THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 02-2005

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

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EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, June 28, 2005 at 9 am
DURATION: 2 ½ HOURS

COURSE NUMBER: CHEM 115

COURSE TITLE: INTRODUCTORY CHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME

INSTRUCTIONS TO CANDIDATES: This paper has 9 pages and 32 questions. Please follow instructions given.

Student Name .....Student Number .....

Section A: Multiple Choice. Answer **all** questions. Each question is worth 1 mark.[24]

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

1. Which substance would **not** liberate carbon dioxide when heated over a bunsen flame?

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

2. Three elements, X, Y and Z belong to the same period of the Periodic Table. X forms an amphoteric oxide, Y forms a basic 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

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

   A Y is 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 Y is a good electrolyte.

4. Which metal nitrate decomposes on heating to form *oxygen as the only gaseous product?*

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

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

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

6. When heated, the carbonate of a metal, X, decomposes more readily than zinc carbonate. The metal, X, will displace copper from a solution of copper(11) sulphate. X may be

   A silver
   B mercury
   C zinc
   D lead
   E magnesium

Student Name .....Student Number .....

7. Z is an alkaline earth metal in Period 3 of the Periodic Table.
The electronic configuration of this element is
A 2,8,1
B 2,8,2
C 2,8,3
D 2,8,8
E 2,8,8,2

8. Which atom has the smallest atomic radius?
A Na
B Mg
C Al
D Si
E P

9. Which atom has the lowest first ionization energy?
A Na
B Mg
C Al
D Si
E P

10. The element selenium, Se, belongs to group V1and period 4 of the Periodic Table.
Which statement is most likely to be true of this element?
A It is more electronegative than sulphur.
B It is a metal.
C Its chloride is ionic and does not hydrolyse in water.
D Its oxide is acidic.
E It is more reactive than sulphur.

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

A Mercury
B Potassium
C Gold
D Silver
E Aluminium

12. Which metal **cannot** displace copper metal from a solution of copper(II)) sulphate?
A Magnesium
B Aluminium
C Zinc
D Iron
E Silver

13. 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.

Student Name .....Student Number .....

14. Which gas has a dark brown colour?

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

15. 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.

16. 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.

17. 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 the same as the reverse reaction.
D A reversible system in which only products are formed.
E A reversible system in which only reactants are formed.

18. 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.

19. Which one of the following observations will show that a chloride hydrolysed on heating with water?

A A vapour is detected which gives white smoke with ammonia.
B A vapour is detected which turns red litmus blue.
C The solid residue is yellow when hot and white when cold.
D A gas is produced that relights a glowing splint.
E A gas is produced that turns lime water milky.

Student Name .....Student Number .....

20. Which reaction will not take place?

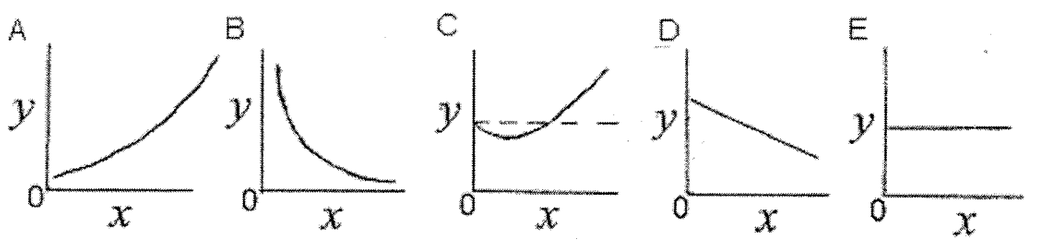
A Cl_2 (g) + 2 NaBr (aq) 2 NaCl (aq) + Br_2 (l)
B Br_2 (l) + 2 NaCl (aq) Cl_2 (g) + 2 NaBr (aq)
C Zn(s) + H_2SO_4 (aq) $ZnSO_4$ (aq) + H_2 (g)
D $Mg(OH)_2$ (s) MgO + H_2O
E $ZnCO_3$ (s) ZnO (s) + CO_2 (g)

Questions 21 to 24 concern an experiment ou carried out to determine the temperature dependence of reaction rate. A solution of sodium thiosulphate was placed in a beaker and its temperature adjusted to 40°C. To this solution was added a small measured volume of dilute hydrochloric acid. The mixture was stirred, and at the same moment a stop-watch was started, and the temperature of the solution measured and noted. The beaker was placed over a piece of paper marked with a cross. The stop-watch was stopped when the cross was no longer visible through the solution and the temperature recorded for a second time.
The experiment was repeated at several different temperatures.

21. The cross disappeared because:

A The paper became wet when the solution leaked out of the beaker.
B Carbon dioxide turned the solution milky.
C Sulfur was produced in the solution and turned it milky.
D The hydrochloric acid was used up in the reaction.
E The sodium salt was highly coloured.

22. Which one of the following graphs best represents the rate of reaction (*y*) against temperature (*x*)?



23. The temperature was measured at the beginning and end of each run so that:

A The thermometer could be checked.
B The difference between the measurements could be calculated.
C The sum of the measurements could be calculated.
D The product of the measurements could be calculated.
E The average of the measurements could be calculated.

24. The mixture was stirred in order to:

A make sure that the reacting particles could come into contact with each other.
B make sure that the mixture was as warm as possible.
C stir up any debris settling on the bottom.
D supply the necessary activation energy for reaction.
E prevent premature cooling of the mixture.

Student Name .....Student Number .....

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 x 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, N = 14, Zn = 65.

1. 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]

2. What mass of anhydrous sodium carbonate (Na_2CO_3) would be required to prepare 250 cm^3 of a 0.25M solution? [2 marks]

3. Find the percent by mass of nitrogen in zinc nitrate ($Zn(NO_3)_2$ [2]

Student Name .....Student Number .....

4. 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]

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

c) What mass of hydrogen gas can be obtained by complete reaction of 3.0 mol HCl with excess Mg ? [2]

d) How many moles of magnesium is required to exactly react with 200 cm^3 of 2.0 M HCl ? [2]

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

Student Name .....Student Number .....

5. 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]

b) Why is the rate of a chemical reaction increased by increasing temperature? [2]

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

b) Consider the reaction:

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

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. Assume that the initial position of equilibrium is to the left. Explain your reasoning. [2]

Student Name .....Student Number .....

7. Explain the meaning of the following terms with reference to the passage of electricity through substances:

i) conductor

ii) electrolyte.

iii) electrolysis. [2 each = 6]

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]

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

Student Name .....Student Number .....

8. This question concerns the reactivity of the metals calcium, copper, silver, zinc.

a) List the four metals in order of ***decreasing*** reactivity.[1]

b) Which of these metals must be stored under oil. Give a reason for your answer.Support your answer by a balanced chemical equation.[3]

c) Which of these metals would **not** liberate hydrogen from dilute hydrochloric acid? [2]

d) Which of these metals would react violently with dilute hydrochloric acid? Write a balanced chemical equation for the reaction. [2]

e) Write balanced chemical equations for the thermal decomposition of:

i) calcium carbonate

ii) copper(II) hydroxide

iii) zinc nitrate

iv) silver nitrate. [8]

END OF EXAMINATION