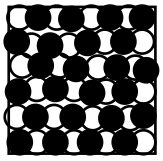
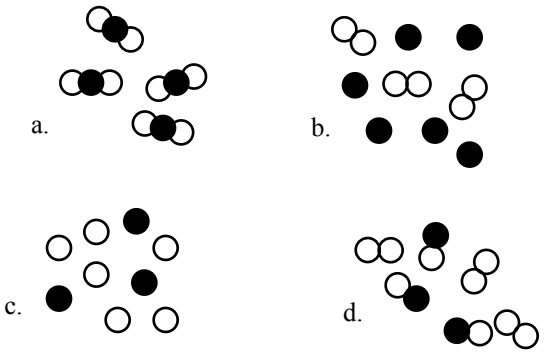
Practice MC Unit A **Atoms, Moles, Stoich and more** Name_____Per____

- ***This is practice - Do NOT cheat yourself of finding out what you are capable of doing. Be sure you follow the testing conditions outlined below.***
- ***DO NOT USE A CALCULATOR. You may use ONLY your periodic table and formula sheets.***
- ***Try to work the problems at a rate of average 1.5 minutes per question. Time yourself perhaps a page or two at a time. It is important that you practice working for speed. Then when time is up, continue working, with a calculator if you must, but use a different color writing utensil so you will have a sense of how many you were able to complete under the time constraints and without the calculator.***

1. The diagram to the right represents solid carbon dioxide, better known as dry ice. Which diagram below best represents Some of the dry ice after it sublimes into a gas?





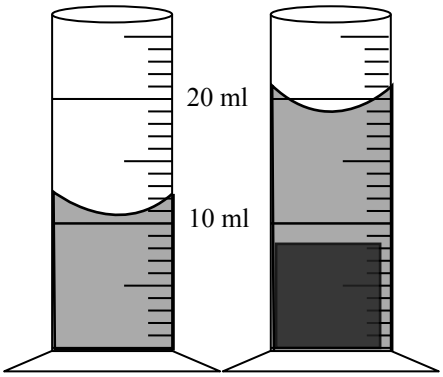
2. A precipitate occurs when a silver nitrate solution is reacted with excess sodium chloride solution. The best way to recover the silver chloride solid from the remaining solution would be
   a. decanting and drying
   b. filtration, washing, and drying
   c. distillation then condensation
   d. another chemical reaction

3. The table below contains data for mercury and water under normal air pressure conditions

substance	Melting Point (ºC)	Boiling Point (ºC)
mercury	−39	357
water	0.0	100

   Based on the data in the table, which of the following pairs of substances could exist at the same temperature?
   a. solid water and liquid mercury
   b. liquid water and solid mercury
   c. water vapor and solid mercury
   d. liquid water and mercury vapor

4. The density of aluminum is ~2.7 g/ml and the density of alcohol at room temperature is ~0.75 g/ml. Calculate the length of one side of the perfect cube of aluminum that is placed in the amount of ethanol in the left cylinder and is shown in the right cylinder.
   a. 2.0 cm
   b. 2.7 cm
   c. 6.0 cm
   d. 8.0 cm



5. Convert 35.6 nm to meters.
   a. 3.56×10^{-9} m
   b. 3.56×10^{-8} m
   c. 3.56×10^{9} m
   d. 3.56×10^{10} m

6. $3.2\ cm^3$ = _____ L
   a. 320 L
   b. 0.032 L
   c. 0.0032 L
   d. 3.2×10^{-6} L

7. $3.337\ g/cm^3$ = _____ kg/m^3
   a. $0.000337\ kg/m^3$
   b. $0.3337\ kg/m^3$
   c. $33.37\ kg/m^3$
   d. $3337\ kg/m^3$

8. How many significant figures in the measurement 0.00230 g?
   a. 2
   b. 3
   c. 4
   d. 5

9. Circle the best answer to the following calculation:

$$\frac{1.5}{0.04306} = 34.835114$$

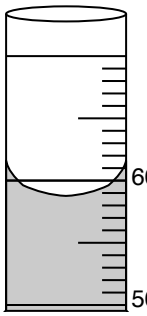
a. 34.8351
b. 34.84
c. 34.8
d. 35

10. The mass of a beaker was 126.81 g and the mass of the beaker with liquid in it was 129.61 g. The mass of the liquid in the beaker should be reported to how many significant figures?

