Your code is: ACCEIH

Put your name here:

Keep this exam **CLOSED** until advised by the instructor.

Fill out the bubble sheet: last name, first initial, student number, section number and **code**.

60 minute long closed book exam.

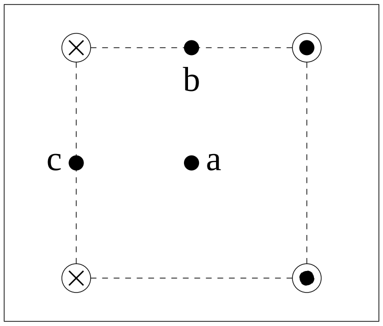
A two-sided 8.5 by 11 handwritten help sheet is allowed.

When done, hand in your **bubble sheet** and your **exam**.

Possibly useful constants:

- $k_e = 8.99 \times 10^9$ Nm^2/C^2
- $\epsilon_0 = 8.85 \times 10^{-12}$ As/(Vm)
- $\mu_0 = 4\pi \times 10^{-7}$ Vs/(Am)
- c = 3.00×10^8 m/s
- e = 1.60×10^{-19} C
- $m_e = 9.11 \times 10^{-31}$ kg
- $m_e c^2 = 0.511$ MeV
- h = 6.63×10^{-34} Js
- h = 4.14×10^{-15} eVs
- hc = 1240 eVnm
- $\sigma = 5.67 \times 10^{-8}$ W/(m^{2}K^4)
- Wien's constant = 2.898×10^{-3} Km
- $R_H = 1.097 \times 10^7$ 1/m
- $E_0 = 13.6$ eV
- $a_0 = 0.529$ Angstrom
- 1 eV = 1.60×10^{-19} J
- 1 AMU (1 u) = 931.494 MeV/c^2 = 1.67×10^{-27}kg
- $\times$ Field directly into page.
- $\bullet$ Field directly out of page

Four electric currents, equal in magnitude are arranged at the corners of a square as shown in the figure.



Two currents go into the page, and two are pointing out of the page. Point **a** is at the center of the square, and points **b** and **c** are in the middle of two of the sides.

4 pt What is the direction of the magnetic field at point **a**?

1. **A**◯ Down (to the bottom of the page).
B◯ Up (to the top of the page).
C◯ To the left.
D◯ To the right.
E◯ The magnetic field is zero at this point.

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4 pt What is the direction of the magnetic field at point **b**?

2. **A**◯ To the right.
B◯ Down (to the bottom of the page).
C◯ The magnetic field is zero at this point.
D◯ Up (to the top of the page).
E◯ To the left.

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4 pt What is the direction of the magnetic field at point **c**?

3. **A**◯ Down (to the bottom of the page).
B◯ The magnetic field is zero at this point.
C◯ To the left.
D◯ To the right.
E◯ Up (to the top of the page).

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9 pt A capacitor consisting of two parallel plates, separated by a distance d is initially charged to a voltage of 8.3 V. The battery is then disconnected from the capacitor. For each statement below, select True or False.

▷ If the battery is disconnected, and then the distance d between the plates is increased, the amount of charge stored on either plate of the capacitor will change.
4. **A**◯ True **B**◯ False

▷ If the battery is disconnected, and then the distance d between the plates is increased, the voltage across the capacitor will decrease.
5. **A**◯ True **B**◯ False

▷ Increasing the distance d after disconnecting the battery will decrease the electrical energy stored in the capacitor.
6. **A**◯ True **B**◯ False

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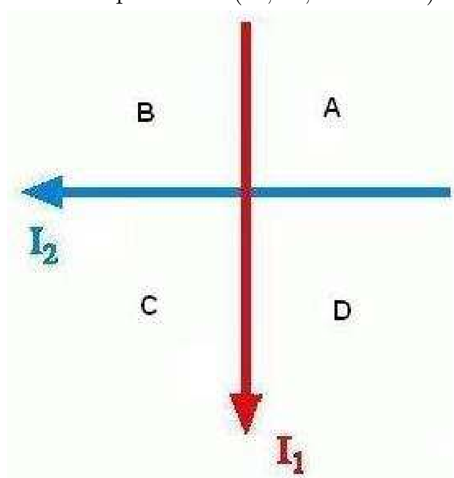
9 pt Two current carrying wires are in the X-Y plane as shown in the diagram below. One wire carries a current I_1 and is located on the y-axis. The other wire carries a current I_2 and is located on the x-axis. The questions below refer to the four quadrants (**A**, **B**, **C** and **D**) in the X-Y plane.

