COLLEGE OF THE BAHAMAS
SCHOOL OF NATURAL SCIENCE AND ENVIRONMENTAL STUDIES
FINAL EXAMINATION, SPRING SEMESTER 01-2003
CHEMISTRY 115: INTRODUCTORY CHEMISTRY
TIME: 2½ HOURS
CODE: R

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

INSTRUCTIONS: Attempt **ALL** questions on this paper.

Each section has its own directions. Read them carefully before attempting any questions.

COMPLETE THE FOLLOWING CAREFULLY

YOUR FULL NAME _____

YOUR LECTURER'S NAME _____

YOUR SECTION NO. _____

YOUR STUDENT NO. _____

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(FOR OFFICIAL USE ONLY)

TOTAL MARKS _____ = _____ % OR TOTAL MARKS _____ /50

SECTION I: Multiple choice questions

INSTRUCTIONS: Answer **ALL** questions in this section. Select the single best alternative and mark it on the **ANSWER SHEET PROVIDED** according to the instructions on it.
The following information may be required: RAM of H = 1, C = 12, N = 14, O = 16, Na = 23, Mg = 24, Si = 28, P = 31, S = 32, Cl = 35.5, Fe = 56 The molar volume of any gas at s.t.p. is 22·4 dm^3mol^{-1}. Avogadro's number is 6.0×10^{23}.

THE MOLE CONCEPT

1) Molar mass is
   A measured in g mol^{-1}.
   B measured in g.
   C measured in mol.
   D measured in atoms.
   E unitless.

2) How many moles of sodium ions are there in 3 mol of sodium phosphate, Na_3PO_4?
   A 6×10^{23}
   B 3
   C 6
   D 9
   E 12

3) One mole of hydrogen and one mole of nitrogen
   A occupy a different volume at s.t.p.
   B have the same mass.
   C occupy the same volume if they are solidified.
   D occupy the same volume if they are liquefied.
   E contain the same number of molecules.

4) Which one of the following masses of anhydrous sodium carbonate (Na_2CO_3) (RFM 106) contains 0.005 moles of this substance?
   A 0.255g
   B 21200g
   C 5.3g
   D 0.53g
   E 106g

5) Which one of the following correctly expresses the number of **molecules** present in 3.6 dm^3 of carbon dioxide gas (CO_2) at s.t.p.?
   A 6×10^{23}
   B $3{\cdot}6 \times 6 \times 10^{23}$
   C $44 \times 6 \times 10^{23}$
   D $(3{\cdot}6 \div 22.4) \times 6 \times 10^{23}$
   E $22{\cdot}4 \times 6 \times 10^{23}$

6) 3 moles of carbon tetrachloride (CCl_4) contain:
   A 4 moles of chlorine atoms.
   B 12 ***molecules*** of chlorine.
   C 1 mole of carbon.
   D 3 mole of chlorine gas.
   E 12 moles of chlorine atoms.

7) What mass of iron would contain the same number of atoms as 10g of silicon? (RAM Fe=56, Si=28)
   A 5.0g
   B 5.6g
   C 2.8g
   D 20g
   E 10g

8) Which one of the following figures is closest to the percentage by mass of magnesium in $MgSO_4.7H_2O$ (RFM 246).
   A 9.8%
   B 51.2%
   C 13.0%
   D 26.0%
   E 19.5%

REACTIVITY SERIES

9) Which one of the following metals is least affected chemically when heated in air?
   A Na **B** Zn **C** Ag **D** Mg **E** Fe

10) Which one of the following metals reacts vigorously with water?
   A sodium
   B lead
   C silver
   D copper
   E aluminium

11) Which one of the following oxides is soluble in water?
   A copper(II) oxide
   B sodium oxide
   C lead(II) oxide
   D zinc oxide
   E iron(II) oxide

12) Which one of the following nitrates decomposes to the metal when heated in a bunsen flame?
   A silver nitrate
   B lead(II) nitrate
   C calcium nitrate

D copper(II) nitrate
E sodium nitrate

13) Which one of the following metals will react when placed in a solution of iron(II) nitrate?
A silver
B copper
C lead
D iron
E zinc

