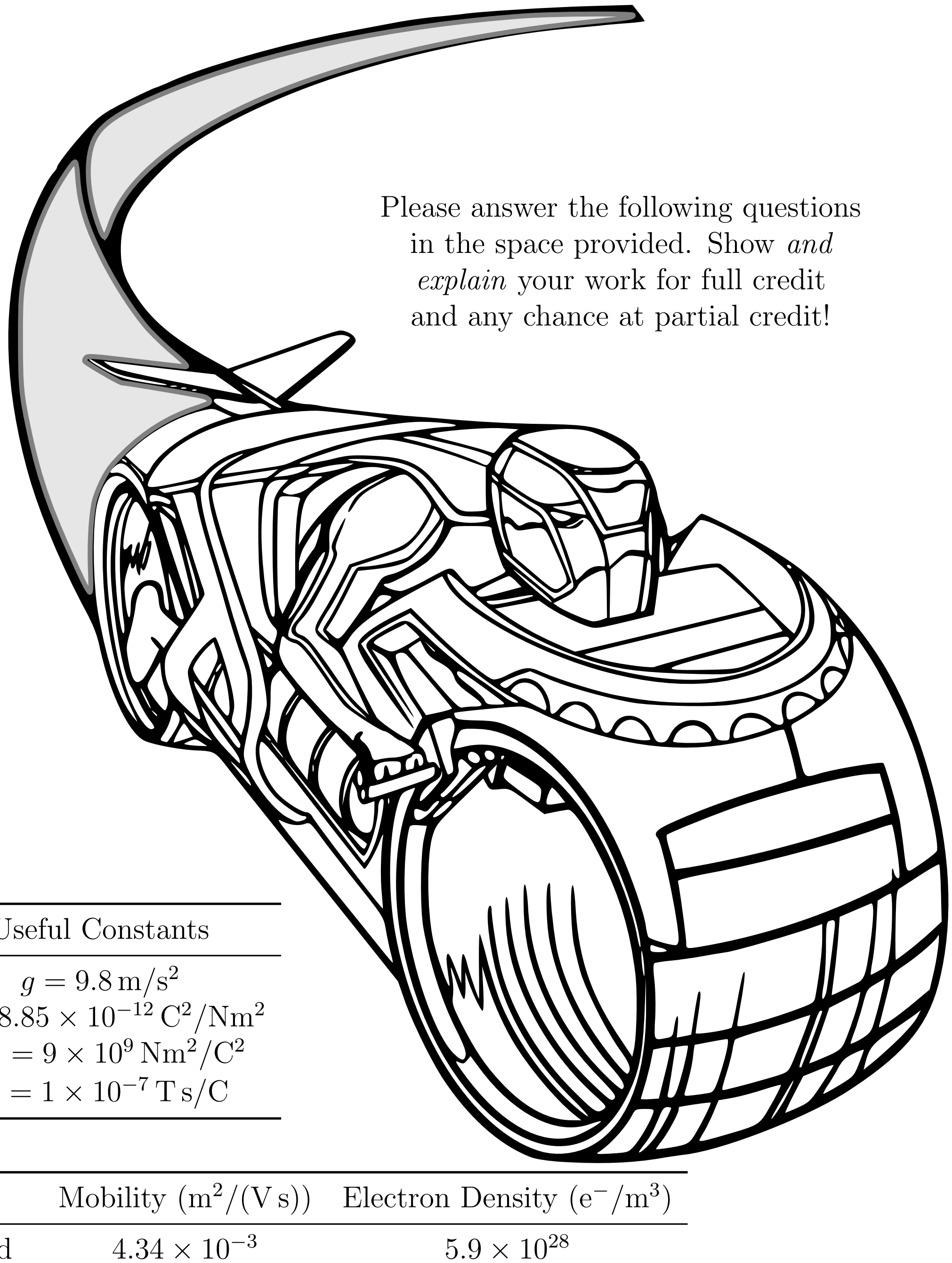
Name: ______________________________

TEST 2

ENTERING THE CIRCUIT

Please answer the following questions in the space provided. Show *and explain* your work for full credit and any chance at partial credit!



