JOE PERFECT

Practice Test - Chapter 1 - Matter and Measurement

Directions: Answer each of the following questions. No calculators are allowed. :)

Target #1: I can define and provide examples for each of the following terms: physical property, chemical property, physical change, chemical change, intensive property, extensive property element, compound, mixture

For # 1-4, fill in the blanks with physical change (PC), physical property (PP), chemical change (CC), or chemical property (CP):

CP 1. Sodium has the ability to react with water.

PP 2. Aluminum has a density of 2.7 g/cm^3.

PC 3. An ice cube melts.

CC 4. A piece of coal burns.

For #5-7, finish the statements. INTENSIVE: density, b.p., m.p., malleability
EXTENSIVE: mass, volume, length

5. The difference between an intensive property and an extensive property is that an intensive property is . . . independent of the amount of substance present.

6. A compound is different than a mixture in that a compound . . . the elements are chemically combined. In a mixture, elements physically mixed.

7. An element is defined as . . . a substance that cannot be separated into simpler substances by chemical means.

For #8-10, circle **true** or **false**. Correct all false statements to make them true.

(T) F 8. Malleability is an example of a physical, intensive property of metals.

(T) F 9. It is possible to separate a compound by use of electrolysis. ie: $H_2O \rightarrow H_2 + O_2$

(T) F 10. Air is an example of a mixture. AIR IS A HOMOGENEOUS MIXTURE!

Target #2: I can differentiate between the three states of matter.

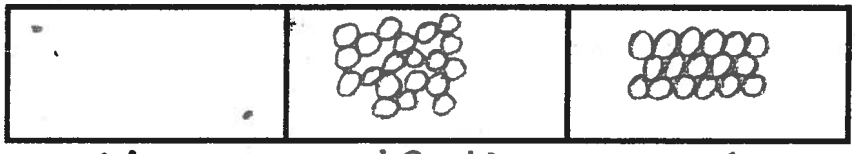
11. Solids are matter . . .
    a. which have a definite shape but no definite volume.
    (b.) which have a definite shape and a definite volume.
    c. have a definite volume and take the shape of their container.
    d. easily compressed and have a definite volume.

LIQUIDS: def. vol. but no def. shape

GASES: no def. shape or volume

12. The state of matter which contains the particles with the greatest kinetic energy is _____.
    a. solids b. liquids (c. gases) particles move very fast!

13. Label each of the following as either a solid, liquid or a gas.



NOTE: Please keep track of the targets that you are having the most troubles with... it is your responsibility to get help with these targets!

Target 3: I can list the commonly used metric prefixes and their meanings.

13. Complete the table below. Giga has been done for you!

FEMTO = 10^{-15}

Prefix	Giga	Mega	Kilo	Milli	Micro	Nano	Pico
Meaning	10^9	10^6	10^3	10^{-3}	10^{-6}	10^{-9}	10^{-12}

14. Circle the biggest quantity for each of the following:
    a. 10 meters or 1,000 mm
    b. 5 micrograms or 0.50 milligrams
    c. 650 mL or 0.065 L

The set-up & calc's for selected problems are at the end of this answer key. ☺

15. Circle all of the following which of the following is/are NOT correct?
    a. There are 1,000 mg in a gram.
    b. There are 100 cm in a meter.
    c. There are 1,000 mL in a liter.
    d. There are 100 mm in a centimeter. 10 mm = 1 cm
    e. There are 1,000 microjoules in a millijoule.

16. 2.5 nm equals . . .

$$4 \times \mu J = \left| \frac{1\ mJ}{10^3\ \mu J} \right| \left| \frac{1\ J}{1\ J} \right| \left| \frac{10^6\ \mu J}{1\ J} \right| = 10^3\ \mu J = 1{,}000\ \mu J$$

    a. 2.5×10^{-9} m b. 2.5×10^{-4} mm c. 2.5×10^{-7} cm d. a & b. e. a & c

Target #4: I can determine the number of significant digits in a measured quantity and determine the appropriate number significant digits in a calculation.

17. Underline the significant digits in each of the following measured numbers:
    a. 50,500 L b. 0.02500 mg c. 400. miles d. 7.0080 cm^3

18. When 125 mg, 1.2 dg, and 1.2223 g are added, how many significant digits does the answer have?
    a. 2 b. 3 c. 4 d. 5 e. 6

19. Which of the following have precisely three significant figures? (There may be more than one correct answer . . . circle all answers which have exactly 3 sig fig's!)
    a. 0.01 (1) b. 100 (1) c. 0.100 (3) d. 0.00100 (3) e. 110 (2)

20. The molar mass of H_2SO_4 is calculated through the following:
    H: 2 X 1.0079 amu
    S: 1 X 32.066 amu → add these #'s and round to 0.001 place!
    O: 4 X 15.9994 amu

    What is the molar mass (g/mol) of H_2SO_4?
    a. 100 b. 98 c. 98.1 d. 98.08 e. 98.079 f. 98.0794

Target #5: I can convert temperatures between Celsius and Kelvin.

°C + 273 = Kelvin

21. Fill in the blanks with the correct temperature:

a. 25°C = 298 K b. 312 K = 39 °C

22. Solid carbon dioxide, dry ice, changes directly from a solid to a vapor at 195 K if left in an open container. What is this temperature in degrees Celsius and Fahrenheit?

a. -78°C, 468°F b. -108°C, 468°F c. 468°C, -108°F (d.) -78°C, -108°F

195 − 273 = −78°C

23. Which is the smallest temperature change?

a. 25°C to 26°C
b. 25 K to 26 K
(c.) 25°F to 26°F
d. They are all the same.

1.8°F = 1°C = 1K

Both choices A & D are -78°C. -108°F is only one which makes sense --- no need to convert from °C → °F in this class though.

Target #6: I can perform calculations involving density.

