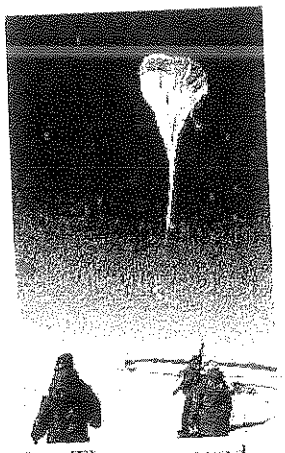
CHEM 20

PRACTICE EXAMINATION 1

Use the following information to answer the next three questions.



Almost all refrigeration and air conditioning devices contain CFCs. The ozone depleting effects of chlorofluorocarbons (CFCs) are well known. In the search for "ozone friendly" alternatives to CFCs, the most promising candidates include hydro-fluorocarbons, HFCs. The compound 1, 1, 1, 2-tetrafluoroethane, CH_2FCF_3, is one alternative currently being used in home refrigeration and automobile air conditioning units.

1. If dissolved in water, CH_2FCF_3 would
   - **A.** conduct electricity
   - **B.** dissociate into ions
   - **C.** behave as a non-electrolyte
   - **D.** behave as an electrolyte

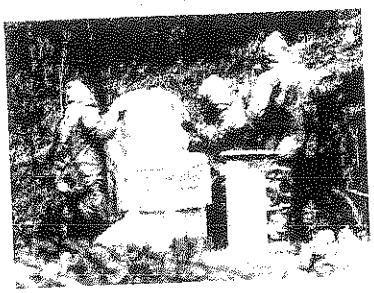
2. The intramolecular bonding in CH_2FCF_3 results from
   - **A.** a simultaneous attraction of neutrons by the atomic nuclei
   - **B.** an exchange of alpha particles between atoms
   - **C.** a mutual attraction of protons by electrons
   - **D.** a mutual attraction of electrons by atomic nuclei

Use this additional information to answer the next question.

Earth's atmosphere consists of nitrogen (78.08%), oxygen (20.95%), argon (0.93%), water vapour (1%) and various trace gases (0.04%). Anthropogenic (man-made) emissions have significantly affected the concentration or composition of these trace gases. Arguably, the most notorious of these trace gases are the CFCs, which now account for some 3 ppb (parts per billion by volume) of the atmosphere.

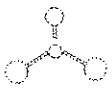
3. Measuring the CFC concentration in the atmosphere is a
   - **A.** diagnostic test
   - **B.** qualitative analysis
   - **C.** logical test
   - **D.** quantitative analysis

Use the following information to answer the next question.



Phosgene, $COCl_{2(g)}$, is a toxic, volatile liquid that smells like hay. It is primarily used in the manufacture of urethane foams, plastics, and coatings, but has also been used as a military chemical weapon. Air containing 0.500 mg of phosgene gas per litre can be fatal.

Numerical Response

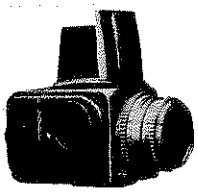


1. The molar concentration in air containing this lethal dose of phosgene is_____ $\times 10^{-6}$ mol/L

(Record your answer to three digits.)

Use the following information to answer the next question.

Modern photography uses silver bromide to form images on paper. Silver bromide is slightly soluble in water and when saturated the solution is described by the equation



$$AgBr_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Br^{-}_{(aq)}$$

4. In this equilibrium equation, the rate of dissolution is

   A. equal to the rate of crystallization

   B. greater than the rate of crystallization

   C. less than the rate of crystallization

   D. independent of the rate of crystallization

Use the following information to answer the next two questions.

Kimchi is a popular Korean appetizer made by fermenting a combination of radishes, turnips, onions, and Chinese cabbages.

Numerical Response

2. If the salt in kimchi has a 3.00% concentration by mass, the mass of salt contained in a 500 g portion of kimchi is _____ g.
   (Record your answer to three digits.)

