AP Chemistry Winter break packet

1) An unknown metal having a mass of 287.8 g was added to a graduated
   cylinder that contained 31.47 mL of water. After the addition of the metal, the
   water level rose to 56.85 mL. What is the density of the metal?

   $D = 11.34$ g/mL

2) Explain the difference between precision and accuracy.

   Check book

3) Explain three types of ways of separating substances by physical means.
   What physical properties are used to make the separation possible?

   Distillation (boiling point), filtration (size), chromatography (intermolecular
   forces), magnet (magnetism)

4) What element has an atomic number of 20 and two electron in its valence
   shell?
   Calcium

5) What is the probable compound formed from aluminum and oxygen has the
   formula?
   Al_2O_3

6) Compare the reactivity of alkali metals, alkaline earth metals, halogens, and
   noble gases.

   Alkali metals are more reactive than alkaline earth because it takes less
   energy to remove its valence electron (lower ionization energy). Halogens are
   also very reactive because they are able to take electrons from other atoms (they
   have a high electron affinity but low ionization energy so they do not form
   cations). Noble gases have a very high ionization energy and do not have
   electron affinity (they would repel electrons and not attract them)

7) What color are the following substances: Iodine, chlorine, nickel (II) ions,
   copper (II) ions, zinc ions, cobalt (II) ions, bromine, sulfur, permanganate ion,
   triiodide complex ion.

   Iodine = purple solide. Chlorine = yellow/green gas. Ni^{2+} = green. Cu^{2+} = blue
   Zn^{2+} = colorless. Co^{2+} = deep purple. Br_2 = reddish brown liquid. Sulfur = yellow
   solid. MnO_4^- = dark purple. I_3^- = dark brown when concentrated yellow when
   dilute

8) Be able to solve for the number of protons, electrons, charge, and neutrons of neutral atom or an atom with a charge.

9) Be able to identify the most and least electronegative element and correctly define electronegativity

Most electronegative is Fluorine. Cesium would be the least electronegative atom (Francium doesn't exist in amounts we can measure. No compounds of francium have ever been studied). Electronegativity is the ability of an atom to attract electrons to itself when bonding with other atoms.

10) Be able to write the electron configuration for a neutral atom and an atom with a charge.

11) What are the Pauli exclusion principle and Hund's rule? See book

12) According to Hund's rule, how many unpaired electrons does the ground state of cobalt have?
Three unpaired electrons

13) Describe the size ionic radius of a cation and an anion compared to a neutral atom.

A cation has lost at least one valence electron so the size of the ion decreases radically compared to the regular atom. An anion has gained an electron so the repulsion between electrons is greater and so is the radius

14) Write the complete electron configuration for As (arsenic) atom in the ground state. Indicate the number of unpaired electrons in the ground state atom, and explain your reasoning.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^3$ three unpaired electrons, one on each p orbital

15) Explain why the first ionization energy of arsenic is greater than that of Sb (antimony).
Arsenic's outermost electrons are closer to the nucleus and therefore experience a greater effective nuclear charge

16) A carbon-oxygen double bond in certain organic molecule absorbs radiation that has a frequency of $5.21 \times 10^{14}\ s^{-1}$
a) What is the wavelength of this radiation (in nm)?   576 nm

b) What is the energy of this radiation per photon? 3.45×10^{-19} J

c) What is the energy (in kJ) per mole of photons?   208 kJ.mol^{-1}

17) After balancing the equation for the combustion of ethanol in the presence of oxygen and reducing all stoichiometric coefficients to their smallest possible whole number, what is the stoichiometric coefficient for O_2? 3

18) Consider the balanced equation:

  Cu + S --> CuS

Approximately what amount of sulfur in grams must be available for 28 grams of Cu to react to form the compound?   14 g

19) How many grams of N_2 occupy a volume of 12.8 liters at STP? 16 g

20) $2NH_3$ --> $3H_2$ + N_2

Ammonia decomposes into hydrogen gas and nitrogen gas.

How many liters of H_2 at 25ºC and 2.33 atm of pressure can be produced by the decomposition of 6.25 moles of NH_3? 98.4 L

21) Complete combustion of a compound containing hydrogen and carbon produced 2.641 g of carbon dioxide and 1.442 grams of water as the only products. The molar mass of the hydrocarbon is 88.1 g/mol. What are the empirical and molecular formulas?

