Sample Calculations

Key

1. Fill in the table:

Symbol (Atom or Ion)	# of protons	# of neutrons (approximate)	# of electrons
Ca^{2+}	20	20	18
Br^-	35	45	36
Xe	54	77	54
Rb^+	37	48	36
P^{3-}	15	16	18
S^{2-}	16	16	18

2. What happens when two protons are added to a neutral carbon atom?

It becomes an oxygen atom ($6p^+ + 2p^+ = 8p^+$ - atomic # of O)

3. What happens when a neutral sodium atom loses one electron?

It becomes an ion w/ +1 charge. (Na^+)

4. Why does a sodium atom tend to lose one electron?

It will be more stable with a complete outer shell, so it loses its single valence electron.

5. 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?

a. 4 shells b/c it's in period 4.

b. 2 e^- in outermost shell (2 valence e^-) b/c it's in group #2.

6. 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?

Ca^{2+} has only 3 occupied shells b/c it lost 2 valence e^- in 4th shell. Ca^{2+} has 8 e^- in outermost shell - same e^- arrangement as Argon.

7. About how many molecules of air are in a liter (one breath) of air?

10^{23}

8. About how many liters of air are in the Earth's atmosphere?

10^{23}

9. What do the elements in group 2 (alkaline earth metals) have in common? How do they each differ from each other? Answer both questions in terms of the arrangement of their electrons around the nucleus.

All elements in group 2 have 2 valence e^-, but each element in group 2 has a different # of occupied shells.

10. What is the molar mass of nitrogen dioxide (NO_2)?

N = 14

O = 16

14(1) + 16(2) = 46 grams

11. What is the molar mass of carbon tetrachloride (CCl_4)?

C = 12
Cl = 35.5

12(1) + 35.5(4) = 152 grams

12. What is the molar mass of Argon (Ar)?

40 grams

For the following problems, show your calculations using conversion factors with units:

13. How many moles are in 17.2 grams of water? H_2O - molar mass 18 grams

$$17.2\text{g } H_2O \times \frac{1\text{ mole}}{18\text{g } H_2O} = 0.956\text{ moles } H_2O$$

14. How many moles are in 23.5 grams of water?

$$23.5\text{g } H_2O \times \frac{1\text{ mole}}{18\text{g } H_2O} = 1.31\text{ moles } H_2O$$

15. How many moles are in 43.8 grams of carbon dioxide (CO_2)? CO_2 - molar mass 44 grams

$$43.8\text{g } CO_2 \times \frac{1\text{ mole}}{44\text{g } CO_2} = 0.977\text{ mole } CO_2$$

16. How many molecules of water are there in 2.2 moles of water? 1 mole H_2O = 6.02 e 23 molecules

$$2.2\text{ moles } H_2O \times \frac{6.02\text{e}23\text{ molecules}}{1\text{ mole}} = 1.3 \times 10^{24}\text{ molecules}$$

17. How many molecules of carbon dioxide are there in 3.5 moles of carbon dioxide? 1 mole CO_2 = 6.02 e 23 molecules

$$3.5\text{ moles } CO_2 \times \frac{6.02\text{e}23\text{ molecules}}{1\text{ mole}} = 2.1 \times 10^{24}\text{ molecules}$$

18. How many molecules of oxygen gas (O_2) are there in 4.2 moles of oxygen gas? 1 mole O_2 = 6.02 e 23 molecules

$$4.2\text{ moles } O_2 \times \frac{6.02\text{e}23\text{ molecules}}{1\text{ mole}} = 2.5 \times 10^{24}\text{ molecules}$$

19. How many atoms are there in 2.2 moles of water? each molecule of water has 3 atoms

$$2.2\text{ moles } H_2O \times \frac{6.02\text{e}23\text{ molecules}}{1\text{ mole}} \times \frac{3\text{ atoms}}{1\text{ molecule}} = 3.9 \times 10^{24}\text{ atoms}$$

20. How many atoms are there in 3.5 moles of carbon dioxide? each molecule of CO_2 has 3 atoms

$$3.5\text{ moles } CO_2 \times \frac{6.02\text{e}23\text{ molecules}}{1\text{ mole}} \times \frac{3\text{ atoms}}{1\text{ molecule}} = 6.3 \times 10^{24}\text{ atoms}$$

21. How many atoms are there in 4.2 moles of oxygen gas? each O_2 molecule has 2 atoms

$$4.2 \text{ moles } O_2 \times \frac{6.02e23 \text{ molecules}}{1 \text{ mole}} \times \frac{2 \text{ atoms}}{1 \text{ molecule}} = \boxed{5.1 \times 10^{24} \text{ atoms}}$$

22. How many molecules are there in 34.9 grams of carbon dioxide? mass → moles → molecules

$$34.9 \text{ g } CO_2 \times \frac{1 \text{ mole}}{44 \text{ g } CO_2} \times \frac{6.02e23 \text{ molecules}}{1 \text{ mole}} = \boxed{4.77e23 \text{ molecules } CO_2}$$

(molar mass)

23. How many atoms are there in 5.2 grams of water? mass → moles → molecules → atoms

$$5.2 \text{ g } H_2O \times \frac{1 \text{ mole}}{18 \text{ g } H_2O} \times \frac{6.02e23 \text{ molecules}}{1 \text{ mole}} \times \frac{3 \text{ atoms}}{1 \text{ molecule } H_2O} = \boxed{5.2 \times 10^{23} \text{ atoms}}$$

24. How many atoms are there in 33.3 grams of oxygen gas?

$$33.3 \text{ g } O_2 \times \frac{1 \text{ mole}}{32 \text{ g } O_2} \times \frac{6.02e23 \text{ molecules}}{1 \text{ mole}} \times \frac{2 \text{ atoms}}{1 \text{ molecule } O_2} = \boxed{1.25 \times 10^{24} \text{ atoms}}$$