Numerical Response

3. The salt concentration of a 48.0 mL sample of kimchi juice is 0.400 mol/L. If this sample is diluted to a new final volume of 100 mL, then the molar concentration of the salt in the kimchi juice would be _____ mol/L.
   (Record your answer to three significant digits.)

Use the following information to answer the next question.

Svante Arrhenius' doctoral thesis centred on the electrical conductivity of liquid solutions. Arrhenius theorized that only those solutions that contained solvated ions were electrically conductive. Moreover, the solvated ions were produced by ionic dissociation, a process influenced greatly by the nature of the solvent and the solute being mixed.

5. According to Arrhenian theory, aqueous solutions of

   A. weak acids conduct electricity well

   B. strong acids conduct electricity poorly

   C. strong acids conduct electricity well

   D. weak acids conduct electricity poorly

6. Coffee, bananas, spinach, and squash all have a hydrogen ion concentration of about 10^{-5} mol/L. This hydrogen ion concentration corresponds to a pH of

   A. 4

   B. 3

   C. –5

   D. 5

Use the following information to answer the next two questions.

Whitening and de-acidifying old papers can be done with sodium borohydride. This can be useful in preserving valuable historical documents.

7. If the pH values before and after sodium borohydride bleaching are 5 and 8, respectively, then the corresponding hydrogen ion concentrations before and after de-acidifying are, respectively,

   A. 10^{-5} and 10^{-8} mol/L

   B. 10^{-8} and 10^{-11} mol/L

   C. 10^{5} and 10^{8} mol/L

   D. -10^{5} and -10^{8} mol/L

8. The change in the hydrogen ion concentration after addition of sodium borohydride corresponds to a

   A. 100 fold decrease

   B. 100 fold increase

   C. 1 000 fold decrease

   D. 1 000 fold increase

Use the following information to answer the next question.

The ideal gas law equation is $PV = nRT$. It can be rearranged to show that pressure and volume are inversely proportional for a fixed amount of gas at a constant temperature. i.e.

$$V = \frac{nRT}{P} \text{ or } V \propto \frac{1}{P}$$

9. The law that summarizes the relationship between the volume and pressure of a fixed quantity of gas at constant temperature is

   A. Boyle's Law

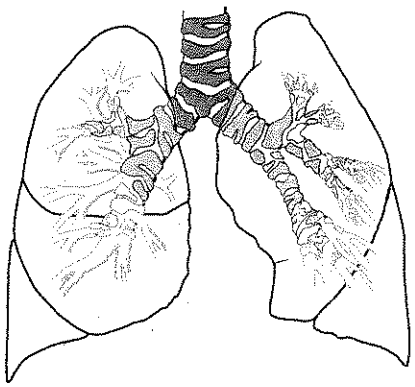
   B. Charles' Law

   C. Avogadro's Law

   D. Henry's Law

Use the following information to answer the next question.

Gas exchange in the lungs occurs across the membranes of tiny sacs called alveoli. Upon inhalation, the alveoli fill with air, of which approximately 20% is oxygen. (Assume that the air behaves as an ideal gas at body temperature, 37°C; absolute pressure of alveolus = 100 kPa; Avogadro's number = 6.022×10^{23} particles/mol.)



10. If the volume of an alveolus is approximately 8.00×10^{-6} mL, what number of oxygen molecules occupy one alveolus?

    A. 2.67×10^{14} **B.** 2.24×10^{15}

    C. 4.44×10^{-10} **D.** 3.74×10^{13}

Use the following information to answer the next question.

The demand valve on a diver's mouthpiece continually adjusts the pressure of the air released into the diver's mouth. At 10 m underwater, air will only cross the demand valve if the air pressure in the lungs is roughly twice the air pressure on the surface.