       C_3H_8 = empirical C_6H_{16} = molecular

22) How much water must be evaporated form 500 ml of 1 M $Ca(OH)_2$ to make it 5 M?   400 mL

23) Compute the quantity in grams of sucrose ($C_{12}H_{22}O_{11}$) required to make a 1 M strength solution of 500 ml (a) 85.5 (b) 171 (c) 342 (d) 684 (e) 982

24) Which of the following solutions will conduct the most electricity and why?
       0.5 M $CuSO_4$ - 0.25 M $MgCl_2$ - 1.0 M $C_6H_{12}O_6$ - 0.25 M Na_3PO_4
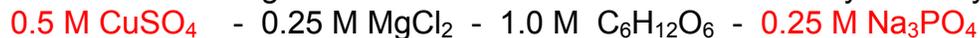
This question is missing information. It is possible to know right away that the glucose solution does not conduct electricity. The magnesium chloride solution has a total concentration of ions of 0.75 M but the sodium phosphate and copper sulfate have equal 1.0 M concentrations of dissolved ions so the conduct equally

$HClO$ + Sn^{2+} + H^+ --> Cl^- + Sn^{4+} + H_2O
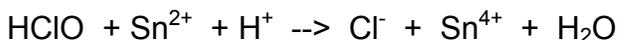
25) Balance the above reaction. Which reactant acts as the reducing agent? How does the oxidation number of chlorine change in the reaction?

Equation is balanced already. Sn^{2+} is oxidized and therefore, it is the reducing agent. Oxidation number of chlorine goes from +1 to -1

26) Aqueous solutions of potassium sulfide and nickel (II) chloride are mixed together. What is the net ionic equation? Ni^{2+} + S^{2-} → NiS

27) Write the net ionic equation for the reaction below. Identify what got oxidized, reduced, the reducing agent, and the oxidizing agent in the following reaction.

zinc metal immersed in copper (II) chloride solution

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

Zn is oxidized (reducing agent), Cu^{2+} is reduced (oxidizing agent)

28) Calculate the mass of product when 100.0 mL of 0.500 M $CaCl_2$ is added to 50.0 mL of 0.75 M sodium phosphate solution. What is the concentration of each ionic specie after the reaction is complete?

5.17 g of $Ca_3(PO_4)_2$ $[Na^+]$ = 0.75M; $[Cl^-]$ = 0.666 M; $[PO_4^{3-}]$ = 0.028 M

29) A sample of H_2 is collected over water. The pressure in the gas collection tube is 1.03 atm. The vapor pressure of the water is 0.06 atm. What pressure does the hydrogen gas exert?
P_{H_2} = 0.97 atm

30) What is the molar mass of the gas that effuses at half the rate of Ne?

80.72 g/mol

31) An ideal gas fills a balloon at a temperature of 27.0°C and 1.00 atm pressure. By what factor will the volume of the balloon change if the gas in the balloon is heated to 127.0°C?   4/3

32) A gas sample with a mass of 12.5 grams occupies 600.0 mL and exerts a pressure of 825 mm of Hg at a temperature of 27.0 C. What is the molecular mass of the gas? The gas constant, R, is 0.08 (L•atm)/(mol•K)
473 g.mol^{-1}

33) Small quantities of hydrogen gas can be prepared in the laboratory by the addition of aqueous nitric acid to magnesium.

$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$

Typically, the hydrogen gas is bubbled through water for collection and becomes saturated with water vapor. Suppose 260.0 mL of hydrogen gas is collect at 30.0 °C and has a total pressure of 764 torr by this process. What is the partial pressure of hydrogen gas in the sample? How many grams of magnesium must have reacted to produce the quantity of hydrogen gas? (The vapor pressure of water is 32 torr at 30.0°C)
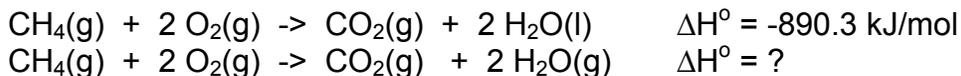
P_{H_2} = 732 mm Hg,   0.245 g Mg
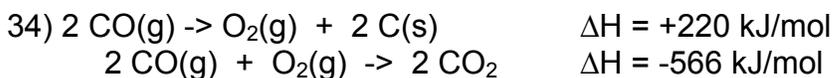
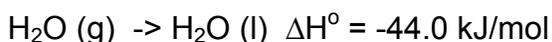34) 2 CO(g) -> O$_2$(g) + 2 C(s)   ΔH = +220 kJ/mol
      2 CO(g) + O$_2$(g) -> 2 CO$_2$ ΔH = -566 kJ/mol
Use the information above to find the enthalpy change for the following reaction
      2 C(s) + 2 O$_2$(g) -> 2 CO$_2$(g)
-786 kJ.mol^{-1}

35)   The two processes for the combustion of methane in oxygen are outlined below.

   CH$_4$(g) + 2 O$_2$(g) -> CO$_2$(g) + 2 H$_2$O(l)   ΔH° = -890.3 kJ/mol
   CH$_4$(g) + 2 O$_2$(g) -> CO$_2$(g) + 2 H$_2$O(g)   ΔH° = ?

