PHYS 273, Spring 2008

12 May **Final Exam** Total points: 40 (+10 extra credit)

Time: 1 hr. 45 min. *Two formula sheets allowed*

Last name: _____ First name:_____ z-id: _____

The (10) questions marked with a "*" carry 3 points each. For these, you must show either in the blank space at the end of the question paper, or in the space next to the question, how you arrived at the answer. The (10) questions without a special mark carry 1 point each. You don't need to show any work for those. Mark your answers on the scantron sheet AND the question paper for both of these types of questions. The (last 5) questions marked with a "**" carry 2 extra credit points each. You must show the work for these. DO NOT ANSWER QUESTIONS 21-25 ON THE SCANTRON SHEET. Turn both the scantron sheet and the question paper in at the end of the exam.

1. * Two identical charges, 2 m apart, exert forces of magnitude 1 N on each other. The value of either charge is about
   A) 1.8×10^{-9} C.
   B) 2.1×10^{-5} C.
   C) 4.2×10^{-5} C.
   D) 1.9×10^{5} C.
   E) 3.8×10^{5} C.

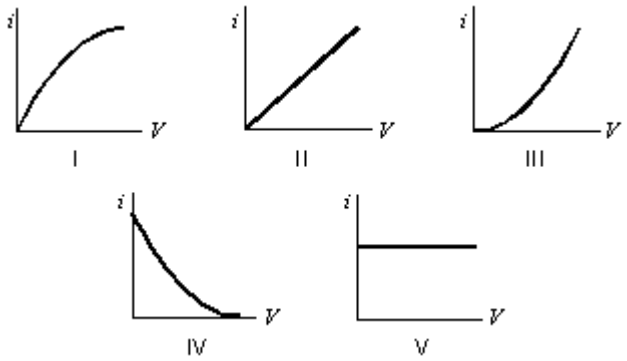
2. Experimenter A uses a test charge q_0 and experimenter B uses a test charge $5q_0$ to measure an electric field produced by stationary charges. A finds a field that is:
   A) the same as the field measured by B.
   B) greater than the field measured by B.
   C) less than the field measured by B.
   D) either greater or less than the field measured by B, depending on the masses of the test charges.
   E) either greater or less than the field measured by B, depending on the accelerations of the test charges.

3. Charge is distributed uniformly along a long straight wire. The electric field 4 cm from the wire is 20 N/C. The electric field 2 cm from the wire is:
   A) 120 N/C
   B) 80 N/C
   C) 40 N/C
   D) 10 N/C
   E) 5 N/C

4. * If the electric field is in the positive x direction and has a magnitude given by $E = -Cx$, where C is a constant, then the electric potential is given by $V =$
   A) Cx.
   B) $-2Cx$.
   C) $Cx^2/2$.
   D) $-Cx^2/2$.
   E) Cx^2.

5. Capacitors C_1 and C_2 are connected in parallel. The equivalent capacitance is given by:
   A) $C_1C_2/(C_1 + C_2)$
   B) $(C_1 + C_2)/C_1C_2$
   C) $1/(C_1 + C_2)$
   D) C_1/C_2
   E) $C_1 + C_2$

6. Which of the following graphs best represents the current-voltage relationship for a device that obeys Ohm's law?



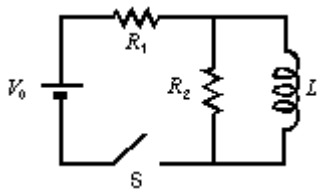
   A) I
   B) II
   C) III
   D) IV
   E) V

7. * A certain resistor dissipates 18 W when connected to a 12 V potential difference. When connected to a 4 V potential difference, this resistor will dissipate
   A) 6 W.
   B) 216 W.
   C) 162 W.
   D) 0.5 W.
   E) 2 W.

8. A magnetic field cannot
   A) exert a force on an electrically charged particle.
   B) change the kinetic energy of an electrically charged particle.
   C) change the momentum of an electrically charged particle.
   D) alter the trajectory of an electrically charged particle.
   E) do any of the above.

9. * Five 20-Ω resistors are connected in parallel and the combination is connected to a 20-V emf device. The current in the emf device is
   A) 0.25 A.
   B) 1.0 A.
   C) 4.0 A.
   D) 5.0 A.
   E) 100 A.

10. * The circuit is at a steady state with the switch S in the open position, as shown in the diagram below. Immediately after the switch is closed, the current through the battery will be



   A) 0.
   B) V_0/R_1.
   C) V_0/R_2.
   D) $V_0(R_1 + R_2)/(R_1R_2)$.
   E) $V_0/(R_1 + R_2)$.

11. In the formula $\vec{F} = q\vec{v} \times \vec{B}$:
   A) $\vec{F}$ must be perpendicular to $\vec{v}$ but not necessarily to $\vec{B}$.
   B) $\vec{F}$ must be perpendicular to $\vec{B}$ but not necessarily to $\vec{v}$.
   C) $\vec{v}$ must be perpendicular to $\vec{B}$ but not necessarily to $\vec{F}$.
   D) $\vec{F}$ must be perpendicular to both $\vec{v}$ and $\vec{B}$.
   E) all three vectors must be mutually perpendicular.

