THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 02-2003

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, June 24TH, 2003 at 9 a.m.
DURATION: 2 HOURS

COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTORY CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME:

INSTRUCTIONS TO CANDIDATES: This paper has 8 pages and 33 questions. Please follow instructions given.

Time allowed: 2 hours

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Section A: Multiple Choice. Answer **all** questions. Each question is worth 1 mark.

For each question, select the most suitable answer and shade the letter corresponding to this answer on the answer sheet provided.

Questions 1 to 11 refer to the following organic compounds:

A $CH_3CH_2CH_2CH_3$

B $CH_3CH{=}CHCH_3$

C $CH_3CH_2CH_2CH_2OH$

D $CH_3CH_2CH_2COOH$

E $CH_3CH_2COOCH_3$

Select, from A to E,

1. A saturated hydrocarbon
2. An alcohol
3. A carboxylic acid
4. An ester
5. An alkene
6. A hydrocarbon which readily decolourises bromine water
7. A compound which is isomeric with E
8. A compound which can be formed by the dehydration of 2- butanol with concentrated phosphoric acid
9. A compound which can be converted to D by reacting with acidified potassium permanganate
10. A sweet smelling compound formed by warming propanoic acid with methanol in the presence of dilute sulphuric acid
11. A compound which has empirical formula CH_2

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12. The compound pentamide belongs to a group of organic compounds called amides. How many atoms of carbon are present in a molecule of pentamide ?

A 1
B 2
C 3
D 4
E 5

13. Which statement is true of compounds belonging to the homologous series of alkanes?

A They are all gases.
B They have identical physical properties.
C They have the same molecular formula.
D They all have the general formula C_xH_{2x+2}.
E They are chemically very reactive.

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14. Which substance would **not** liberate carbon dioxide when heated?

A Sodium carbonate.
B Barium carbonate.
C Magnesium carbonate.
D Calcium carbonate.
E Copper (II) carbonate.

15. A compound, Y, is a metal chloride which gives a lilac flame test. Which statement is **not** true?

A Y is a potassium chloride.
B Y is soluble in water.
C Y is an ionic compound.
D Hydrogen chloride gas is produced when Y dissolves in water.
E All of the above.

16. The relative atomic mass of nitrogen is 14. This means that

A a nitrogen atom is 14 times as heavy as a carbon-12 atom.
B a carbon-12 atom is 14 times as heavy as a nitrogen atom.
C a nitrogen atom is 14 times as heavy as 1/12 the mass of a carbon-12 atom.
D a carbon-12 atom is 14 times as heavy as 1/12 the mass of a nitrogen atom.
E an atom of nitrogen contains 14 electrons.

17. The relative molecular mass of carbon dioxide(CO_2) gas is 44. Which statement is **not** true?

A One mole of carbon dioxide weighs 44 g.
B One mole of carbon dioxide occupies a volume of 22.4 dm^3 at s.t.p.
C One mole of carbon dioxide contains 6.0×10^{23} molecules of carbon dioxide.
D One mole of carbon dioxide contains $3 \times 6.0 \times 10^{23}$ atoms.
E One mole of carbon dioxide contains $44 \times 6.0 \times 10^{23}$ molecules.

18. Three elements, X, Y and Z belong to the same period of the Periodic Table. Y forms a basic oxide, X forms an amphoteric oxide whilst Z forms an acidic oxide. The order of increasing atomic number of the elements is

A XYZ
B ZYX
C YXZ
D XZY
E YZX

19. Which is the best description of a chemical system in dynamic equilibrium?

A A reversible system in which reaction has stopped.
B A reversible system in which the rate of the forward reaction is equal to the rate of the reverse reaction.
C A reversible system in which the forward reaction is equal to the reverse reaction.
D A reversible system in which only products are formed.
E A reversible system in which only reactants are formed.

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20. A catalyst increases the rate of a chemical process by

A Decreasing the energy of activation for the process.
B Increasing the kinetic energy of the reactant molecules.
C Decreasing the enthalpy change for the reaction.
D Increasing the collision frequency of the reactant molecules.
E Decreasing the kinetic energy of the reactant molecules.