11. At this pressure, the alveoli in a diver's lungs will contain

A. twice the amount of oxygen as they would at the surface

B. the same amount of oxygen as they would at the surface

C. one-half the amount of oxygen as they would at the surface

D. one-quarter the amount of oxygen as they would at the surface

Use the following information to answer the next question.

Normal blood pressure in a young adult is about 120 mm Hg when the ventricles of the heart are contracting (systolic blood pressure) and 80 mm Hg when the ventricles are relaxed (diastolic pressure). This is normally reported as 120/80.

12. In kPa, this blood pressure would be stated as

A. 16.0/10.7

B. 91.3/53.2

C. 158/92.1

D. 900/525

13. A balanced equation for the reaction of Milk of Magnesia (magnesium hydroxide) with excess stomach acid (hydrochloric acid) is

A.

$$HCl_{(aq)} + Mg(OH)_{2(s)} \rightarrow HOH_{(l)} + MgCl_{2(aq)}$$

B.

$$HCl_{(aq)} + Mg(OH)_{2(s)} \rightarrow H_2O_{(l)} + MgCl_{(l)}$$

C.

$$2HCl_{(aq)} + Mg(OH)_{2(s)} \rightarrow 2HOH_{(l)} + MgCl_{2(aq)}$$

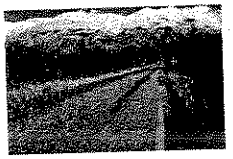
D.

$$2HCl_{(aq)} + 2Mg(OH)_{2(s)} \rightarrow HOH_{(l)} + 2MgCl_{(aq)}$$

Numerical Response

4. The volume of 0.110 mol/L HCl that would be neutralized by 0.236 g of magnesium hydroxide in a dose of Milk of Magnesia is _____ mL.
(Record your answer to three digits.)

Use the following information to answer the next two questions.



Potassium chromate and lead acetate can be combined to form lead chromate as shown by the following reaction.

$$K_2CrO_{4(aq)} + Pb(CH_3COO)_{2(aq)} \rightarrow PbCrO_{4(s)} + 2KCH_3COO_{(aq)}$$

Because of its resistance to mechanical wear, light, and heat, lead chromate (or chrome yellow), is the pigment used for the yellow lane markers on highways. Lead, however, is toxic and oxidized chromium is carcinogenic, so alternative pigments are preferable.

Numerical Response

5. If 200 kg of lead (II) chromate are produced from the reaction of 1 000 L of $K_2CrO_{4(aq)}$ and excess lead (II) acetate, the concentration of potassium chromate is _____ $\times 10^{-b}$ mol/L.
Therefore, b is an integer.
(Record your answer to three significant digits.)

14. The spectator ions in the reaction of potassium chromate and lead (II) acetate in aqueous solution are

A. Pb^{2+} and K^+

B. Pb^{2+} and CH_3COO^-

C. K^+ and CrO_4^{2-}

D. K^+ and CH_3COO^-

Use the following information to answer the next three questions.

Methanol is used as a fuel in race cars and has the potential to replace gasoline in regular automobiles. Methanol can be manufactured from carbon monoxide and hydrogen as shown.

$$2H_{2(g)} + CO_{(g)} \rightarrow CH_3OH_{(l)}$$

15. If 70.0 kg of $CO_{(g)}$ are combined with 9.00 kg of $H_{2(g)}$ the limiting reagent is

A. $CO_{(g)}$ and $H_{2(g)}$

B. $CH_3OH_{(l)}$

C. $CO_{(g)}$

D. $H_{2(g)}$

Numerical Response

6. The mass of methanol predicted to form from the reactant amounts in the previous question is _____ kg.
(Record your answer to three digits.)

Use the following information to answer the next four questions.

Acetylene is commercially used for welding and cutting steel and other materials because it burns with a very hot flame. Prior to 1955, the sole means of producing acetylene ($C_2H_{2(g)}$) was from the following reaction.

$$CaC_{2(s)} + 2H_2O_{(l)} \rightarrow C_2H_{2(g)} + Ca(OH)_{2(s)}$$

Numerical Response

7. If 4.30 kg of calcium carbide are used, the mass of acetylene expected is _____ kg.
(Record your answer to three digits.)