24. A 9.00 gram rectangular solid with a density of 1.5 g/cm³ has a length of 60.00 mm and a width of 2.00 cm. What is the height of this rectangular solid? *(Remember . . . no calculators!)*

a. 1.5 mm b. 10. cm c. 1.0 cm d. 5.0 cm (e.) 5.0 mm

$D = \frac{M}{V}$; $V = \frac{M}{D} = \frac{9.00\ g}{1.5\ g/cm^3} = 6.0\ cm^3$ = volume

$V = L \times W \times H$; $6.0\ cm^3 = (6.000\ cm)(2.00\ cm)(H)$; $H = 0.50\ cm = 5.0\ mm$ ☺

25. An empty container weighs 15.2 grams. When filled with water (density = 1.00 g/mL), it weighs 35.9 grams. When filled with an unknown liquid to the same mark as it was filled to with the water, it weighs 36.2 grams. What is the density of the unknown liquid?

a. 1.80 g/mL b. 1.61 g/mL (c.) 1.01 g/mL d. 0.986 g/mL e. 0.00506 g/mL

CONTAINER: 35.9 g − 15.2 g = 20.7 g H_2O = 20.7 mL (vol. of container)

UNKNOWN: $D = M/V = \frac{36.2\ g - 15.2\ g}{20.7\ mL} = \frac{21.0\ g}{20.7\ mL}$ = a little bigger than 1 ⇒ choice "c"

Target # 7: I can convert between units by using dimensional analysis.

26. The copper content of a normal healthy human is approximately 1.1×10^{-4} percent by mass. How many grams of copper would exist in a person weighing 1.00×10^{3} lb? (1.0 kg = 2.2 lb)

a. 0.00050 g b. 0.050 g c. 0.50 g d. 5.0 g e. 50.0 g

$$x\,g\,Cu = \left|\frac{1{,}000\ lbs}{2.2\ lbs}\right|\left|\frac{1\ kg}{1\ kg}\right|\left|\frac{10^3\ g}{1\ kg}\right|\left|\frac{1.1\times10^{-4}\ g\ Cu}{100\ g\ body}\right| = \frac{(10^3)(10^3)(1.1\times10^{-4})}{(2.2)(10^2)} \approx \frac{10^2}{(2.2)(10^2)} = \frac{1}{2.2} \approx 1/2$$

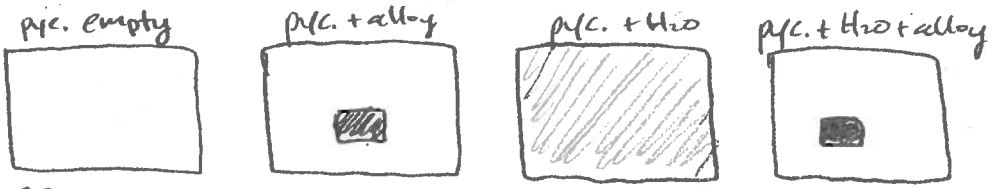
27. The density of an object is 15 mg/m³. What is its density in g/cm³?

a. 1.5×10^{8} b. 1.5×10^{6} c. 1.5×10^{2} d. 1.5×10^{-6} e. 1.5×10^{-8}

$$x\ \frac{g}{cm^3} = \left|\frac{15\ mg}{1\ m^3}\right|\left|\frac{1\ g}{10^3\ mg}\right|\left|\frac{(1\ m)^3}{(100\ cm)^3}\right| = \frac{15}{(10^3)(10^2)^3} = \frac{15}{10^3 \cdot 10^6} = \frac{15}{10^9} = 15\times10^{-9} = 1.5\times10^{-8}$$

<u>Part 2:</u> Show all of your work and label your answer with correct units. Please circle your final answer. You may use calculators!

A pycnometer is a device used to measure density. It weighs 20.455 grams when empty and 31.486 grams when filled with water. Pieces of an alloy are placed into the empty, dry pycnometer. The mass of the alloy and the pycnometer is 28.695 grams. Water is added to the alloy to exactly fill the pycnometer. The mass of the pycnometer, water, and alloy is 38.689 grams. Assume the density of the water is 1.000 g/cm³, calculate the density (in g/cm³ **<u>and</u>** in g/mm³) of the alloy?



mass alloy = 28.695g − 20.455g = 8.240g

Vol pyc = 31.486g − 20.455g = 11.031g = 11.031 cm³ since $d_{H_2O} = 1.000\ g/cm^3$

(vol) mass H_2O = 38.689g − 28.695g = 9.994g = 9.994 cm³

Vol Alloy = $V_{pyc} - V_{H_2O}$ = 11.031 cm³ − 9.994 cm³ = 1.037 cm³

$$D = \frac{m}{V} = \frac{8.240\ g}{1.037\ cm^3} = 7.946\ g/cm^3$$

$$x\ \frac{g}{mm^3} = \left|\frac{7.946\ g}{1\ cm^3}\right|\left|\frac{(1\ cm)^3}{(10\ mm)^3}\right| = 0.007946\ g/mm^3$$

work for CH.1 practice test

14 (a) 1 meter = 1,000 mm

(b) convert both to grams

$$x\,g = \left|\frac{5\,\mu g}{}\right|\left|\frac{1\,g}{10^6\,\mu g}\right| = 5\times10^{-6}\,g$$

$$x\,g = \left|\frac{0.50\,mg}{}\right|\left|\frac{1\,g}{10^3\,mg}\right| = 0.50\times10^{-3}\,g = \boxed{5.0\times10^{-4}\,g}$$

BIGGER ☺

(c) $650\,ml = 0.65\,L$

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16 (a) $x\,m = \left|\frac{2.5\,nm}{}\right|\left|\frac{1\,m}{10^9\,nm}\right| = 2.5\times10^{-9}\,m$ ☺

(b) $x\,mm = \left|\frac{2.5\,nm}{}\right|\left|\frac{1\,m}{10^9\,nm}\right|\left|\frac{10^3\,mm}{1\,m}\right| = \frac{2.5\times10^3}{1\times10^9} = 2.5\times10^{-6}\,mm$ ☹

(c) $x\,cm = \left|\frac{2.5\,nm}{}\right|\left|\frac{1\,m}{10^9\,nm}\right|\left|\frac{10^2\,cm}{1\,m}\right| = \frac{2.5\times10^2}{1\times10^9} = 2.5\times10^{-7}\,cm$ ☺

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18 Convert to same unit... then add

$125\,mg = 0.125\,g$

$1.2\,g = 1.2\,g$

$1.2223\,g = 1.2223\,g$

$1.4673\,g$ round to 0.01 place $1.47\,g$

3 sig. fig's

Practice Test - Chapter 2 - Atoms, Molecules and Ions

Directions: Answer each of the following questions. No calculators are allowed.

Target 1: I can differentiate between protons, neutrons, and electrons in terms of charge, mass and location in an atom.

For #1-3, choose proton, neutron and/or electron.

proton & neutron — 1. Particle(s) located in the nucleus. e⁻ in electron cloud

electron — 2. The particle with the least mass. e⁻ ≈ 1800x less massive than pt or n°

proton — 3. The particle with a positive charge.

