Pope,

Bernard G.

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

Fill out the bubble sheet: last name, first initial, student number, section number. Leave the code area empty.

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50 minute long closed book exam.

One 8.5 by 11 handwritten help sheet is allowed.

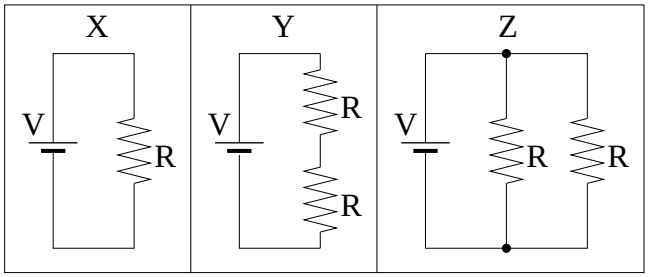
When done, hand in your **bubble sheet** and your **exam**.

Thank you and good luck!

Posssibly useful constants:

- $k_e = 8.99 \times 10^9$ Nm^2/C^2
- $\epsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2
- $\mu_0 = 4\pi \times 10^{-7}$ Tm/A
- $c = 3.00 \times 10^8$ m/s
- $e = 1.60 \times 10^{-19}$ C
- number of seconds in a year $= 3.15 \times 10^7$
- 1 rpm $= 2\pi$ radians in 60 seconds

Consider the three electric circuits marked with **X**, **Y** and **Z** as shown in the figure. All the resistors and all the batteries are identical, and all the batteries are ideal.



5 pt Select the circuit with the smallest voltage drop across a single resistor.

1. **A**◯ circuits **X** and **Y**, tie for smallest
B◯ circuit **Y**
C◯ circuits **X** and **Z**, tie for smallest
D◯ circuits **Y** and **Z**, tie for smallest
E◯ circuits **X**, **Y** and **Z**, 3-way tie
F◯ circuit **X**
G◯ circuit **Z**

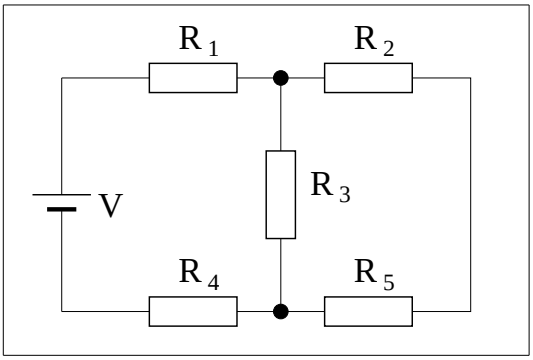
5 pt Select the circuit with the smallest current through a single resistor.

2. **A**◯ circuits **X** and **Y**, tie for smallest
B◯ circuit **Y**
C◯ circuit **X**
D◯ circuit **Z**
E◯ circuits **X** and **Z**, tie for smallest
F◯ circuits **Y** and **Z**, tie for smallest
G◯ circuits **X**, **Y** and **Z**, 3-way tie

5 pt Rank the total power dissipated by the **entire** circuit from lowest to highest. (Lowest first, highest last.)

3. **A**◯ **Y**, **Z**, **X**
B◯ **X**, **Y**, **Z**
C◯ **X**, **Z**, **Y**
D◯ **Z**, **Y**, **X**
E◯ **Z**, **X**, **Y**
F◯ **Y**, **X**, **Z**

Consider the electric circuit shown in the figure. Assume that V = 18.3 V, $R_1 = R_2 = R_3 = R_4 = R_5 = 3.00\ \Omega$. (The rectangular boxes in the diagram are the resistors.)



5 pt What is the equivalent resistance of the circuit?
(in `ohm`*)*

4.**A**◯ 6.84 **B**◯ 8.00 **C**◯ 9.36
D◯ 1.10×10^1 **E**◯ 1.28×10^1 **F**◯ 1.50×10^1
G◯ 1.75×10^1 **H**◯ 2.05×10^1

5 pt What is the electric current flowing through resistor R_4?
(in `A`*)*

5.**A**◯ 4.80×10^{-1} **B**◯ 6.00×10^{-1} **C**◯ 7.50×10^{-1}
D◯ 9.37×10^{-1} **E**◯ 1.17 **F**◯ 1.46
G◯ 1.83 **H**◯ 2.29

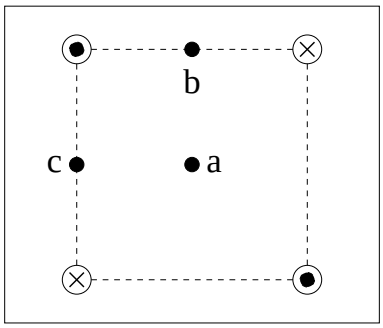
5 pt A point charge Q moving in a uniform magnetic field of 1.81 T experiences a force of 1.02×10^{-12} N. The velocity of the charge is perpendicular to the magnetic field. If the magnetic field points South and the force points out of the page, then choose the single correct answer. (In this problem we use the points of the compass for directions on the paper with North pointing to the top of the page, and 'into' and 'out of' to indicate directions with respect to the page.)

6. **A**◯ Q is negative, moving West.
B◯ Q is positive, moving North.
C◯ Q is positive, moving West.
D◯ Q is positive, moving East.
E◯ Q is negative, moving North.
F◯ Q is negative, moving South.