25. What is the mass of 3.5 moles of nitrogen dioxide?

$$3.5 \text{ moles } NO_2 \times \frac{46 \text{ g } NO_2}{1 \text{ mole}} = 161 \text{ g } NO_2 = \boxed{1.6 \times 10^2 \text{ g } NO_2}$$

(sig figs)

26. What is the mass of 4.4 moles of carbon dioxide?

$$4.4 \text{ moles } CO_2 \times \frac{44 \text{ g } CO_2}{1 \text{ mole}} = 193.6 \text{ g } CO_2 = \boxed{1.9 \times 10^2 \text{ g } CO_2}$$

(sig figs)

27. What is the mass of 5.7 moles of water?

$$5.7 \text{ moles } H_2O \times \frac{18 \text{ g } H_2O}{1 \text{ mole}} = \boxed{1.0 \times 10^2 \text{ g } H_2O}$$

28. What is the mass of 8.94×10^{24} molecules of water? molecules → moles → mass

$$8.94 \times 10^{24} \text{ molecules} \times \frac{1 \text{ mole}}{6.02e23 \text{ molecules}} \times \frac{18 \text{ g } H_2O}{1 \text{ mole}} = \boxed{267 \text{ g } H_2O}$$

29. What is the mass of 3.01×10^{23} molecules of carbon dioxide?

$$3.01 \times 10^{23} \text{ molecules} \times \frac{1 \text{ mole}}{6.02e23 \text{ molecules}} \times \frac{44 \text{ g } CO_2}{1 \text{ mole}} = \boxed{22.0 \text{ g } CO_2}$$

infinite # of sig figs b/c exact count

30. What is the mass of 100 molecules of water? Give your answer in amus *and* grams.

In grams: $100 \text{ molecules} \times \frac{1 \text{ mole}}{6.02\times10^{23} \text{ molecules}} \times \frac{18 \text{ g } H_2O}{1 \text{ mole}} = 2.99\times10^{-21} \text{ grams}$

In amus: each molecule is 18 amu, so $100 \text{ molecules} \times \frac{18 \text{ amu}}{1 \text{ molecule}} = 1800 \text{ amu}$

31. 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**

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

a) 470 nm = _____ pm $4.70\times10^{2} \text{ nm} \times \frac{10^{-9} \text{ m}}{1 \text{ nm}} \times \frac{1 \text{ pm}}{10^{-12} \text{ m}} = 4.70\times10^{5} \text{ pm}$

b) 4.9 Gm = _____ km $4.9 \text{ Gm} \times \frac{10^{9} \text{ m}}{1 \text{ Gm}} \times \frac{1 \text{ km}}{10^{3} \text{ m}} = 4.9\times10^{6} \text{ km}$

c) 2.4 g = _____ mg $2.4 \text{ g} \times \frac{1 \text{ mg}}{10^{-3} \text{ g}} = 2.4\times10^{3} \text{ mg}$

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

e) 720 μm = _____ m $7.20\times10^{2} \text{ μm} \times \frac{10^{-6} \text{ m}}{1 \text{ μm}} = 7.20\times10^{-4} \text{ m}$

f) 3.0×10^{8} m/sec = _____ km/hr $\frac{3.0\times10^{8} \text{ m}}{\text{sec}} \times \frac{3600 \text{ sec}}{1 \text{ hr}} \times \frac{1 \text{ km}}{10^{3} \text{ m}} = 1.08\times10^{9} \frac{\text{km}}{\text{hr}}$

33. Fill in the blanks.

a) 1 m = 10^{3} mm

b) 1 mm = 10^{-3} m

c) 4 g = 4×10^{-3} kg

d) 4 kg = 4×10^{3} g

e) 1 Mm = 10^{6} m

f) 1 m = 10^{-9} Gm

34. How many significant figures does each of the following measurements have? If it's ambiguous, explain why, and give examples of how the measurement could be rewritten to eliminate the ambiguity.

a) 0.0002020 g (4)

b) 4.000 m (4)

c) 40.0 cm (3)

d) 5000 miles ambiguous - could be: 5×10^3 (1 sig fig), 5.0×10^3 (2 sig figs), 5.00×10^3 (3 sig figs), 5.000×10^3 (4 sig figs)

e) 3.42 inches (3)

f) 2.5 seconds (2)

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

# of sig figs written below each #

a) 3.4 cm (2) x 5239 cm (4) = multiplication: 17812.6 cm^2 = $1.8 \times 10^4 cm^2$

b) 5280 ft (min 3 s.f.) / 3.0 (2 s.f.) = division: 1760 ft = 1.8×10^3 ft

c) 4001.6 miles (5) / 2.5 hours (2) = division: 1600.64 mi/hr = 1.6×10^3 mi/hr

36. For each problem, calculate the solution and leave your answer with the correct number of significant figures and proper units. Some problems might require unit conversions before you can perform the calculation!! # sig figs written below each #

a) 4.25 m (3) + 2.1 m (2) = addition:

4.25 m
+ 2.1 m
6.35 m ⇒ 6.4 m

digit of uncertainty is underlined

b) 52.4 ft (3) – 0.5 ft (1) = subtraction:

52.4 ft
− 0.5 ft
51.9 ft

c) 1248.72 m (6) + 36 mm (2) = addition - diff. units!

36 mm × $\frac{10^{-3}\ m}{1\ mm}$ = 0.036 m

1248.72 m
+ 0.036 m
1248.756 m ⇒ 1248.76 m