Target 2: I can explain the 4 basic forces of nature (gravity, electromagnetism, the strong force and weak force) as they apply to the atom and ions.

(T) or F 4. Gravity is a force that acts between objects with mass. Gravity between subatomic particles is so small that it has no chemical significance.

(T) or F 5. Electromagnetic forces are forces between charged objects.

T or (F) 6. The strong force within an atom is the force which keeps electrons from crashing into the nucleus.

↳ strong force holds nucleus together... keeps it stable.

Target 3: I can determine the number of protons, neutrons and electrons in isotopes and in ions.

For #7-10, choose the correct voabulary term from the list below:

atomic number, mass number, isotope, cation, anion

MASS NUMBER — 7. The number of protons + the number of neutrons

Atomic NUMBER — 8. Indicates the number of protons in a nucleus.

ISOTOPE — 9. Atoms of the same element with different number of neutrons.

ANIONS — 10. Negatively charged ions.

11. The isotope Mg-25 contains _____ protons and _____ neutrons.

a. 12, 24.30 b. 13, 24.30 c. 12, 25 d. 13, 25 (e.) 12, 13 f. 13,12

12. An oxygen atom contains ____ protons and an oxide ion (O^{2-}) contains ____ protons.
(a) 8, 8 b. 8, 10 c. 10, 8 d. 8, 16 e. 10, 18 f. 10,16

13. Which one group below do all members contain the same number of electrons?
a. H, He, Li (1 2 3) b. H^+, Li^+, Na^+ (0 2 10) c. Li^+, He, H (2 2 1) d. Li, Li^+, Li^{2+} (3 2 1) (e) He, Li^+, Be^{2+} (2 2 2)

14. Circle all of the following that have exactly 18 electrons.
(a) Ar (b) P^{3-} (c) K^+ d. O^{2-} (e) Sc^{3+}
10e-

Target 4: I can calculate the atomic weight of an element given the abundances and masses of its isotopes.

15. The atomic masses on the periodic table are not integral numbers. For example, carbon is listed as 12.01115 instead of 12.00000. Why?
a. Our technology does not allow for exact measurement of such a small quantity.
b. Atoms gain and lose electrons easily and that changes their masses significantly.
(c) Atomic masses are weighted averages of isotopic masses. Averages are usually decimals
d. Atomic masses are measured in real samples that are contaminated with other elements.
e. There is a theoretical uncertainty in the masses of atoms.

16. Element "X" has an atomic mass of 221.4 amu. Given the information below, calculate the mass of the third isotope. (No calculators are ever allowed on multiple choice questions!)

isotope	% abundance	mass (amu)
#1	75.00	220.9 } Both smaller than the average.
#2	12.00	220.0 } Isotope #3 must have a mass
#3	13.00	??? bigger than the average. You can eliminate choices A, B & C. ☺

a) ~~217.9~~ b) ~~220.9~~ c) ~~220.3~~ d) 221.5 (e) 225.7

No calc's needed ... choice "E" is only logical choice!

17. An element has two isotopes. 69.1 % of the isotopes have a mass of 134 amu. The other 30.9 % of the isotopes have a mass of 137 amu. Estimate the atomic mass of this element. (Remember . . . no calculators!)

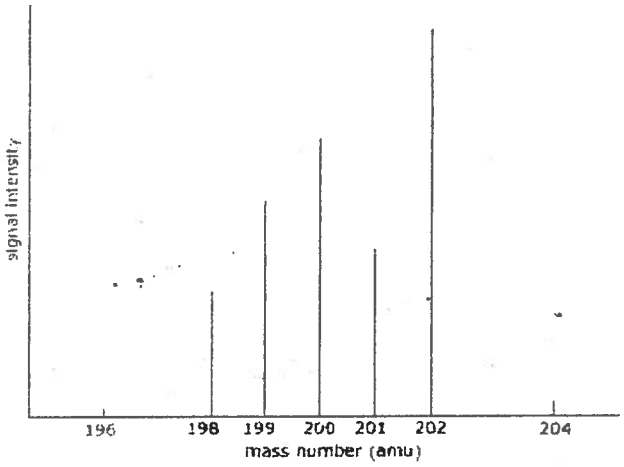
a) 133.8 amu b) 134.2 amu (too low) (c) 134.9 amu d) 136.1 amu (too high) e) 137.7 amu

Average must be between 134 & 137 ... this eliminates choices A & E.

Target 5: I can describe how a mass spectrometer is used to determine the atomic weights of elements.

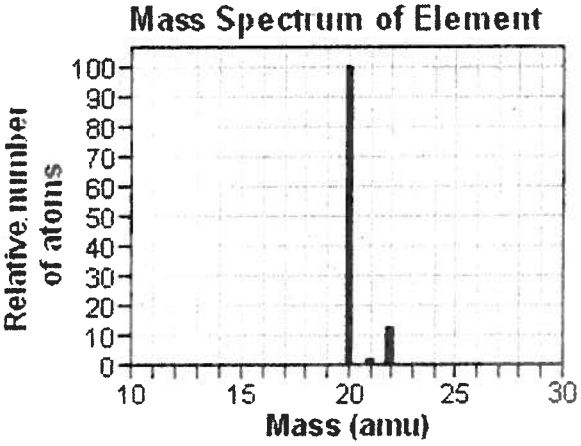
18. Mass spectrometers work by . . .
    a) converting ions into isotopes and analyzing the number of neutrons in the isotopes.
    b) changing isotopes into neutral particles and analyzing the mass of these particles.
    c) changing positives ions into negative ions and measuring the mass difference between the two ions.
    (d) converting atoms into ions and analyzing the mass and charge of the ions.
    e) measuring the ionic charge of specific ions and compare the charge of ion to the mass of the original atom after washing the ion in a bath of isotopic electric field.

19. Consider the following spectrum for an unknown element. The identity of the element is most likely _____ .



a) Tl -204
b) Hg -201 only logical choice!
c) Au -197
d) Rn -222
e) Ra -226

20. Consider the following spectrum for an unknown element. The atomic mass of the element is closest to _____ amu.



~~a)~~ 19.5
~~b)~~ 20.0
c) 20.5 → Answer must be between 20 & 22... and closer to 20. Choice "c" is best choice ☺
d) 22.0
e) 23.5

Target 6: I can describe the works of John Dalton, J.J. Thomson (cathode ray tube), Robert Millikan (Oil Drop Experiement) and Ernst Rutherford (Gold Foil Experiement).

21. In 1808, John Dalton developed the first modern atomic theory. Which one of his postulates was not exactly true? Explain.