Useful Constants
$g = 9.8\,\mathrm{m/s^2}$
$\epsilon_0 = 8.85 \times 10^{-12}\,\mathrm{C^2/Nm^2}$
$\frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}\,\mathrm{Nm^2/C^2}$
$\frac{\mu_0}{4\pi} = 1 \times 10^{-7}\,\mathrm{T\,s/C}$

	Mobility ($\mathrm{m^2/(V\,s)}$)	Electron Density ($\mathrm{e^-/m^3}$)
Gold	4.34×10^{-3}	5.9×10^{28}
Copper	4.39×10^{-3}	8.5×10^{28}
Silver	6.73×10^{-3}	5.86×10^{28}

1. The servers that house the world of Tron use capacitors to regulate their power input. You attach one of these square parallel plate capacitors, which have plate dimensions of 10 cm by 10 cm, to a 120 V battery. After it is fully charged, you measure that 1 nC of charge is stored on the top plate.

(2) (a) What is the physical distance between the two plates of your capacitor?

A. 1.07 mm

B. π mm

C. 10.6 mm

D. 106 mm

(2) (b) In an effort to improve the capacitor, you fill the region between the plates with some insulating material. When you do so, the amount of charge stored on your top plate increases by 6 nC (when attached to the same battery). What is the dielectric constant of your insulating material?

A. 7×10^{-9}

B. $\frac{1}{6}$

C. 6

D. 7

(2) 2. The mainframe requires a high current input to properly function, so you are doing tests with different wire compositions. Two wires are identical in length and diameter and are connected to identical batteries. The only difference is that one wire is made of copper and one is made of silver. How will the currents through the two wires compare?

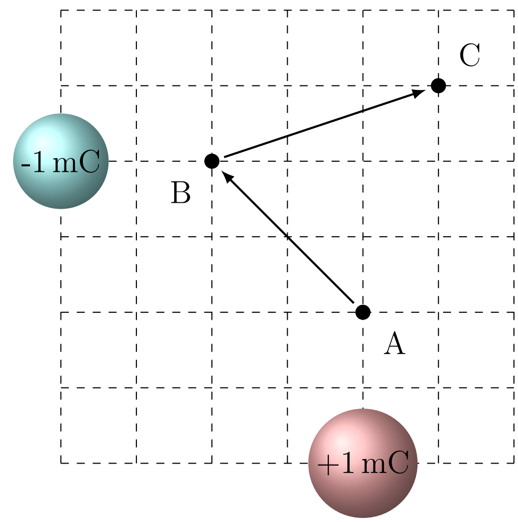
A. $I_{silver} > I_{copper}$

B. $I_{silver} < I_{copper}$

C. $I_{silver} = I_{copper}$

D. Not enough information to tell

(4) 3. Many of the programs in the world of Tron use electric potential to navigate. Suppose a negatively charged program is placed at location A in the vicinity of two point charges, one negative ($-1\,\mathrm{mC}$) and one positive ($1\,\mathrm{mC}$). The program moves from A to B and then from B to C. What is the total change in electric potential from A to C? You can assume each of the grid lines is a distance of $1\,\mathrm{m}$.