a. 2
b. 3
c. 4
d. 5

11. Read the graduated cylinder to the right, and select the measurement that best represents the volume of fluid.

a. 61 ml
b. 59 ml
c. 58.8 ml
d. 58.85 ml



Note: The entire cylinder is not shown. Assume that it extends to 0

12. There are _____ electrons, _____ protons, and _____ neutrons in an atom of $^{132}_{54}Xe$

a. 54, 54, 78
b. 54, 54, 77
c. 54, 54, 132
d. 78, 78, 54

13. All isotopes of a particular element must have the same

a. number of electrons
b. number of protons
c. number of neutrons
d. number of protons and neutrons

14. Silver has two naturally occurring isotopes

$^{107}_{47}Ag$ $^{109}_{47}Ag$

The fractional abundance of the lighter of the two isotopes is closest to

a. 0.25
b. 0.45
c. 0.55
d. 0.75

15. The most abundant isotopes of hydrogen and oxygen are $^{1}_{1}H$, $^{2}_{1}H$, $^{16}_{8}O$, and $^{17}_{8}O$, respectively. Using these isotopes only, what is the number of different possible values for the molar mass of water in grams?

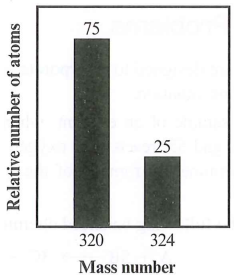
a. 2
b. 4
c. 5
d. 6

16. Which particle has 54 electrons?

a. $^{132}_{54}Xe^{+}$
b. $^{128}_{52}Te^{2-}$
c. $^{118}_{50}Sn^{2+}$
d. $^{137}_{56}Ba^{2-}$

17. An unnamed element with an atomic number of 130 is vaporized and injected into a mass spectrometer. The results are shown below. Use the data to calculate the average atomic mass of this element.

a. 320 amu
b. 321 amu
c. 322 amu
d. 323 amu



18. Element X reacts with sodium to form an ionic compound with the formula Na_3X. Element X must be a member of which group?

a. 1
b. 13
c. 15
d. 16

19. A certain nonmetallic element forms a compound with gallium having the general formula Ga_2X_3 Element X is a member of which group?

a. 2
b. 13
c. 15
d. 16

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20. Of the choices below, which one is NOT an ionic compound?
    a. PCl_5
    b. $RbCl_5$
    c. $PbCl_2$
    d. NaCl

21. Which of the following represents the correct method for converting 11.0 g of copper metal to the equivalent number of copper atoms?
    a. $11\left(\frac{1}{63.55}\right)\left(\frac{6.02\times10^{23}}{1}\right)$
    b. $11\left(\frac{1}{63.55}\right)$
    c. $11\left(\frac{63.55}{1}\right)\left(\frac{6.02\times10^{23}}{1}\right)$
    d. $11\left(\frac{1}{63.55}\right)\left(\frac{1}{6.02\times10^{23}}\right)$

22. The number of moles in 3.01×10^{24} atoms of carbon atoms
    a. 2
    b. 3
    c. 5
    d. 8

23. If 1.5×10^{23} atoms of an unknown element have a mass of 12 g, what is the molar mass of the element closest to?
    a. 3.0 g mol^{-1}
    b. 12 g mol^{-1}
    c. 24 g mol^{-1}
    d. 48 g mol^{-1}

24. The mass of element X found in 1.00 mole of each of four different compounds is 28.0 g, 42.0 g, 56.0 g, and 70 g, respectively. The possible atomic weight of X is
    a. 8.00
    b. 14.0
    c. 28.0
    d. 38.0

25. If 63 g of $H_2C_2O_4 \cdot 2\ H_2O$ (MM 126 g/mol) were heated to drive off the water of hydration, how much anhydrous $H_2C_2O_4$ would remain?
    a. 27 g
    b. 31 g
    c. 45 g
    d. 61 g

26. When a hydrate of $CuSO_4 \cdot ?\ H_2O$ weighing 24.95 g is heated until all the water is removed. The anhydrate weighs 15.95 g. What is the value of ? in the hydrated salt? (MM $CuSO_4$, 159.5 g/mol)
    a. 2
    b. 3
    c. 4
    d. 5

27. The simplest formula for a hydrocarbon that is 20.0 percent hydrogen by mass is
    a. CH
    b. CH_2
    c. CH_3
    d. CH_4

