

Physics 220 – Section 1
Fall 2007
Sample Midterm #1

CID: _____

Instructions

1. Be sure to write your CID on this paper.
2. Do not write your name on this test or we will not return it to you.
3. Enter your answer on the bubble sheet **and** in the box on the exam paper.
4. There are no time limits.
5. You may not use equations stored in your calculator.
6. Consider the number $A = 4.56 \times 10^{-7}$. The “exponent” of A is -7 and the first significant digit of A is 4. Do **not** round the first significant digit to 5!

Possibly Useful Information:

$$e = 1.602 \times 10^{-19} \text{ C}$$

$$k_e = 8.99 \times 10^9 \text{ SI units}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ SI units}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ SI units}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$G=10^9, M=10^6, k=10^3, m=10^{-3}, \mu=10^{-6}, n=10^{-9}, p=10^{-12}$$

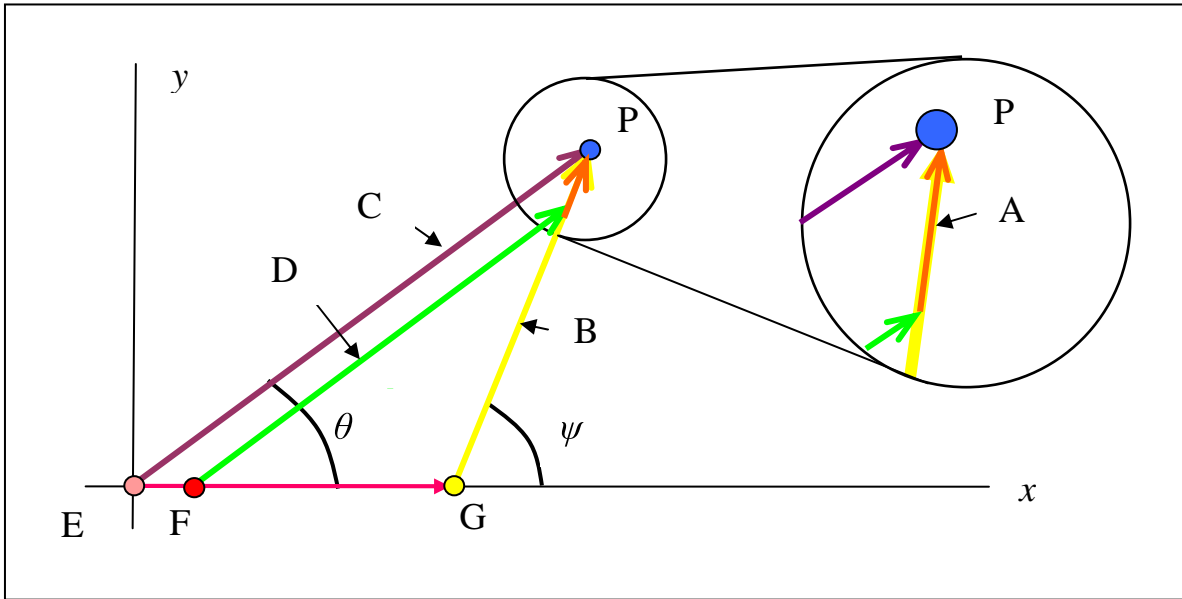
Problems 1-10 are worth 5 points each

1. When you scuff your rubber shoes on a woolen carpet, the soles of your shoes pick up excess electrons from the carpet. Your soles are insulators. The charge on the end of your finger is:
- A. positive
 - B. negative
 - C. zero
 - D. zero unless your finger is near a conductor like a doorknob.
 - E. none of the above.

2. Kirchoff's Laws include which of the following:
- A. Voltage coming into a junction must leave a junction.
 - B. The kinetic energy of electrons around a loop is conserved.
 - C. The net change in voltage around any circuit loop is zero.
 - D. Resistance in parallel adds as reciprocals.
 - E. None of the above.

3. When a source charge is moving at half the speed of light, the threads that it emits are
- A. longer in front of the particle (in front means ahead of the particle in the direction it is traveling).
 - B. longer behind the particle.
 - C. the same in front and behind the particle.
 - D. longer in the plane perpendicular to the direction of motion.
 - E. Moving charges only emit stubs.
4. According to special relativity:
- A. Moving objects compress in all directions.
 - B. Moving charges have constant momentum when acted on by conservative forces.
 - C. Moving clocks tick faster than stationary clocks.
 - D. Moving objects may go arbitrarily fast.
 - E. Moving objects can have arbitrarily large momentum.
5. The electric field contour of a point charge is a set of
- A. Lines coming radially outward from the charge.
 - B. Spheres surrounding the charge.
 - C. Loops going around the charge.
 - D. Planes perpendicular to the equipotential surfaces.
 - E. None of the above.
6. A moving point charge produces an electric field E_P at a point P in space. The largest possible magnetic field it could produce at P is:
- A. Ec^2
 - B. Ec
 - C. E
 - D. E/c
 - E. 0
7. Two resistors in parallel must have the same
- A. voltage across them
 - B. resistance
 - C. current
 - D. power
 - E. none of the above.
8. Current in a horizontal wire flows to the east. At a point directly below the wire, the magnetic field points
- A. upward
 - B. downward
 - C. south
 - D. north
 - E. None of the above.

