

Physics 220 – Section 1
Sample Final

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!
7. Be sure your test has 51 questions.

Possibly Useful Information:

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

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

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

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

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

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

Part I. Unit 3.

1. A material that has dipole moments that align opposite an external magnetic field is:

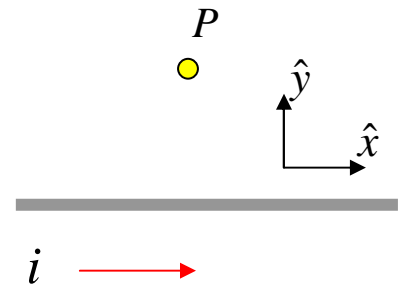
- A. Paramagnetic
- B. Diamagnetic
- C. Ferromagnetic
- D. Cupromagnetic
- E. Either paramagnetic or ferromagnetic

2. A charge $+q$ and charge $-q$ are separated by a rod of length d . The electric dipole moment, \vec{p} , is given by

- A. qd pointing from $+$ to $-$.
- B. qd pointing from $-$ to $+$.
- C. q/d pointing from $+$ to $-$.
- D. q/d pointing from $-$ to $+$.

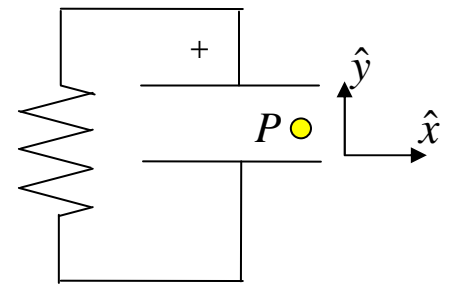
3. A point P is located above a wire as shown. The current goes to the right and is decreasing in time. In what direction is the electric acceleration field?

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



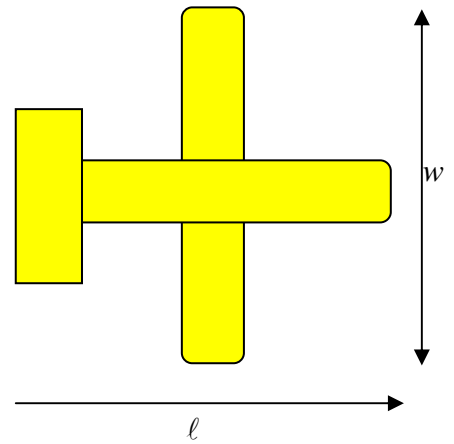
4. A capacitor is charged and then discharged through a resistor R . While the capacitor is discharging, what direction is the magnetic field at point P , located between the capacitor plates? ($+\hat{z}$ is out of the page.)

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



5. An airplane has a length ℓ and a wingspan w . It flies through a magnetic field going directly into the page. What is the voltage difference between the wingtips?

- A. vBw
- B. $vB\ell$
- C. qvB
- D. qBw



6. A split commutator is used in

- A. An AC motor
- B. A DC motor
- C. an impedance motor
- D. all motors

7. A battery, an inductor, a resistor, and a switch are all connected in series. At time $t = 0$, the switch is closed. The current as a function of time is:

- A. $i(t) = \frac{V}{R} \exp\left(-\frac{Lt}{R}\right)$
- B. $i(t) = \frac{V}{R} \exp\left(-\frac{Rt}{L}\right)$
- C. $i(t) = \frac{V}{R} \left[1 - \exp\left(-\frac{Lt}{R}\right)\right]$
- D. $i(t) = \frac{V}{R} \left[1 - \exp\left(-\frac{Rt}{L}\right)\right]$

8. If the current phasor for a capacitor is in the $+y$ direction, in what direction is the capacitor's voltage phasor?

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

9. In home wiring, a white wire is

- A. hot
- B. ground
- C. neutral
- D. chassis ground

10. A typical radio tuning circuit has

- A. resistance
- B. capacitance
- C. inductance
- D. all of the above

11.-12. Questions 11 and 12 deal with magnetic properties of matter.

11. What is a typical value for the susceptibility of a ferromagnetic material?

- A. -1.0×10^{-6}
- B. $+1.0 \times 10^{-5}$
- C. $-1.0 \times 10^{+5}$
- D. $+1.0 \times 10^{+4}$

12. If a diamagnetic material is brought near a strong magnetic field between the poles of an electromagnet, it is

- A. strongly attracted
- B. strongly repelled
- C. weakly attracted
- D. weakly repelled

13-14. Questions 13 and 14 deal with Maxwell's Equations.