PERIODIC TABLE

14) Which one of the following elements forms an oxide which dissolves in water to give a strongly acidic solution?
A sodium
B lithium
C copper
D neon
E chlorine

15) Which one of the following decreases in magnitude as you go down the group of alkali metals?
A size of atom
B number of electrons
C number of protons
D melting point
E reactivity

16) Astatine is the element below iodine in Group VII of the periodic table. Which one of the following predictions about astatine and its compounds is most likely to be correct?
A Astatine is more reactive than iodine.
B Hydrogen astatide is a base.
C Sodium astatide is a covalent compound.
D Astatine is a solid at room temperature.
E Astatine reacts explosively with oxygen when they are mixed.

17) Which one of the following ions does not exist in aqueous solution?
A Fe^{2+}
B Fe^{3+}
C Ca^{+}
D Na^{+}
E Ba^{2+}

18) Element X is in group VI of the periodic table. The chloride of element X is likely to be:
A acidic
B neutral
C basic
D ionic
E covalent

ELECTROCHEMISTRY AND REDOX

19) Which one of the following ions is easiest to discharge?
A sulfate
B iodide
C bromide
D chloride
E nitrate

20) Which one of the following is a correct definition of an oxidising agent?
A an electron acceptor
B an electron donor
C a proton donor
D a proton acceptor
E an oxygen acceptor

21) Which one of the following factors does **NOT** affect the products of electrolysis?
A the size of the electrolytic cell
B the concentration of the electrolyte
C the material from which the cathode is constructed.
D the material from which the anode is constructed.
E the presence of water.

22) Which one of the following is **NOT** a correct statement in the context of electrolysis?
A the anode is the electrode at which oxidation takes place.
B the cathode is the negative electrode.
C positive ions migrate towards the anode.
D electrons flow in an external circuit.
E the cathode is the electrode at which reduction takes place.

RATE AND EQUILIBRIUM

23) Which one of the following is the best explanation for the effect of an increase in temperature on the rate of a reaction?
A It increases the number of particles with the necessary activation energy.
B It enables the reacting particles to collide at the correct angle.
C It lowers the activation energy for the reaction.
D It enables the activated complex to be more easily converted to the products.
E It prevents product molecules from changing back into reactants.

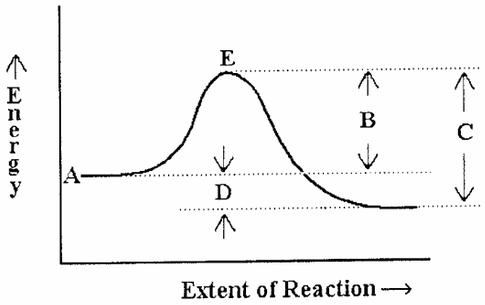
24) The brown gas prepared by the action of concentrated nitric acid on copper is an equilibrium mixture of dinitrogen tetroxide (pale yellow) and nitrogen dioxide (dark brown).

$$\underset{\text{yellow}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown}}{2NO_2(g)} \qquad \Delta H \text{ +ve}$$

Which one of the following changes to a sample of the gas at equilibrium would result in a change from yellow to brown?

A increase in pressure
B increase in temperature
C addition of a catalyst
D removal of dinitrogen tetroxide by liquefaction
E lowering of the temperature

Questions 25 to 27 These involve the energy profile diagram for a reversible reaction shown below.



Select, from the diagram, the appropriate energy change **A-E** for each of the following items. Each letter may be used ONCE, MORE THAN ONCE, OR NOT AT ALL.

25) The heat (enthalpy) change of the reaction
26) Activation energy of the forward reaction
27) Activation energy of the reverse reaction

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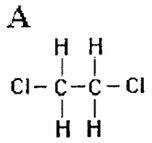
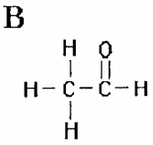
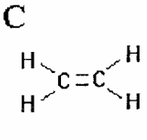
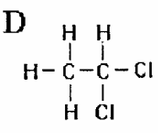
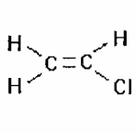
ORGANIC

28) A gaseous hydrocarbon reacts slowly with bromine to form a mixture of bromoalkanes and hydrogen bromide. Which one of the following formulae correctly represents the hydrocarbon?

