**Chemistry 105**
**Homework Set # 1 (25 points)**
**Due Saturday, September 22**

These questions are from chapters 1-3 of *Chemistry for Changing Times* and Chapters 1 & 6 of *Colour*. You will also find helpful information in the virtual lecture notes for Discussions 1-3.

**Scientific Notation, Unit Conversions and the scientific method.**

1. Write the following numbers in standard notation: *(See text, Appendix A.2 and Discussion 1 Notes)*

   (a) $1.90 \times 10^5$

   (b) $2.8 \times 10^{-3}$

   (c) $3.77 \times 10^2$

   (d) $4.6 \times 10^{-2}$

   (e) $5.05 \times 10^4$

   (f) $6.40 \times 10^{-4}$

   (g) $7.3 \times 10^{-3}$

   (h) $8.2 \times 10^6$

   (i) $9.111 \times 10^{-1}$

2. Write each of the following measured numbers in scientific notation with the correct number of significant figures. *(See Notes for Discussion 1 and text, Appendices A.2 and A.4, page A-9)*

   (a) 0.00022

   (b) $4,400,000$

   (c) 0.0000601

   (d) $88,000$

   (e) 0.01010

   (f) 0.12

   (g) $14,200$

   (h) 1600

3. Chapter 1 discusses the steps involved in the scientific method. Describe the scientific method in your own words.

4. Describe the difference between a hypothesis and a theory. Include the characteristics of a scientific hypothesis.

5. Review Sections 1.10 (pages 16-21) and Appendix A.3 (pages A-5 through A-8) in the text and complete the following problems. Show all your work, including conversion factors.

   (a) Convert 180 eggs into dozens.

   (b) Convert 500 millimeters into meters.

   (c) Convert 4.2 liters into milliliters.

   (d) Convert 12 centimeters into millimeters.

   (e) Convert 3 pints into liters.

   (f) Convert 1.45 meters into inches.

   (g) Convert 65 miles per hour into kilometers per second.

   (h) At a speed of 60 miles per hour, how many minutes will it take to drive 250 kilometers? (hint: start with 250 kilometers and use 60 miles = 1 hour as a conversion factor, then convert hours to minutes.

**Light: Frequency, Wavelength and Energy**

Review the notes for Discussion 1 before completing these problems. Some additional information is provided here:

As we have see in the notes for Discussion 1, light has a dual nature. Sometimes it is convenient to think about light as a wave, and sometimes we must think about light as composed of particles. Photons, or light particles, were introduced to explain puzzling experimental results that could not be explained by the wave model. These experiments suggested that light consisted of small packets of energy, rather than appearing as a continuum of energy. Energy from light was found to be transferred in these small discrete clumps, rather than in arbitrary amounts.

The energy of a photon (E) is related to its wavelength ($\lambda$) by:

$$E = h\nu = \frac{hc}{\lambda}$$

Where $h$ is a constant known as Planck's constant with a value of $6.626 \times 10^{-34}\ J\ s$ ($J$ = Joules, an energy unit). Note the inverse relationship between wavelength and energy. A shorter wavelength corresponds to a higher energy, whereas a longer wavelength corresponds to a lower energy. This particle-like nature of light becomes very important when we consider how light interacts with matter. The amount of energy a photon has dictates how the photon can interact with atoms and molecules.

*Example: What is the energy of a photon with a wavelength of 400 nm?*

*Convert nm to m:*

$$\frac{400\ nm}{} \times \frac{1 \times 10^{-9}\ m}{1\ nm} = 4.0 \times 10^{-7}\ m$$

*Use the equation above to calculate E:*

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J\ s)(3.00 \times 10^{8}\ m/s)}{4.0 \times 10^{-7}\ m} = 5.0 \times 10^{-19}\ J$$

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6. Convert 535 nm into meters. What color of light does this correspond to?

7. Ultraviolet light has wavelengths in the $4 \times 10^{-4}$ m to $1 \times 10^{-9}$ m range. Convert this range to micrometers ($\mu m$).

8. Angstroms (Å) is a length unit commonly used in chemistry. There are $1 \times 10^{10}$ Å in one meter. Convert the visible wavelength range of 400-700 nm into Angstroms.

9. Light travels at a speed of $3.00 \times 10^8$ $m/s$. Convert this to miles per hour.

10. What is the frequency of light ($\nu$) associated with a wavelength of 620 nm? *(See Discussion 1 Lecture Notes)*

11. What is the wavelength of light associated with a frequency of $8.22 \times 10^{14}$ per second? *(Discussion 1 Lecture Notes)*

12. What is the energy (in Joules) of a photon with a wavelength of 420 nm?

13. What is the energy (in Joules) of a photon with a wavelength of 590 nm (orange light)?

14. Which has more energy: yellow light or orange light? Explain.

15. Which has more energy: ultraviolet light or gamma rays? Explain.

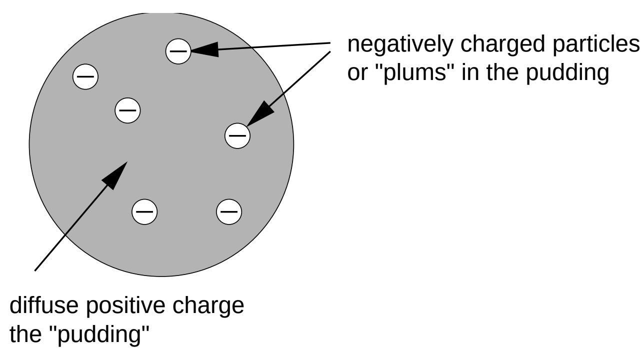
**Atomic Structure**

16. The element potassium has three naturally occurring isotopes: $^{39}K$, $^{40}K$ and $^{41}K$. How many protons, neutrons and electrons does each isotope have? *(See text, section 3.5)*

17. Complete the following table for electrically neutral atoms of the given isotope: *(See text, section 3.5)*

| Symbol | Atomic number | Mass number | number of protons | number of neutrons | Number of electrons |
|---|---|---|---|---|---|
| | 18 | 38 | | | |
| $^{15}_{7}N$ | | | | | |
| | | | 1 | 1 | |
| | | 34 | | | 16 |
| | 3 | | | 4 | |
| | | | | 46 | 38 |

18. In the early 1900's a common model for the structure of the atom was the plum pudding model. In this model, negatively charged electrons reside in the atom surrounded by a diffuse, continuous medium of positive charge (like plums in a pudding, or for a more modern analogy, like chocolate chips in a cookie).




(a) In 1911 Earnest Rutherford carried out an experiment that changed the was we view the atom. Describe this gold foil experiment. *(See Section 3.4 in the text)*

(b) How is the plum pudding model inconsistent with Rutherford's experimental findings? Approach this by considering the plum pudding hypothesis, and then predict what you would have expected to happen in Rutherford's experiment if the plum pudding model was true. *(See Chapter 1, Section 1.3 for information regarding the scientific method.)*

(c) Draw a picture of Rutherford's model of the atom. Use your picture to describe why most of the alpha particles pass through the gold foil in Rutherford's experiment.