13. Magnetic fields with curl can either be produced by

- A. Stationary electric charges or changing electric fields
- B. Stationary electric charges or changing magnetic fields
- C. Constant electric currents or changing electric fields
- D. Constant electric currents or changing magnetic fields

14. At a particular point in space, the magnetic field is given by the equation $\vec{B} = \alpha t^2 \hat{x}$ where α is a constant. We can conclude that:

- A. $\text{curl } \vec{B} = 0$
- B. $\text{curl } \vec{E} = 0$
- C. $\text{div } \vec{B} = 0$
- D. $\text{div } \vec{E} = 0$
- E. $\text{curl } \vec{B} = \mu_0 \epsilon_0 2\alpha t \hat{x}$
- F. $\text{curl } \vec{E} = -2\alpha t \hat{x}$
- G. $\text{div } \vec{B} = \mu_0 \epsilon_0 2\alpha t \hat{x}$
- H. $\text{div } \vec{E} = -2\alpha t \hat{x}$

15-16. Questions 15 and 16 deal with accelerating charges.

15. A proton moves near the speed of light around a circular orbit. At a distance of 3.00 m from the proton, which field is likely the largest (in SI units):

- A. electric velocity field
- B. magnetic velocity field
- C. electric acceleration field
- D. magnetic acceleration field

16. A source particle emits a thread at time $t = 0$. The acceleration of the source at this time is \vec{a} . The vector from the location of the source at $t = 0$ to a field point is \vec{R} . If the source is moving slowly, the direction of the electric field at the field point is in the direction of

- A. \vec{R}
- B. \vec{a}
- C. $\vec{R} \times \vec{a}$
- D. $\vec{R} \times (\vec{R} \times \vec{a})$
- E. $\vec{R} \times [\vec{R} \times (\vec{R} \times \vec{a})]$

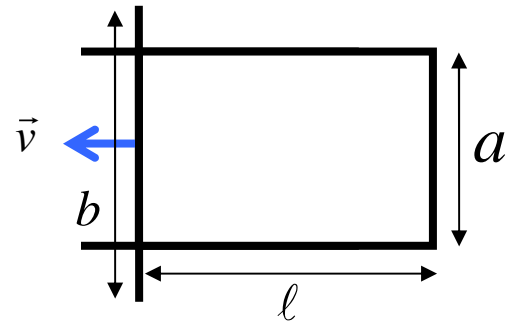
17-18. A U-shaped wire is placed in a uniform magnetic field that is coming out of the page. The longer wire segment on the left is moving to the left with a velocity v .

17. What is the EMF around the loop?

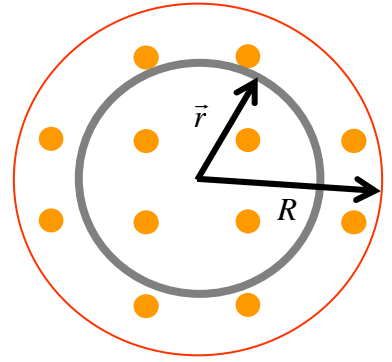
- A. $B\ell$
- B. Ba
- C. Bb
- D. $B\ell v$
- E. Bav
- F. Bbv

18. The induced current in the loop flows

- A. clockwise
- B. counterclockwise
- C. there is no induced current



19-20. An electromagnet has circular pole faces of radius R as shown in the illustration. The magnetic field is uniform in space, comes out of the page, and increases in time as $B(t) = \alpha t$ where α is a positive constant.



19. The direction of the electric field lines at a radius $r < R$ is
- A. counterclockwise
 - B. clockwise
 - C. there is no electric field because there is no wire for current to pass through

20. The magnitude of the electric field at r can be found from which of the following equations:

- A. $2\pi rE = \pi r^2\alpha$
- B. $2\pi RE = \pi R^2\alpha$
- C. $2\pi rE = \pi R^2\alpha$
- D. $2\pi RE = \pi r^2\alpha$

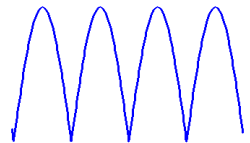
21-22. Questions 21 and 22 deal with motors and generators.