5 pt The speed of the point charge is 3.53×10^6 m/s. Calculate the magnitude of the charge.
(in `C`*)*

7.**A**◯ 1.72×10^{-20} **B**◯ 2.50×10^{-20}
C◯ 3.62×10^{-20} **D**◯ 5.25×10^{-20}
E◯ 7.61×10^{-20} **F**◯ 1.10×10^{-19}
G◯ 1.60×10^{-19} **H**◯ 2.32×10^{-19}

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.

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

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

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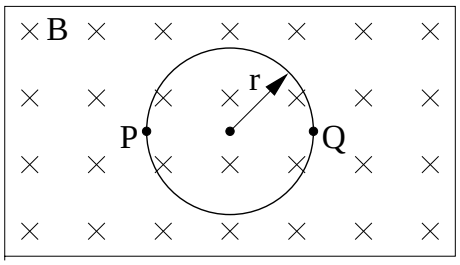
5 pt What is the direction of the magnetic field at point **b**?

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

A flexible loop has a radius of r = 21.7 cm and it is inside a uniform magnetic field of B = 0.339 T. The loop is grasped at points P and Q and stretched until its area is zero. It takes 121 ms to close the loop.



5 pt What is the magnitude of the average induced electromotive force in the loop during the stretching process?
(in `V`*)*

10.**A**◯ 1.99×10^{-1} **B**◯ 2.25×10^{-1} **C**◯ 2.54×10^{-1}
D◯ 2.87×10^{-1} **E**◯ 3.25×10^{-1} **F**◯ 3.67×10^{-1}
G◯ 4.14×10^{-1} **H**◯ 4.68×10^{-1}

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5 pt Complete the following sentence:
During the stretching process described above ...

11. **A**◯ ... current flows in different directions at different stages of the process.
B◯ ... current flows counter clockwise.
C◯ ... no current flows.
D◯ ... current flows clockwise.

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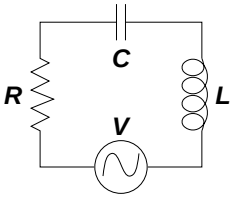
12 pt Consider the RLC circuit shown in the figure.



Select 'True', 'False' or 'Cannot tell' for the following statements.

▷ The current through the inductor is the same as the current through the resistor at all times.
12. **A**◯ True **B**◯ False **C**◯ Cannot tell

▷ The voltage drop across the resistor is the same as the voltage drop across the inductor at all times.
13. **A**◯ True **B**◯ False **C**◯ Cannot tell

▷ Energy is dissipated in the resistor but not in either the capacitor or the inductor.
14. **A**◯ True **B**◯ False **C**◯ Cannot tell

▷ The current through the inductor always equals the current charging/discharging the capacitor.
15. **A**◯ True **B**◯ False **C**◯ Cannot tell

5 pt

What is the value of the inductance L so that the above circuit carries the largest current?
Data: R = 2.91×10^2 Ω, f = 1.93×10^3 Hz, C = 6.10×10^{-3} F, $V_{rms} = 7.74 \times 10^1$ V.
(in `H`*)*

16.**A**◯ 4.74×10^{-7} **B**◯ 6.30×10^{-7} **C**◯ 8.38×10^{-7}
D◯ 1.11×10^{-6} **E**◯ 1.48×10^{-6} **F**◯ 1.97×10^{-6}
G◯ 2.62×10^{-6} **H**◯ 3.49×10^{-6}

4 pt

Using the inductance found in the previous problem, what is the impedance seen by the voltage source?
(in `ohm`*)*

17.**A**◯ 1.24×10^2 **B**◯ 1.65×10^2 **C**◯ 2.19×10^2
D◯ 2.91×10^2 **E**◯ 3.87×10^2 **F**◯ 5.15×10^2
G◯ 6.85×10^2 **H**◯ 9.11×10^2

6 pt Light from a bright star in the night sky takes 6.09 years to reach Earth. How far away is this star?
(in `km`*)*

18. **A**◯ 3.26×10^{13} **B**◯ 4.33×10^{13}
C◯ 5.76×10^{13} **D**◯ 7.66×10^{13}
E◯ 1.02×10^{14} **F**◯ 1.36×10^{14}
G◯ 1.80×10^{14} **H**◯ 2.40×10^{14}

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12 pt Light of wavelength 555 nm travels through vacuum and then is incident on a glass block.

▷ The FREQUENCY of the light in the glass is (GLE) than the FREQUENCY of the light in the vacuum.
19. **A**◯ Greater than **B**◯ Less than
C◯ Equal to

▷ The VELOCITY of the light in the glass is (GLE) than the VELOCITY of the light in vacuum.
20. **A**◯ Greater than **B**◯ Less than
C◯ Equal to

▷ The WAVELENGTH of the light in the glass is (GLE) than the WAVELENGTH of the light in the vaccum.
21. **A**◯ Greater than **B**◯ Less than
C◯ Equal to

You are correct. Your receipt is 158-838

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6 pt The refractive index of a transparent material can be determined by measuring the critical angle when the solid is in air. If $\theta_c = 39.7^o$, what is the index of refraction of the material?

22. **A**◯ 8.85×10^{-1} **B**◯ 1.18 **C**◯ 1.57
D◯ 2.08 **E**◯ 2.77 **F**◯ 3.68
G◯ 4.90 **H**◯ 6.52

You are correct. Your receipt is 158-883