# Answers - Unit 1: Chemical Reactions

1. a) magnesium nitrate b) sodium hydrogen carbonate c) carbon tetrachloride
   d) potassium phosphate

2. a) $N_2O_3$ b) $(NH_4)_3PO_4$ c) $CuSO_4$ d) $P_2O_5$

3. a) **3** $Mg + N_2 \rightarrow Mg_3N_2$ b) **2** $Fe + $ **3** $H_2SO_4 \rightarrow Fe_2(SO_4)_3 + $ **3** $H_2$
   c) **3** $Ni(NO_3)_2 + $ **2** $Al(OH)_3 \rightarrow $ **3** $Ni(OH)_2 + $ **2** $Al(NO_3)_3$
   d) $CH_4 + $ **2** $O_2 \rightarrow CO_2 + $ **2** $H_2O$
   e) $LiAlH_4 + $ **4** $H_2O \rightarrow LiOH + Al(OH)_3 + $ **4** $H_2$

4. a) $MgBr_2 + Cl_2 \rightarrow MgCl_2 + Br_2$
   b) $2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$
   c) $N_2 + 3H_2 \rightarrow 2NH_3$
   d) $NaOH + HCl \rightarrow NaCl + H_2O$
   e) $C_3H_8 + 5\ O_2 \rightarrow 3CO_2 + 4H_2O$
   f) $2\ Na_2O \rightarrow 4\ Na + O_2$

5. a) 0.240 mol b) 0.35 mol c) 0.123 mol d) 0.260 mol e) 0.451 mol

6. a) 0.0540 g b) 12.5 g c) 13.8 g d) 5.96 g 7. 49.2 g 8. 0.110 mol

9. 0.5 mol of Al, 1.5 mol of N, 4.5 mol of O

10. Fe = $1.51x10^{23}$ atoms, O & H = $3.01 \times 10^{23}$ atoms of each

11. $1.3x10^{-17}$ g 12. 126 g 13. 0.360 mol 14. $9.68\ x10^{-17}$ g

15. x = 0.196 mol of $H_2$ produced

16 a) X = 0.30 mol b) 6.7 L 17. a) 0.47 mol b) 54.0 g 18. a) 21.6 g b) 8.94L c) X=6.78 kJ

19. $N_2$ is the limiting factor. Volume of ammonia produced = 67.2 L

20. $O_2$ is the limiting factor. Methane is in excess (16.1 g). 2.0 moles of $CO_2$ produced

21. Limiting is $O_2$ excess ($C_2H_2$): 15.6g 8.8 mol $CO_2$ produced

22. 28.8 g excess $O_2$ limiting S mass of $SO_3$ produced = $4.0x\ 10^2$g

23. Limiting $N_2$ excess $H_2$ = 0.024 g, 0.13 mol $HN_3$ produced

24. $O_2$ = 1.2mol $C_2H_6$ = 0.35 mol $O_2$ is the Limiting Reactant 30.36g of $CO_2$ produced

25. 24.31 amu 26. a) Na 27.37% , H 1.20%, O 57.14%, C 14.30%
   b) K 41.08%, S 33.70%, O 25.22%

27. 23.15 g 28. a) $NO_2$ b) $C_3H_8$

# Answers - Unit 2: Physical Properties of Matter

1. From left to right; solid, solid/liquid, liquid, liquid/gas, gas a) 50ºC b) -50ºC
2. plateaus represent a phase change
3. added energy goes to breaking bonds/overcoming forces of attraction (Changes potential energy not kinetic energy)
4. larger sample used would make it take longer for the substance to heat up and change phases

5. if there was an impure substance, we would see more plateaus, because each substance has a different temperature at which it changes phase
6. KE changes whenever the line is NOT plateaued (changes when temp. changes. PE changes only during the plateau.
7. A cooling curve would start high (at 200) and would decrease to 0. Plateaus would be at the same temperatures as the warming curve.
   a) - 50ºC b) 50ºC
8. ethylene glycol
9. substance requires very high temperatures to go from liquid to gas
10. 80ºC
11. decrease the pressure of the water vapour/space above the water
12. KE of particles needs to increase to a specific temperature at which the vapour pressure in the bubble equals the pressure on the surface of the liquid. At this temperature, (where it plateaus, so KE stays constant), the particles are able to overcome the intermolecular forces and escape from the liquid phase, spreading out further.
13. The stronger the intermolecular forces, the more kinetic energy the particles need to overcome them. Temperature is related to KE, so higher energy means higher temperatures for boiling and melting points.
14. Both involve the change from liquid to gas. Boiling is at a specific temperature/ evaporation is below the boiling point, boiling is throughout the whole liquid/evaporation is on the surface, and boiling is rapid/evaporation is slow.
15. London dispersion forces, Dipole – dipole forces and Hydrogen bonding. The stronger the forces, the higher the melting and boiling points of a substance.
16. Temp is a measure of the average KE of a sample.
17. Solids have definite shape and definite volume. Because of the close particle arrangement, they are difficult to compress. Liquids have definite volume but take the shape of the container they are in. They are very slightly compressible because there is a bit more space between the particles. Gases have no definite shape or volume. They will expand to fill the container they are in. Gases are very compressible because of the space between the particles.
18. The three main points of the KMT are that molecules are small hard spheres with insignificant volume, all collisions between particles are elastic and that they have random, rapid, constant motion.
19. A balloon will collapse when put in the fridge because as the temp decreases, so does the KE. Molecules slow down and don't move as quickly and won't hit the sides of the balloon as hard so it will shrink.
20. Evaporation is a cooling process because as the molecules with a higher KE leave the liquid phase, the average KE of the molecules left behind is lower which is related to a lower temp.