21. The output of a typical AC generator could be best represented by which of the following equations?

- A. $\mathcal{E}(t) = BA \cos(\omega t)$
- B. $\mathcal{E}(t) = BA \omega \cos(\omega t)$
- C. $\mathcal{E}(t) = \frac{BA}{\omega} \cos(\omega t)$
- D. $\mathcal{E}(t) = BA t$

22. The figure to the left could represent

- A. the output of a generator that uses split commutators.
- B. the electric field of an electromagnetic wave.
- C. the magnetic field of an electromagnetic wave.
- D. the energy stored in an electromagnetic wave.
- E. the polarization of light reflecting off a pond.



23-24. A circuit consists of an AC power supply, a capacitor, a resistor, and an inductor in series.

23. Which of the following is true?

A. $X_L = \omega L$ and $X_C = \omega C$

B. $X_L = \omega L$ and $X_C = \frac{1}{\omega C}$

C. $X_L = \frac{1}{\omega L}$ and $X_C = \omega C$

D. $X_L = \frac{1}{\omega L}$ and $X_C = \frac{1}{\omega C}$

24. The resonant frequency is

A. $f = \frac{1}{LC}$ B. $f = \frac{1}{2\pi LC}$

C. $f = \frac{1}{(LC)^2}$ D. $f = \frac{1}{2\pi(LC)^2}$

E. $f = \frac{1}{\sqrt{LC}}$ F. $f = \frac{1}{2\pi\sqrt{LC}}$

25-26. Questions 25 and 26 deal with applications of AC circuits.

25. A center-fed dipole is a type of

- A. current loop
- B. magnetic dipole
- C. circuit breaker
- D. GFCI
- E. antenna

26. Light is polarized in the x -direction. The light passes through a Polaroid filter with an axis of polarization that is 60° from the x -axis. If the intensity of the incident light is I_0 , what is the intensity of the light that passes through the filter?

A. $I = \frac{I_0}{4}$ B. $I = \frac{3I_0}{4}$ C. $I = \frac{\sqrt{3}I_0}{2}$ D. $I = \frac{I_0}{\sqrt{2}}$ E. $I = \frac{I_0}{2}$

Part II. Comprehensive

A.. Matching (2 points each)

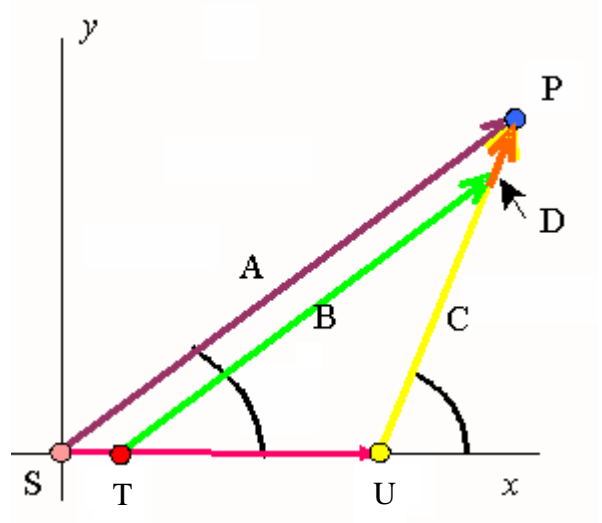
Choose the *best* answer. You may use the same letter more than once. Only mark one letter on the answer key. **Note that some letters appear more than once because the key only goes through J.**

27. conductor	A. line integral per unit area
28. speed of threads	B. electrons flow without any energy loss
29. force between two charges	C. ELI
30. magnetic field	D. the amplitude of a wave is modulated
31. distance between field lines	E. falls of as $1/r^2$
32. the shape of magnetic field lines	F. always equal to or greater than 1
33. Amperian loops	G. zero
34. radiation	H. surfaces unclosing a volume
35. dielectric constant	I. allows digital data to be transferred at a higher rate
36. curl	J. ICE
37. electric field inside a hollow, spherically symmetric charge distribution	A. proportional to field strength
38. high frequency	B. causes a force when a field particle is moving
39. AM	C. c
40. wavenumber	D. closed loops
41. voltage precedes current in inductors	E. fields produced by accelerating charges
	F. the number of radians per meter in a wave

B. Multiple Choice (4 points each)

42. A source travels with uniform speed along the x axis. At time $t = 0$ the source is located at the origin of the coordinate system. At this time a thread is emitted. The thread arrives at a field point, P , at time $t = t_p$. Where is the source at time t_p ?

- A. At point S .
- B. At point T
- C. At point U .
- D. At point P .

