

King Fahd University of Petroleum and Minerals

Department of Physics



PHYS102-051

FINAL EXAM

Test Code: 001

23 January 2006

Exam Duration: 3hrs (from 7:30am to 10:30am)

Name:	
Student Number:	
Section Number:	

1. Consider three point charges q_1 located at $y = 1$ mm, q_2 at $y = 2$ mm, and q_3 at the origin. If the net force on q_3 is zero, then
 - A) $q_2 = -q_1$.
 - B) $q_2 = -4q_1$.
 - C) $q_2 = -2q_1$.
 - D) $q_2 = +4q_1$.
 - E) $q_2 = +2q_1$.

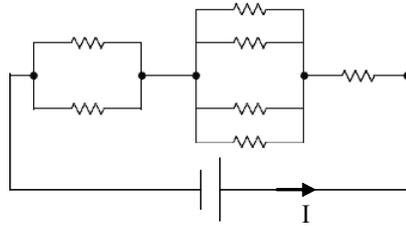
2. A long solenoid has 10 turns per cm and carries a 4 A current. A circular loop with cross-sectional area = 8 cm^2 has 5 turns and lies within the solenoid with its axis parallel to the axis of the solenoid. Find the magnitude of the induced emf if the current increases 0 to 4 A in 0.1 s.
 - A) 4.0×10^{-4} V.
 - B) 7.0×10^{-4} V.
 - C) 5.5×10^{-4} V.
 - D) 3.0×10^{-4} V.
 - E) 2.5×10^{-4} V.

3. A 500 turns toroid has a radius of 5 cm. If the magnetic field inside the toroid is 0.04 T, the current passing through the toroid is
 - A) 25 A
 - B) 15 A.
 - C) 30 A.
 - D) 10 A.
 - E) 20 A.

4. Consider the following reversible processes in which the temperatures of two identical gases (A and B) with the same number of moles are increased from the same initial temperature to the same final temperature. For gas A, the process is carried out at constant volume while for gas B it is carried out at constant pressure. The change in entropy
 - A) is greater for A only if the initial temperature is high.
 - B) is greater for A.
 - C) is the same for A and B.
 - D) is greater for B.
 - E) is greater for A only if the initial temperature is low.

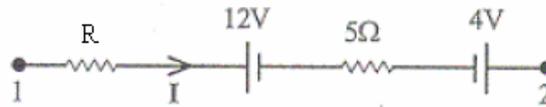
5. An electric field of magnitude 400 V/m is normal to a magnetic field of magnitude 0.25 T. If an electron moving through these two fields experiences no force, what is the speed of the electron?
 - A) 0.63 mm/s.
 - B) zero.
 - C) 1.6 km/s.
 - D) 10 km/s.
 - E) 100 m/s.

6. In the figure shown, each resistance is $1\ \Omega$. Calculate the emf of the battery if the current I is $4\ \text{A}$.



- A) 9V .
 B) 7V .
 C) 5V .
 D) 3V .
 E) 4V

7. In the figure shown, the potential difference between point 1 and 2, $(V_2 - V_1)$, is $-40\ \text{V}$, and the current is equal to $4.0\ \text{A}$, then, the value of the resistance R is



- A) $2.1\ \Omega$.
 B) $9.4\ \Omega$.
 C) $3.0\ \Omega$.
 D) $6.7\ \Omega$.
 E) $4.5\ \Omega$.

8. A flat circular coil has 80 turns of diameter $20\ \text{cm}$ with a total resistance of $40\ \Omega$. The plane of the coil is perpendicular to a uniform magnetic field. At what rate should the magnetic field change for the power dissipated in the coil to be $2\ \text{W}$?

- A) $5.5\ \text{T/s}$.
 B) $1.2\ \text{T/s}$.
 C) $2.4\ \text{T/s}$.
 D) $4.5\ \text{T/s}$.
 E) $3.6\ \text{T/s}$.