Dalton said all atoms of same element are identical to one another. This was proven false in 1932 when Chadwick discovered the neutron. We now know that there are ISOTOPES of elements. ☺ C-12 (6 n°) C-14 (8 n°)

22. Which ONE of the following statements is NOT true concerning cathode rays?
    a. They originate from the negative electrode.
    b. They travel in straight lines in the absence of electric or magnetic fields.
    c. They impart a negative charge to metals exposed to them.
    d. They are made up of electrons.
    e. The properties of cathode rays depend upon the material from which they are emitted. Thomson used cathode ray tube to discover the e⁻.

23. The Gold Foil Experiment . . .
    a. confirmed the plum-pudding model of the atom.
    b. led to the discovery of the nucleus. → Rutherford discovered nucleus was positive AND that nucleus was REALLY small compared to rest of the atom.
    c. was the basis for Thomson's model of the atom.
    d. utilized the deflections of beta particles by gold foil.
    e. proved the Law of Multiple Proportions.

24. The Oil Drop Experiment by Robert Millikan was able to calculate the . . .
    a. mass of the electron by first determining its charge.
    b. mass of the proton.
    c. mass of the proton AND the mass of the neutron.
    d. charge of both the electron and the proton.
    e. atomic mass of H-3 (called tritium!).

Target 7: I can use the periodic table to predict the charges of monatomic ions.

25. Use the periodic table to predict the charges of the following ions:

a. hydrogen ion H^+ ___+1___ b. nitride ion N^{3-} ___−3___ c. aluminum ion Al^{3+} ___+3___

Target 8: I can use the periodic table to predict whether an element is a metal, nonmetal or a metalloid.

26. Classify each of the following elements as either a metal, nonmetal or metalloid.

Metalloid a. Si

Metal b. Ag

Nonmetal c. Br

Metal d. Al

Target 9: I can write the names and formulas of ionic compounds, molecular/covalent compounds, acids and simple organic compounds.

27. Name or write the formulas for each of the following compounds.

iron(II) sulfate a. $FeSO_4$

magnesium sulfide b. MgS

dinitrogen tetroxide c. N_2O_4

copper(II) acetate d. $Cu(C_2H_3O_2)_2$

SO e. sulfur monoxide

NaH f. sodium hydride

$Pb(CN)_4$ g. lead(IV) cyanide

$Zn_3(PO_4)_2$ h. zinc phosphate

Be sure to memorize your polyatomic ions.

28. Name or write the formulas for each of the following acids.

sulfuric acid a. H_2SO_4

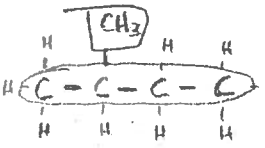
phosphorous acid b. H_3PO_3

H_2S e. hydrosulfuric acid

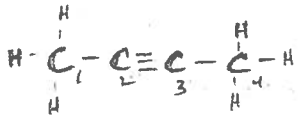
H_2CO f. hypocarbonous acid

Be sure to memorize rules for naming acids.

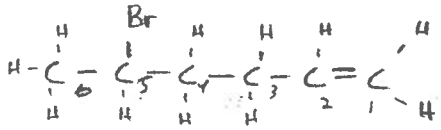
29. Name each of the following:

a) 

2-methylbutane

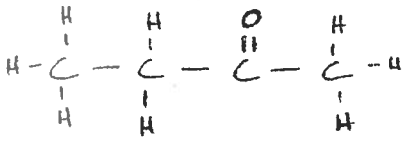
b) 

2-butyne

c) 

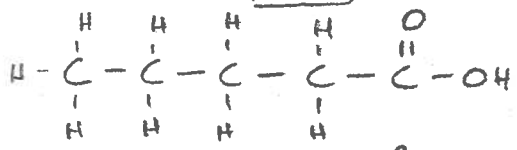
5-bromo-1-hexene

30. Classify each of the following as an alcohol, aldehyde, ketone or an acid. Then name each molecule.

a) 

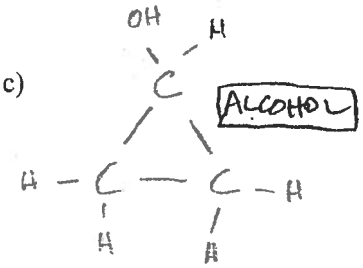
KETONE

2-butanone

b) 

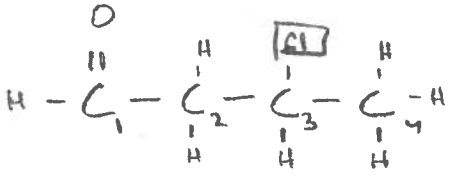
ACID

pentanoic acid

c) 

ALCOHOL

cyclopropanol

d) 

ALDEHYDE

3-chlorobutanal

Target 10: I can distinguish between empirical formulas, molecular formulas and structural formulas.

31. An empirical formula is to a molecular formula as ...
    a. a car is to a truck.
    b. a car is to an automobile.
    c. a color is to white.
    d. 100 is to 1,000
    e. 1/2 is 3/6.

Empirical formula is the reduced formula!

32. List the empirical formula for each of the following:

C_3H_5O a. $C_6H_{10}O_2$ H_2O b. H_4O_2

33. What is the difference between a molecular formula and a structural formula? Please provide an example to aid in your answer.

H_2O ⇒ MOLECULAR FORMULA
[shows # & kinds of atoms in a molecule.]

⇒ STRUCTURAL FORMULA
[shows how atoms are attached/bonded to one another.]

JOE PERFECT

Practice Test - Chapter 3 - Stoichiometry

Target 1. I can predict the products for and write balanced equations for the following types of reactions: combustion, decomposition, sysnthesis (called combination reactions), single displacement and double displacement reactions.

1. Predict the products for each equation that follows. Balance each equation. Classify it as combustion (C), decomposition (D), sysnthesis (S), single displacement (SD) or double displacement (DD). Place the letters of the classification on the blanks at left.

DD a. $Al_2(CO_3)_3 + 6NaNO_3 \rightarrow 2\ Al(NO_3)_3 + 3\ Na_2CO_3$

C b. $4C_5H_9O + 27\ O_2 \rightarrow 20\ CO_2 + 18\ H_2O$

D c. $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

SD d. $2\ LiF + Ca \rightarrow CaF_2 + 2\ Li$

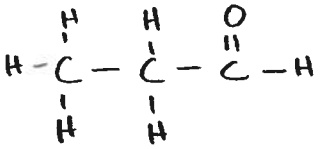
S e. $2Sr + O_2 \rightarrow 2\ SrO$

2. When sodium carbonate decomposes during heating, two products are formed. What are the two products?
   a. Na and CO3 b. Na2O and C c. Na and CO2 d. Na and CO (e) Na2O and CO2

$Na_2CO_3 \xrightarrow{\Delta} Na_2O + CO_2$; You always get a metal oxide & CO_2 whenever a carbonate decomposes.

