Chemistry: Ch. 5 Worksheet: Name: Answer Key

1. Fill in the following chart.

Isotope	Symbol	Mass Number	# of Protons	# of Neutrons	#of Electrons
Calcium-42	^{42}Ca	42	20	22	20
Sulfur-34	^{34}S	34	16	18	16
lead-206	^{206}Pb	206	82	124	82

2. Write the equation for calculating the wavelength and frequency of a photon of light.

$c = \lambda \cdot \nu$

3. Write the equation for calculating the energy of a wavelength of light knowing its frequency.

$E = h \cdot \nu$

4. Which of the following represents the shortest wavelength? Show your work. b. is the shortest wavelength

a) 3.5×10^{-6} m b) 6.3×10^{-5} cm c) 7350 nm

$6.3\times10^{-5}\text{ cm} \cdot \frac{1\text{ m}}{100\text{ cm}} = 6.3\times10^{-7}\text{ m}$

$7350\text{ nm} \cdot \frac{1\text{ m}}{1000\text{ nm}} = 7.350\text{ m}$

5. A source produces red light of wavelength 7.0×10^2 nm. What is this wavelength in Å? (Å is the abbreviation for angstrom, which is 10^{-10} m)

$7.0\times10^{2}\text{ nm} \cdot \frac{10\text{ Å}}{1\text{ nm}} = 7.0\times10^{3}\text{ Å}$

6. KTGL broadcasts at a frequency of 92.9 MHz (Megahertz). What is the wavelength for this wave?

$c = \lambda \cdot \nu$

$\lambda = c/\nu$

$\frac{2.998\times10^{8}\text{ m}}{\text{s}} \cdot \frac{\text{s}}{92.9\times10^{6}} = 3.23\text{ m}$ (radio wave = long wave)

7. What is the energy in kJ for light with wavelength 250 nm?

$E = h \cdot \nu$

$E = h \cdot c/\lambda$

$6.626\times10^{-34}\text{ J}\cdot\text{s} \cdot \frac{2.998\times10^{8}\text{ m}}{\text{s}} \cdot \frac{1}{250\text{ nm}} \cdot \frac{1\times10^{9}\text{ nm}}{1\text{ m}} = 7.9\times10^{-19}\text{ J}$

8. Excited lithium atoms emit visible light that has a frequency of 4.47×10^{14} s^{-1}. What is the wavelength and energy of this radiation? Predict the color of light this radiation represents.

V I B G Y O R

380 nm

750 nm

670 nm

$\lambda = c/\nu$

$\frac{2.998\times10^{8}\text{ m}}{\text{s}} \cdot \frac{\text{s}}{4.47\times10^{14}} \cdot \frac{1\times10^{9}\text{ nm}}{1\text{ m}} = 670\text{ nm}$ (orange)

$E = h \cdot \nu$

$6.629\times10^{-34}\text{ J}\cdot\text{s} \cdot \frac{4.47\times10^{14}}{\text{s}} = 2.96\times10^{-19}\text{ J}$

9. Molybdenum metal must absorb radiation with a minimum frequency of 1.09×10^{15} s^{-1} before it can emit an electron from its surface via the photoelectric effect.

a. What is the minimum energy required to produce this effect?

$E = h \cdot \nu$

$6.626\times10^{-34}\text{ J}\cdot\text{s} \cdot \frac{1.09\times10^{15}}{\text{s}} = 7.22\times10^{-19}\text{ J}$

b. What wavelength of radiation will provide a photon of this energy?

$\lambda = \frac{c}{\nu}$

$\frac{2.998\times10^{8}\text{ m}}{\text{s}} \cdot \frac{\text{s}}{1.09\times10^{15}} = 2.75\times10^{-7}\text{ m}$

(275 nm)

10. Solve the following problems

a. A very large sample of iron filings was estimated at 4.5×10^6 g, what is this in tons?

$$\frac{4.5\times10^{6}\,g}{} \cdot \frac{1\,kg}{1000\,g} \cdot \frac{2.2046\,lbs}{1\,kg} \cdot \frac{ton}{2000\,lbs} = 5.0\ tons$$

b. The depth of a column of water is 45.67 dm, what is this in inches?

$$\frac{45.67\,dm}{} \cdot \frac{10\,cm}{1\,dm} \cdot \frac{1\,in}{2.54\,cm} = 179.8\ in$$

c. The barometric pressure outside is 1.405×10^4 g/cm^2. If 1 atmosphere of pressure equals 14.7 lb/in^2, what is this barometric pressure in atmospheres?

$$\frac{1.405\times10^{4}\,g}{cm^2} \cdot \frac{1\,kg}{1000\,g} \cdot \frac{2.2046\,lbs}{1\,kg} \cdot \frac{2.54^2\,cm^2}{1\,in^2} \cdot \frac{in^2 \cdot 1\,atm}{14.7\,lbs} = 13.59\ atm$$

d. The diameter of a U.S. penny is 19 mm. The diameter of a copper atom, by comparison, is 1.57 Å. How many copper atoms could be arranged side by side in a straight line across the diameter of a penny?

$1\,Å = 10^{-10}\,m$

$mm = 10^{-3}\,m$

$10^7\,Å = 1\,mm$

$$\frac{19\,mm}{penny} \cdot \frac{1\times10^{7}\,Å}{1\,mm} \cdot \frac{1\ Cu\ atom}{1.57\,Å} = 1.2\times10^{8}\ Cu\ atoms$$

e. The nuclei of atoms are very small and contain in excess of 99% of an atom's mass. Let's assume that the nucleus of a hydrogen atom is 1.0×10^{-4} Å across. Given that 1 amu = 1.66054×10^{-24} g;

1. What is the density of an average hydrogen nucleus in g/cm^3? You will need to find the volume of the hydrogen nucleus. Assume it is spherical

$d = \frac{m}{V}$

$V = \frac{4}{3}\pi r^3$

$$\frac{1.01\,amu\ H}{} \cdot \frac{1.66054\times10^{-24}\,g}{1\,amu} \cdot \frac{3}{4} \cdot \frac{1}{\pi} \cdot \frac{1}{(0.5\times10^{-4}\,Å)^3} \cdot \frac{(1\times10^{8}\,Å)^3}{1\,cm^3} = 3.2\times10^{12}\ g/cm^3$$

2. If a drop of water (sphere with a radius of 5 mm) had the same density, what would its mass be?

$V = \frac{4}{3}\pi r^3$

$$\frac{3.2\times10^{12}\,g}{1\,cm^3} \cdot \frac{4}{3} \cdot \pi \cdot (0.5\,mm)^3 \cdot \frac{1\,cm^3}{10^3\,mm^3} = 1.68\times10^{9}\,g = 2\times10^{9}\,g$$

$m = d \cdot V$

$$\frac{1.68\times10^{9}\,g}{} \cdot \frac{1\,kg}{1000\,g} \cdot \frac{2.2046\,lbs}{1\,kg} \cdot \frac{1\,ton}{2000\,lbs} = 1850\ tons$$

train car full of coal = 132 tons

$$\frac{1850\,tons}{} \cdot \frac{1\,train\,car}{132\,ton} = 14\ train\ cars = 1\ drop\ of\ H_2O$$