28. In which of the following compounds is the mass ratio of element X to oxygen closest to 2.5 to 1? (The molar mass of X is 40.0 g/mol.)
    a. X_5O_2
    b. X_2O
    c. XO_2
    d. XO

29. Determine the empirical formula when 1.04 g of chrome was burned in oxygen to produce 1.52 g of oxide product.
    a. CrO_2
    b. Cr_2O_3
    c. Cr_2O
    d. Cr_3O_2

30. A compound whose empirical formula is C_2H_4O has a molar mass of ~130 g mol^{-1}. What is the molecular formula of the compound?
    a. C_2H_4O
    b. $C_4H_8O_2$
    c. $C_6H_{12}O_3$
    d. $C_6H_{12}O_2$

31. Find the empirical formula for a compound only one element of which is a metal. The compound's percentage composition by mass is 40.0% metal, 12.0% C, and 48% O.
    a. $CaCO_3$
    b. Na_2CO_3
    c. $NaHCO_3$
    d. $SrCO_3$

32. When iron is heated in the presence of fluorine gas, the product of the reaction was found to contain nearly 50% by mass of each element. What is the empirical formula of this compound?
    a. Fe_2F
    b. FeF_2
    c. FeF_3
    d. Fe_3F

33. Balance the following equation:

    $$\_\_\_NH_3 + \_\_\_O_2 \rightarrow \_\_\_NO_2 + \_\_\_H_2O$$

    The balanced equation shows that 1.00 mole of NH_3 requires ___ mole(s) of O_2
    a. 1.25
    b. 1.33
    c. 1.75
    d. 3.5

34. When the following chemical equation is balanced using the lowest possible whole numbers, what is the sum of the stoichiometric coefficients?

    $$\_\_\_H_3PO_4 + \_\_\_ Mg(OH)_2 \rightarrow \_\_\_Mg_3(PO_4)_2 + \_\_\_H_2O$$

    a. 4
    b. 6
    c. 11
    d. 12

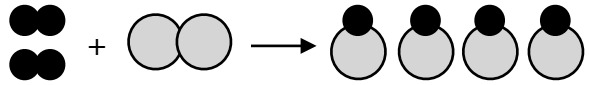
35. Calculate the mass of hydrogen formed when 27 g of aluminum reacts with excess hydrochloric acid according to the balanced equation below.

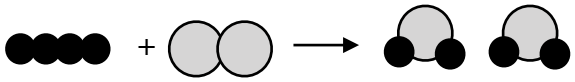
    $$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$$

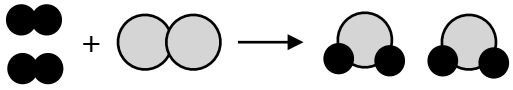
    a. 1.5 g
    b. 2.0 g
    c. 3.0 g
    d. 6.0 g

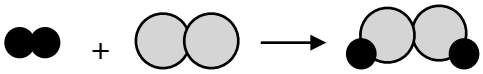
36. Consider the reaction between hydrogen (H_2) gas and oxygen (O_2) gas to form water. Write a balanced chemical equation in the space below.

    Which of the following particulate diagrams is the best representation of this reaction?

    (A) 

    (B) 

    (C) 

    (D) 

37. Calculate the mass of hydrogen formed when 27 g of aluminum reacts with excess hydrochloric acid according to the balanced equation below.

    $$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2$$

    a. 1.5 g
    b. 2.0 g
    c. 3.0 g
    d. 6.0 g

38. During the synthesis of a solid organic compound, the following data are collected / calculated.

mass of filter paper	1.6 g
mass of filter paper and dry compound	4.3 g
theoretical yield of dry compound	3.7 g

    Which shows the correct setup for the calculation of percentage yield?

    a. $\left(\frac{4.3-1.6}{3.7}\right)\times 100$
    b. $\left(\frac{1.6-4.3}{3.7}\right)\times 100$
    c. $\left(\frac{3.7-2.7}{3.7}\right)\times 100$
    d. $\left(\frac{3.7-1.6}{4.3}\right)\times 100$

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39. $4\,Al + 3O_2 \rightarrow 2\,Al_2O_3$

What mass of oxygen is required to react with 9.0 g of aluminum according to the reaction above?