Numerical Response

8. The mass of $Ca(OH)_2$ that forms in the same reaction is _____ kg.
(Record your answer to three digits.)

Numerical Response

9. The solubility of the calcium hydroxide (lime water) produced is 0.185 g/100 mL at 0°C. Expressed as a molar solubility, this concentration is _____ mmol/L. (Record your answer to three digits.)

Use this additional information to answer the next question.

The unbalanced equation for complete combustion of acetylene is

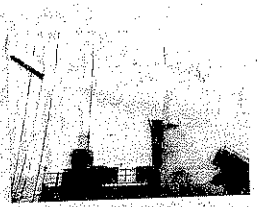
$$\_\_C_2H_{2(g)} + \_\_O_{2(g)} \rightarrow \_\_CO_{2(g)} + \_\_H_2O_{(g)}$$

Numerical Response

10. The four digit number created by reading the coefficients from left to right in the balanced equation is _____ _____ _____ _____. (Record your answer as a four digit number.)

Use the following information to answer the next two questions.

The U.S. space shuttles use a fuel that consists mainly of ammonium perchlorate (aluminum powder and an organic polymer are also used).



This ammonium perchlorate-based propellant is also used for sidewinder air to air missiles and Tomahawk cruise missiles. The effectiveness of ammonium perchlorate as a propellant is due to its rapid rate of decomposition. The partial simple decomposition reaction is shown below.

$$NH_4ClO_{4(s)} \rightarrow H_2O_{(g)} + ???$$

16. The additional products in the balanced chemical equation are

A. $2O_{2(g)}$, $Cl_{(g)}$, $N_{(g)}$

B. $3O_{(g)}$, $Cl_{(g)}$, $N_{(g)}$

C. $O_{2(g)}$, $Cl_{2(g)}$, and $N_{2(g)}$

D. $2O_{2(g)}$, $Cl_{2(g)}$, and $N_{2(g)}$

Use this additional information to answer the next question.

Aluminum powder improves the propellants' efficiency by engaging in formation reactions with the oxygen and chlorine produced by the decomposition of $NH_4ClO_{4(s)}$. This formation reaction releases vast quantities of heat energy.

17. The product of these reactions involving $Al_{(s)}$ are

A. $AlO_{(s)}$ and $AlCl_{(s)}$

B. $Al_2O_{2(s)}$ and $Al_2Cl_{4(g)}$

C. $Al_2O_{3(s)}$ and $AlCl_{3(g)}$

D. $AlO_{2(s)}$ and $AlCl_{3(g)}$

Use the following information to answer the next three questions.

Acuras have been designed to reduce the amount of nitric oxide emitted by their engines. In automobile engines, nitric oxide is the product of the reaction of nitrogen and oxygen at high temperature.

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

18. Nitrogen monoxide formation requires heat because it is

A. an exothermic process

B. an endothermic process

C. a spontaneous process

D. a heat losing process

Use this additional information to answer the next question.

Although $NO_{(g)}$ is involved in the production of photochemical smog leading to the depletion of the ozone layer, it is also extremely useful in the production of nitric acid, fertilizers, and explosives. It is also a key compound in certain biology processes.

19. The type of bonding prevalent within molecules of $NO_{(g)}$ is

A. ionic

B. hydrogen bonding

C. covalent

D. electronegative

Use this additional information to answer the next question.

Nitrous oxide, also known as laughing gas, is also a by-product of nitrogen assimilation in bacteria and algae. Similar to $NO_{(g)}$, $N_2O_{(g)}$ is also a greenhouse gas that can damage the stratospheric ozone layer.