3. Assume that a sample of propanal was completely combusted in air. Write the balanced equation associated with this reaction. What is the coefficient in front of the water used to balance this equation? Assume all coefficients are whole numbers and as small as possible.

a. 1
b. 2
(c) 3
d. 4
e. 6

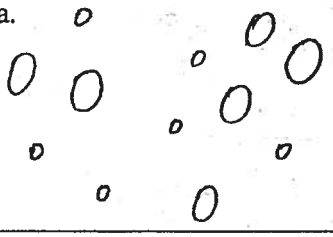
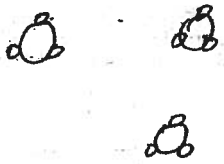
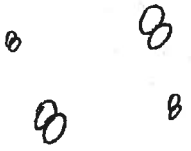
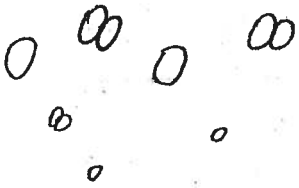
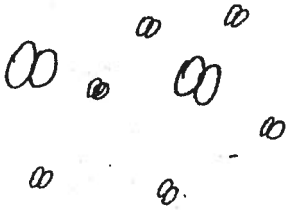
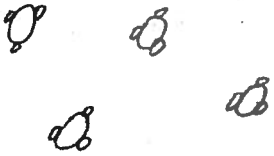
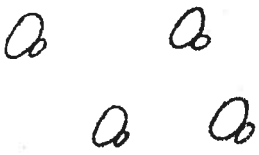
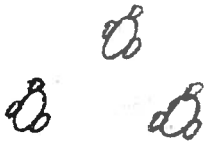


C_3H_6O

PROPANAL

$C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$

4. Which of the following particulate diagrams best shows the synthesis of ammonia (NH_3) from nitrogen and oxygen?

a. 	→	
b. 	→	
c. 	→	
d. 	→	
e. 	→	

only choice which matches stoich!! ☺

$\underline{1}\ N_2 + \underline{\underline{3}}\ H_2 \rightarrow \underline{\underline{2}}\ NH_3$

or $\underline{\underline{=}}$ $2\ N_2 + 6\ H_2 \rightarrow 4\ NH_3$

Target 2: I can explain the Law of Conservation of Mass as it relates to reactions, living organisms and ecosystems.

5. Circle the three true statements regarding the Law of Conservation of Mass.
   (a.) This law states that mass cannot be created or destroyed in a chemical or biological process.
   b. As an ice cube melts, the mass of the water is slightly greater in the solid than the mass of the water after melting. MASS H_2O B4 = MASS H_2O AFTER!
   c. As an ice cube melts, the mass of the water is slightly smaller in the solid than the mass of the water after melting.
   (d.) Assume you go for a 4 mile jog. Your mass before the jog is greater than your mass after the jog. some mass is lost from body as sweat evaporates!
   (e.) Assume that you had a closed jar containing a piece of iron sitting in water. After 3 months, the iron rusted. The mass of the jar and all of its contents is the same before the rusting and after the metal rusts for 3 months.

$$2Na(s) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + H_2(g)$$

6. Assume that 5 grams of sodium was placed in exactly 100 grams of water. The total mass of the products and left over reactant is _____.
   (a.) 105 grams MASS PRODUCTS = MASS REACTANTS
   b. Slightly less than 105 grams assuming the water was in excess.
   c. Slightly greater than 105 grams assuming the water was in excess.
   d. Slightly less than 105 grams assuming the sodium was in excess.
   e. Slightly greater than 105 grams assuming the sodium was in excess.

Target 3: I can interconvert between the number of moles and mass of a substance. I can also use Avogadro's number and molar mass to calculate the number of particles (atoms, molecules or formula units) making up a substance.

7. What is the mass in grams of 7.2×10^{22} molecules of H_2O? (No calculator!)
   (a.) 2.2 g b. 0.0022 g c. 2.2×10^3 g d. 220,000 g e. 2.2×10^{45} g

8. Which of the following is the most massive?
   (a.) 5.85 grams of NaCl
   b. 0.500 mole of NaCl
   c. 115,000 atoms of gold
   d. 1.00×10^5 ng of lead
   e. 250 molecules of propane (C_3H_8)

#7 work:

$$kg = \left|\frac{7.2\times10^{22}\text{ molecules}}{6.02\text{ molecules}}\right|\left|\frac{1\text{ mol }H_2O}{1\text{ mol }H_2O}\right|\left|\frac{18\text{ g}}{1\text{ mol }H_2O}\right| =$$

$$\approx \frac{(7.2\times10^{22})(18)}{6\times10^{23}} \approx (1\times10^{-1})(18) = (0.1)(18)$$

$= 1.8$ g

choice "A" is close

(b) $\left|\frac{0.5\text{ mol}}{1\text{ mol}}\right|\left|\frac{58.5\text{ g}}{1\text{ mol}}\right| \approx 29$ g By far most massive!

(c) $\left|\frac{115{,}000\text{ atoms}}{6.02\times10^{23}\text{ atoms}}\right|\left|\frac{1\text{ mol}}{1\text{ mol}}\right|\left|\frac{197\text{ g}}{1\text{ mol}}\right|$ = really, really small!!

(d) $\left|\frac{10^5\text{ ng}}{10^9\text{ ng}}\right|\left|\frac{1\text{ g}}{10^9\text{ ng}}\right| = 10^{-4}$ g really small

(e) common sense tells you this is by far the smallest!

9. How many sulfur atoms are there in 25 molecules of $C_4H_4S_2$?

a. 1.5×10^{25}
b. 4.8×10^{25}
c. 3.0×10^{25}
(d) 50
e. 6.02×10^{23}

$$\text{x S atoms} = \left|\frac{25 \text{ molecules } C_4H_4S_2}{1 \text{ molecule}}\right|\left|\frac{2 \text{ atoms S}}{}\right| = 50 \text{ atoms of sulfur}$$

Target 4: I can calculate the percentage composition of a compound by mass.