a. 0.25 g
b. 6.75 g
c. 8.0 g
d. 27 g

40. The reaction of 7.8 g benzene, C_6H_6, with excess HNO_3 resulted in 0.90 g of H_2O. What is the percentage yield?

Molar Mass (g/mol): $C_6H_6 = 78$ $HNO_3 = 63$ $C_6H_5NO_2 = 123$ $H_2O = 18$

$$C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$$

a. 100%
b. 90%
c. 50%
d. 12%

41. When 2.00 g of H_2 reacts with 32.0 g of O_2 in an explosion, the final gas mixture will contain:
a. H_2, H_2O, and O_2
b. H_2 and H_2O only
c. O_2 and H_2O only
d. H_2O only

42. What mass of Al is produced when 0.500 mole of Al_2S_3 is completely reduced with excess H_2?
a. 2.7 g
b. 13.5 g
c. 27.0 g
d. 54.0 g

43. $N_2 + 3Cl_2 \rightarrow 2NCl_3$

When 1.40 g of N_2 reacts with 3.55 g of Cl_2, the final gas mixture will contain

Molar masses: $N_2 = 28$, $Cl_2 = 71$, $NCl_3 = 120.4$

a. N_2, Cl_2, and NCl_3
b. N_2 and NCl_3 only
c. Cl_2 and NCl_3 only
d. NCl_3 only

$$N_{2(g)} + 2O_{2(g)} \rightarrow N_2O_{4(g)}$$

44. The above reaction takes place in a closed flask. The initial amount of $N_{2(g)}$ is 8 mole, and that of $O_{2(g)}$ is 12 mole. There is no $N_2O_{4(g)}$ initially present. What is the total amount of mole of all substances in the container when the amount of $N_2O_{4(g)}$ reaches 6 mole?
a. 2 mole
b. 6 mole
c. 8 mole
d. 20 mole

$$N_{2(g)} + 2O_{2(g)} \rightarrow N_2O_{4(g)}$$

45. The above reaction takes place in a closed, rigid vessel. The starting moles of $N_{2(g)}$ is 1.0, and that of $O_{2(g)}$ is 1.5 atm. There is no $N_2O_{4(g)}$ initially present. *The experiment is carried out at constant volume and temperature.* What is the total number of moles in the container when the amount of moles of $N_2O_{4(g)}$ reaches 0.75 mol?
a. 0.75 mol
b. 1.0 mol
c. 1.75 mol
d. 2.5 mol

46. When a 16.8-gram sample of an unknown mineral was dissolved in acid, 4.4-grams of CO_2 were generated. If the rock contained no carbonate other than $MgCO_3$, what was the percent of $MgCO_3$ by mass in the limestone?
Molar mass (g/mol): $MgCO_3 = 84$ and $CO_2 = 44$
a. 33%
b. 50%
c. 67%
d. 80%

47. 11.2 g of metal carbonate, containing an unknown metal, M, were heated to give the metal oxide and 4.4 g CO_2.

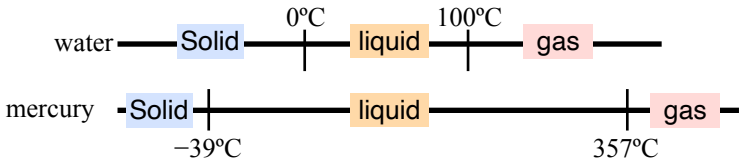
$$MCO_{3(s)} + \text{heat} \rightarrow MO_{(s)} + CO_{2(g)}$$

What is the identity of the metal M?
a. Mg
b. Ca
c. Cr
d. Cd

1. a When a substance sublimes, it converts from solid directly to gas. At atmospheric pressure, CO_2 does not melt, hence its name, "dry ice." When the solid CO_2 sublimes and turns to gas, the substance still remains CO_2 molecules.

2. b Decanting is effective, but without washing, ions remaining in the wetness on the silver chloride precipitate would end up as dried salt on the silver chloride precipitate.

3. a Sometimes when negative numbers are involved, thinking about phases can be confusing. A number line can help. Remember that at the melting temperature, both solid and liquid can exist, and at the boiling temperature, both liquid and gas can exist.



4. b In this problem, all that matters is that the block of aluminum displaces ~8 ml of liquid. It does not matter that the liquid is alcohol, the volume of alcohol displaced is 8 ml, thus the aluminum object is 8 ml. Since 8 ml = 8 cm^3, and because the object is a cube, $\sqrt[3]{8cm^3} = 2cm$ on each side.

