King Fahd University of Petroleum and Minerals

Department of Physics

PHYS102-052
FINAL EXAM
<u>Test Code</u>: 002

Monday 5th June 2006
Exam Duration: 3hrs (from 7:30am to 10:30am)

Name:	
Student Number:	
Section Number:	

1. Which of the following statements is TRUE?
   A) In a uniform magnetic field, faster protons make circles in shorter times than slower protons.
   B) The direction of magnetic forces is the same for a proton and electron moving in the same direction.
   C) In a uniform magnetic field, there is always non-zero force on a moving charge particle.
   D) A magnetic field alone cannot accelerate a moving charged particle.
   E) A magnetic field alone cannot change the speed of a moving charged particle.

2. Calculate the equivalent resistance between a and b for the circuit shown in Figure 3.
   A) 6.5 Ω.
   B) 3.4 Ω.
   C) 4.5 Ω.
   D) 2.4 Ω.
   E) 1.4 Ω.

3. The electric flux leaving a non-conducting sphere is 350 Vm. If the radius of the sphere is 5 cm, the charge density of the sphere is:
   A) 5.9 $\mu C/m^3$.
   B) zero.
   C) 2.5 $\mu C/m^3$.
   D) 8.9 $\mu C/m^3$.
   E) 1.3 $\mu C/m^3$.

4. The potential at point P shown in figure 1 is 20 V. What is the potential at point **Q**.
   A) 30 V.
   B) 20 V.
   C) -20 V.
   D) 18 V.
   E) -18 V.

5. Two capacitors: C_1=2 μF and C_2=1 μF are connected in parallel. A constant voltage of 10 V is applied across both capacitors. The **CORRECT** statement is?
   A) The potential difference across C_1 is half the potential difference across C_2.
   B) The charge on C_1 is half the charge on C_2.
   C) The energy stored in both capacitors is the same.
   D) Energy stored in C_1 is twice the energy stored in C_2.
   E) Energy stored in C_1 is half the energy stored in C_2.

6. A 5 g of ice at 0 ^{o}C is mixed with 150 g of unknown material at 1 ^{o}C. If all the ice melts and the equilibrium temperature of the mix is 0 ^{o}C, what is the specific heat of the unknown material?
   A) 7.5 kJ/kg K.
   B) 80 kJ/kg K.
   C) 0.53 kJ/kg K.
   D) 4.16 kJ/kg K.
   E) 11 kJ/kg K.

7. Two charges lie on the x axis: Q_1= -1×10^{-8} C is at x = 0.01 m, Q_2 = 5×10^{-8} C is at x = 0.03 m, the electric field at the origin is:
   A) 4.0×10^{5} N/C along +x-axis.
   B) 14.0×10^{5} N/C along +x-axis.
   C) 9.0×10^{5} N/C along +x-axis.
   D) 5.0×10^{5} N/C along -x-axis.
   E) 4×10^{5} N/C along -x-axis.

8. Two long straight current-carrying parallel wires cross the x-axis and carry currents I and 3I in the same direction, as shown in Figure 4. At what value of x is the net magnetic field zero?
   A) 3 cm.
   B) 4 cm.
   C) -3 cm.
   D) 1 cm.
   E) -1 cm.

9. A conducting sphere has a potential of 400 V at its surface. If the radius of the sphere is 5 cm, what is the electric potential at a distance 2 cm from the center of the sphere?
   A) - 400 V.
   B) 400 V.
   C) 0 V.
   D) 100 V.
   E) - 64 V.

10. Figure 6 shows a long straight wire and a circular loop (R=4 cm), both are carrying the same current I=25 A. Calculate the value of the magnetic field at the center of the loop.
   A) 8.8×10^{-4} T.
   B) 4.1×10^{-4} T.
   C) 9.4×10^{-4} T.
   D) 1.2×10^{-4} T.
   E) 5.2×10^{-4} T.

