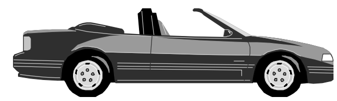
Period 1 Activity Solutions: Review of Physics 670

1.1 How Can Ratio Reasoning Be Used to Solve Problems?

Your instructor will review ratios. Use the technique of ratio reasoning to answer the questions in this section.

1) A car uses 16.5 gallons of gasoline to go 325 miles.



   a) How many miles per gallon does this car get?

   325 miles / 16.5 gal = 19.7 miles/gal

   b) If gasoline costs $1.59 per gallon, how much does it cost for the gas needed to go 547 miles in this car?

   547 ~~miles~~ x 1 gal / 19.7 ~~miles~~ = 27.7 gal

   $1.59 / ~~gal~~ x 27.7 ~~gal~~ = $44.04

2) Using the information on an electric bill, calculate the cost of electricity per kilowatt hour.

   $ monthly total cost / number of kilowatt hours = $cost /kWh

3) Ride the exercise bicycle to generate electricity and light the bulbs.

   a) If five 50-watt bulbs are lit, how many kilowatts of electricity are generated?

   5 ~~bulbs~~ x 50 watts / ~~bulb~~ = 250 ~~watts~~ x 1 kW / 1,000 ~~watts~~ = 0.25 kW

   b) If you ride the bicycle and generate this much electricity for 8 hours, how many kilowatt hours of electricity have you generated?

   0.25 kW x 8 h = 2 kWh

   c) If you sold the electricity you generated for $0.10/kWh, how much money would you receive for it?

   If electricity costs $0.10/ kWh, you would make only

   $0.10 / ~~kWh~~ x 2 ~~kWh~~ = $0.20

4) The gas company charges you for how many one hundred cubic feet (ccf) you use each month.

   a) Using the information on a gas bill, calculate the cost of natural gas per 100 cubic feet (ccf).

   $ monthly total cost / number of ccf = $cost /ccf

b) A gas hot water heater requires 5.6 x 10^{-3} ccf of natural gas to heat one gallon of water. Using the cost per ccf you calculated above, find the cost of heating a tank of 40 gallons of water with this gas heater.

If natural gas costs $1.54 per ccf, we find

$$\frac{5.6 \times 10^{-3}\ \text{ccf}}{1\ \text{gal}} \times 40\ \text{gal} \times \frac{\$1.54}{\text{ccf}} = \$0.345$$

c) If your family uses 710 40-gallon tanks of hot water per year, how much would it cost to heat this amount of water?

710 tanks of water x $0.345/tank = $244.95

d) A 40-gallon electric hot water heater requires 2.8 kilowatts of electricity to operate. The heater takes 2.3 hours to heat 40 gallons of water. If electricity costs $0.09 per kilowatt hour, how much does it cost to heat 40 gallons of water with this electric heater?

$0.09/kWh x 2.8 kW x 2.3 h = $0.580

e) If your family uses 710 40-gallon tanks of hot water per year, how much would it cost to heat this amount of water using the electric hot water heater described above?

710 tanks of water x $0.580/tank = $411.80

1.2 How are Ratios Used to Calculate Efficiency?

Your instructor will discuss ratios and the efficiency of energy processes.

5) Compare the relative efficiencies of an incandescent bulb and a compact fluorescent bulb.

a) Use a wattmeter to measure the power required by an incandescent bulb. ____________

b) Measure the power required by a compact fluorescent bulb. ____________

c) Find the ratio of the power required by the incandescent bulb to the power required by the compact fluorescent bulb.

$$\frac{\textbf{Power of incandescent bulb}}{\textbf{Power of compact fluorescent bulb}}$$

d) Measurements have shown that each of these bulbs produce 6 watts of visible light. Calculate the efficiency of the incandescent bulb.

Efficiency = 6 watts / watts measured in part 1)

e) Calculate the efficiency of the compact fluorescent bulb.

Efficiency = 6 watts / watts measured in part 2)

f) How do the efficiencies of the bulbs compare?

The compact fluorescent is much more efficient.

6) Group Discussion Question: Why is the compact fluorescent bulb so much more efficient than the incandescent bulb?

1.3 How Do Exponents and Scientific Notation Simplify Calculations?

Your instructor will review exponents and scientific notation.