A C_2H_4
B C_2H_6
C C_2H_2
D C_3H_6
E C_3H_4

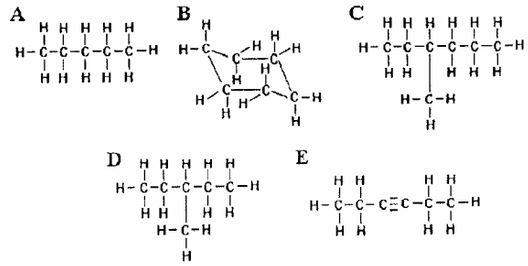
29) Which one of the following compounds can be made by an addition reaction of ethene?

A 
B 
C 
D 
E 

30) Which one of the following statements about the homologous series of alkynes is correct?

A Their general formula is C_nH_{2n-2}.
B They all have the functional group >C=C<.
C They are all gases at room temperature and pressure.
D Each member of the series is an isomer of the next member in the series.
E The molecules all contain at least one methyl group, CH_3.

31) Which one of the following structural formulae represents an isomer of hexane?



MISCELLANEOUS

32) Before carrying out a flame test on a substance, it is first moistened with concentrated hydrochloric acid. For which one of the following reasons is this done?

A In order to clean the substance.
B In order to form a relatively volatile chloride of the metal.
C In order to make the substance more flammable.
D In order to remove water from the substance.
E In order to remove unwanted sodium ions.

33) Which one of the following gases will turn moist red litmus paper blue?

A oxygen.
B sulfur dioxide.
C ammonia.
D carbon dioxide.
E hydrogen.

Questions 34 to 40 These involve the following gases or vapours:

A oxygen
B nitrogen dioxide
C hydrogen
D carbon dioxide
E water vapour

Select, from A to E, for each of the following questions. Each letter may be used ONCE, MORE THAN ONCE, OR NOT AT ALL.

34) Which gas turns limewater milky?
35) Which gas relights a glowing splint?
36) Which gas is dark brown?

37) Which gas is formed when sodium reacts with water?
38) Which gas is released when calcium carbonate is heated?
39) Which gas turns blue cobalt(II) chloride paper pink?
40) Which gas is released when zinc is added to dilute hydrochloric acid?

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SECTION II: Short answer questions

It is important to view each of the following questions as a whole. Read completely through each one before writing any answers. Answer each question in the space provided on your question paper. Full marks can only be awarded if you indicate clearly how you arrive at your answers. ***Underline your answers*** where appropriate.

1) This question concerns various aspects of organic chemistry.
   a) i) Write a balanced chemical equation to show the combustion of ethene (C_2H_4) in a plentiful supply of air. (2)

ii) Explain briefly why it is dangerous to restrict the supply of air when gases such as ethene are burnt. (2)

b) Write a balanced chemical equation to show the reaction between ethene and hydrogen iodide gas ***using structural formulae throughout.*** Name the organic product. (3)

What ***type*** of reaction is this? (1)

c) When ethanol is heated with acidified potassium dichromate a chemical reaction occurs.
i) What colour change is observed? (1)

ii) Name the organic product and give its structural formula. (2)

iii) What effect would a solution of this organic product have on litmus paper? (1)

iv) Ethanol and this organic product react to give one member of a class of organic compounds which are noted for their pleasant smells. What is this substance and what class of organic compound does it belong to? (2)

2) This question concerns the reactivity series of metals as applied to the five metals magnesium, copper, zinc, potassium and silver.

a) Place the five metals in order of reactivity, putting the most reactive first. (1)

2) This question concerns the reactivity series of metals as applied to the five metals magnesium, copper, zinc, potassium and silver.

a) Place the five metals in order of reactivity, putting the most reactive first. (1)

b) State which one of these metals reacts explosively with water and give an equation for the reaction which occurs. (2)

c) Describe what you **SEE** when a strip of copper is placed in a solution of silver nitrate. Give an equation for the reaction occurring. (3)

d) State which one of the above metals has a nitrate which decomposes to the nitrite if heated strongly. Give an equation for this reaction. (2)

e) Name two metals from the five above which are found in the free state in nature. (2)

3) This question concerns chemical equilibrium.