11. A wire has 25 Ω resistance. Another wire, of the same material, has half the length and half the diameter of the first wire. The resistance of the second wire is:

A) 50 Ω.
B) 100 Ω.
C) 20 Ω.
D) 25 Ω.
E) 80 Ω.

12. A 12 V battery supplies 100 watts power to two identical bulbs connected in series. The resistance of each bulb is:

A) 1.2 Ω
B) 0.7 Ω
C) 0.5 Ω
D) 2.7 Ω
E) 0.3 Ω

13. The average power supplied by a string vibrating at a frequency f is 2.4 mW. The amplitude of the wave is 1.5 mm and its speed is 86.6 m/s. If the linear density of the string is 2×10^{-3} kg/m what is the frequency of vibration?

A) 38 Hz.
B) 18 Hz.
C) 12 Hz.
D) 22 Hz.
E) 14 Hz.

14. What is the angle between a 1.0-mT uniform magnetic field and the velocity of an electron, if the electron has an acceleration of 7.0×10^{12} m/s^2 and a speed of 7.0×10^{4} m/s?

A) 90°
B) 30°
C) 55°
D) 25°
E) 35°

15. A cylindrical copper conductor is 10 cm long and has a resistivity $\rho=1.68\times10^{-8}\ \Omega$.m. If a potential difference of 100 Volts is applied across the conductor, the resulting current density J in the conductor is:
    A) 9×10^{8} A/m^2
    B) 6×10^{10} A/m^2
    C) 3×10^{11} A/m^2
    D) 6×10^{7} A/m^2
    E) 1×10^{4} A/m^2

16. Conduction electrons move to the right in a certain wire. This indicates that:
    A) the current density points right and the electric field points left.
    B) the current density points left but the direction of the electric field is unknown.
    C) the current density and electric field both point right.
    D) the current density and electric field both point left.
    E) the current density points left and the electric field points right.

17. A uniform magnetic field is perpendicular to the plane of a circular loop of cross sectional area 0.15 m^2 and resistance 0.05 Ω. At what rate must the magnitude of the magnetic field change to induce a 1.5 A current in the loop?
    A) 0.2 T/s
    B) 1.5 T/s
    C) 0.7 T/s
    D) 0.5 T/s
    E) 3.5 T/s

18. Figure 7 shows a long straight wire carrying current I in the plane of a rectangular conducting loop. Which of the following statements is **CORRECT**?
    A) No current will be induced in the loop as the current in the straight wire decreases gradually.
    B) No current will be induced if the loop is moved up parallel to the wire.
    C) A counterclockwise current is induced if the loop is moved away from the wire.
    D) A clockwise current is induced if the loop is moved toward the wire.
    E) The induced current in the loop decreases gradually as the current in the straight wire gradually increases.

19. A wire lying along the y axis from y = 0 to y = 0.36 m carries a current of 2.0 mA in the negative direction of the y axis. The wire fully lies in a uniform magnetic field given by B=0.36 i + 0.46 j (T). What is the magnetic force on the wire?
A) 3.3×10^{-4} N in the positive z direction.
B) 3.3×10^{-4} N in the negative z direction.
C) 2.6×10^{-4} N in the positive z direction.
D) 1.2×10^{-3} N in the positive z direction.
E) 2.6×10^{-4} N in the negative z direction.

20. An ideal gas with 1.2 moles expands isothermally to 5 times its initial volume. The change in entropy of the gas is:
A) 16 J/K.
B) 6 J/K.
C) 48 J/K.
D) 12 J/K.
E) 24 J/K.

21. The sound level at point A is 8 dB. If point A is 5 m from the sound source, then the power emitted from the source is:
A) 5 nW.
B) 2 nW.
C) 1 nW.
D) 3 nW.
E) 4 nW.

22. In Figure 2, $R_1 = R_2 = R_3 = 5\ \Omega$. What is the value of the emf of the second battery ε_2.
A) 20 V.
B) 10 V.
C) 12 V.
D) 5 V.
E) 15 V.