## Answers – Unit 3: Gases and the Atmosphere

1. ºK = ºC + 273 or ºC = ºK – 273
2. a) Pressure is inversely proportional to volume, as pressure increases, volume decreases
   b) P is inversely proportional to V, $P_1V_1 = P_2V_2$ c) See Boyle's Law lab for drawings
   d) Closed syringes, deep sea fish rising to the top, opening a water bottle up in an airplane and having it collapse when it lands on the ground
3. a) temperature is proportional to volume, as temperature increases, volume increases
   b) T is proportional to V $V_1/T_1 = V_2/T_2$
   d) putting a bag of chips near a heater it will puff up, putting a balloon in the freezer makes it shrink
4. a) temp is proportional to pressure, as temp increases so does pressure.
   b) P is proportional to T $P_1/T_1 = P_2/T_2$
   d) throwing an aerosol can in a fire, gauge pressure in tire is higher after driving on hot asphalt

5. Boyle's Law, $P_2$ = **649 kPa** 6. Boyle's Law, $\mathbf{V_1}$ = **16L** 7. Charles's Law, $V_2$ = **13.4L**
8. Charles's Law, $T_1$ = **96ºK** 9. Boyle's Law, $V_2$ = **0.25L**, yes this would be harmful
10. Combined Law, $P_1$=**2.51 atm** 11. Combined Law,$T_2$= **160. K**

12. Gay-Lussac's Law, $P_2$=**8.63 atm**
13. See research notes on each scientist.
14. No, oxygen levels increased because of increasing success of photosynthetic life forms such as oxygen generating cyanobacteria.
15. Air quality describes the concentration of air pollutants in the air that we breathe. Scientists study air pollutants that can alter the atmosphere and affect human health. The Brewer Ozone Spectrophotometer measures ozone levels.
16. Air pollution is a broad term applied to any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere. The two main components of smog are ground level ozone and particulate matter.

## Answers - Unit 4: Solutions

1. raise the temperature of the liquid

2. as the water warms up, the gas becomes less soluble in the liquid. It forms bubbles along the glass.

3. polar solutes dissolve in polar solvents, nonpolar solutes dissolve in nonpolar solvents

4. unsaturated – more solute can be dissolved
   saturated – no more solute can be dissolved at this given temperature
   supersaturated – solution is hold more solute at a given temperature. This point is reached with an increase in temperature

5. increase temperature, use a different solvent, increase the amount of solvent

6. a) $Na_2SO_4 \rightarrow 2Na^+_{(aq)} + SO_4^{2+}{}_{(aq)}$ b) $(NH_4)_2CO_3 \rightarrow 2NH_4^+{}_{(aq)} + CO_3^{2-}{}_{(aq)}$

7. a) no, $Al(OH)_3$ b) yes c) No, $Mg_3(PO_4)_2$ d) yes e) no, $Fe_2(SO_4)_3$ f) yes

8. a) $Li_2SO_{4(aq)} + Pb(NO_3)_{2(aq)} \rightarrow PbSO_{4(s)} + 2LiNO_{3(aq)}$
   b) $2(NH_4)_3PO_{4(aq)} + 3CaCl_{2(aq)} \rightarrow 6NH_4Cl_{(aq)} + Ca_3(PO_4)_{2(s)}$

9. a) ~ 80g/100mL $H_2O$ b) ~ 43ºC c) i) unsaturated ii) saturated with ppt iii) saturated
   d) ~ 20ºC
   e) solubility @ 70ºC = 130g/100mL
      1. decrease the temperature to 50ºC where 80g/100mL is the solubility
      2. boil off approximately 38.5g of water, this will leave 61.5g of water. At 70ºC 80g of $KNO_3$ will saturate 61.5g of water
      3. add 50g more $KNO_3$ to saturate @ 70ºC = 130g/100mL of water

10. n = C ◦ V = 0.4(0.25) = 0.1 mol mass = mole (molar mass) = 0.1 (58.44) = 5.84g of NaCl needed.
    - Tare a clean 250.0 mL volumetric flask and add 5.84 g NaCl to it.
    - Add less than 250.0 mL of distilled water to the flask, stopper and mix.
    - Slowly bring the volume up to the 250.0 mL mark by adding more distilled water.