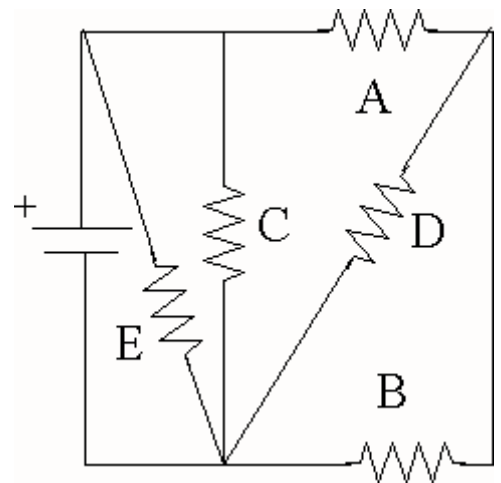


43. A magnetic field is pointing downward. A negatively charged particle is moving west through the field. In what direction is the force on the charge?

- A. north
- B. south
- C. east
- D. west
- E. up
- F. down

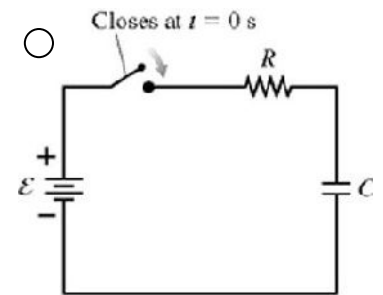
44. Resistors A and B in the picture are in

- A. Series
- B. Parallel
- C. Neither



45. What is the voltage across the capacitor a very long time after the switch in the illustration is closed?

- A. 2ε
- B. ε
- C. $\varepsilon/2$
- D. 0



46. In a laser beam, the electric field points to the east and the magnetic field points to the north at a fixed time. In what direction is the beam traveling?

- A. north
- B. south
- C. west
- D. east
- E. up
- F. down

47. An AFCI protects against

- A. short circuits
- B. excessive current
- C. fires caused by arcing
- D. brown-outs

48. The energy density of an electric field is:

- A. $\frac{1}{2}CV^2$
- B. $\frac{1}{2}LI^2$
- C. $\frac{1}{2}\varepsilon_0E^2$
- D. $\frac{1}{2\varepsilon_0}E^2$
- E. $\frac{1}{2}\mu_0B^2$
- F. $\frac{1}{2\mu_0}B^2$

49. As a thread moves away from an accelerating source, its length grows as what power of r ?

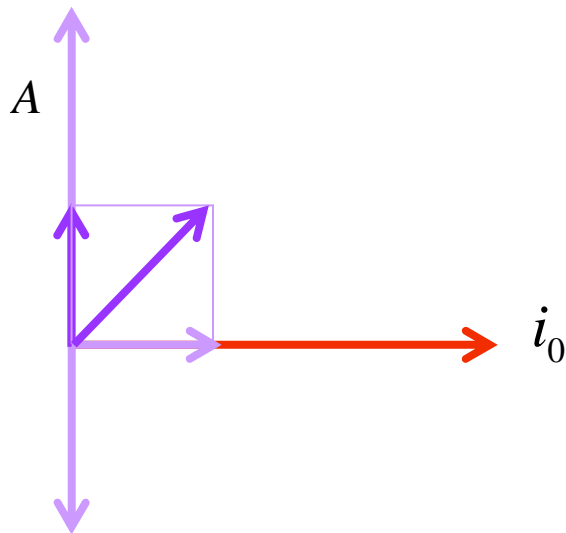
- A. r^{-2}
- B. r^{-1}
- C. r^0
- D. r^{+1}
- E. r^{+2}

50. Kirchoff's Laws state

- A. the current into a junction equals zero
- B. the current into a junction equals the current out of the junction
- C. the sum of the currents around a loop is zero
- D. the net voltage around a loop is zero
- E. A and C
- F. B and D
- G. A and B
- H. C and D
- I. A and D
- J. B and C

51. A phasor diagram for a series LRC circuit is shown. What is the vector labeled A?

- A. X_L
- B. R
- C. X_C
- D. \mathcal{E}
- E. Z



Part I. Answers

1.B 2.B 3.A 4.F 5.A 6.B 7.D 8.A 9.C 10.D
11.D 12.D 13.C 14.F 15.C 16.D 17.E 18.A
19. B 20.A 21.B 22.A 23.B 24.F 25.E 26.A

Part II. Answers:

27B 28C 29E 30B 31A 32D 33D 34E 35F 36A 37G 38I 39D 40F 41C
42C 43A 44C 45B 46E 47C 48C 49D 50F 51A