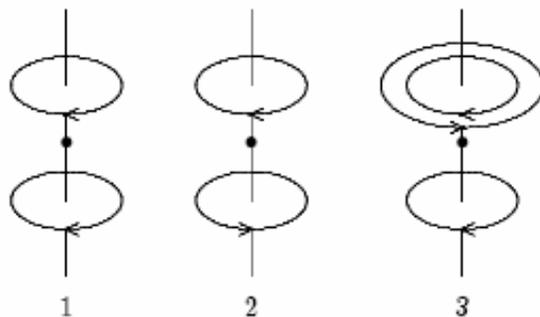
9. A cylindrical ring with inner radius $R_1 = 2\ \text{mm}$ and outer radius $R_2 = 5\ \text{mm}$, carries a constant current of $8\ \text{A}$ along its length. The current density is

- A) $4.6 \times 10^7\ \text{A/m}^2$.
 B) $1.5 \times 10^3\ \text{A/m}^2$.
 C) $1.2 \times 10^5\ \text{A/m}^2$.
 D) $2.8 \times 10^9\ \text{A/m}^2$.
 E) $3.2 \times 10^4\ \text{A/m}^2$.

10. A $300\ \text{g}$ of lead at $100\ ^\circ\text{C}$ is mixed with $100\ \text{g}$ of water at $70\ ^\circ\text{C}$ in an insulated container. If the specific heat of lead is $0.030\ \text{cal/g} \cdot ^\circ\text{C}$ and for water is $1\ \text{cal/g} \cdot ^\circ\text{C}$, then the final temperature of the mixture is:

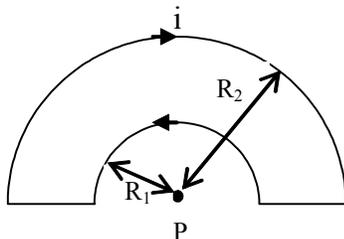
- A) $85.5\ ^\circ\text{C}$.
 B) $72.5\ ^\circ\text{C}$.
 C) $65.5\ ^\circ\text{C}$.
 D) $79.5\ ^\circ\text{C}$.
 E) $67.5\ ^\circ\text{C}$.

11. Air enters a hot-air furnace at 7°C and leaves at 77°C . If the pressure does not change, then each entering cubic meter of air expands to:
- 0.5 m^3 .
 - 1.9 m^3 .
 - 2.2 m^3 .
 - 0.9 m^3 .
 - 1.3 m^3 .
12. Two long parallel straight wires carry equal currents in opposite directions. At a point midway between the wires, the magnetic field they produce is
- non-zero and perpendicular to the plane of the two wires.
 - zero.
 - none of the answers.
 - non-zero and parallel to the wires.
 - non-zero and along a line connecting the wires.
13. Which of the following statements is false?
- A uniform magnetic field does not change the speed of a moving charge.
 - A uniform magnetic field can change the momentum of a moving charge.
 - A uniform magnetic field does not exert a force on a stationary charged particle.
 - A uniform magnetic field can accelerate a moving charge.
 - A uniform magnetic field changes the kinetic energy of a charged particle.
14. The diagram shows three arrangements of circular loops, centered on vertical axes and carrying identical currents in the directions indicated. Rank the arrangements according to the magnitudes of the magnetic fields at the midpoints between the loops on the central axes, maximum to minimum.

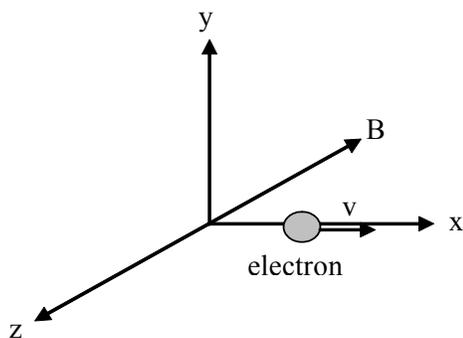


- 1, 3, 2
 - 3, 2, 1
 - 3, 1, 2
 - 2, 3, 1
 - 2, 1, 3
15. Three charges lie on the x axis: $Q_1 = 1 \times 10^{-8}\text{ C}$ is at $x = 1\text{ cm}$, $Q_2 = 2 \times 10^{-8}\text{ C}$ is at $x = 2\text{ cm}$, $Q_3 = -3 \times 10^{-8}\text{ C}$ is at $x = 3\text{ cm}$. The potential energy of this arrangement, relative to the potential energy for infinite separation, is
- $-5.0 \times 10^{-4}\text{ J}$.
 - $-9.0 \times 10^{-4}\text{ J}$.
 - $-8.0 \times 10^{-4}\text{ J}$.
 - $+5.0 \times 10^{-4}\text{ J}$.
 - $+8.0 \times 10^{-4}\text{ J}$.