11. C = 0.800 M 12. 9.24 g 13. C = 0.569 M 14. 1.07 g

15. $C_2$ = 0.286 M 16. $C_2$ = 0.0632 M 17. $C_2$ = 0.375 M 18. $V_1$ = 0.0133 L = 13.3 ml

19. (0.900)(0.050) = (0.180)($V_2$) $V_2$ = 0.250 L Vol. added: 250mL – 50 mL = 200 mL

20. C = 1.25 mol/L 21. C = 0.630 mol/L 22. m = 63.7 g

23. V = 0.574L 24. V = 0.750 L 25. 45 mL ethanol

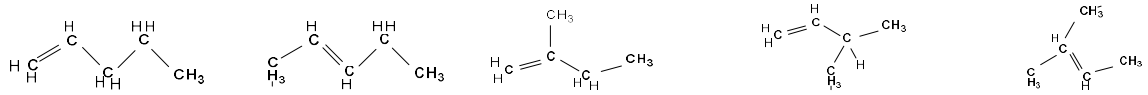
26. 3.23 % m/m  27. 0.28 M

# Answers - Unit 5: Organic Chemistry

1. Compare and Contrast Alkanes, Alkenes and Alkynes in terms of:

| | Alkanes | Alkenes | Alkynes |
|---|---|---|---|
| Bonding | Single covalent | Double covalent | Triple covalent |
| General Formula | $C_nH_{2n+2}$ | $C_nH_{2n}$ | $C_nH_{2n-2}$ |
| Structural Formula |  |  |  |
| Reactivity | Least reactive | In the middle | Most reactive |
| Uses | Fuels (propane, butane) | Starting materials for many chemicals and polymers. | Acetylene – fuel in welding. |

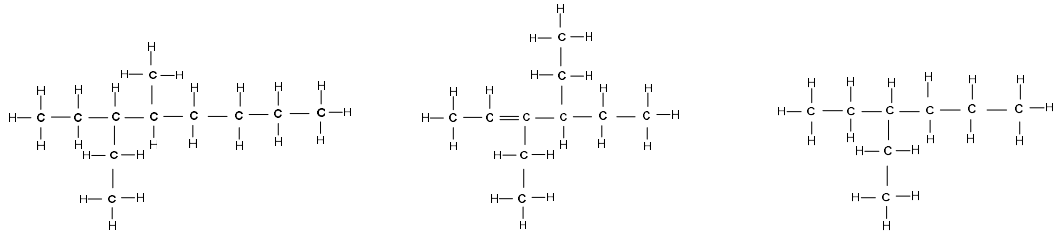
2. a) butane  b) 2-methylpentane  c) 2-methylpentane  d) 2-methylpropane
   e) 1- butene  f) 2-butene  g) 3,4,5-trimethyl-1-hexene  h) 4,5-dimethyl-2-heptene

3. 

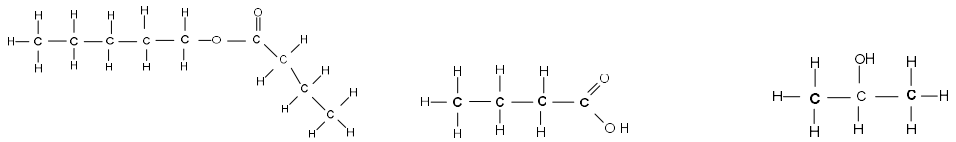
   1-pentene  2-pentene  2-methyl-1-butene  3-methyl-1-butene  2-methyl-2-butene

4 a) 1-butyne
   b) 4,5-dimethyl-2-hexyne
   c) 4-ethyl-1-octyne
   d) 4-ethyl-3,5,6-trimethyl-1-heptyne
   e) 2-hexanol
   f) 3-methyl-2-butanol
   g) 3-methyl-2-pentanol
   h) 2,4-dimethyl-3-hexanol
   i) 2,4,8- trimethyl-3-decanol
   j) 2-hexanol
   k) propanoic acid
   l) nonanoic acid
   m) hexanoic acid
   n) pentanoic acid

5. a) alkanes  b) alkenes  c) alkanes



d) ester  e) carboxylic acid  f) alcohol



g) alcohol  h) ester  i) ester