7) A space probe has a mass of 6 x 10^3 kg and travels at a velocity of 4 x 10^2 m/s. How much kinetic energy does the probe have?

$$E_{kin} = \tfrac{1}{2} M v^2 = \tfrac{1}{2} (6 \times 10^3 \text{ kg}) \times (4 \times 10^2 \text{ m/s})^2 = 4.8 \times 10^8 \text{ J}$$

8) The space probe's rockets fire for 30 seconds to increase the probe's velocity from 4 x 10^2 m/s to 5.5 x 10^2 m/s. How much average force did the rockets exert to accelerate the space probe? (Neglect the decrease in mass of the space probe due to the rocket fuel burned.)

$$a = \frac{v_{final} - v_{initial}}{t} =$$

$$= \frac{(5.5 \times 10^2 \text{ m/s}) - (4 \times 10^2 \text{ m/s})}{30 \text{ s}} = \frac{1.5 \times 10^2 \text{ m/s}}{30 \text{ s}} = 5 \text{ m/s}^2$$

$$F = M a = (6 \times 10^3 \text{ kg}) \times 5 \text{ m/s}^2 = 30 \times 10^3 \text{ N} = 3 \times 10^4 \text{ N}$$

9) If the space probe is 9 x 10^6 meters from the Earth's surface, how large is the force of gravity between the probe and the Earth?

(Hint: The earth's mass = 5.98 x 10^{24} kg and the universal gravitational constant G = 6.67 x 10^{-11} N m^2/kg^2. Since the earth's radius = 6.37 x 10^6 meters, how far above the center of the earth is the probe?)

$$F = \frac{G\, M_{probe}\, M_{earth}}{D^2} = \frac{(6.67 \times 10^{-11} N\, m^2/kg^2) \times (6 \times 10^5 kg) \times (5.98 \times 10^{24} kg)}{(9 \times 10^6 m + 6.37 \times 10^6 m)^2} =$$

$$= \frac{239.3 \times 10^{18} N\, m^2}{(15.37 \times 10^6 m)^2} = \frac{239.3 \times 10^{18} N\, m^2}{236.2 \times 10^{12} m^2} = 1.01 \times 10^6\, N$$

1.4 What Is Electric Current? How Is It Induced?

10) An electron has a charge of 1.60 x 10^{-19} coulombs.

a) What total charge moves when 1 x 10^5 electrons move through a conductor?

$$\frac{(1.60 \times 10^{-19} \text{ coul})}{\text{electron}} \times (1 \times 10^5 \text{ electrons}) = 1.60 \times 10^{-14} \text{ coul}$$

b) How much current flows through the conductor, if these electrons flow for 2 seconds?

$$I = \frac{Q}{t} = \frac{1.60 \times 10^{-14} \text{ coul}}{2 \text{ s}} = 0.80 \times 10^{-14} \text{ A} = 8.0 \times 10^{-15} \text{ A}$$

11) **Magnetic Force on a Current** Your instructor will review induced current and induced magnetic fields.

a) Place a wire between the ends of a large C shaped magnet. Briefly touch the ends of the wire to both terminals of a 3 battery tray. What happens to the wire?

The wire will either jump into the "C" of the magnet or out of it, depending on the direction of the current flowing through the wire.

Change the direction of the current flowing through the wire by switching the leads to the battery. Describe what happens.

The wire jumps in the opposite direction.

b) What causes the wire to move?

Current in the wire induces a magnetic field around the wire. This magnetic field is attracted to or repelled by the magnetic field of the C magnet.

12) **Induced Current and Magnetic Forces** Your instructor will demonstrate a large solenoid with an iron core, which is connected to a variable current source.

a) What happens when a solid ring is placed over the solenoid?

The ring levitates (jumps up). The changing magnetic field created by the solenoid induces a changing current in the ring. This current creates a changing magnetic field around the ring. The two magnetic fields repel, causing the ring to jump.

b) What happens when a ring with a slit is placed over the solenoid?

Nothing happens. The ring does not jump because the slit in the ring creates an open circuit. Current cannot flow around the ring, so the ring has no induced magnetic field around it.

1.5 What Determines Exponential Growth and Decay Rates?

Your instructor will discuss linear and exponential growth and exponential decay.

13) Roll the 20 dice in the plastic cup onto your table and remove any dice that land with a "1" showing. Repeat for 20 throws, each time removing any dice showing a "1." After each roll, record below the number of dice left after you remove the dice showing a "1." When each table has completed 20 throws, we will combine the data for all groups.

Roll	Dice Left	Dice Left		Roll	Dice Left	Dice Left
	Your table	All tables			Your table	All tables
1				11		
2				12		
3				13		
4				14		
5				15		
6				16		
7				17		
8				18		
9				19		
10				20		

14) On the graph, using the totals for all groups, plot the number of dice left versus the number of rolls of the dice.

What type of change does this graph line represent? **Exponential decay**

15) What is the halving time in terms of the number of rolls? ________________