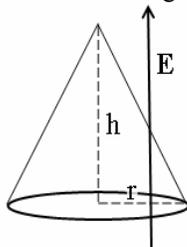
16. In the figure shown, $R_2 = 3 \times R_1 = 9$ cm. The current $i = 10$ A. Calculate the magnitude magnetic field at point p.



- A) 7.0×10^{-5} Tesla.
 B) 9.0×10^{-5} Tesla.
 C) 6.0×10^{-5} Tesla.
 D) 3.0×10^{-5} Tesla.
 E) 1.0×10^{-5} Tesla.
17. In the figure, an electron of speed 2.0×10^5 m/s moves along positive x axis in a uniform magnetic field of 0.2 T pointing into the page $-z$ direction. The magnetic force on the electron is

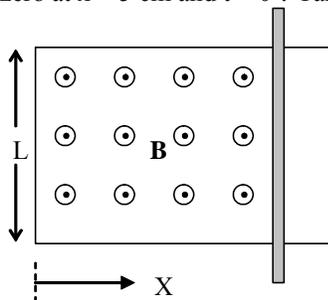


- A) 6.4×10^{-15} N, +y axis.
 B) 6.4×10^{-15} N, x-y plane.
 C) 6.4×10^{-15} N, +z axis.
 D) 6.4×10^{-15} N, -y axis.
 E) 6.4×10^{-15} N, -z axis.
18. A cone having a base radius $r = 0.10$ m and height $h = 0.50$ m is located in a uniform electric field $E = 25$ V/m as shown in the figure. Calculate the electric flux through the curved surface of the cone.



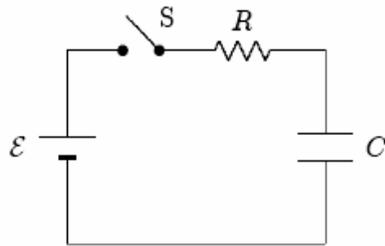
- A) 2.25 V m.
 B) 0.79 V m.
 C) 0.25 V m.
 D) zero.
 E) 1.9 V m.

19. A metal bar is free to move over a U-shaped metal rail, as shown in the figure. At $t=0$ s, the external field is 0.4 T directed out of the page and is increasing at a rate of 0.2T/s. What will be the velocity of the metal bar such that the induced emf will be zero at $x = 5$ cm and $t = 0$? Take $L=5$ cm.

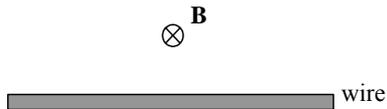


- A) 0.025 m/s, along +x direction.
 B) 0.01 m/s along -x direction.
 C) 0.025 m/s, along -x direction.
 D) 0.01 m/s, along +x direction.
 E) 0.5 m/s, along -x direction.
20. A 2.0 volt battery has an internal resistance $r = 0.2 \Omega$ is used to operate a lamp of resistance $R = 2.3 \Omega$. What is the percentage of the power delivered to the lamp relative to that of the battery?
 A) 100 %.
 B) 92 %.
 C) 98 %.
 D) 78 %.
 E) 84 %.
21. A 2- μ F and 1- μ F capacitors are connected in series and a potential difference is applied across the combination. The 2- μ F capacitor has
 A) twice the charge of the 1- μ F capacitor.
 B) the same energy as the 1- μ F capacitor.
 C) half the potential difference of the 1- μ F capacitor.
 D) twice the potential difference of the 1- μ F capacitor.
 E) half the charge of the 1- μ F capacitor.
22. A string is vibrating at a frequency of 12 Hz and amplitude of 1.5 mm. The string has a linear mass density 2 g/m and length 2.0 m. If the tension in the string is 15 N, what is the average power supplied by the source?
 A) 4.5 mW.
 B) 0.6 mW.
 C) 3.5 mW.
 D) 1.1 mW.
 E) 2.2 mW.
23. In a uniform magnetic field, a particle of charge 1.5 μ C and mass 2.0 μ g completes 5 revolutions in one second. What is the magnitude of the magnetic field?
 A) 42 mT.
 B) 15 mT.
 C) 94 mT.
 D) 6.7 mT.
 E) 9.4 mT.