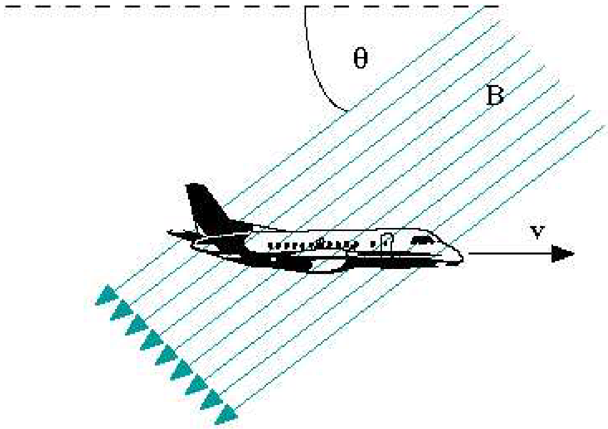


Select True or False for each of the following statements.

▷ The magnetic field is non-zero everywhere in quadrant **A**.
7. **A**◯ True **B**◯ False

▷ A charge moving in the X-Y plane in quadrant **B** will not accelerate.
8. **A**◯ True **B**◯ False

▷ The magnetic field is into the page everywhere in quadrant **B**.
9. **A**◯ True **B**◯ False



9 pt
An airplane with a wingspan of 39 m is flying due north at 425 km/h. The Earth's field is $1.2 \cdot 10^{-4}$ T and inclined at an angle of 38^o below horizontal. What is the magnitude of the potential difference, in volts between the ends of the wing?

10.A◯ 0.2357 **B**◯ 0.2664 **C**◯ 0.3010
D◯ 0.3402 **E**◯ 0.3844 **F**◯ 0.4343
G◯ 0.4908 **H**◯ 0.5546

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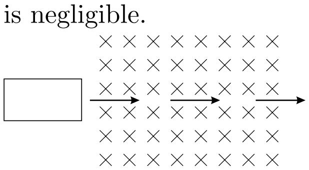
9 pt A square loop of wire with a small resistance is moved with constant speed from a field free region into a region of uniform B field (B is constant in time) and then back into a field free region to the right. The self inductance of the loop is negligible.



▷ While the loop is entirely in the field, the emf in the loop is zero.
11. **A**◯ True **B**◯ False

▷ When leaving the field the coil experiences a magnetic force to the right.
12. **A**◯ True **B**◯ False

▷ Upon entering the field, a clockwise current flows in the loop.
13. **A**◯ True **B**◯ False

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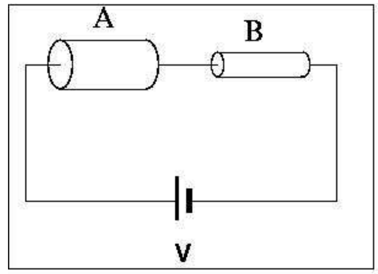
9 pt The diagram below shows a battery of voltage **V** connected to two cylindrical wires. Both wires are made out of the same material and are of the same length, however the diameter of wire **A** is twice the diameter of wire **B**



Select True or False for each of the following statements.

▷ The resistance of wire **A** is half the resistance of wire **B**.
14. **A**◯ True **B**◯ False

▷ The power dissipated in wire **B** is four times the power dissipated in wire **A**.
15. **A**◯ True **B**◯ False

▷ If the resistivity of wire **B** decreases AND the resistivity of wire **A** remains unchanged, then the voltage across wire **A** will decrease.
16. **A**◯ True **B**◯ False

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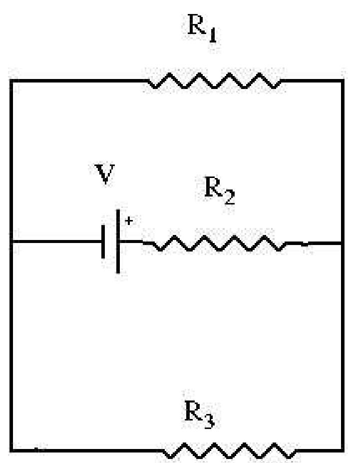
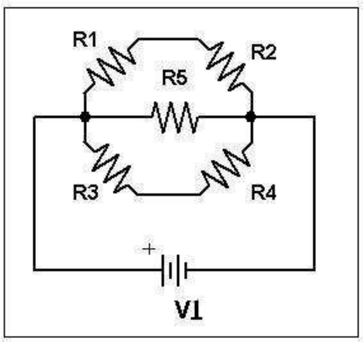
9 pt In the circuit below find the current flowing through resistor R_2 (in A) when $R_1 = 46\ \Omega$, $R_2 = 74\ \Omega$, $R_3 = 156\ \Omega$ and $V_1 = 156$ V.