12. In Ampere's law, $\oint \vec{B} \cdot d\vec{s} = \mu_0 i$, the symbol $d\vec{s}$ is:
    A) an infinitesimal element of the closed path of integration.
    B) in the direction of $\vec{B}$.
    C) perpendicular to $\vec{B}$.
    D) an infinitesimal piece of the wire that carries current *i*.
    E) none of the above.

13. Two long ideal solenoids A and B, with radii 4 cm and 6 cm respectively, have the same number of turns of wire per unit length. The magnetic field inside solenoid A is the same as that inside B. The current in A must be
    A) twice that in B.
    B) one-third that in B.
    C) two-thirds that in B.
    D) 1.5 times that in B.
    E) the same as in B.

14. * A 3.2 mH inductor and a 4.8 mH inductor are connected in series and a time varying current is established in them. When the potential difference across the combination is 40 V, the potential difference across the 4.8 mH inductor is:
    A) 19.2 V.
    B) 20 V.
    C) 24 V.
    D) 0 V.
    E) 40 V.

15. * We have a 0.5 mH inductor. To make an *LC* circuit that oscillates at 5 kHz, we need a capacitor of approximately
    A) 200 F.
    B) 40 mF.
    C) 2 μF.
    D) 8 nF.
    E) 250 pF.

16. * A steady current of 5 A in a certain ideal inductor results in a stored energy of 2 J. What would the current have to be in order to increase the stored energy to 50 J?
    A) 150 A.
    B) 75 A.
    C) 20 A.
    D) 0.6 A.
    E) None of the above.

17. The electrical analog of a spring constant k is
    A) L.
    B) $1/L$.
    C) C.
    D) $1/C$.
    E) R.

18. According to Gauss' law for magnetism, magnetic field lines
    A) form closed loops.
    B) can only intersect each other at south and north poles.
    C) start at north poles and end at south poles.
    D) start at both north and south poles and extend out to infinity.
    E) do none of the above.

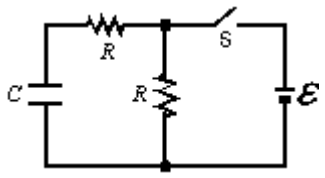
19. * The magnetic field magnitude of a plane electromagnetic wave in vacuum is given by $B_m \sin(kx - \omega t)$. Which one of the following is an allowed combination of k and ω?
    A) $k = 3.6 \times 10^{14}$ Tm^{-1}, $\omega = 1.2 \times 10^{6}$ rad/s.
    B) $k = 1.2 \times 10^{-6}$ rad/s, $\omega = 360$ m^{-1}.
    C) $k = 360$ m^{-1}, $\omega = 1.2 \times 10^{-6}$ rad/s.
    D) $k = 0.004$ m^{-1}, $\omega = 1.2 \times 10^{6}$ rad/s.
    E) None of the above

20. * If the amplitude of the electric field in a plane electromagnetic wave in vacuum is 60 mV/cm then the amplitude of the magnetic field is:
    A) 2×10^{-7} T
    B) 2×10^{-8} T
    C) 0.27 T
    D) 6.67×10^{-8} Tm^{-1}
    E) 3.33×10^{-8} Tm^{-1}

21. ** A charged oil drop with a mass of 4×10^{-4} kg is held suspended in Earth's gravitational field by a upward electric field of 300 N/C. The charge on the drop is approximately
    A) $+1.3 \times 10^{-5}$ C.
    B) -1.3×10^{-5} C.
    C) $+6.5 \times 10^{-6}$ C.
    D) -6.5×10^{-6} C.
    E) 0.

22. ** If 4 J of work is required to carry a 50-C charge from one point to another, the potential difference between these two points is:
    A) 1250 V.
    B) 12.5 V.
    C) 2 V.
    D) 0.08 V.
    E) dependent on the path taken.

23. ** In the circuit shown, both resistors have the same value *R*. Suppose switch S is initially closed. When it is then opened, the circuit has a time constant τ_a. Conversely, suppose S is initially open. When it is then closed, the circuit has a time constant τ_b. The ratio τ_b/τ_a is



    A) 1.
    B) 2.
    C) 0.5.
    D) 0.667.
    E) 1.5.

24. ** An electron enters a region of uniform perpendicular $\vec{E}$ and $\vec{B}$ fields. It is observed that the velocity $\vec{v}$ of the electron is unaffected. A possible explanation is:
    A) $\vec{v}$ is parallel to $\vec{E}$ and has magnitude E/B
    B) $\vec{v}$ is parallel to $\vec{B}$
    C) $\vec{v}$ is perpendicular to both $\vec{E}$ and $\vec{B}$ and has magnitude B/E
    D) $\vec{v}$ is perpendicular to both $\vec{E}$ and $\vec{B}$ and has magnitude E/B
    E) the given situation is impossible

25. ** A point source emits electromagnetic energy isotropically at a rate of *P*. If the intensity at a point 50 cm from the source is 2 mW/cm^2, the value of *P* is approximately
    A) 63 W.
    B) 100 mW/cm.
    C) 12.56 mW.
    D) not calculable from the given data.
    E) None of the above.