5. b You need to know that there are 1×10^9 nanometers in every meter, thus $35.6nm\left(\frac{1m}{10^9\,nm}\right)$ which is equal to 35.6×10^{-9} m, which you should convert to standard scientific notation for 3.56×10^{-8} m

6. c You should know that 1 cm^3 = 1 ml, and of course that 1000 ml = 1 L, so 3.2 cm^3 is 3.2 ml, and converting to liters will be a smaller number by 3 decimal places.

7. d Unit conversions can be tricky with compound and derived units. $\left(\frac{3.337g}{cm^3}\right)\left(\frac{1kg}{1000g}\right)\left(\frac{100cm}{1m}\right)\left(\frac{100cm}{1m}\right)\left(\frac{100cm}{1m}\right) =$ which you can condense to $\left(\frac{3.337g}{cm^3}\right)\left(\frac{kg}{10^3g}\right)\left(\frac{10^6cm^3}{1m^3}\right) =$ and thus $\left(\frac{3.337\times10^3kg}{m^3}\right) =$

8. b Only the italicized/bold digits are significant: 0.00***230*** Leading zeros (to the left of the number) are simply placeholders; important, but not significant. Note, if you changed to standard scientific notation 2.30×10^{-3} you would have to include the trailing zero, but you would not include the leading zeros. In standard scientific notation, all digits are significant.

9. d Since the operation is division (same rules for multiplication) and the 1.5 has only 2 sig figs, the answer to this quotient must be rounded off to only **two** significant figures. (The rule is different for addition/subtraction.)

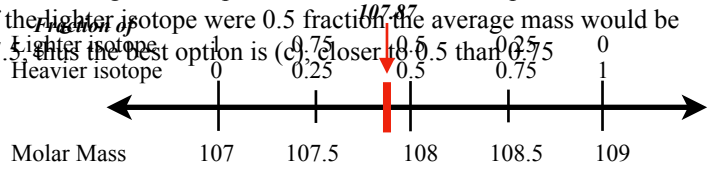
10. b 129.61 − 126.81 = 2.80 There are only 3 sig figs in this answer. Watch out! Sig figs can be lost during subtraction or gained during addition.

11. d 58.8 ml or 58. or 59.1 etc but not 58.85 ml since the increments on the cylinder are 1's, you must record the answer to the 10ths, and you cannot record the measurement to the 100ths. Also please take note that you should read the bottom of the meniscus not the top. (This too, may seem picky, but has been worth one point out of 46 on the FR in the past.)

12. a Recall that the mass number is placed in the top left position, the atomic number is placed at the lower left position. The atomic number tells us the number of protons which is equal to the number of electrons for an atom (not for an ion) and the atomic number subtracted from the mass number will equal the number of neutrons.

13. b Isotopes are atoms of the same element (all having exactly the same number of protons) with varying numbers of neutrons. The term isotope can refer to an atom or ion, thus the term isotope gives you no information about the number of electrons. The prefix *iso* means *same*. Later we will learn the terms isomer, isoelectronic and isothermal. *Maybe you remember isotonic from biology?*

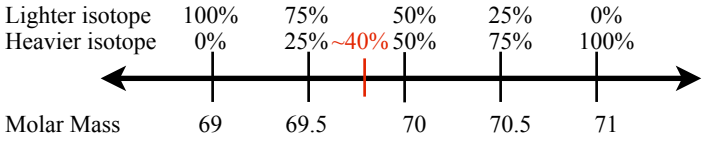
14. c **Practice estimating.** AP will use the term "fractional" to refer to a **decimal quantity** not an actual fraction such as ½. Since the average molar mass of silver is 107.87, closer to the lighter isotope, a and b are not viable options, since there must be more than 0.5 (50%) of the lighter isotope. If the lighter isotope were 0.5 fraction the average mass would be 108. For 0.75 fraction the average mass would be 107.5, thus the best option is (c), closer to 0.5 than 0.75 Perhaps the numberline shown is helpful.



15. b Of course you know that water is made of two H's and 1 O. It's tempting to quickly answer 6, however look closely at the options when adding up the masses of H, H, & O: 1+1+16=18, 1+1+17=19, 1+2+16=19(repeat), 1+2+17=20, 2+2+16=20(repeat), 2+2+17=21, thus a total of only four *different* molar mass options for H_2O.

16. b For this question, the mass number is of little consequence, you simply need to consider the atomic number and the charge. For the telluride ion $^{128}_{52}Te^{2-}$, the number of electrons will be 54 since an atom of tellurium would have 52 protons and 52 electrons and the 2− ion would have gained two more electrons for a total of 54.