23. Figure 5 shows 4 wires caring currents: I_1, I_2, I_3 and I_4. The value of the line integral $\oint B.ds$ shown in the figure is:
A) 5.9×10^{-6} T.m
B) 2.7×10^{-6} T.m
C) 1.4×10^{-6} T.m.
D) 3.8×10^{-6} T.m.
E) 7.8×10^{-6} T.m.

24. An ideal gas has a volume of 0.25 m^3 and is at 25 ^oC and 1 atmospheric pressure. The gas expands to 0.45 m^3, and the pressure is reduced to half its initial value. The new temperature is:
A) 189 K.
B) 438 K.
C) 268 K.
D) 323 K.
E) 167 K.

25. A 2.5×10^4 Ω resistor and a capacitor are connected in series and then a 15 V potential difference is applied across them. The potential difference across the capacitor rises to 10 V in 2.6 μs. Find the capacitance.
A) 95 μF.
B) 90 μF.
C) 109 pF.
D) 82 pF.
E) 46 pF.

26. Figure 8 shows a metal rod of length 25 cm moving at a constant velocity along two parallel metal rails. If the magnetic field is 0.35 T into the page, and the induced emf is 15 mV, calculate the speed of the metal bar.
A) 17 cm/s.
B) 34 cm/s.
C) 8 cm/s
D) 14 cm/s.
E) 25 cm/s.

27. Consider three point charges q_1, q_2 and q_3. If q_1 repels q_3 and q_3 attracts q_2, then one possibility is that:
A) q_1 is negative, q_2 and q_3 are positive.
B) q_1 is positive , q_2 and q_3 are negative.
C) q_1, q_2 and q_3 are all positive.
D) q_1 and q_3 are positive and q_2 is negative.
E) q_1, q_2 and q_3 are all negative.

28. A solenoid is 3.0 cm long and has a radius of 0.50 cm. It is wrapped with 500 turns of wire carrying a current of 2.0A. The magnetic field at the center of the solenoid is:
A) 1.3×10^{-3} T.
B) 16T.
C) 9.9×10^{-8} T.
D) 20T.
E) 4.2×10^{-2} T.

29. A uniform magnetic field of 2.0 T along the positive z-axis crosses an electric field E. What is the electric field needed to guide an electron with a speed of 40 km/s along a straight line in the positive x-axis direction?
A) 20 kV/m along the negative z-axis.
B) 20 kV/m along the positive x-axis.
C) 80 kV/m along the positive y-axis.
D) 20 kV/m along the negative y-axis.
E) 80 kV/m along the negative y-axis.

30. A long straight wire carries a current that increases at a rate of 6×10^{4} A/s. The wire passes through the center of a circular loop of radius 5 cm, as shown in Figure 9. The induced *emf* in the loop is:
A) 3.2 mV.
B) 8.4 mV.
C) 0 mV.
D) 1.9 mV.
E) 4.5 mV.