20. The types of bonding interactions that an individual N_2O molecule, are likely experience

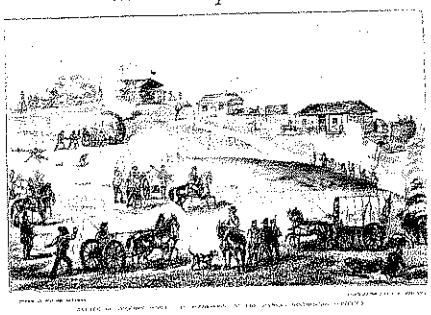
A. London dispersion forces and dipole-dipole attractions

B. hydrogen bonds and dispersion forces

C. ionic bonds and dipole-dipole attractions

D. network covalent bonds and dispersion forces

Use the following information to answer the next question.



Guncotton is a smokeless powder that was invented in 1845 as a cheap substitute for gunpowder. Guncotton, like nitro-glycerine and other explosive chemicals, contains nitro groups (NO_2) bound to carbon.

21. Based on the electronegativities of N and O, the bonded atom(s) with a slight positive charge would be

A. O

B. neither N nor O

C. both N and O

D. N

Use the following information to answer the next question.

Explosions such as the one that rocked Guadalajara, Mexico in 1992 can happen when natural gas and hydrocarbon vapours mix with air in city's sewer system.

22. This is a dramatic example of a situation in which

A. the energy required to break bonds in the reactants was **greater** than the energy released in forming new bonds in the products

B. the energy required to break bonds in the reactants was **less** than the energy released in forming new bonds in the products

C. an endothermic reaction occurred rapidly

D. the energies of bond breaking and bond formation were equal

23. The boiling point of diethyl ether is 34.6°C, while that of 1-butanol is 117°C. Which of the following statements correctly explains the difference in boiling points?

A. 1-butanol has a higher molar mass than diethyl ether, therefore, it experiences stronger London dispersion forces.

B. 1-butanol is polar while diethylether is not, therefore, stronger dipole-dipole forces elevate 1-butanol's boiling point.

C. Both compounds are polar and have the same molar mass but hydrogen bonding between 1-butanol molecules elevate that compound's boiling point.

D. Diethyl ether molecules as well as 1-butanol molecules hydrogen-bond in the liquid state but 1-butanol hydrogen-bonds more effectively.

Use the following information to answer the next question.

Sodium chloride is needed to maintain essential body functions. Abnormally low levels of sodium and chloride ions may result in muscular weakness, spasms, dizziness, headaches and even comas. In the laboratory, $NaCl_{(s)}$ can be formed from the direct action of $Cl_{2(s)}$ on $Na_{(s)}$ as shown below.

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

24. The bonding between Na and Cl in $NaCl_{(s)}$ is a result of

A. a transfer of electrons from Cl to Na

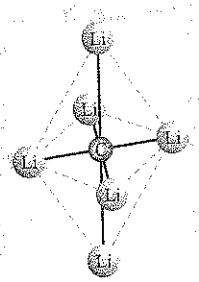
B. equal sharing of valence electrons

C. reduction of the non-metal and oxidation of the metal

D. reduction of the metal and oxidation of the non-metal

Use the following information to answer the next two questions.

The hypervalent molecule CLi_6 was observed for the first time in the gas phase in 1992. This observation was significant because of the unusual bonding within the molecule.



25. According to Lewis bonding theory, how many electrons does carbon appear to have surrounding it?

A. 6 **B.** 8

C. 10 **D.** 12

26. The number of electrons surrounding the carbon atom

A. shows that CLi_6 is very unstable

B. appears to violate the octet rule

C. conforms to the octet rule

D. shows that Lithium has no valence electrons

Use the following information to answer the next three questions.