17. b *Remember you can NOT use your calculator on the AP chemistry exam (unless the exam occurs online as in 2020). Whether you like it or not, you've got to get used to it. Perhaps you need to practice your times tables?* For this problem, you must have the good sense to go to the periodic table and look up the average molar mass of gallium and see that it has a value of 69.72, and then view the answers to realize that you do NOT need to do an exact calculation. If there were 50% of each of the two isotopes, the average molar mass would have to be right in themiddle at 70, and since the molar mass is lower than 70, you should easily narrowed the possible answers down to either (a) or (b).
If there were only 25 % of the heavier isotope and 75% of the lighter isotope, the molar mass would have to be 69.5, and since the molar mass is greater than 69.5, the remaining choice, between 50% and 25% leaves the option of (b) 40%. Perhaps the number line shown to the right will help.



18. c Since sodium always carries a 1+ charge as an ion, the element that would cause the need for three of the sodium ions to occur in a formula must have a charge of 3−. This of course is the case for the elements in group 15, the nitrogen group with its 5 valence electrons and the fact that nonmetals in this chemical family to grab three more electrons resulting in 8 valence electrons.

19. d Gallium ions carry the charge 3+ and there are two of them present for a total charge of 6+, thus the three ions of element X must produce a total 6− charge. Since there are 3 X ions present in the chemical formula, each X ion must carry a 2− charge, and group 16, the nonmetals in the oxygen family generally carry a 2− charge.

20. a Metals combined with nonmetals are ionic. Compounds made of groups of nonmetals are molecular compounds.

21. a Putting in the correct units, allows you to see that the dimensional analysis will work.
$11g\left(\frac{1mol}{63.55g}\right)\left(\frac{6.02\times10^{23}atoms}{1mol}\right) = Cu\ atoms$, the actual value would be approximately 1×10^{23}, but the actual value is unimportant for this question.

22. c Always make a quick inspection of the answer choices, and for this problem you don't need to get bogged down in the calculations, because as soon as you realize 3/6 is = 0.5, the answer can ONLY be (c) since that is the only 5 among the choices.
$3.01\times10^{24}\left(\frac{1mol}{6.02\times10^{23}atoms}\right) = 0.5\times10^{1}mol = 5mol$
Do you need help with computations involving scientific notation?

23. d It is important to remember that molar mass is simply the mass divided by moles. $1.5\times10^{23}\left(\frac{1mol}{6.02\times10^{23}atoms}\right) =$ ¼
and $\left(\frac{12g}{¼}\right) = 48g\bullet mol^{-1}$ which is the same as 12 × (4/1) **or** $\frac{12g}{1.5\times10^{23}atoms}\times\frac{6.02\times10^{23}atoms}{1mol}$

24. b In any compound that contains some element X, the number of atoms of X will always be whole numbers 1, 2, 3, etc (since you can't have half an atom). Thus you must look for a factor that is common to each of the masses of X provided. (*7 or 3.5 would also be possible, but was not provided among the answers.*)

25. c Since the molar mass is 126 g/mol, thus 63 g is ½ mole. Thus when the water is removed, a ½ mole of the anhydrate will remain. Add the molar mass of $H_2C_2O_4$ to find out its molar mass is 90, thus a half mole or 45 g will remain.

26. d Make your life easier and round off the numbers; 25 g hydrate and 16 g anhydrate, thus 9 g of water removed during heating. Remember that determining formulas is about finding the mole ratios; in this case the mole ratio between the ~16 g of anhydrate and the 9 g of water. 16g / ~160g/mol is 0.1 mole of anhydrate and 9g / 18g/mol is 0.5 mole water, thus 1 hydrate for every 5 water = $CuSO_4 \bullet 5H_2O$

27. c Again, it is helpful to know that a hydrocarbon is any compound made of just hydrogen and carbon. Sometimes the easiest way to work this problem is to use the answers and calculate the mass ratio for the mass of H to the total mass of compound: CH is 1/13, CH_2 is 2/14, CH_3 is 3/15, CH_4 is 4/16
The CH_3 compound: 3/15 should pop out as ⅕ which is 20%.