For Problems 9-10, select the letter from the figure that matches the item described in the problem.

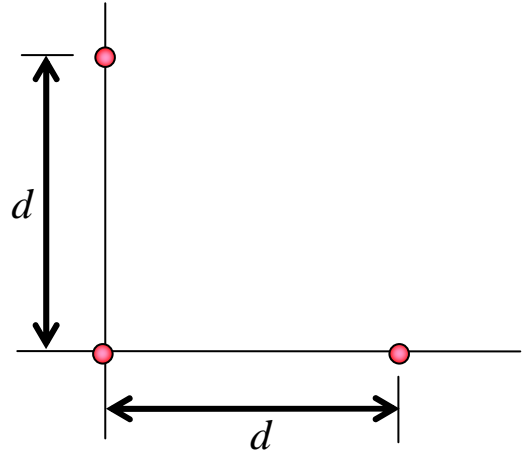


9. The head line.

10. The position of the source particle at the time the thread reaches point P .

Problems 11-26 are worth 5 points each

11-12. Three charges, each of charge $q = 3.00 \mu\text{C}$, are placed as shown in the figure. The distance from the charge at the origin to each of the other two charges is $d = 2.00 \text{ cm}$.



11. Find the magnitude of the force between two charges located at adjacent corners of the square (two charges separated by d). We'll call this answer F_1 . (Be sure to read Instruction 6 above!) Enter the first significant digit of F_1 in the box and on your answer sheet.

12. Find F_2 , the total force on the charge located at the origin. If we say $F_2 = aF_1$, then a equals:

- A. 2
- B. $\sqrt{2}$
- C. 1
- D. $1/\sqrt{2}$
- E. $1/2$

13-14. An electric potential in a region of space is given by the expression $V(y) = 3(V/m^2)y^2$. What is the electric field at $y=3.00 \text{ m}$?

13. Enter the first significant digit of the magnitude of the electric field. Give both magnitude and direction.

14. The electric field is in which direction?

- A. $+\hat{x}$
- B. $-\hat{x}$
- C. $+\hat{y}$
- D. $-\hat{y}$
- E. $+\hat{z}$
- F. $-\hat{z}$

15-16. Derive the expression for the cyclotron frequency.

15. Which expression best illustrates the starting point for your derivation?

- A. Magnetic force = Electric force
- B. Electric field = Change in electric potential / change in position
- C. Centripetal force = Magnetic force
- D. Electric force = Charge times electric field
- E. Magnetic force = Charge times velocity times magnetic field
- F. Angular frequency = Velocity times radius
- G. Frequency = Angular frequency divided by two pi

16. Electrons move in circular paths in a 0.200 T magnetic field. What is the frequency of their circular motion? Enter the value closest to the actual answer.

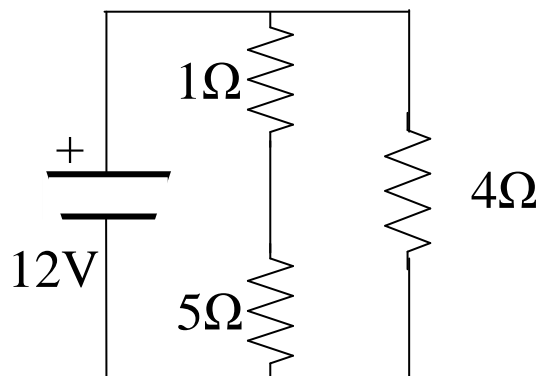
- A. 1×10^6 Hz
- B. 5×10^6 Hz
- C. 1×10^7 Hz
- D. 5×10^7 Hz
- E. 1×10^8 Hz
- F. 5×10^8 Hz
- G. 1×10^9 Hz
- H. 5×10^9 Hz

17-18. Solve for the current through the battery in the circuit below.

17. What is the equivalent resistance of the three resistors in the circuit? Enter the first significant digit of your answer.

18. What is the power provided by the battery? Enter the closest value to the correct answer.

- A. 10 W B. 20 W C. 30 W D. 40 W E. 50 W F. 60 W G. 70 W H. 80 W



19-20. Consider Kirchoff's loop and junction equations for the circuit of Problem 18.

19. How many loop equations and how many node equations do you have?

- A. 3 loop equations and 3 node equations
- B. 3 loop equations and 2 node equations
- C. 3 loop equations and 1 node equations
- D. 2 loop equations and 3 node equations
- E. 2 loop equations and 2 node equations
- F. 2 loop equations and 1 node equations
- G. 1 loop equations and 3 node equations
- H. 1 loop equations and 2 node equations
- I. 1 loop equations and 1 node equations

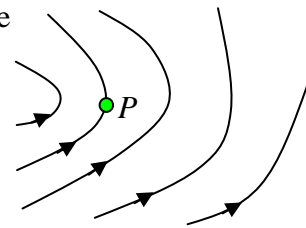
20. Many possibilities exist for the choice of currents, loop equations, and node equations. Which of the following could not be a valid equation?

