Conceptual Physics Review
Chapter 17, Periodic Table, 18.2, Significant Figures

Chapter 17 & Periodic Table of Elements

- Describe atoms and elements.
- Compare the ages of atoms to the ages of the materials they compose.
- Give examples that illustrate the small size of atoms.
- Describe molecules.
- Describe compounds.
- Know the relative masses and charges of the subatomic particles, as well as their locations in the atom.
- Explain the organization of the periodic table referring to the significance of both the period and the group an element is in, as that position relates to the arrangement of electrons in the atom.
- Describe the solid, liquid, gaseous, and plasma states of matter.
- Know what the atomic number of an element tells you about that element.
- Know what the average atomic mass of an element tells you about that element, and explain why it is not a whole number.
- Describe, briefly, how the electrons are arranged around the nucleus of an atom.
- Describe the result if the number of protons in an atom is changed.
- Describe the result if the number of neutrons in an atom is changed.
- Describe the result if the number of electrons in an atom is changed.
- What is an isotope? What is meant by carbon-12 and what is meant by carbon-14? How do these two isotopes of carbon differ from each other and how are they alike?
- What is an ion? How do atoms form ions? Which group of elements never forms ions?

Chapter 18 (section 18.2)

- Define mass density.
- Explain why density is the same for different amounts of the same material.

Significant Figures

- Distinguish between precision and accuracy for data.
- Define precision for an instrument.
- Describe what is meant by uncertainty in measurement and explain how many digits a measurement should include.
- Be able to count how many significant figures a particular measurement has.
- Know and apply the rules for how many sig figs the answer to a multiplication or division problem should have.
- Know and apply the rules for how many sig figs the answer to an addition or subtraction problem should have.

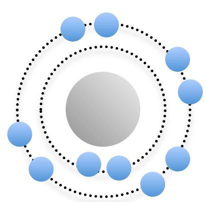
Sample Calculations

1. Fill in the table:

Symbol (Atom or Ion)	Atomic #	Average Atomic Mass	Mass # of most common isotope	# of Protons	# of Neutrons in most common isotope	# of Electrons
Xe	54	131.29	131	54	77	54
Se^{2-}	34	78.96	79	34	45	36
Ca	20	40.078	40	20	20	20
Cs^{-}	55	132.905	133	55	78	56
P	15	30.973	31	15	16	15
I^{-}	53	126.904	127	53	74	54
N^{3-}	7	14.007	14	7	7	10
Li^{+}	3	6.941	7	3	4	2
He	2	4.003	4	2	2	2
Sr^{2+}	38	87.62	88	38	50	36

2. How many protons are in a neutral atom of flourine?
   9
3. How many electrons are in a neutral atom of flourine?
   9
4. How many neutrons are in a typical neutral flourine atom?
   10
5. Draw a symbol for the flourine ion that has gained one electron.
   F^{-}
6. How many neutrons does a typical neutral atom of rubidium contain?
   48
7. A calcium ion has a charge of +2. What does this mean? Draw the symbol.
   A charge of +2 means that the calcium atom has lost 2 negatively-charged electrons, so it has two more protons then electrons in the atom—thus, its overall charge is +2. The symbol is Ca^{2+}
8. Carbon-12, Carbon-13 and Carbon-14 are all isotopes of carbon. What are the similarities and differences between these isotopes?
   All three isotopes have 6 protons and (if electrically neutral) 6 electrons. The number after "Carbon" refers to the atomic mass of the atoms. Thus, they differ in that they have different numbers of neutrons. C-12 has 6 neutrons, C-13 has 7, and C-14 has 8.

9. What does it mean when a neutral sodium atom loses one electron? Draw a diagram to aid in your explanation. Why does the sodium atom tend to lose one electron?
   A neutral sodium atom has a lone electron in its outermost ("valence") shell, which it can easily lose. A diagram of sodium after it loses this outermost shell is shown here. A "complete octet" of electrons in the outermost ("valence") shell is more stable.



10. How many electron shells (energy levels) does a neutral calcium atom have? How many electrons are in its outermost shell? How can you answer these two questions using the location of Ca on the periodic table?
Calcium is in Period 4, which means that it has 4 electron shells (if neutral). It's in Group 2, which means that it has 2 electrons in that outermost shell.