a) State Le Chatelier's Principle. (2)

b) Ammonia is produced industrially by the following reversible reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H \text{ -ve}$$

i) What happens to the equilibrium concentration of ammonia in the above equation if we:

decrease the temperature. (1)

increase the pressure. (1)

---

add more nitrogen gas (with no change in volume). (1)

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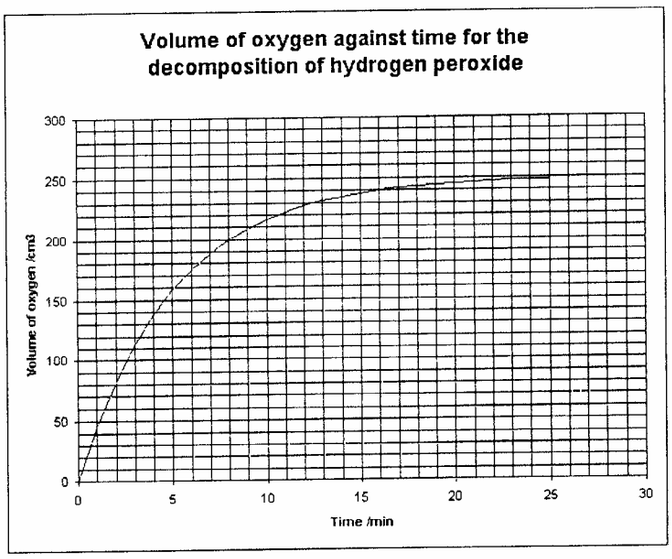
4) Hydrogen peroxide decomposes in aqueous solution in the presence of manganese dioxide (MnO_2) as catalyst with the formation of water and oxygen gas:

$$2H_2O_2(aq) \xrightarrow{MnO_2} 2H_2O(l) + O_2(g)$$

This reaction may be easily followed by measuring the volume of oxygen with a gas syringe connected to a conical flask in which the reaction is carried out.
The graph below illustrates the result of one experimental run where the entire apparatus was at 20°C.



Answer the following questions.

a) What total volume of oxygen was liberated during the reaction? (1)

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b) Given that the molar volume of any gas at 20°C is 24000cm^3mol^{-1}, how many moles of oxygen were liberated? (1)

c) From the graph determine the volume of oxygen liberated between 5 and 10 minutes. (1)

d) The reaction is carried out at a higher temperature (but the total volume of oxygen is kept the same). Sketch a line on the graph showing how the volume of oxygen now varies with time. Label your line "A". (2)

e) The reaction is carried out at 20°C as originally stated, using the same volume of a hydrogen peroxide solution but having ***half the concentration.*** Sketch a line on the graph showing how the volume of oxygen now varies with time. Label this line "B". (2)

6) In each of the situations below, write balanced half-equations to show firstly the process occurring at the anode and secondly the process occurring at the cathode. Indicate states where appropriate. (5)

a) The electrolysis of molten sodium chloride.

AT ANODE:_____

AT CATHODE:_____

b) The electrolysis of concentrated aqueous sodium chloride solution.

AT ANODE:_____

AT CATHODE:_____

Mention one important chemical that is made by this electrolysis. (1)

_____

7) In the portion of the periodic table shown below the elements lithium, carbon, oxygen and neon have been placed in their correct positions. The positions of eleven other elements have been represented by letters. These letters are not the real symbols for the elements concerned.

Lithium			Carbon		Oxygen	L	Neon
X	B	K	J		G	Q	T
Y						R	

By reference to the table answer the following questions. (Do not give the actual name of the element in your answer.)

a) Give the letter of the most reactive metal. _____

b) Give the letter of the most reactive non-metal. _____

c) Give the letter of one element whose carbonate does not decompose on heating. _____

d) Give the letter of one element whose oxide is basic. _____

e) Give the letter of one element whose oxide is amphoteric. _____

f) Give the letter of one element whose carbonate decomposes on heating. _____

g) Give the letter of a metal whose hydroxide does not decompose on heating. _____

h) Give the letter of a metal whose hydroxide decomposes on heating. _____

i) Name the "family of elements" represented by L, Q, and R. _____

This is the end of the paper. Go back and check your work.