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Exam II

Fall 2003
Serway, Chapters 26:3-30

Part I: Qualitative

Write the letter of the correct answer on the answer sheet.

<u>*NO PARTIAL CREDIT: SUBMIT ONE ANSWER ONLY.*</u>

Note that in qualitative multiple-choice questions, sometimes one answer is clearly correct, while the others are clearly incorrect. However, with some questions you must choose the <u>best</u> or <u>most complete</u> answer.

<u>*Note also that even though this section is qualitative, the formula sheet may prove useful for some questions*</u>.

1. Consider a charged, isolated capacitor with no dielectric material between the conductors. The process of inserting a dielectric

   (a) increases the stored energy
   (b) decreases the stored energy
   (c) does not change the stored energy
   (d) may increase or decrease the stored energy depending on the dielectric constant

2. Although we proved it only for the electric field in a parallel-plate capacitor, the energy density of <u>***any***</u> electric field

   (a) is proportional to the magnitude of the electric field.
   (b) is proportional to the square of the magnitude of the electric field.
   (c) is inversely proportional to the magnitude of the electric field.
   (d) is inversely proportional to the square of the magnitude of the electric field.

3. The <u>***EMF***</u> of a battery is

   (a) the maximum potential energy stored in the battery.
   (b) the maximum potential difference across the terminals of a battery.
   (c) the maximum force exerted by the battery on the protons in the circuit.
   (d) the maximum force exerted by the battery on the electrons in the circuit.

4. What is the difference between ***resistance*** and ***resistivity***?

   (a) Resistance is a property of the material, while resistivity depends on the amount, size, and shape of the material.
   (b) Resistivity is a property of the material, while resistance depends on the amount, size, and shape of the material.
   (c) Resistance is a property of ohmic devices, while resistivity is a property of non-ohmic devices.
   (d) Resistivity is a property of ohmic devices, while resistance is a property of non-ohmic devices.

5. A set of resistors is placed in ***series*** with a source of constant potential difference. Which of the following must be the same for each resistor?

   (a) Potential difference across it
   (b) Current through it
   (c) Power dissipated in it
   (d) Resistance of it

6. Consider three light bulbs connected to a 120-V source in the configuration shown. Each bulb is designed to give its normal brightness when connected across a potential difference of 120 V. In this configuration,


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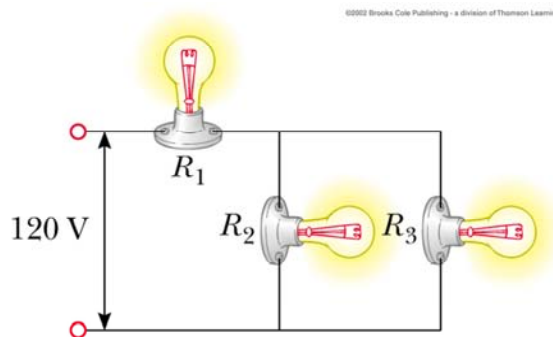
   (a) all the bulbs shine at their normal brightness.
   (b) R_2 and R_3 shine at their normal brightness, but R_1 shines dimmer than its normal brightness.
   (c) R_2 and R_3 shine dimmer than their normal brightness, but R_1 shines at its normal brightness.
   (d) all three bulbs shine dimmer than their normal brightness.

7. When you plug multiple devices into a wall socket, the devices are being placed in the circuit

   (a) in series.
   (b) in parallel.
   (c) in a combination of series and parallel configurations.
   (d) impossible to tell without knowing how the house was originally wired.

8. A particle is in uniform circular motion in a uniform magnetic field as shown. What can you say about the charge of the particle?

(a) It is positive.
(b) It is negative.
(c) It is neutral.
(d) No conclusion can be drawn from the given information.
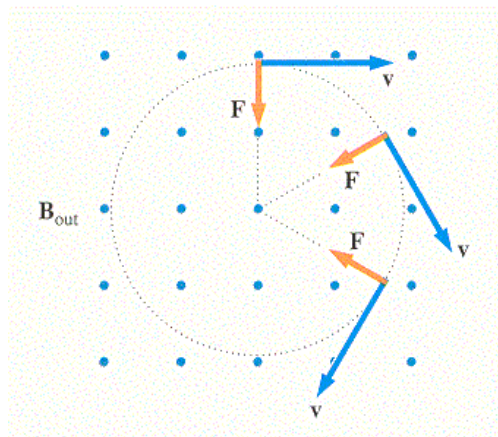
9. A copper rod is suspended by two identical, vertical springs perpendicular to a uniform, outward magnetic field as shown. A battery, not show, is placed across the other two ends of the springs. In what direction must the current flow through the copper rod in order to **_stretch_** the springs downward?