11. How many electron shells does a calcium ion (+2 charge) have? How many electrons are in its outermost shell? What element (in its neutral state) has the same electron arrangement as the calcium ion?
The +2 charge indicates that 2 electrons have been removed from the Calcium atom, making it a Calcium ion. It's outermost shell is now shell 3, with a "complete octet" of 8 electrons. This is the same electron arrangement as in a stable atom of Argon.

12. If the ion formed from magnesium and the ion from fluorine were to form a compound, what ratio would they combine to make the compound electrically neutral? Write the formula for the compound.
Magnesium makes an Mg^{2+} ion, and Flourine makes an F^- ion. To make an electrically neutral compound, we'd need to have equal numbers of charges. It would take 2 flourine ions to balance the 2 positive charges in the single magnesium ion, so the compound would be MgF_2

13. Label each of the following substances as an element or a compound.
    a. N_2 ___element___
    b. Li_2O ___compound___
    c. Mg ___element___

14. Label each of the following substances as a molecule or an atom.
    a. N_2 ___molecule___
    b. H_2O_2 ___molecule___
    c. Ar ___atom___

For problems 16-23, refer to Table 18.1 on p. 261 of your textbook as necessary.

15. Which has a greater density – one kilogram of ice or one kilogram of water (at 4°C)?
A kilogram of water at 4°C is more dense than a kilogram of ice. That's why ice floats!
16. Which has a greater mass – one cubic meter of iron or one cubic meter of gold?
Gold is more dense than iron. An equal volume of both metals means that the gold would have a greater mass.
17. Which has a greater volume – one kilogram of lead or one kilogram of platinum?
Platinum is more dense than lead. If we have the same mass of both metals, the less dense metal must take up a greater volume. Thus, the lead has a greater volume.
18. Which has a greater density – one kilogram of lead or two kilograms of lead?
They both have the same density.
19. Which has a greater density – a single uranium atom or Earth?
Uranium is one of the densest elements, while the earth is composed of many different materials, most of which are less dense than uranium. So the uranium atom, as small as it is, is denser,
20. Which has a greater volume – 10 kg of lead or 5 kg of aluminum?
You could calculate the volume of each one, but it's easier just to look at their relative densities. Lead is more than 4 times as dense as aluminum, so it takes up 4 times less *space for an equal mass. Here, even with double the mass, we still aren't taking up as much space as the aluminum, so aluminum has a greater volume.*

21. What is the mass of 5.4 m^3 of aluminum?

$$\frac{5.4m^3}{1} \times \frac{(100cm)^3}{(1m)^3} \times \frac{2.7g}{cm^3} = 1.5 \times 10^7 g$$

22. What is the volume of 6.72 kg of platinum?

$$\frac{6.72kg}{1} \times \frac{1000g}{1kg} \times \frac{1cm^3}{21.4g} = 314cm^3$$

23. What is the weight (in Newtons) of 1.0 cubic meters of cork? The density of cork is 200.0 kg/m^3.

$$\frac{1.0m^3}{1} \times \frac{200.0kg}{m^3} \times \frac{9.80N}{1kg} = 2.0 \times 10^3 N$$

24. Find the density of a 5.0-kg solid cylinder that is 10.0 cm tall with a radius of 3.0 cm.

$$density = \frac{mass}{volume} = \frac{5.0kg}{\pi r^2 h} = \frac{5.0kg}{\pi(0.030m)^2(0.100m)} = 1.8 \times 10^4 kg/m^3$$

25. The planet Saturn has a mass of 5.69×10^{26} kg and a volume of 8.01×10^{23} m^3. What is the density of Saturn?

$$density = \frac{mass}{volume} = \frac{5.69 \times 10^{26} kg}{8.01 \times 10^{23} m^3} = 710.\ kg/m^3$$

26. You are handed a 5.00×10^{-3} kg coin and told that it is gold. You discover (by using water displacement) that the coin has a volume of 5.90×10^{-7} m^3. Is the coin really gold, or simply a good imitation?

