1. (a) Two point charges are 24 nanometers apart and they repel each other with an electrostatic force of 1.20 mN. With what force will they repel each other when they are 6.0 nanometers apart? 19.2 mN

(b) An electron experiences an acceleration \( a = 9.00 \times 10^{12} \, \text{m/s}^2 \) east due to an electric field. What is the magnitude and direction of that electric field? 51.2 N/C

(c) An electron is accelerated through a potential difference of 5.00 \( \times 10^4 \) volts. What change in the electron’s kinetic energy does this acceleration produce? An increase of \( 8.01 \times 10^{-15} \) J

(d) A certain wire has a resistance of 12.0 ohms. What resistance would a wire of the same length but twice the diameter have if it was made of the same material? 3 ohms

2. (a) Three resistors are connected in parallel. The equivalent resistance of this combination is 13.0 ohms. If two of the resistors are identical, each with a resistance of 40.0 ohms, what is the resistance of the third resistor? 37 ohms

(b) Three identical capacitors are connected in parallel. The equivalent capacitance of this combination is 243 \( \mu \text{F} \). What would be the capacitance of these three if they were to be connected in series? 27 \( \mu \text{F} \)

(c) A certain 12.0 volt battery produces its maximum power output when a 4.00 ohm resistor is connected across its terminals. What is the terminal voltage of the battery in this situation? 6 volts

(d) Electrons moving east at \( 4.00 \times 10^5 \) m/s remain moving with this velocity as they pass through a region where there is a magnetic field of 2.40 T pointing straight down. What electric field exists in this region? \( 9.6 \times 10^5 \) N/C south

3. Calculate the currents that flow in this circuit.

- 2.35 A up through the 34 V battery
- 1.05 A up through the 57 ohm resistor
- 3.40 A down through the 86 V battery

4. A completely empty hemispherical dome house sits on a horizontal plane. The radius of the dome is 24.0 meters. In this region of space there is a uniform electric field of magnitude 3550 N/C, which points downward at an angle of 82° below horizontal. What is the electric flux through the curved part of the dome? - \( 6.36 \times 10^6 \) N\( \cdot \)m\(^2\)/C

5. A flat square coil of side length 2.40 m has 12 turns is in a uniform vertical magnetic field as shown. The magnitude of B is given by this equation:

\[
B = (0.25)t^2
\]

where B is in tesla when t is in seconds. If the resistance of the coil is 2.00 \( \Omega \), (a) what current flows in the coil at time \( t = 5.0 \) seconds? (b) will the current flow downward to the right or upward to the left in the side of the coil shown in the diagram? 72.5 A, upward to the left
6. A 0.250 μF capacitor, a 2.40 H inductor, and a 124 ohm resistor are connected in series across a 125 Hz a.c. source that produces an effective emf of 96.0 volts. How much energy is dissipated in the resistor in five minutes? 33.3 J

7. A thin glass rod carries a uniformly distributed static charge of 3.40 microcoulombs. The rod is 25.0 centimeters long. What magnitude electric field does this charged rod produce at a point that is 2.50 centimeters from one end of the rod and on the same line as the rod. 4.45x10^6 N/C

8. In a certain region of space there exists an electric field that points in the +x direction of a specified coordinate system. The magnitude of this electric field is given by E = (2.45x10^4)/x^3, where E is in N/C when x is in meters. What is the potential difference between points x_1 = 2.00m and x_2 = 4.00 m? -2.30x10^3 V

9. A small sphere of radius 1.00 mm carries a net charge Q = 2.40x10^-6 C is fixed in space. How much electric field energy, due to Q, is stored outside the sphere but within 1.00 cm of the center of the sphere? 23.3 J

10. A certain long straight cylindrical current-carrying wire has a diameter of 5.00 millimeters. At a radial distance of 7.50 millimeters from the center of the wire there is a magnetic field of 7.00x10^-5 T due to the current. What is the current density (assumed uniform) in the wire? 1.34x10^5 A/m^2

11. The diagram shows a long straight wire carrying a 20.0 A current into the paper. There is a constant and uniform magnetic field of magnitude B = 4.50 T parallel to the plane of the paper as shown. What is the magnitude and direction of the force per length of the wire due to this magnetic field? 90.0 N/m, directed 35° below the +x axis

12. A transformer has 150 turns in the primary coil and 9 turns in the secondary coil. An alternating emf given as a function of time by \( \mathcal{E} = (156)\sin(377t) \) is connected across the primary coil. The transformer is 100% efficient. An RL series circuit is connected across the secondary coil, where R = 120 Ω and L = 2.0 H. What is the effective voltage across the inductor? 6.52 V

13. Protons are fixed in place on two corners of an equilateral triangle of side length 2.00 nm. An electron is fixed in place on the other corner. What is the electric field, due to these charged particles, at the midpoint of the side that connects the two protons? 4.8x10^6 N/C perpendicular to the side of the triangle and pointing toward the electron.