21. Which metal nitrate decomposes on heating to form the corresponding metal?

A $NaNO_3$
B $Zn(NO_3)_2$
C $Cu(NO_3)_2$
D $AgNO_3$
E KNO_3

22. Which metal is a liquid at room temperature and pressure?

A Mercury
B Potassium
C Gold
D Silver
E Aluminium

23. Which metal **cannot** displace copper metal from a solution of copper(11) sulphate?

A Magnesium
B Aluminium
C Zinc
D Iron
E Silver

24. When calcium carbonate is heated, the gas liberated

A turns limewater milky.
B relights a glowing splint.
C burns with a pop.
D is nitrogen dioxide.
E is calcium oxide.

25. Which gas has a dark brown colour?

A Oxygen
B Hydrogen
C Nitrogen dioxide
D Water vapour
E Carbon dioxide

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Section B: Answer **all** questions in the spaces provided on the question paper.

You may use the following information wherever necessary:
The molar volume of a gas at s.t.p is 22,400 cm^3 mol^{-1} = 22.4 dm^3 mol^{-1}.
Avogadro's number = 6.0×10^{23}
Relative atomic masses: H = 1.0, O = 16, C =12, Mg = 24, Cl = 35.5, S = 32, Na = 23, K = 39, Al = 27, Cu =64.

1. The following question concerns two compounds, X and Y, whose structural formulae are given.

$CH_2=CHCH_2CH_3$ $CH_3CH=CHCH_3$

Compound X *Compound Y*

a) X and Y are isomers. Why are these compounds described as *isomers*? [1 mark]

b) Are X and Y *chain* isomers or *positional* isomers? [1 mark]

c) Explain why X and Y are described as *unsaturated* compounds. [1 mark]

d) Give the full structural formula and systematic name of the **main** organic product formed when X is hydrated. Call this compound Z. [2 marks]

e) Give the full structural formula and systematic name of an isomer of Z. [2 marks]

f) Write a balanced equation for the complete combustion of Y. Use the molecular formula for Y in the equation. [2 marks]

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2. How many moles of

a) water are there in 72 g of water? [2 marks]

b) nitrogen gas are there in 4480 cm^3 of the gas at s.t.p? [2 marks]

c) potassium chloride are there in 1.2 dm^3 of a 0.35 M solution? [2 marks]

3. A solution of sodium carbonate (Na_2CO_3) is prepared by dissolving 0.53 g of the solute and making up the volume of the solution to 200 cm^3. What is the molar concentration of the solution? [2 marks]

4. Find the percent composition of sulphuric acid, H_2SO_4. [2 marks]

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5. Hydrogen gas can be produced by the reaction of dilute hydrochloric acid on magnesium metal:

$$Mg\,(s) + 2\,HCl\,(aq) \rightarrow MgCl_2(aq) + H_2\,(g)$$

a) How many moles of hydrogen gas can be obtained by complete reaction of 3.0 mol HCl with excess Mg ? [1 mark]

b) How many cm^3 of hydrogen gas, at s.t.p, can be obtained by complete reaction 3.0 mol HCl with excess Mg ? [2 marks]

c) What mass of hydrogen gas can be obtained by complete reaction of 3.0 mol HCl with excess Mg ? [1 mark]

d) What mass of magnesium is required to exactly react with 200 cm^3 of 2.0 M HCl ? [2 marks]

e) How many cm^3 of 2.0 M HCl are required to react with excess Mg to produce 1120 cm^3 of hydrogen gas? [2 marks]

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6. The reaction between calcium carbonate and hydrochloric acid is exothermic.

a) Draw a **fully labeled** energy profile diagram for this reaction. Be sure to label your axes. [4 marks]

b) Explain, in terms of the kinetic theory, collision theory and transition state theory, how the rate of this reaction can be increased by raising the temperature of the reaction mixture. [3 marks]

7. a) State Le Chatelier's Principle. [2 marks]

b) Consider the reaction:

$[Co(H_2O)_6]^{2+}$ (aq) + 4 Cl^- (aq) ⇌ $[CoCl_4]^{2-}$ (aq) + 6 H_2O (l)
colourless *pink* *colourless* *blue*

Given that the forward reaction is endothermic, what **colour change** do you expect to see when an equilibrium mixture, containing all four species in the equation, is heated. Explain your reasoning. [2 marks]

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8. a) Explain the meaning of the following terms:

i) conductor

ii) electrolyte.

iii) electrolysis. [2 marks each = 6 marks]

b) A solution of dilute sulphuric acid is electrolysed using graphite electrodes.

i) Write an equation to represent the reaction occurring at the cathode. [2 marks]

ii) Write an equation to represent the reaction occurring at the anode. [2 marks]

END OF EXAMINATION