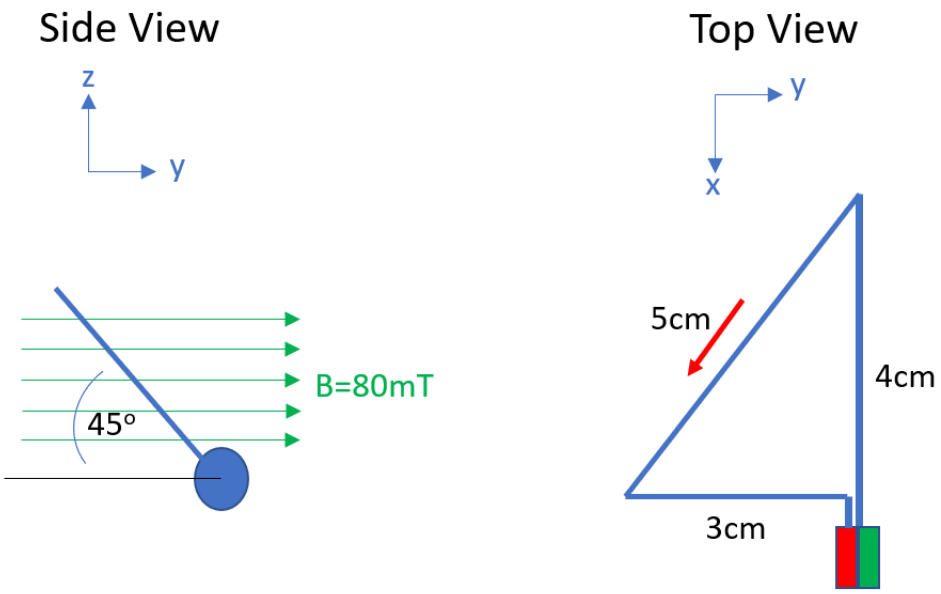
B A proton moving in the negative z direction with a velocity of $8.99\frac{m}{s}$.

C An alpha-particle (two protons and two electrons) moving with a velocity of $(-3\hat{i} + 4\hat{j} - 5\hat{k})\frac{m}{s}$

Note: the mass of a proton is $m_p = 1.637 \cdot 10^{-27}kg$ *and the mass of a electron is* $9.11 \cdot 10^{-31}kg$. *The charge on an electron is* $1.602 \cdot 10^{-19}C$.

Question 5 (15 pts)

Consider a right triangle with sides of $3cm$ and $4cm$ carrying $5A$ of current as shown in the figure below. It is placed in a $80mT$ magnetic field at an angle of 45^o.



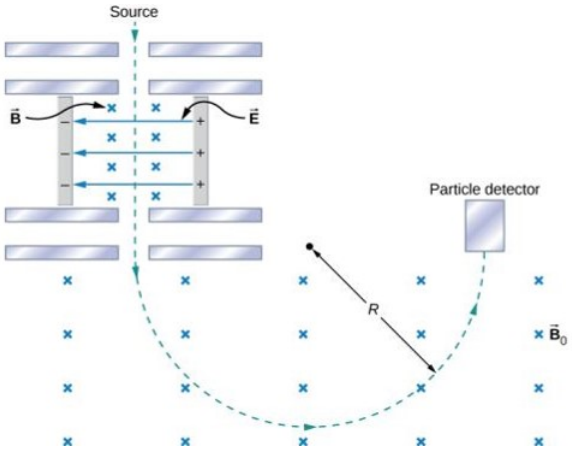
A What is the force on each of the three sides of the triangle?

B What is the magnetic dipole moment of this current-carrying loop?

C What is the torque on this current-carrying loop?

Question 6 (20 pts)

Consider the below mass spectrometer with the following fields with $E = 12,500\frac{V}{m}$, $B = 0.01T$, and $B_0 = 1.404T$ in the directions shown in the Figure below.



A Describe qualitatively how the velocity selector portion of the mass spectrometer works.

B What is the velocity of a particle emerging from the velocity selector?

C A gas chromatography system breaks the source gas into constituent atoms and ionizes them. These ions then enter the mass spectrometer. An equal number of ions (singularly charged) hit a detector at radius $12.91cm$ and $14.75cm$, what is the mass of each type of ion?

D Given the table at the end of this exam, what is the original gas that was fed into the gas chromatogrphy system? (Note: 1 AMU $= 1.66 * 10^{-27}kg$).

Question 7 - Extra Credit (5pts)

A How much horsepower can a horse exert over a short period of time?

B If the horse exerts its maximum pull for 5 minutes, how much Energy does it use. (Note: one horsepower equals 745.7 W).

Reference: Atomic Mass Table

ATOMIC NUMBER	ELEMENT	ATOMIC MASS
1	Hydrogen	1.008
2	Helium	4.0026
3	Lithium	6.94
4	Beryllium	9.0122
5	Boron	10.81
6	Carbon	12.011
7	Nitrogen	14.007
8	Oxygen	15.999
9	Fluorine	18.998
10	Neon	20.180
11	Sodium	22.990
12	Magnesium	24.305
13	Aluminium	26.982
14	Silicon	28.085
15	Phosphorus	30.974
16	Sulfur	32.06
17	Chlorine	35.45
18	Argon	39.948
19	Potassium	39.098
20	Calcium	40.078
21	Scandium	44.956
22	Titanium	47.867
23	Vanadium	50.942