10. What is the percent by mass of hydrogen in perchloric acid? ($HClO_4$)

(a) 1.0 % b. 3.0 % c. 6.0 % d. 23 % e. 46%

H: $1 \times 1.01 = 1.01$
Cl: $1 \times 35.5 = 35.5$
O: $4 \times 16 = 64$
} 100 g/mole

$$\%H = \frac{1.01}{100} \times 100 = 1\%$$

11. Which element in sodium acetate has the greatest percentage by mass? $NaC_2H_3O_2$

a. Na b. C c. H d. O e. Xe

Na: $1 \times 23 = 23$
C: $2 \times 12 = 24$
H: $3 \times 1 = 3$
O: $2 \times 16 = 32$
82

$\frac{32}{82} \times 100 =$ greatest % by mass of the 4 elements. ☺

Target 5: I can calculate the empirical formula of a compound, having been given either:
a) mass or % composition, or
b) the mass of CO_2 and H_2O produced by combustion.

12. A compound that is composed of only hydrogen and carbon contains 80.0% carbon and 20.0% hydrogen. What is the empirical formula of this compound?

a. $C_{20}H_{60}$
b. C_7H_{20}
(c.) CH_3
d. C_3H_6
e. $C_{20}H_7$

$$\text{x mol C} = \left|\frac{80 \text{ g C}}{12 \text{ g C}}\right|\left|\frac{1 \text{ mol}}{}\right| = \frac{80}{12} = \frac{40}{6} = 6\tfrac{2}{3} = 6.7 \text{ mol C}$$

$$\text{x mol H} = \left|\frac{20 \text{ g H}}{1 \text{ g H}}\right|\left|\frac{1 \text{ mol}}{}\right| = 20 \text{ mol H}$$

$$C_{\frac{6.7}{6.7}} H_{\frac{20}{6.7}} \approx \boxed{CH_3}$$

13. Consider the following table of molar masses for elements X, Y and Z.

Element	X	Y	Z
Molar mass (g/mol)	20.0	30.0	40.0

An unknown compound contained 60.0 grams of X, 45.0 grams of Y and 180 grams of Z. Calculate the empirical formula of this unknown compound.

a. $X_2Y_2Z_3$
b. XY_2Z_3
c. XYZ_2
d. X_4Y_2Z
e. X_2YZ_3

$X \text{ mol } X = \frac{60\text{g}}{20\text{g}} \frac{1\text{mol}}{} = 3 \text{ moles X} \div 1.5 = 2$

$X \text{ mol } Y = \frac{45\text{g}}{30\text{g}} \frac{1\text{mol}}{} = 1.5 \text{ moles Y} \div 1.5 = 1$

$X \text{ mol } Z = \frac{180\text{g Z}}{40\text{g}} \frac{1\text{mol}}{} = 4.5 \text{ moles Z} \div 1.5 = 3$

X_2YZ_3

Target 6: I can calculate the molecular formula, having been given the empirical formula and the molecular weight.

→ MOLAR MASS = 60 g/mole

14. The empirical formula of a compound is C_3H_8O. The molar mass of the compound is 180 g/mol. What is the molecular formula of the compound?

a. C_3H_8O b. $C_3H_{16}O_2$ c. $C_6H_{16}O_2$ d. $C_9H_{24}O_3$ e. $C_9H_{16}O$

$\frac{180}{60} = 3$ $\quad 3 \times EF = MF$ $\quad 3X\ C_3H_8O = \boxed{C_9H_{24}O_3}$

You could find the MM of all 5 choices... only choice "D" is 180.!!

15. The empirical formula of a compound is N_2O. The molar mass of the compound is 44 g/mol. What is the molecular formula of the compound?

a. N_2O b. N_2O_2 c. N_2O_4 d. N_3O_7 e. N_4O_8

$N_2O = 44$ g/mole This is a case where the empirical formula is the SAME as the molecular formula!!

16. A phosphorous oxide compound contains 43.7% oxygen by mass. The molecular formula of this compound could be _____.

a. P_7O_2 b. PO_7 c. P_2O d. P_5O_3 e. P_4O_6

43.7 % oxygen
56.3 % phosphorus

$X \text{ mol } O = \frac{43.7\text{g}}{16\text{g}} \frac{1\text{mol}}{} \approx 3$

$X \text{ mol } P = \frac{56.3\text{g}}{31\text{g}} \frac{1\text{mol}}{} \approx 2$

EF P_2O_3

MF P_4O_6

choice "E" is only reasonable choice.

Target 7: I can use stoichiometry to solve problems involving chemical reactions.

Consider the following combustion reaction for #17 and #18:

$$2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$$

17. Assume that 6.0 moles of butane (C_4H_{10}) burn in excess oxygen. How many grams of water are produced?

a. 5.4 b. 540 c. 1.1 d. 110 e. 1.1×10^3

$$x\ g\ H_2O = \left|\frac{6\ mol\ C_4H_{10}}{2\ mol\ C_4H_{10}}\right|\left|\frac{10\ mol\ H_2O}{1\ mol\ H_2O}\right|\left|\frac{18\ g\ H_2O}{1\ mol\ H_2O}\right| = \frac{(6)(10)(18)}{1} = 6 \cdot 90 = 540\ g$$

18. Assume 8.0 grams of oxygen react with excess butane. How many grams of CO_2 are produced?

a. 0.067 b. 6.7 c. 27 d. 270 e. 2.7×10^7

$$x\ g\ CO_2 = \left|\frac{8\ g\ O_2}{1}\right|\left|\frac{1\ mol\ O_2}{32\ g\ O_2}\right|\left|\frac{8\ mol\ CO_2}{13\ mol\ O_2}\right|\left|\frac{44\ g\ CO_2}{1\ mol\ CO_2}\right| = \frac{(8)(8)(44)}{4(32)(13)} = \frac{(8)(44)}{4 \times 13} = \frac{88}{13} = 6\text{ or }7$$

CHOICE "B"

Target 8: I can determine the limiting reactant in a reaction and determine the amount of excess reactant left over from a reaction.

Consider the following reaction for # 19 and #20:

$$N_2 + 3\ H_2 \rightarrow 2\ NH_3$$

$$x\ mol\ H_2 = \left|\frac{0.1\ g}{2\ g}\right|\left|\frac{1\ mol}{}\right| = 0.05\ mol\ H_2$$

$$x\ mol\ N_2 = \left|\frac{.56\ g}{28\ g}\right|\left|\frac{1\ mol}{}\right| = 0.02\ mol\ N_2$$

19. Assume that 0.10 grams of H_2 react with 0.56 grams of N_2. The limiting reactant is

a. N_2 b. H_2 c. NH_3 d. Both H_2 and N_2

Balanced equation says you need 3x more moles of H_2 than N_2 ... and 0.05 is NOT 3x bigger than 0.02 ... H_2 is limiting reactant!