We can find out if the coin is gold by calculating its density and comparing it with that of gold (density = 19.3 g/ml).

$$density = \frac{mass}{volume} = \frac{5.00 \times 10^{-3} kg}{5.90 \times 10^{-7} m^3} \times \frac{1000g}{1kg} \times \frac{(1m)^3}{(100cm)^3} \times \frac{1cm^3}{1ml} = 8.47 g/ml$$

The coin would appear to be a fake.

27. For each of the following pairs, circle the quantity that is greater.

a. 1 nm **(1 mm)**

b. **(1 Gm)** 1 pm

c. 1 kHz **(1 MHz)**

d. 1 m **(1 Mm)**

e. **(1 g)** 1 cg

f. 1 μm **(1 km)**

28. For each of the following conversions, SHOW your steps, including conversion factors WITH UNITS.

a. 470 nm to pm $\quad 4.7 \times 10^2 \text{ nm} \times \frac{10^{-9}\text{ m}}{1\text{ nm}} \times \frac{1\text{ pm}}{10^{-12}\text{ m}} = 4.7 \times 10^5 \text{ pm}$

b. 4.9 Gm to km $\quad 4.9 \text{ Gm} \times \frac{10^9\text{ m}}{1\text{ Gm}} \times \frac{1\text{ km}}{10^3\text{ m}} = 4.9 \times 10^6 \text{ km}$

c. 2.4 g to mg $\quad 2.4 \text{ g} \times \frac{1\text{ mg}}{10^{-3}\text{ g}} = 2.4 \times 10^3 \text{ mg}$

d. 5.5×10^{14} Hz to MHz $\qquad 5.5\times10^{14}\text{ Hz}\times\frac{1\text{ MHz}}{10^{6}\text{ Hz}}=5.5\times10^{8}\text{ MHz}$

e. $(20.0\text{ m}\times5.0\text{ m}\times3.0\text{ m})$ to mm^3

$$20.0\text{m}\times5.0\text{m}\times3.0\text{m}=\frac{300\text{m}^3}{1}\times\frac{(10^3\text{mm})^3}{(1\text{m})^3}=3.0\times10^{11}\text{mm}^3$$

f. 1.40 g/mL to kg/L $\qquad \frac{1.40\text{g}}{\text{mL}}\times\frac{1\text{kg}}{1000\text{g}}\times\frac{1000\text{mL}}{1\text{L}}=1.40\text{kg/L}$

29. How many significant figures does each of the following measurements have?

a. 0.0002020 g
4 sig figs
b. 4.000 m
4 sig figs
c. 40.0 cm
3 sig figs
d. 5000 miles
1 sig fig
e. 3.42 inches
3 sig figs
f. 2.5 seconds
2 sig figs
g. 0.00101 kg
3 sig figs
h. 7070 m
3 sig figs
i. 13225 cm
5 sig figs
j. 20.01 mm
4 sig figs
k. 0.9906 cg
4 sig figs
l. 0.00760 ml
3 sig figs

30. For each problem, calculate the solution and leave your answer with the correct number of significant figures.

a. $3.4\text{ cm}\times5239\text{ cm}=$ 1.8e4 cm^2

b. $5.0\text{ ft}/(1.00\times10^2)$ minutes = 5.0e-2 ft/min

c. 4001.6 miles / 2.5 hours = 1.6e3 miles/hour

d. $55.5\text{ mm}\times32\text{ mm}=$ 1.8e3 mm^2

e. 0.099 kg / 0.110 L = 0.90 kg/L, or 9.0e-1 kg/L

f. $720\text{ m}\times(3.0\times10^1)\text{ m}=$ 2.2e4 m^2

31. For each problem, calculate the solution and leave your answer with the correct number of significant figures.

a. 4.25 m + 2.1 m = 6.4 m (using mathematical "0.5 rounds up" rule, which skews data!)

b. 52.4 ft – 0.5 ft = 51.9 ft

c. 1248.72 m + 36 m = 1285 m

d. 1.087 km – 0.056 km = 1.031 km

e. 33.6 L + 0.033 L = 33.6 L

f. 220.1 g + 0.17 g = 220.3 g