RLP-PHYB · RLP Physics B — Energy, Thermal Physics, Electromagnetism and Waves

Unit 3: Electricity and Magnetism

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 3.1 — Missouri Winter Sparks: Charge and Coulomb's Law

FLUENCY

1. Find the force between a +3.0 μC charge and a +5.0 μC charge 0.25 m apart. Is it attractive or repulsive?

2. An object has 2.0×10^{12} more electrons than protons. What is its charge?

3. Two charges exert 0.80 N on each other. What is the force if the distance between them is tripled?

4. Both charges in a pair are doubled and the distance between them is also doubled. By what factor does the force change?

5. How many electrons must be removed from a neutral metal sphere to give it a charge of +1.0 nC?

6. Two −4.0 nC charges are 3.0 cm apart. Find the force and say whether it is attractive or repulsive.

APPLICATION

7. A +2.0 μC charge is at x = 0 and a −4.0 μC charge is at x = 0.20 m. A +1.0 μC charge is placed at x = 0.10 m. Find the net force on it.

8. A −1.5 μC charge is at the origin. A +4.0 μC charge is at (0.50 m, 0) and another +4.0 μC charge is at (0, 0.50 m). Find the size and direction of the net force on the −1.5 μC charge.

9. Two protons in a nucleus are about 2.0×10^{-15} m apart. Find the electric force between them, and explain what this tells you about the nucleus.

10. Two 1.0 kg spheres 1.0 m apart each carry +1.0 μC. Compare the electric repulsion with the gravitational attraction.

CHALLENGE

11. A +1.0 μC charge is at x = 0 and a +4.0 μC charge is at x = 0.30 m. Where between them can a third charge sit with zero net electric force on it?

12. Two identical 2.0 g balloons hang from the same point on 0.50 m threads. After both are rubbed with the same charge, each thread makes 10° with the vertical. Find the charge on each balloon (treat them as point charges).

REVIEW

13. What net force gives a 8 kg object an acceleration of 3 m/s^2?

14. What net force gives a 60 kg object an acceleration of 1.5 m/s^2?

15. Use Newton's law of gravitation to find the force between Earth (5.972×10^{24} kg) and the Moon (7.35×10^{22} kg), 3.844×10^{8} m apart. Then say what would happen to the force if the distance were halved.

Lesson 3.2 — Circuit Lab: Ohm's Law, Series and Parallel with a Multimeter

FLUENCY

1. A 1.5 V source is connected across a 5 Ω resistor. What current flows?

2. A 12 V source is connected across a 2 Ω resistor. What current flows?

3. Resistors of 15 Ω and 12 Ω are in series across 12 V. Find the total resistance, the current and the voltage across each resistor.

4. Resistors of 6 Ω and 12 Ω are in series across 1.5 V. Find the total resistance, the current and the voltage across each resistor.

5. Resistors of 12 Ω and 30 Ω are in parallel across 6 V. Find the equivalent resistance and the total current.

6. Resistors of 4 Ω and 6 Ω are in parallel across 120 V. Find the equivalent resistance and the total current.

7. Three resistors (100, 220 and 330 Ω) are in series across 9.0 V. Find the current and the voltage across the 220 Ω resistor.

8. 100, 150 and 300 Ω resistors are in parallel across 6.0 V. Find the equivalent resistance and the total current.

APPLICATION

9. A 1,500 W electric kettle runs on 120 V. Find its current and resistance, and the cost of running it 30 min a day for 30 days at $0.32/kWh (illustrative rate).

10. Two identical 12 Ω bulbs are connected to a 6.0 V battery, first in series and then in parallel. Find the power of each bulb in each case. Which arrangement is brighter?

11. A student connects the multimeter on its current setting directly across a battery to "measure the battery's current". What happens and why?

CHALLENGE

12. A 100 Ω resistor is in series with a parallel pair of 200 Ω and 300 Ω, across 12 V. Find the total current and the voltage across the parallel pair.