Answer Key

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

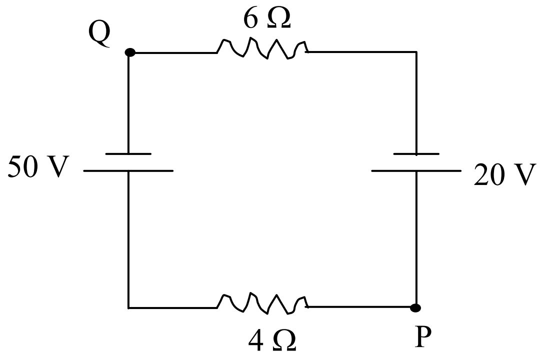

Figure 1

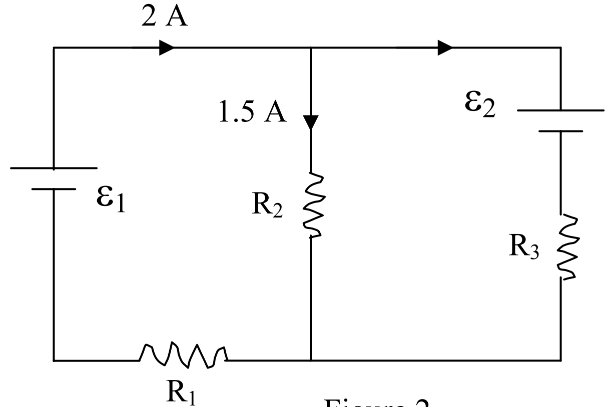

Figure 2

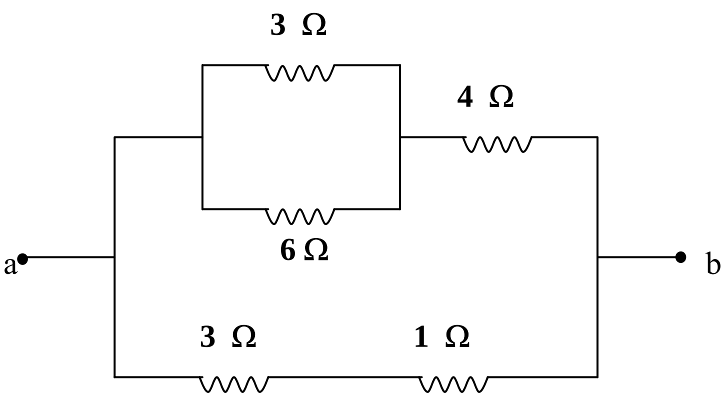

Figure 3

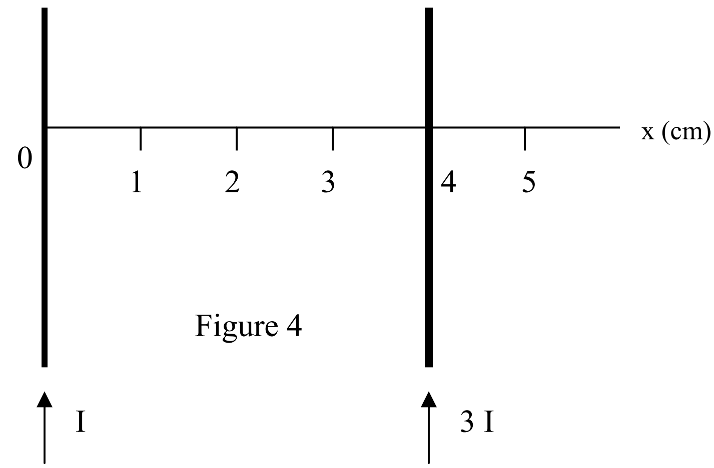

Figure 4

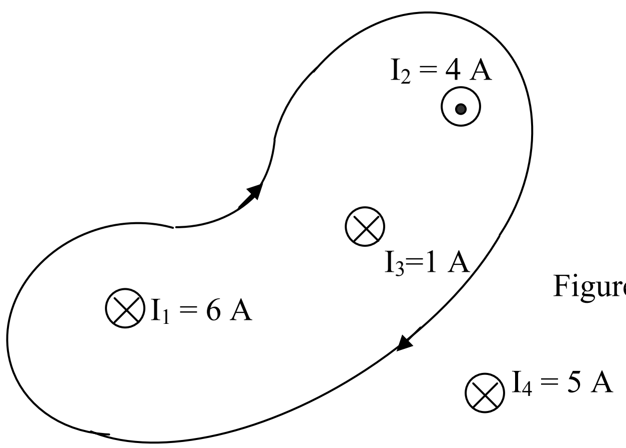

Figure 5

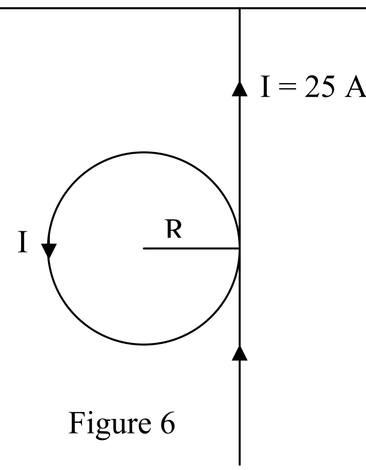

Figure 6

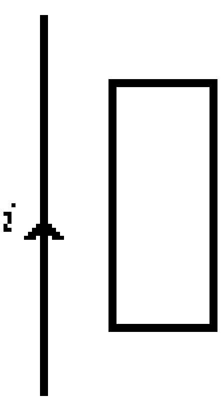

Figure 7

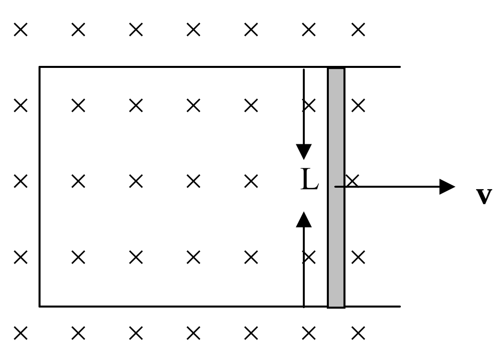

Figure 8

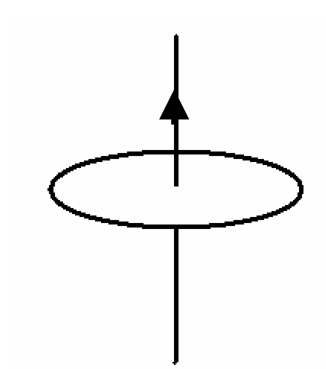
Figure 9

Physics 102
Formula sheet for Final Exam
Spring Session 2005-2006(Term 052)

$v = \sqrt{\frac{\tau}{\mu}} \quad v = \lambda f$

$v = \sqrt{\frac{B}{\rho}}$

$S = S_m \cos(kx - \omega t)$

$I = \frac{\text{Power}}{\text{Area}}$

$y = y_m \sin(kx - \omega t - \varphi)$

$P = \frac{1}{2}\mu\omega^2 y_m^2 v$

$\Delta P = \Delta P_m \sin(kx - \omega t)$

$\Delta P_m = \rho v \omega S_m$

$I = \frac{1}{2}\rho v (\omega S_m)^2$

$\beta = 10 \log \frac{I}{I_0}$,

$I_0 = 10^{-12}\,\text{W/m}^2$

$f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$

$y = \left(2y_m \cos\frac{\varphi}{2}\right)\sin\left(kx - \omega t - \frac{\varphi}{2}\right)$