What is the value of enthalpy change, ΔH°, for the second reaction knowing that:

   H$_2$O (g) -> H$_2$O (l) ΔH° = -44.0 kJ/mol

   -802.3 kJ/mol

36) The specific heat of water is 1.00 cal/g °C. The temperature of a sample of water decreased from 48.0 °C to 22.0°C as 152 calories of heat were lost. What is the mass of the sample of water? m = 5.85 g

37) An equation for the electrolysis of water is

H$_2$O (l) + 68.3 kcal --> H$_2$ (g) + 1/2 O$_2$ (g)
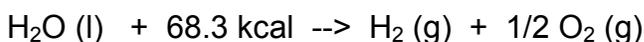
How many liters of gaseous product are produced by the addition of 250.0 kcal of electrical energy to the reaction above? V = 123 L

38) Consider this reaction:

   2N$_2$H$_4$ (l) + N$_2$O$_4$ (l) -> 3N$_2$ (g) + 4H$_2$O (g) ΔH = -1078 kJ
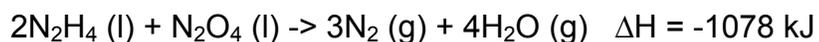
How much energy is released by this reaction during the formation 125 g of N$_2$
-1604 kJ

39) A 4.186 g piece of aluminum heated to 95.3 °C is placed in a coffee cup calorimeter that initially contains 35.6g of water at 21.8 °C. If the final temperature is 24.7 °C, what is the specific heat capacity of the aluminum? (specific heat of water = 4.18 J/g °C) 1.46 J.g^{-1}°C^{-1}

40) Write the lewis dot structure, molecular geometry and express the hybridization of the central atom in NO_2^-. Does the ion form a resonating structure?

N has a double bond with one O and a single bond with the other one. N also has one lone pair. The hybridization is sp^2 and the geometry is bent. This is a resonant structure

41) What are four species isoelectronic with Ar?

Cl^-, S^{2-}, K^+, Ca^{2+}

42) The melting point of MgO is higher than that of NaF. Why?

The charges of magnesium and oxide ions are greater than the charges of Na^+ and F^- therefore the attraction is greater and so is the lattice energy

43) What are the bond angles of the following species? BF_3 CF_4 NF_3 OF_2

$120°$, $109.5°$, ~$107°$, ~$109.5°$

44) Find the enthalpy change, ΔH, for the following reaction using the following information. $N_2 + O_2 \rightarrow 2\ NO$

Bond Energies in kJ/mol N=N = 418; N≡N = 941; N=O = 607; O=O = 495

+222 kJ/mol

45) The following questions pertain to the H_2CO molecule.
a) Draw a complete Lewis structure of H_2CO.
b) What is the hybridization of the carbon atom?
c) What is the organic functional group of this molecule

single bonds between both H atoms and carbon. A double bond between C=O. Oxygen has two lone pairs. Sp^2 hybridization, trigonal planar structure and this is an aldehyde

46) What will be the shape of a molecule when the central atom is surrounded by six atoms and the molecule does not contain lone pairs of electrons? What would be the shape if it were surrounded by 5 atoms and one lone pair of electrons?

Octahedral, square pyramidal

47) How many sigma and pi bonds are there in the molecule $H_3C-C≡C-CH_3$

9 sigma, 2 pi

48) What is the type of hybridization used by chlorine in the ClF_4^- ion?
Sp^3d^2

49) The reaction N_2H_4 (l) → N_2 + $2H_2$ $\Delta H° = -50.6$ kJ is:
   a) Spontaneous at all temperatures
   b) non-spontaneous at all temperatures
   c) spontaneous only at low temperatures
   d) spontaneous only a high temperatures

50) A plot of rate constant versus 1/T for a reaction will allow you to calculate:
   a) rate law   b) rate order   c) activation energy   d) intermediate

51) For the reaction: $(CH_3)_3CBr(aq)$ + $OH^-(aq)$ r $(CH_3)_3COH(aq)$ + $Br^-(aq)$
it is found that halving the concentration of $(CH_3)_3CBr$ causes the reaction rate to be halved but halving the concentration of OH^- has no effect on the rate. What is the rate law for the reaction?

Rate = $k[(CH_3)_3CBr]$

52) The boiling temperature of Ne is less than that of Kr. Explain?

Kr has a larger and more polarizable electron cloud which means greater LDF

53) Google the molecular structure of benzene and pyridine and explain why benzene is not soluble in water while pyridine is.

Pyridine has a polar nitrogen atom in its structure which can form hydrogen bonds with water molecules. Benzene is non polar and has weak LDF interactions with water

54) Which has higher melting point methanol or methane? Explain why?

Methanol as it can form hydrogen bonds with other methanol molecules. Methane only has weak LDF interactions

55) Which has a lower melting point neon or argon? Explain why?
Neon, same reason as question 52