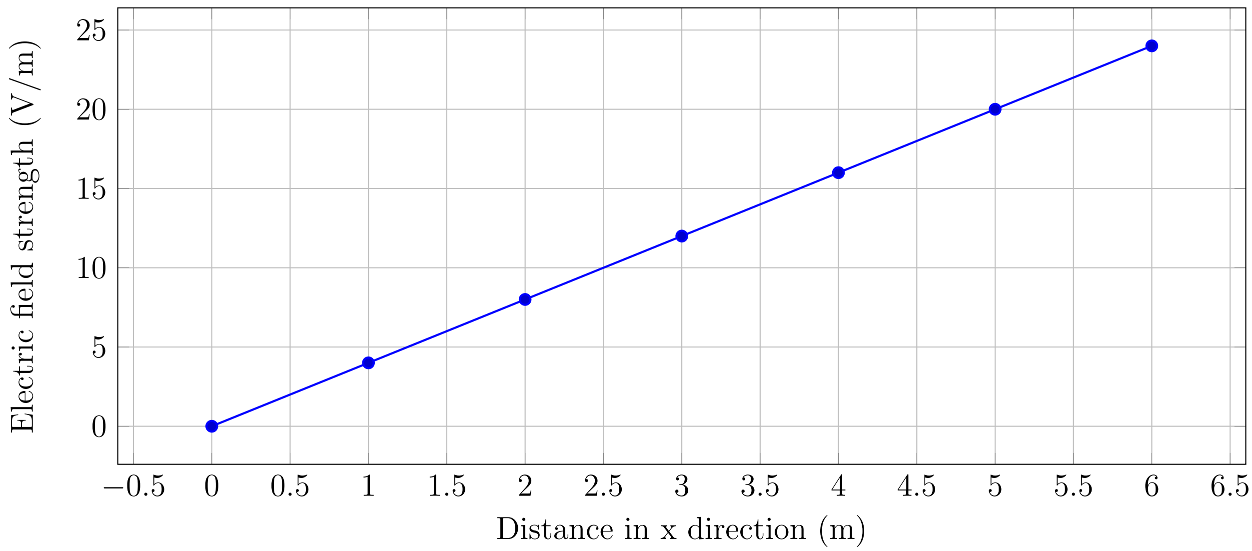


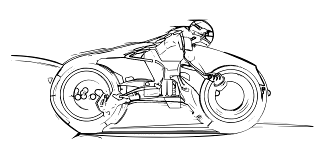
(4) 4. A charged light-bike ($2\,\mathrm{C}$) is moving directly towards you at a speed of $50\,\mathrm{m/s}$. What is the magnitude *and direction* of the magnetic field you observe a height of $5\,\mathrm{m}$ directly above the bike?

(6) 5. A light-cycle in Tron has a charge of 2 C and a mass of 100 kg. It is initially moving at 1 m/s to the right at the location $x = 1$. A variable strength electric field is present in the region and looks like:

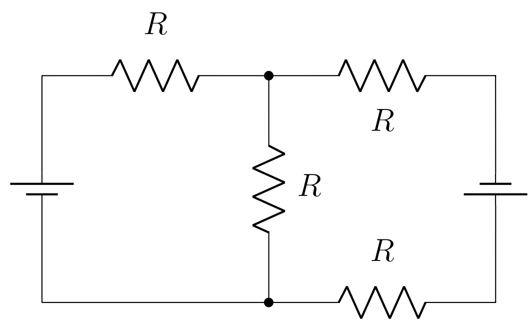
$$\vec{\mathbf{E}} = (4\,\mathrm{V/m^2})x\,\hat{\mathbf{x}}$$

where x measures the distance to the right. How fast is the bike traveling at the point $x = 5$? I've provided a plot of the electric field below if it helps you visualize the situation.

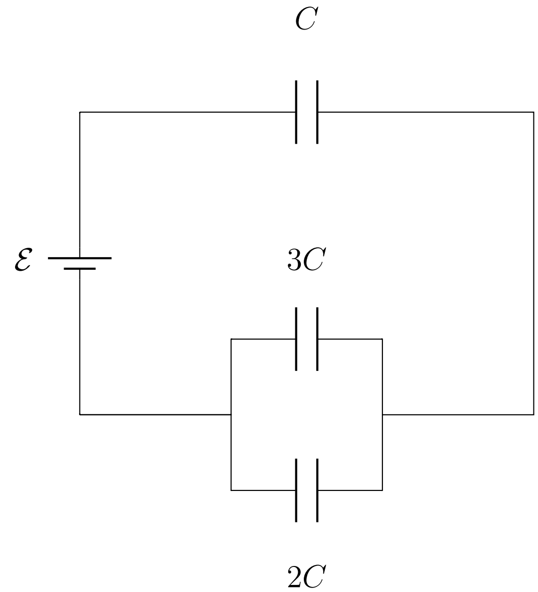




(8) 6. The identity-disks that the programs of Tron use in combat utilize the below circuit, where $R = 2\,\Omega$ and $\mathcal{E} = 5\,\mathrm{V}$. Determine the magnitude *and direction (up or down)* of the current flowing through the center wire. (*The smaller side of the battery symbol denotes the negative side.*)



(3 (bonus)) 7. Back in the real world, power fluctuations are still causing issues with the ENCOM servers. Consider the circuit below, where the battery emf is 10 V and $C = 2\,\mu\mathrm{F}$. The circuit is in steady state. Determine the *energy* stored in the bottom ($2C$) capacitor.



And you are done! Have a great and relaxing Spring Break!