The entertainment that sparklers provide is due to oxidation or reduction reactions. Redox reactions provide the eruptive force necessary to cast metal fragments into the air. These small fragments of metal then react with oxygen to create sparks.
One such reaction might be

$$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$$

27. In the above reaction, the reduced element is

A. $Mg_{(s)}$

B. $O_{2(g)}$

C. $MgO_{(s)}$

D. neither $Mg_{(s)}$ nor $O_{2(g)}$

28. The element that is the source of the electrons in the sparkler reaction is

A. $Mg_{(s)}$

B. $O_{2(g)}$

C. both $Mg_{(s)}$ and $O_{2(g)}$

D. neither $Mg_{(s)}$ nor $O_{2(g)}$

29. The oxidation half-reaction occurring in sparklers is

A. $Mg_{(s)} \rightarrow Mg^{+} + e^{-}$

B. $Mg_{(s)} \rightarrow Mg^{2+} + 2e^{-}$

C. $O_{2(g)} \rightarrow 2O^{+} + 2e^{-}$

D. $O_{2(g)} \rightarrow 2O^{2+} + 4e^{-}$

Use the following information to answer the next question.

Juglone ($C_{10}H_6O_3$) is a compound produced from the husks of black walnuts. It acts as a natural herbicide that destroys competitive plants growing around it. Juglone also has a long history of use as a dye.

30. Juglone would be considered an

A. inorganic compound with covalent bonds

B. organic compound with ionic bonds

C. inorganic compound with ionic bonds

D. organic compound with covalent bonds

Written Response

1. Provide a laboratory procedure that would allow you to precipitate all the Pb^{2+} from 500 mL of a contaminated waste solution that also contains $Ag^{+}_{(aq)}$ ions.
Your procedure must allow you to obtain information useful for calculating the $Pb^{2+}_{(aq)}$ ion concentration.
(For full credit you must correctly specify the chemicals and materials used.)

(8 marks)

ANSWERS AND SOLUTIONS — PRACTICE EXAMINATION 1

1. C	5. C	12. A	NR7. 1.75	19. C	26. B
2. D	6. D	13. C	NR8. 4.97	20. A	27. B
3. D	7. A	NR4. 73.6	NR9. 25.0	21. D	28. A
NR1. 5.06	8. C	NR5. 6.19	NR10. 2 5 4 2	22. B	29. B
4. A	9. A	14. D	16. D	23. C	30. D
NR2. 15.0	10. D	15. D	17. C	24. C	WR1.*
NR3. 0.192	11. A	NR6. 71.4	18. B	25. D	

***for written response, see solutions**

1. C

Though CH_2FCF_3,a molecular compound held together by strong C–H, C–F and C–C (intramolecular) bonds, might be soluble in water (it is polar), it will not dissociate into aqueous ions. According to Arrhenius' dissociation theory, a solution containing dissolved ions conducts electricity.
The dissolved entity and solution are both called an electrolyte. CH_2FCF_3 will, therefore, behave as a non-electrolyte.

2. D

Intermolecular bonding describes the weak forces of interaction between molecules in the liquid and solid state.
Intramolecular bonding describes the covalent bonds that bind atoms together within molecules. The atoms in molecules of CH_2FCF_3 are held together by covalent bonds. The electrons that form a covalent bond between two atoms are shared between the bound nuclei (shared between means "mutually attracted to") by the overlap of partially filled valence atomic orbitals.

3. D

Measuring the concentration of a chemical entity in a solution is a quantitative analysis (e.g., measuring the mass of acetylsalicylic acid in an Aspirin tablet by acid base titration, measuring the molar volume of hydrogen by collecting a sample over water and measure its P, V and T).
A qualitative analysis
(e.g., starch test for iodine) only detects the presence of a chemical entity.

NR1. 5.06

$$\left[COCl_{2(g)}\right] = \frac{0.000\,500\ \text{g} \times \dfrac{\text{mol}}{98.91\ \text{g}}}{\text{L}}$$

$$= 5.06 \times 10^{-6}\ \text{mol/L}$$

Note: $[COCl_{2(g)}]$, denotes the concentration of $COCl_{2(g)}$