28. d *Remember you can NOT use your calculator on the AP chemistry exam (unless the exam occurs online as in 2020). Whether you like it or not, you've got to get used to it. Perhaps you need to practice your times tables?*
In this problem, if the mass ratio is to be 2.5 X to 1 Oxygen, since the mass of oxygen is 16 calculate the mass for X that is 2.5 times greater than 16. This would be 40, which is the molar mass of X, thus the formula must be XO.

29. b First it would be best to realize that 1.04 g of chromium which forms 1.52 g of chrome oxide, means that 0.48 g of oxygen have reacted. Since the molar mass of the element oxygen is 16, you should realize that this is 0.03 mol of oxygen, The molar mass of chromium is 52, thus 1.04 g is 0.02 mol of chromium (*need help with seeing how to make this calc simple? Do NOT do long division.*), this means the mole ratio of Cr:O is 2:3, thus Cr_2O_3
Again, all of this should be done WITHOUT a calculator. *If you are struggling to "see" the easy math, you may need help with your times tables. Get a times table app on your phone and practice up.*

30. c Remember that the empirical formula is the lowest whole number ratio. The molecular formula will be the same, or some whole number multiple of the empirical formula, thus "d" is not even an option. Add the molar mass of the empirical formula, 44 g/mol, then divide that into the molar mass given….~130/44 = ~3, thus you need to push a 3 through the empirical formula to end up with $C_6H_{12}O_3$

31. a If you change the carbon and oxygen percentages to moles $\begin{matrix} 12g(\%)\times\frac{1mol}{12g}=1C \\ 49g(\%)\times\frac{1mol}{16g}=3O \end{matrix}$ you can see that the 1:3 ratio of carbon and oxygen and you need the rest of the compound to weigh a total of 40 g…2× Na's is close (46 g) but the Ca (40 g/mol) is closer.

32. c Fe = ~56 g mol^{-1} and F = 19 g mol^{-1} thus 50% by mass would need to be 1 Fe (56) and 3 F (3×19 = 57)

33. d It might be easiest to balance the equation with *mostly* whole numbers: $2\ NH_3 + 7/2 O_2 \rightarrow 2NO_2 + 3H_2O$. The question asks about the amount of oxygen reacting with ONE mole of ammonia, thus cut the 7/2 (3.5) of oxygen in half to 1.75

34. d $2\ H_3PO_4 + 3\ Mg(OH)_2 \rightarrow Mg_3(PO_4)_2 + 6\ H_2O$ Add the coefficients up and don't forget the 1 in front of $Mg_3(PO_4)_2$
Note: If you are having trouble balancing equations, you should act fast and get some extra help.

35. c In multiple choice questions without a calculator, you must look for the "easy math" You may find this process easiest if you put all the numbers in the dimensional analysis on the page and look for common factors you can cancel out.
$27gAl\left(\frac{1mol}{27g}\right)\left(\frac{3H_2}{2Al}\right)\left(\frac{2g}{1mol}\right) = 3\ g\ H_2$

36. c $2\ H_2 + O_2 \rightarrow 2\ H_2O$
Represent the two H_2 gas reactant as two separate molecules, and the O_2 as a single molecule producing two separate water molecules.

37. a Remember, % yield is the same calculation as a grade on a quiz; $\frac{experimental(whatyoudidget)}{theoretical(whatyoushouldget)}\times 100$
Percent error is [(Exp − Theor) / Theor] × 100

38. c $9g\times\frac{1mol}{27g}=\frac{1}{3}mol\times\frac{3O_2}{4Al}=\frac{1}{4}molO_2\times 32gmol^{-1}=8gO_2required$

39. c Look for easy approximations: $7.8gC_6H_6\left(\frac{1mol}{78g}\right)=0.1molC_6H_6$ and continue
$0.1molC_2H_6\left(\frac{1H_2O}{1C_6H_6}\right)\left(\frac{18g}{1mol}\right)=1.8gH_2O$ then percent yield also will be easy values: $\left(\frac{0.9gH_2O}{1.8gH_2O}\right)\times 100 = 50\%H_2O$

40. c First you should recognize that you need to write a balanced equation: $2H_2 + O_2 \rightarrow 2H_2O$ Next, realize that this is a limiting reactant problem 2 g of H_2 is 1 mole and 32 g of O_2 is 1 mole. The 1 mole of H_2 will limit the reaction, thus we know that after the reaction stops, O_2 will remain in the container as well as the H_2O produced.