$\Delta L = \frac{\lambda}{2\pi}\varphi$

$\Delta L = n\frac{\lambda}{2} \quad n = 0,2,4,....$.

$\Delta L = n\frac{\lambda}{2} \quad n = 1,3,5,....$.

$\Delta L = m\lambda$,

$\Delta L = \left(m + \frac{1}{2}\right)\lambda$

$f_n = \frac{nv}{2L}, \quad n = 1,2,3,...$

$f_n = \frac{nv}{4L}, \quad n = 1,3,5,...$

$y = 2y_m \sin(kx)\cos(\omega t)$

$\alpha = \frac{\Delta L}{L}\frac{1}{\Delta T}$,

$PV = nRT = NkT$

$\beta = \frac{1}{V}\frac{\Delta V}{\Delta T}$,

$n = \frac{m}{M} = \frac{N}{N_A}$

$Q = mL \quad , \quad W = \int P dV$

$Q = mc\Delta T$

$P = \frac{2}{3}\frac{N}{V}\left(\frac{1}{2}m\bar{v}^2\right)$

$v_{rms} = \sqrt{\frac{3RT}{M}}$

$\frac{1}{2}m\vec{v}^2 = \frac{3}{2}k_B T$

$\Delta E_{int} = Q - W$,

$\Delta E_{int} = nc_v \Delta T$

$C_p - C_v = R$

$P_{cond} = \frac{Q}{t} = \kappa A \frac{T_H - T_C}{L}$

$Q = n\, c_p\, \Delta T \quad , \quad Q = n\, c_v\, \Delta T$

$P V^\gamma = \text{constant}$

$W = Q_H - Q_L$

$\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$

$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}, \quad (K)_{Ref} = \frac{Q_L}{W}$