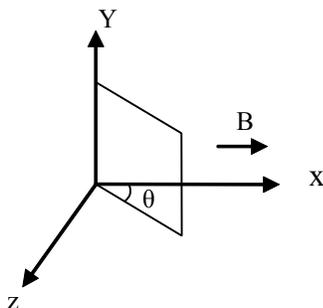
24. An uncharged capacitor is connected as in the circuit shown. When the switch is closed, the charge on the capacitor reaches half its maximum value in 20 ms. If $R=500\ \Omega$ and the voltage of the battery is 10 V, then the capacitance of the capacitor is:



- A) $84\ \mu\text{F}$.
 B) $36\ \mu\text{F}$.
 C) $65\ \mu\text{F}$.
 D) $32\ \mu\text{F}$.
 E) $58\ \mu\text{F}$.
25. A straight wire of linear mass density $100\ \text{g/m}$ is located perpendicular to a magnetic field of $0.5\ \text{T}$ as shown in the figure. What current in the wire is needed to balance the gravitational force on the wire?



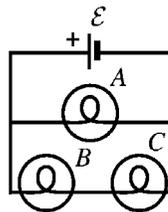
- A) 2.0 A, to the left.
 B) 0.49A to the left.
 C) Cannot be balanced.
 D) 0.49 A to the right.
 E) 2.0 A, to the right.
26. A square coil of side 20 cm is rotating about the y-axis. It is oriented as shown in the figure. The external field is $B = 0.5\ \text{T}$ along the positive x-axis. What is the change in the magnetic flux through the coil if the angle θ changes from 37° to 53° ?



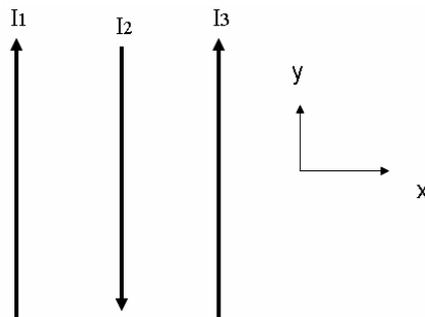
- A) $-6\ \text{mWb}$.
 B) $-7\ \text{mWb}$.
 C) $4\ \text{mWb}$.
 D) $-4\ \text{mWb}$.
 E) $6\ \text{mWb}$.

27. The intensity of a sound wave at point A is I. If the amplitude of the wave is reduced to half its value, what is the change in sound level at point A?
- A) 5.0 dB.
 B) -4.0 dB.
 C) -6.0 dB.
 D) 9.0 dB.
 E) -2.0 dB.
28. The electric field at 0.50 m away from the center of a thin metallic spherical shell of radius 0.30 m is -400×10^3 V/m. If a point charge $q = -13.0 \mu\text{C}$ is located at the center of the sphere, the charge density at the outer surface of the sphere is:
- A) $-4.7 \mu\text{C}/\text{m}^2$.
 B) $-1.7 \mu\text{C}/\text{m}^2$.
 C) $+9.2 \mu\text{C}/\text{m}^2$.
 D) $-9.8 \mu\text{C}/\text{m}^2$.
 E) $+6.3 \mu\text{C}/\text{m}^2$.

29. Three identical light bulbs are connected to a battery as shown in the figure. Which one of the following statements is correct?



- A) The maximum power loss is through B and C.
 B) The minimum power loss is through A.
 C) The maximum power loss is through B.
 D) The maximum power loss is through A.
 E) The maximum power loss is through C.
30. The figure shows three parallel wires carrying currents $I_1 = 2$ A, $I_2 = 6$ A, and I_3 . The spacing between adjacent wires is 1 cm. Calculate the value of I_3 such that the magnitude of the net force per unit length at the third wire is 0.25×10^{-3} N/m.



- A) 3.5 A.
 B) 1.5 A.
 C) 4.5 A.
 D) 5.5 A.
 E) 2.5 A.

Answer Key

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