41. c You could consider the chemical reaction, ($Al_2S_3 \rightarrow 2\,Al + 3S$) or you could simply realize that since the Al would be collected as monatomic atoms as the product, and since there are 2 Al's in the compound, there must be a 2:1 ratio between the Al_2S_3 and 2 Al, thus: $0.5 molAl_2S_3\left(\frac{2Al}{1Al_2S_3}\right) = 1 moleAl\left(\frac{27g}{1mol}\right) = 27gAl$

42. b Hopefully you can immediately recognize this as a limiting reactant problem.
First, determine which gas limits. $1.4g\left(\frac{1mol}{28g}\right) = \frac{0.05molN_2}{1} > 3.55g\left(\frac{1mol}{71g}\right) = \frac{0.05molCl_2}{3}$
since after using the stoichiometry to normalize the mole values, Cl_2 is smaller, thus the Cl_2 limits.
Thus the final mixture will have both product and the excess gas, N_2, present.

43. c This problem is a simple stoichiometry problem that you can certainly do without a calculator. When the reaction reaches a quantity of 6 mole of product (remember the problem states that there was no product, N_2O_4 to start with), use the coefficients in the balanced equation to determine that 12 mole of O_2 and 6 mole of N_2 must have reacted to produce the 6 mole of product.
In problems such as these, it can be handy to use a chart called a RICE table. (Reaction, Initial, Change, End) The RICE table is just an organizational tool, that you can use to organize the stoichiometry shown below.

R	N_2 + 2 O_2 → N_2O_4		
I	8	12	0
C	− 6	− 12	+6
E	2	0	6

$6 molN_2O_4\left(\frac{2molO_2}{1molN_2O_4}\right) = 12 molO_2$ and since the reaction was started with only 12 mole of O_2, there will be none left

$6 molN_2O_4\left(\frac{1molN_2}{1molN_2O_4}\right) = 6 molN_2$ and since the reaction was started with 8 mole of N_2, there will be 2 mole of N_2 left.

Thus 2 mole N_2 left over, no O_2 left over, and 6 mole of N_2O_4 produced, will mean a total of 8 mole of substances left in the flask. p

44. b You may find it helpful to set up a RICE box for this problem as well, again, the "I" row stands for initial conditions, the "C" rowstands for change or where you apply the stoichiometry, and the "E" row is the moles of the gases at the "end" of the reaction. Further, hopefully you remember from first year chem that when the temperature and volume are held constant, the pressure of a gas is directly proportional to the number of moles of that gas, thus the stoichiometry can be done in atmospheres, NO NEED TO CONVERT TO MOLES.

R	N_2 + 2 O_2 → N_2O_4		
I	1	1.5	0
C	-0.75	-1.5	+0.75
E	0.25	0	0.75

First let's take a moment to appreciate the concept that the decomposition of metal carbonates (or reaction of metal carbonates with acid) will generally produce carbon dioxide in a 1/1 ratio with the moles of the metal carbonate that you start with. Historically this has been helpful in past AP problems.

45. b All metal carbonates will react with acid to produce carbon dioxide and a metal oxide. This reaction is specifically: $MgCO_3 + H^+ \rightarrow MgO + CO_2$. The original 16.8 g sample contains both $MgCO_3$ and some other inert substances that do not react with acid to produce any gas.
thus $\left(\frac{8.4gMgCO_3}{16.8gsample}\right)\times 100 = 50\%$

$4.4 g CO_2 \times \frac{1mol}{44g} = 0.1 mol CO_2 \times \frac{1mol\ MgCO_3}{1mol\ CO_2} \times \frac{84g}{1mol} = 8.4 g MgCO_3$

46. c This problem requires a bit more clever thought and understanding. Work the problem "backwards" starting with the information that the carbon dioxide product tells you. Since $4.4gCO_2\left(\frac{1mol}{44g}\right) = 0.1molCO_2$, the balanced equation tells us that 0.1 mol of CO_2 must come from 0.1 mole of MCO_3. Further, we know that 0.1 mole of MCO_3 contains 0.1 mole of M and also 0.1 mole of CO_3. Since CO_3 has a mass of 60 g/mol, we can calculate that the 0.1 mole of the CO_3 has a mass of 6 g and the remainder of the compound (whose mass we were told was 11.2 g), the M part, must weigh 5.2 g.
But remember there is 0.1 mole of M in this compound, thus $\left(\frac{5.2g}{0.1mol}\right) = \left(\frac{52g}{1mol}\right)$ and so you are looking for an element that has a molar mass of 52, which is Cr.