$\Delta S = \int \frac{dQ_r}{T}$

$F = \frac{kq_1q_2}{r^2} \quad , \quad F = q_0 E$

$\varphi = \int_{\text{Surface}} \vec{E}\cdot d\vec{A} \quad , \quad E = \frac{kq}{r^2}$

$E = \frac{kQ}{R^3} r \quad , \quad E = \frac{2k\lambda}{r}$

$\varphi_c = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_o} \quad , \quad E = \frac{\sigma}{\varepsilon_o}$

$\vec{\tau} = \vec{P} \times \vec{E} \quad , \quad V = \frac{kQ}{r}$

$W = \Delta K = -\Delta U$

$\Delta V = V_B - V_A = -\int_A^B \vec{E}.d\vec{S} = \frac{\Delta U}{q_0}$

$E_x = -\frac{\partial V}{\partial x}, \; E_y = -\frac{\partial V}{\partial y},$

$E_z = -\frac{\partial V}{\partial z}$

$U = \frac{kq_1q_2}{r_{12}}, \quad C = \frac{Q}{V}$

$C_o = \frac{\varepsilon_0 A}{d}$

$U = \frac{1}{2}CV^2, \quad u = \frac{1}{2}\varepsilon_o E^2,$

$C = \kappa C_0$

$I = \frac{dQ}{dt} \; , \; I = JA$

$R = \frac{V}{I} = \rho\frac{L}{A}$

$\rho = \rho_0 [1 + \alpha(T - T_0)]$,

$P = IV$

$q(t) = C\varepsilon[1 - e^{-t/RC}]$,

$q(t) = q_o\, e^{-t/RC}$

$\vec{F} = q(\vec{v} \times \vec{B}), \quad \vec{F} = i(\vec{L} \times \vec{B})$

$F_{ba} = \frac{\mu_o L i_a i_b}{2\pi d}$

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\, d\vec{s} \times \vec{r}}{r^3}$$

$$\oint \vec{B} \cdot d\vec{s} = \mu_0\, i_{enc}$$

$$B = \frac{\mu_0\, i}{4\pi R}\varphi\ , \quad B = \frac{\mu_0\, i}{2\pi r},$$

$$B = \frac{\mu_0\, i}{2\pi R^2} r\ , \quad B = \frac{\mu_0 N i}{2\pi r}$$

$$B_s = \mu_0\, n\, i$$

$$\varphi_B = \int_{Surface} \vec{B} \cdot d\vec{A}$$

$$\varepsilon = -\frac{d\varphi_B}{dt}\ , \quad \varepsilon = B L v$$

$$v = v_o + at$$

$$x - x_o = v_o t + \frac{1}{2} a t^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$

$k = 9.0 \times 10^9\ N.m^2/C^2$

$q_e = -1.6 \times 10^{-19}\ C$

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

$m_p = 1.67 \times 10^{-27}\ kg$

$1\ eV = 1.6 \times 10^{-19}\ J$

1 cal = 4.186 J

$m = 10^{-3}$, $\mu = 10^{-6}$, $n = 10^{-9}$

$p = 10^{-12}$

$\mu_0 = 4\pi \times 10^{-7}\ Wb/A.\ m$

$1\ atm = 1.013 \times 10^5\ N/m^2$

R = 8.31 J/mol. K

$g = 9.8\ m/s^2$

L_f = 333 kJ/kg (water)

L_v = 2256 kJ/kg (water)

c_i = 4190 kJ/kg (ice)

c_w = 4190 kJ/kg (water)