- A. $I_1 = I_2 - I_3$
- B. $I_1 = I_2 + I_3$
- C. $I_1 + I_2 = I_3$
- D. $I_1 = I_3$
- E. All of the above are valid.
- F. None of the above are valid.

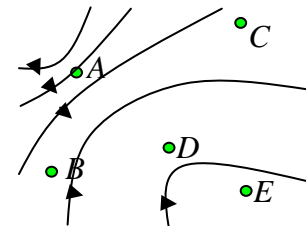
21-22. Any representation of a vector field such as the electric or magnetic field must give us information about the magnitude and direction of the field at any point in space.

21. Electric field lines are depicted in the illustration to the right. At point P , the electric field points:

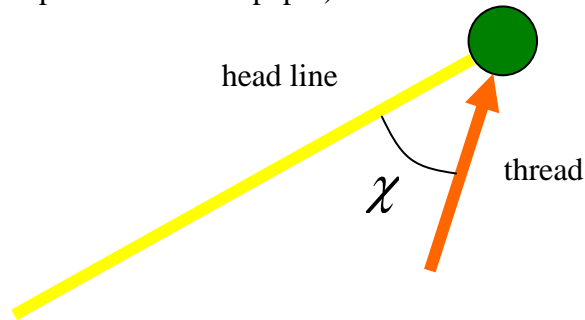
- A. to the left
- B. to the right
- C. to the top of the page
- D. to the bottom of the page
- E. out of the page toward you
- F. into the page away from you



22. A set of field contours is shown in the figure to the right. At what point is the field the strongest?



23-24. In the following diagram, a section of head line and the head of a thread are depicted. Both of these lie in the plane of the page. A field particle moves in the upward direction (toward the top of the sheet of paper).



23. If the length of the thread is ℓ , the length of the stub is

- A. 2ℓ
- B. ℓ
- C. $\ell / 2$
- D. $\ell \sin \chi$
- E. $\ell \cos \chi$
- F. $\ell \chi$
- G. indeterminate until the velocity of the field particle is specified.

24. The direction of the stub is

- A. in the direction of the head line
- B. in the direction of the thread
- C. to the left
- D. to the right
- E. toward the top of the page
- F. toward the bottom of the page
- G. into the page
- H. out of the page

25-26. A cylindrical piece of copper has a length of 2.00 cm and a radius of 3.00 mm. The resistivity of copper is $1.68 \times 10^{-8} \Omega\text{m}$ at a temperature of 20 °C. Find the resistance of the copper cylinder at 20 °C. Put your answer in scientific notation and in units of Ohms.

25. What is the exponent of the resistance?

- A. -6
- B. -5
- C. -4
- D. -3
- E. -2
- F. -1
- G. 0
- H. +1
- I. +2
- J. +3

26. What is the resistance of the wire at 100 °C? The temperature coefficient of resistivity for copper is $0.0038 (\text{°C})^{-1}$. Recall that the equation for the temperature dependence of resistance is $R = R_0[1 + \alpha(T - T_0)]$. Enter the first significant digit of your answer.

Selected Answers:

1-B, 2-C, 3-B, 4-E, 5-B, 6-D, 7-A, 8-D, 9-C, 10-G

11-12.

$$F_1 = \frac{q^2}{4\pi\epsilon_0 d^2} = 202$$

$$F_2 = \sqrt{2}F_1$$

$$13-14. \quad E = -\frac{dV}{dy} = -3\frac{V}{m^2}2y, \quad \vec{E}(3m) = -18\frac{V}{m}\hat{y}$$

15-16.

$$\frac{mv^2}{r} = qvB$$

$$\frac{mv}{r} = m\omega = qB$$

$$f = \frac{\omega}{2\pi} = \frac{qB}{2\pi m} = 5.60 \text{ GHz}$$

17-18. The total resistance is 2.4Ω , the current is 5A , the power is 60W .

19-20. 1 node equation and 2 loop equations. The node equation must involve three currents. The signs and names can be chosen arbitrarily, however. The correct answer is D.

21-22. C,A

23-24. The equation for the stub is $\vec{s} = \hat{r}_h \times \vec{\ell}$. When we put the tails of the two vectors together, the angle between the vectors is still χ , so the magnitude, s , is $\ell \sin \chi$. The direction of the stub is out of the page by the right-hand-rule.

25-26.

$$R_0 = \rho \frac{\ell}{A} = 1.19 \times 10^{-5} \Omega$$

$$R = R_0[1 + 80\alpha] = 1.55 \times 10^{-5} \Omega$$