20. How many grams of NH_3 can be produced if 20.0 grams of H_2 react with 168 grams of N_2?

↳ 10 mol H_2 (LR) ↳ 6 mol N_2

a. 3.98 b. 39.8 c. 398 d. 1.13 e. 113

$$x\ g\ NH_3 = \left|\frac{10\ mol\ H_2}{3\ mol\ H_2}\right|\left|\frac{2\ mol\ NH_3}{1\ mol\ NH_3}\right|\left|\frac{17\ g\ NH_3}{1\ mol\ NH_3}\right| = \frac{340}{3} \approx 113\ g$$

21. Consider the following reaction:

$$Mg + 2\ H_2O \rightarrow Mg(OH)_2 + H_2$$

Assume that 48.6 grams of magnesium react with 36.0 grams of water. Which reactant is the excess reactant? How many grams are left over or in excess after the reaction is complete?

a. Mg, 12.2 b. Mg, 24.3 c. H_2O, 9.00 d. H_2O, 18.0

$$x\ mol\ Mg = \left|\frac{48.6\ g\ Mg}{24.3\ g\ Mg}\right|\left|\frac{1\ mol}{}\right| = 2\ mol\ Mg\ (excess)$$

$$x\ mol\ H_2O = \left|\frac{36\ g\ H_2O}{18\ g\ H_2O}\right|\left|\frac{1\ mol}{}\right| = 2\ mol\ H_2O\ (LR)$$

⇒ According to bal. eq., 1 mol reacts, 1 mole doesn't.

1 mol = 24.3 g

Target 9: I can calculate the theoretical and actual yields of a chemical reaction when given the appropriate data.

22. Consider the following reaction:

$$Mg_3N_2 + 3\,H_2O \rightarrow 2\,NH_3 + 3\,MgO$$

A lab was performed by students in which they mixed a specific amount of Mg_3N_2 and H_2O. They produced 15 grams of MgO in the lab. Theoretically, they should have produced 18 grams. What their percent yield?

a. 17 % b. 25 % c. 50 % d. 83 % e. 117 %

$$\%\ \text{Yield} = \frac{AY}{TY} \times 100 \;;\; \frac{15}{18} \times 100 = \frac{5}{6} \times 100 = 83\%$$

23. Consider the following reaction:

$$2\,S + 3\,O_2 \rightarrow 2\,SO_3$$

Billy reacted 8.0 grams of sulfur with excess oxygen and was able to collect 15 grams of SO_3. What was Billy's percent yield?

a. 5.0 % b. 25 % c. 50 % d. 75 % e. 125 %

First, calculate Billy's theo. yield!

$$x\ g\ SO_3 = \left|\frac{8\ g\ S}{32\ g\ S}\right|\left|\frac{1\ mol\ S}{2\ mol\ S}\right|\left|\frac{2\ mol\ SO_3}{1\ mol\ SO_3}\right|\left|\frac{80\ g\ SO_3}{1\ mol\ SO_3}\right| = \frac{(8)(2)(80)}{(32)(2)} = \frac{80}{4} = 20\ g$$

$$\%\ \text{Yield} = \frac{AY}{TY} \times 100 \;;\; \% = \frac{15\ g}{20\ g} \times 100 = 75\%\ \text{yield}$$

Part 2: Answer each of the following questions on separate sheets of paper.

1. Predict the products for the following reactions and write a balanced equation for each:
   a) The combustion of propanoic acid.
   b) The synthesis reaction between potassium and chlorine gas.
   c) The decomposition of magnesium carbonate.
   d) Reacting barium and water.
   e) The reaction between silver nitrate and potassium chloride.

2. Below is a chart containing data for the three naturally occurring isotopes of Mg:

Isotope	abundance (%)	mass (u)
Mg-24	78.70	23.98504
Mg-25	10.13	24.98584
Mg-26	11.17	25.98259

   Calculate the atomic mass of magnesium.

3. Calculate the percentage of oxygen (by mass) in nickel (II) acetate.

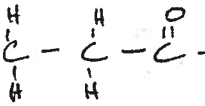
4. Assume you have 5.0 liters of water. Calculate each of the following:
   a) the number of grams of water.
   b) the number of moles of water.
   c) the number of molecules of water.
   d) the number of hydrogen atoms in this sample of water.

5. Antifreeze is composed of 51.6 % oxygen, 9.70% hydrogen, and 38.7% carbon by mass. The molar mass of antifreeze is 62.1 g/mol. Calculate its empirical and molecular formulas.

6. Menthol, the substance we can smell in mentholated cough drops, is composed of C, H, and O. A 0.1005-g sample of menthol is combusted, producing 0.2829 g CO_2 and 0.1159 g of H_2O. What is the empirical formula of menthol? If the compound has a molecular mass of 156 g/mol, what is its molecular formula?

7. When a mixture of 10.0 g of acetylene, C_2H_2, and 10.0 g of oxygen, O_2, is ignited, the resultant combustion produces CO_2 and H_2O.
   a) Write the balanced equation for this reaction.
   b) Which reactant is the limiting reactant?
   c) How many grams of C_2H_2, O_2, CO_2, and H_2O are present after the reaction is complete?

PART 2 : Answer Key

propanoic acid :  $C_3H_6O_2$

① (a) $2\,C_3H_6O_2 + 7\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$

(b) $2\,K + Cl_2 \rightarrow 2\,KCl$

(c) $MgCO_3 \rightarrow MgO + CO_2$ (Carbonates decompose by forming CO_2)

(d) $Ba + 2\,H_2O \rightarrow Ba(OH)_2 + H_2$

(e) $AgNO_3 + KCl \rightarrow AgCl + KNO_3$

② ATOMIC MASS $= \dfrac{(78.70)(23.98504) + (10.13)(24.98584) + (11.17)(25.98259)}{100} =$ 24.33 amu

③ $Ni(C_2H_3O_2)_2$

Ni	1 x 58.69 =	58.69
C	4 x 12.01 =	48.04
H	6 x 1.008 =	6.048
O	4 x 16.00 =	64.00
		176.78 g/mol

$\%\ \text{Oxygen} = \dfrac{\text{mass O}}{\text{total mass}} \times 100$

$\%\ O = \dfrac{64.00}{176.78} \times 100$

$\%\ O = 36.20\ \%$

④ (a) Since given no other information, we will assume the density of water is 1.0 g/mL.