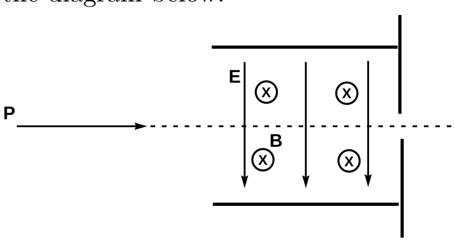
17.A◯ 0.987 **B**◯ 1.115 **C**◯ 1.260 **D**◯ 1.424
E◯ 1.609 **F**◯ 1.819 **G**◯ 2.055 **H**◯ 2.322

[*9 pt*] In the circuit below R1 = 87 Ω, R2 = 72 Ω, R3 = 123 Ω, R4 = 17 Ω, R5 = 256 Ω and V1 = 59 V. What is the power dissipated (in W) in the R1 resistor?



18.A◯ 2.51 **B**◯ 3.14 **C**◯ 3.93 **D**◯ 4.91
E◯ 6.13 **F**◯ 7.67 **G**◯ 9.58 **H**◯ 11.98

[*9 pt*] A proton is accelerated from rest through a potential of 14.0 kV. The proton then enters a velocity filter, consisting of a parallel-plate capacitor and a magnetic field as shown in the diagram below.

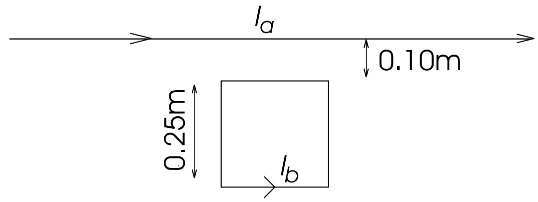


The electric field between the parallel capacitor plates is $2.7{\cdot}10^{5}$ N/C and the mass of the proton is $1.67{\cdot}10^{-27}$ kg. What magnetic field is required so that the proton is not deflected? (Ignore relativistic effects for high velocities.)

(in `T`*)*

19.A◯ 3.73×10^{-2} **B**◯ 5.41×10^{-2} **C**◯ 7.84×10^{-2}
D◯ 1.14×10^{-1} **E**◯ 1.65×10^{-1} **F**◯ 2.39×10^{-1}
G◯ 3.47×10^{-1} **H**◯ 5.03×10^{-1}

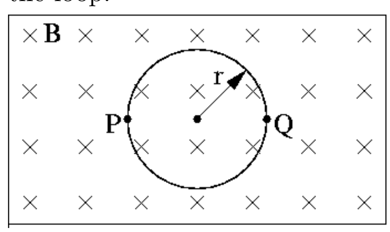
[*8 pt*] In the figure below, a long straight wire carries a current of I_a= 5.00 A. A square loop with a side of length 0.250m is placed a distance 0.100 m away from the wire. The square loop carries a current I_b=2.20 A.



Find the magnitude of the net force on the square loop.
(in `N`*)*

20.A◯ 8.24×10^{-7} **B**◯ 1.03×10^{-6} **C**◯ 1.29×10^{-6}
D◯ 1.61×10^{-6} **E**◯ 2.01×10^{-6} **F**◯ 2.51×10^{-6}
G◯ 3.14×10^{-6} **H**◯ 3.93×10^{-6}

[*8 pt*] A flexible loop has a radius of 0.449 m and it is inside a constant magnetic field of 0.587 T. The resistance of the loop is 2.06 Ω. The loop is grasped at points P and Q and stretched until its area is zero. It takes 0.181 seconds to close the loop.



What is the average induced current (in amps) in the loop during the stretching process?

21.A◯ 0.16 **B**◯ 0.23 **C**◯ 0.33 **D**◯ 0.47
E◯ 0.69 **F**◯ 1.00 **G**◯ 1.45 **H**◯ 2.10