−5.00 cm−
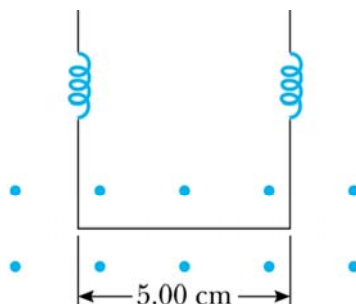
(a) To the right
(b) To the left
(c) Cannot be determined without seeing the battery
(d) The springs would not stretch for either direction of the current

10. A **_magnetic dipole_** in the form of a circular current loop lies in the *xy*-plane as shown. When viewed from a point on the positive *z*-axis, the current is clockwise. In what direction is the **_magnetic dipole moment_**?

z

y

x
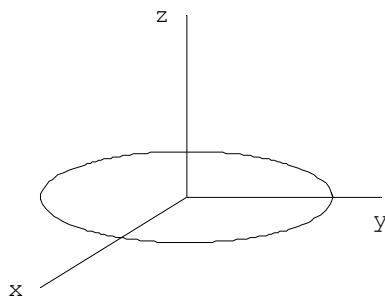
(a) +x direction   (b) +y direction
(c) +z direction   (d) -z direction

11. Consider the following conductor carrying a current as shown. In what direction is the magnetic field created by this current at the center of the circular loop?


$I = 7.00$ A

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(a) Up   (b) Down   (c) Into the paper   (d) Out of the paper

12. Suppose three wires are perpendicular to the page with current directions and values as shown. For which of the following closed curves is the magnitude of the line integral $\oint_C \vec{B} \bullet d\vec{l}$ a ***maximum***?

1 A   d   5 A   c   b   ×)2 A   a
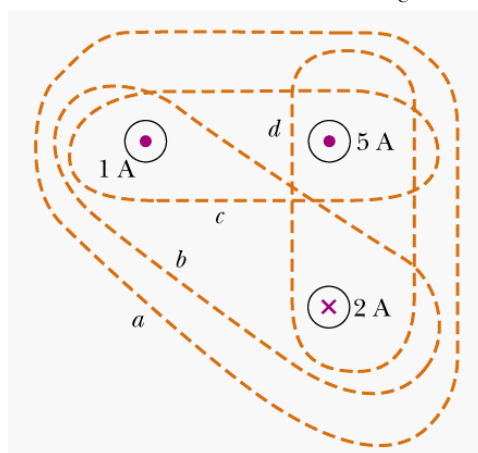
13. A long, hollow conducting tube carries a current along its length and uniformly distributed over its cross-section. What does Ampere's law predict concerning the magnetic field inside the tube?

hollow
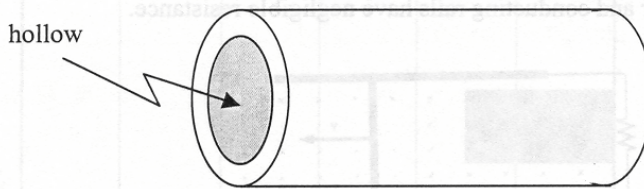
(a) It is zero.
(b) It is non-zero but uniform.
(c) It is non-zero and non-uniform, being greater near the inside surface of the tube.
(d) Ampere's law cannot be used to answer this question because to use it, you would first have to know the value of the magnetic field inside the hollow part of the tube.

14. A long, straight wire carries a steady current *I*. Now consider a ***Gaussian sphere*** on the side of the wire as shown. The sphere has radius *R* and surface area *A*. The center of the sphere is a distance 2*R* from the wire. What is the ***magnetic flux*** through the sphere?
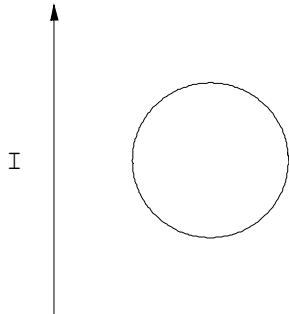
    (a) Zero
    (b) BA
    (c) $\mu_0 I$
    (d) $\mu_0 I / 4\pi R^2$

15. $\oint_S \vec{B} \bullet d\vec{A} = 0$, Gauss's law for magnetism, is one of the four fundamental laws of electromagnetism, collectively referred to as Maxwell's equations. Which of the following statements is ***NOT*** a consequence of this law?

    (a) The magnetic flux for a closed surface in a magnetic field is always zero.
    (b) Magnetic field lines are loops with no beginnings or endings.
    (c) Magnetic monopoles theoretically can exist.
    (d) Magnetic monopoles do not exist.

Part II: Quantitative

Write the letter of the correct answer on the answer sheet. Use the backs of these test pages for scratch work.