REVIEW

13. A motor does 3000 J of work in 10 s. What is its power output?

14. A motor does 600 J of work in 30 s. What is its power output?

Lesson 3.3 — Do Currents Make Magnetic Fields? Electromagnet Evidence and Argument

FLUENCY

1. A 9 V source is connected across a 5 Ω resistor. What current flows?
2. A 3 V source is connected across a 2 Ω resistor. What current flows?
3. Find the magnetic field 2.0 cm from a long wire carrying 5.0 A.
4. A solenoid has 300 turns over 10 cm and carries 0.50 A. Find the field inside.
5. If the current in a long straight wire doubles and you move twice as far away, what happens to the field?

6. Use the right-hand rule: current flows north in a wire lying on a table. Just above the wire, which way does a compass needle's north end point?

APPLICATION

7. At what distance from a wire carrying 10 A is the wire's field equal to Earth's field of about 50 μT?

8. How many turns per meter does an air-core solenoid need to make a 10 mT field with 2.0 A?

9. A student's electromagnet lifts 4 clips with 20 turns and 9 clips with 40 turns, but also lifts 1 clip with the circuit open. What does the open-circuit result mean, and does it weaken their claim that the current makes the field?

CHALLENGE

10. Two long parallel wires 5.0 cm apart carry 8.0 A each in the same direction. Find the field one wire makes at the other, and the force per meter on the second wire (F/L = BI). Do they attract or repel?

REVIEW

11. Find the gravitational potential energy gained when a 70 kg object is lifted 1.5 m ($g = 9.8\ m/s^2$).

12. A +3.0 μC charge is 0.20 m from a −2.0 μC charge. Find the force and its direction.

Lesson 3.4 — Fields, Induction and the Wind Turbines of Atchison County

FLUENCY

1. A device draws 8 A from a 120 V supply. What power does it use, and how much energy in 1 hour?

2. A device draws 2 A from a 12 V supply. What power does it use, and how much energy in 1 hour?

3. Find the electric field 3.0 cm from a +5.0 nC charge.

4. A proton sits in a 2.0×10^4 N/C field. Find the force and its acceleration ($m = 1.673 \times 10^{-27}$ kg).

5. How much energy does an electron gain crossing a 12 V battery, in joules?

6. A 200-turn coil of area 3.0×10^{-3} m^2 sees its field rise by 0.080 T in 0.050 s. Find the induced emf.

APPLICATION

7. A transformer has 600 primary turns and 50 secondary turns and is connected to 120 V AC. Find the secondary voltage. Would it work on a 6 V battery?

8. A wind farm sends 50 MW through lines with 8.0 Ω total resistance (illustrative). Compare the I^2R loss at 69 kV and at 230 kV.

9. Explain with energy conservation why it gets harder to turn a generator's crank when a bulb is connected.

CHALLENGE

10. An electron starts from rest and is accelerated through 500 V. Find its final speed ($m = 9.109 \times 10^{-31}$ kg).

REVIEW

11. A device takes in 1200 J and delivers 333 J of useful energy. What is its efficiency, and where did the rest go?

12. A balloon holds 2.0 L at 20 °C. At constant pressure, what is its volume at 60 °C?

Unit 3 checkpoint

1. Two +2.0 μC charges 0.30 m apart repel with _____ N.
2. If the distance between two charges is halved, the force
   A. halves
   B. doubles
   C. quadruples
   D. stays the same
3. True or false: A 1 V potential difference gives each coulomb 1 J of energy.
4. A 470 Ω resistor across 9.4 V carries _____ mA.
5. In a series circuit, which quantity is the same for every resistor?
   A. Voltage
   B. Current
   C. Power
   D. Resistance
6. 200 Ω and 300 Ω in parallel have an equivalent resistance of _____ Ω.
7. Which observation is the strongest evidence that a current produces a magnetic field?
   A. The wire gets warm
   B. A compass beside a wire swings only while current flows and reverses when the current reverses
   C. Iron is magnetic
   D. The battery is heavy
8. A wire carrying 3.0 A makes a field of _____ μT at 1.0 cm.
9. True or false: A strong magnet held still inside a coil keeps inducing a current.
10. Why does the grid transmit power at high voltage?
    A. High voltage travels faster
    B. For the same power, the current is smaller, and I²R losses fall with the square of the current
    C. Transformers only work at high voltage
    D. It is safer near homes
11. A transformer with 100 primary and 2,000 secondary turns on 12 V AC gives _____ V.
12. True or false: Testing four transmission designs in a circuit simulator before choosing one is an example of using a computer simulation to model the impact of proposed solutions.