$$x\ g\ H_2O = \left|\frac{5.0\ L}{1}\right|\left|\frac{1000\ mL}{1\ L}\right|\left|\frac{1\ g}{1\ mL}\right| = 5{,}000\ g = 5.0 \times 10^3\ g$$ (2 sig. fig's)

(b) $$x\ mol\ H_2O = \left|\frac{5.0 \times 10^3\ g}{1}\right|\left|\frac{1\ mol\ H_2O}{18.0\ g\ H_2O}\right| = 277.8\ mol\ H_2O = 280\ moles\ H_2O$$ (2 sig. fig's)

(c) $$x\ molecules = \left|\frac{277.8\ mol}{1}\right|\left|\frac{6.02 \times 10^{23}\ molecules}{1\ mole}\right| = 1.672 \times 10^{26}\ molecules$$
$= 1.7 \times 10^{26}$ molecules H_2O

(d) $$x\ H\ atoms = \left|\frac{1.672 \times 10^{26}\ molecules\ H_2O}{1}\right|\left|\frac{2\ H\ atoms}{1\ molecule\ H_2O}\right| = 3.345 \times 10^{26}\ atoms$$
$= 3.3 \times 10^{26}$ atoms H

(5) Assume you have a 100-g sample.

$$X \text{ mol } O = \left|\frac{51.6\text{ g O}}{}\right|\left|\frac{1\text{ mol O}}{16.00\text{ g O}}\right| = 3.225 \text{ mol O} \div 3.222 \approx 1$$

$$X \text{ mol } H = \left|\frac{9.70\text{ g H}}{}\right|\left|\frac{1\text{ mol H}}{1.008\text{ g H}}\right| = 9.623 \text{ mol H} \div 3.222 \approx 3$$

$$X \text{ mol } C = \left|\frac{38.7\text{ g C}}{}\right|\left|\frac{1\text{ mol C}}{12.01\text{ g C}}\right| = 3.222 \text{ mol C} \div 3.222 = 1$$

CH_3O EMPIRICAL FORMULA

C 1 x 12.0 = 12.0
H 3 x 1.01 = 3.03
O 1 x 16.0 = 16.0
31.0 g/mol

$$\frac{MF\text{ (mass)}}{EF\text{ (mass)}} = \frac{62.1\text{ g/mol}}{31.0\text{ g/mol}} = 2 \quad MF = 2 \times EF$$

$MF = C_2H_6O_2$

(6) Use the mass of CO_2 & mass of H_2O to calculate the mass of C & H in the menthol! (calculate moles first)

$$X \text{ mol } C = \left|\frac{0.2829\text{ g } CO_2}{}\right|\left|\frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2}\right|\left|\frac{1\text{ mol C}}{1\text{ mol } CO_2}\right| = 0.006428 \text{ mol C} \Rightarrow 0.07720 \text{ grams C}$$

$$X \text{ mol } H = \left|\frac{0.1159\text{ g } H_2O}{}\right|\left|\frac{1\text{ mol } H_2O}{18.016\text{ g } H_2O}\right|\left|\frac{2\text{ mol H}}{1\text{ mol } H_2O}\right| = 0.01287 \text{ mol H} \Rightarrow 0.01297 \text{ grams H}$$

By subtraction, determine mass of oxygen in the menthol.

Total mass of sample = mass C + mass H + mass O

0.1005 g = 0.07720 g C + 0.01297 g H + mass O

mass oxygen = 0.01033 g O $\Rightarrow$ 0.0006456 moles of oxygen

$$C_{\frac{0.006428}{0.0006456}}\ H_{\frac{0.01287}{0.0006456}}\ O_{\frac{0.0006456}{0.0006456}} \Rightarrow \text{Empirical Formula: } C_{10}H_{20}O_1 \Rightarrow \text{molar mass is } 156.3\text{ g/mole}$$

$$\frac{MF\text{ (mass)}}{EF\text{ (mass)}} = \frac{156\text{ g/mole}}{156.3\text{ g/mole}} \approx 1$$

The molecular formula is also $C_{10}H_{20}O$. ☺

(7) (a) $\underline{2}\ C_2H_2 + \underline{5}\ O_2 \rightarrow \underline{4}\ CO_2 + \underline{2}\ H_2O$

(b) $x \text{ mol } C_2H_2 = \left|\frac{10.0\text{ g } C_2H_2}{26.04\text{ g } C_2H_2}\right| \left|\frac{1\text{ mol } C_2H_2}{}\right| = 0.3840 \text{ mol } C_2H_2$ (EXCESS REACTANT)

$x \text{ mol } O_2 = \left|\frac{10.0\text{ g } O_2}{32.00\text{ g } O_2}\right| \left|\frac{1\text{ mol } O_2}{}\right| = 0.3125 \text{ mol } O_2$ (LIMITING REACTANT)

(c) $x \text{ g } CO_2 = \left|\frac{0.3125\text{ mol } O_2}{5\text{ mol } O_2}\right| \left|\frac{4\text{ mol } CO_2}{1\text{ mol } CO_2}\right| \left|\frac{44.01\text{ g } CO_2}{}\right| =$ 11.0 grams CO_2

$x \text{ g } H_2O = \left|\frac{0.3125\text{ mol } O_2}{5\text{ mol } O_2}\right| \left|\frac{2\text{ mol } H_2O}{1\text{ mol } H_2O}\right| \left|\frac{18.02\text{ g } H_2O}{}\right| =$ 2.25 g H_2O

$x \text{ g } C_2H_2 \text{ "used"} = \left|\frac{0.3125\text{ mol } O_2}{5\text{ mol } O_2}\right| \left|\frac{2\text{ mol } C_2H_2}{1\text{ mol } C_2H_2}\right| \left|\frac{26.04\text{ g } C_2H_2}{}\right| = 3.26 \text{ g } C_2H_2 \text{ used}$

10.0 g present initially
− 3.26 g reacts
6.74 g C_2H_2 excess

6.7 g C_2H_2 excess

NO oxygen is left at the end of the reaction as it is the limiting reactant!

To double check that the Law of Conservation of Mass is obeyed ... (INITIAL MASS = FINAL MASS)

INITIAL MASS OF REACTANTS: 10.0 g + 10.0 g = 20.0 grams

FINAL MASS OF PRODUCTS: 11.0 g CO_2 + 2.25 g H_2O + 6.7 g C_2H_2

= 20.0 grams