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:

- $k_e = 8.99 \times 10^9 \text{Nm}^2/\text{C}^2$
- $\epsilon_0 = 8.85 \times 10^{-12} \text{As/(Vm)}$
- $\mu_0 = 4\pi \times 10^{-7} \text{Vs/(Am)}$
- $c = 3.00 \times 10^8 \text{m/s}$
- $e = 1.60 \times 10^{-19} \text{C}$
- $m_e = 9.11 \times 10^{-31} \text{kg}$
- $m_ec^2 = 0.511 \text{MeV}$
- $h = 6.63 \times 10^{-34} \text{Js}$
- $h = 4.14 \times 10^{-15} \text{eVs}$
- $hc = 1240 \text{eVnm}$
- $\sigma = 5.67 \times 10^{-8} \text{W/(m}^2\text{K}^4)$
- Wien’s constant = $2.898 \times 10^{-3} \text{Km}$
- $R_H = 1.097 \times 10^7 \text{1/m}$
- $E_0 = 13.6 \text{eV}$
- $a_0 = 0.529 \text{Angstrom}$
- $1 \text{eV} = 1.60 \times 10^{-19} \text{J}$
- $1 \text{AMU (1 u)} = 931.494 \text{MeV/c}^2 = 1.67 \times 10^{-27} \text{kg}$
- $\times$ 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 $\bigcirc$ Down (to the bottom of the page).
   B $\bigcirc$ Up (to the top of the page).
   C $\bigcirc$ To the left.
   D $\bigcirc$ To the right.
   E $\bigcirc$ The magnetic field is zero at this point.

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

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

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

3. A $\bigcirc$ Down (to the bottom of the page).
   B $\bigcirc$ The magnetic field is zero at this point.
   C $\bigcirc$ To the left.
   D $\bigcirc$ To the right.
   E $\bigcirc$ Up (to the top of the page).
An airplane with a wingspan of 39 m is flying due north at 425 km/h. The Earth’s field is $1.2 \times 10^{-4}$ T and inclined at an angle of 38° below horizontal. What is the magnitude of the potential difference, in volts between the ends of the wing?

\[ A \circ 0.2357 \quad B \circ 0.2664 \quad C \circ 0.3010 \quad D \circ 0.3402 \quad E \circ 0.3844 \quad F \circ 0.4343 \quad G \circ 0.4908 \quad H \circ 0.5546 \]

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.

\[ 10. A \circ 0.2357 \quad B \circ 0.2664 \quad C \circ 0.3010 \quad D \circ 0.3402 \quad E \circ 0.3844 \quad F \circ 0.4343 \quad G \circ 0.4908 \quad H \circ 0.5546 \]

Select True or False for each of the following statements.

\[ 17. A \circ 0.987 \quad B \circ 1.115 \quad C \circ 1.260 \quad D \circ 1.424 \quad E \circ 1.609 \quad F \circ 1.819 \quad G \circ 2.055 \quad H \circ 2.322 \]
In the circuit below $R_1 = 87 \ \Omega$, $R_2 = 72 \ \Omega$, $R_3 = 123 \ \Omega$, $R_4 = 17 \ \Omega$, $R_5 = 256 \ \Omega$ and $V_1 = 59 \ \text{V}$. What is the power dissipated (in W) in the $R_1$ resistor?

\[18. \ \text{A} \circ \ 2.51 \quad \text{B} \circ \ 3.14 \quad \text{C} \circ \ 3.93 \quad \text{D} \circ \ 4.91 \]
\[\text{E} \circ \ 6.13 \quad \text{F} \circ \ 7.67 \quad \text{G} \circ \ 9.58 \quad \text{H} \circ \ 11.98\]

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

\[19. \ \text{A} \circ \ 3.73 \times 10^{-2} \quad \text{B} \circ \ 5.41 \times 10^{-2} \quad \text{C} \circ \ 7.84 \times 10^{-2} \]
\[\text{D} \circ \ 1.14 \times 10^{-1} \quad \text{E} \circ \ 1.65 \times 10^{-1} \quad \text{F} \circ \ 2.39 \times 10^{-1} \]
\[\text{G} \circ \ 3.47 \times 10^{-1} \quad \text{H} \circ \ 5.03 \times 10^{-1}\]

In the figure below, a long straight wire carries a current of $I_a = 5.00 \ \text{A}$. 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 $I_b = 2.20 \ \text{A}$.

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

\[20. \ \text{A} \circ \ 8.24 \times 10^{-7} \quad \text{B} \circ \ 1.03 \times 10^{-6} \quad \text{C} \circ \ 1.29 \times 10^{-6} \]
\[\text{D} \circ \ 1.61 \times 10^{-6} \quad \text{E} \circ \ 2.01 \times 10^{-6} \quad \text{F} \circ \ 2.51 \times 10^{-6} \]
\[\text{G} \circ \ 3.14 \times 10^{-6} \quad \text{H} \circ \ 3.93 \times 10^{-6}\]

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 $\Omega$. 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?

\[21. \ \text{A} \circ \ 0.16 \quad \text{B} \circ \ 0.23 \quad \text{C} \circ \ 0.33 \quad \text{D} \circ \ 0.47 \]
\[\text{E} \circ \ 0.69 \quad \text{F} \circ \ 1.00 \quad \text{G} \circ \ 1.45 \quad \text{H} \circ \ 2.10\]