PARTIAL CREDIT POSSIBLE: Select one (1), two (2), or three (3) choices.
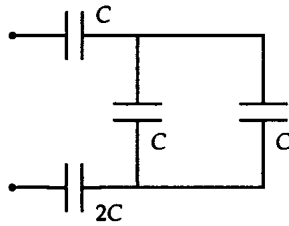
6 points for the single correct answer
4 points if correct answer is among two choices
2 points if correct answer is among three choices
0 if correct answer not present or of more than 3 answers are submitted

16. If C = 12 pF, determine the equivalent capacitance for the combination show.

(a) 48 pF
(b) 12 pF
(c) 24 pF
(d) 6.0 pF
(e) 59 pF

17. A certain capacitor has a capacitance of 5.00 nF when there is a vacuum between its plates. What is the capacitance when silicone oil (κ = 2.50) fills the space between the plates?

(a) 2.00 nF
(b) 20.0 nF
(c) 12.5 nF
(d) 125 nF
(e) 225 nF

18. A wire of length 2.0 m and radius 0.50 mm has a resistance of 0.45 Ω. What is the resistivity of the material used to make the wire?

(a) 5.6 x 10^{-7} $\Omega \bullet$m
(b) 1.2 x 10^{-7} $\Omega \bullet$m
(c) 1.8 x 10^{-7} $\Omega \bullet$m
(d) 2.3 x 10^{-7} $\Omega \bullet$m
(e) 7.1 x 10^{-7} $\Omega \bullet$m

19. Consider the following circuit. Suppose $R_1 = R_2 = 200\ \Omega$ and that the battery is 50 V. Calculate the current, I, through the battery.
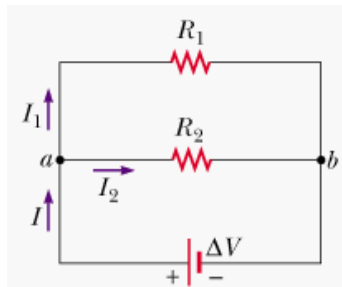
(a) 0.50 A
(b) 1.0 A
(c) 1.5 A
(d) 2.0 A
(e) 2.5 A

20. An electron is moving with a speed of 3.5×10^5 m/s when it encounters a magnetic field of 0.60 T. The magnetic field makes an angle of $60°$ with respect to the velocity of the electron. What is the magnitude of the magnetic force on the electron?

(a) 4.9×10^{-13} N
(b) 3.2×10^{-13} N
(c) 1.7×10^{-13} N
(d) 3.4×10^{-14} N
(e) 2.9×10^{-14} N

21. A deuteron is accelerated from rest through a potential difference of 10 kV and then moves perpendicularly into a uniform magnetic field of $B = 1.6$ T. What is the radius of the resulting circular path? (A deuteron is a "heavy" hydrogen ion. Its mass is 3.3×10^{-27} kg, but its charge is still 1.6×10^{-19} C.)

(a) 9.0 mm
(b) 10 mm
(c) 13 mm
(d) 16 mm
(e) 19 mm

22. A single-turn, square wire loop 5.0 cm on a side carries a current of 450 mA. What is the magnitude of the magnetic moment of the loop?

(a) 1.1×10^{-3} A·m^2
(b) 5.0×10^{-3} A·m^2
(c) 2.5×10^{-4} A·m^2
(d) 2.5×10^{-5} A·m^2
(e) 1.6×10^{-5} A·m^2

23. A circuit is constructed using two quarter circles as shown. If $a = 1.0$ cm, $b = 3.0$ cm, and $I = 30$ A, what is the magnitude of the magnetic field at point P?
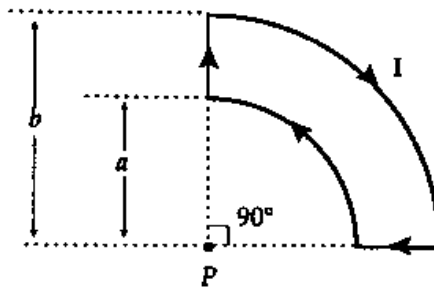
(a) 0.62 mT
(b) 0.59 mT
(c) 0.35 mT
(d) 0.31 mT
(e) 0.10 mT

24. A long, straight cylindrical cable has a radius of 5.00 cm. It carries a current of 12.0 A uniformly distributed over its cross-section. What is the magnitude of the magnetic field 8.00 cm from the center of the wire?

(a) 4.72×10^{-3} T
(b) 9.03×10^{-4} T
(c) 1.00×10^{-5} T
(d) 2.00×10^{-5} T
(e) 3.00×10^{-5} T

25. A solenoid used in MRI (magnetic resonance imaging) is 2.4 m long and 95 cm in diameter. It is wound from a niobium-titanium superconducting wire 2.00 mm in diameter. What current is necessary to produce a magnetic field of 1.5 T inside the solenoid?

(a) 1.2 kA
(b) 2.4 kA
(c) 4.8 kA
(d) 48 kA
(e) 96 kA