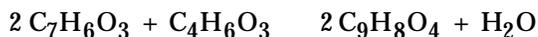


1997 NATIONAL CHEMISTRY EXAMINATION
CIC National High School Chemistry Examination
CCO National Selection Examination

PART A: MULTIPLE CHOICE QUESTIONS (60 minutes)

- The fundamental basis of the present-day periodic table is that the elements are
 - arranged in order of increasing atomic weight.
 - taken in groups of eight.
 - arranged in order of increasing number of protons in the atomic nucleus.
 - grouped according to chemical properties.
 - arranged in order of increasing number of neutrons in the atomic nucleus.
- A certain gas is an oxide of nitrogen containing 30.51% N by mass, with a density of 4.085 g/L at 0°C and 101.3 kPa. The formula of this gas is
 - N₂O₄
 - NO₂
 - NO
 - N₂O
 - N₂O₅
- Magnesium oxide and phosphorus pentachloride gas react to form magnesium chloride and diphosphorus pentoxide. If MgO is present in excess, what mass of PCl₅ is needed to form 284 g of P₂O₅?
 - 249 g
 - 417 g
 - 833 g
 - 403 g
 - 208 g
- You have a solution which is 0.350 mol/L in CaCl₂. What volume of this solution would you require in order to dispense 0.070 moles of chloride ion?
 - 50 mL
 - 100 mL
 - 200 mL
 - 400 mL
 - 1000 mL
- If AgBr is assumed to be completely insoluble, what mass of AgBr precipitates when 30.0 mL of an 0.500 mol/L solution of AgNO₃ is added to 50.0 mL of an 0.400 mol/L solution of NaBr?
 - 3.76 g
 - 1.28 g
 - 6.57 g
 - 3.76 kg
 - 2.82 g
- Aspirin can be prepared from salicylic acid (C₇H₆O₃) and acetic anhydride (C₄H₆O₃) according to the equation



This reaction gives a yield of 74%, provided that a 50% excess of acetic anhydride (the cheaper reagent) is used. If a chemist wants to prepare 20.0 g of aspirin in the laboratory, what mass of acetic anhydride should she use?

- A. 20.7 g B. 11.5 g C. 23.0 g D. 7.65 g E. 8.50 g
7. A chemist synthesizes a new acidic compound which has two acidic hydrogen atoms per molecule. He dissolves a sample of 1.26 g of the pure compound in water and titrates with 0.100 mol/L NaOH. If 75.0 mL of NaOH are required to reach the end point, what is the molar mass of the new acid?
- A. 336 g/mol B. 168 g/mol C. 80 g/mol D. 1344 g/mol E. 672 g/mol
8. Which of the following elements has the largest density at 25°C and atmospheric pressure (101.3 kPa)?
- A. Li B. Cs C. Al D. Pb E. Rn
9. Radioactive isotopes such as ^{137}Cs can be formed in nuclear reactors when a nucleus of ^{235}U absorbs a neutron and undergoes fission into two other nuclei, while emitting more neutrons. In a given fission event, the products are ^{137}Cs and an isotope of rubidium, while three neutrons are emitted in the fission. Which isotope of rubidium is formed?
- A. ^{96}Rb B. ^{98}Rb C. ^{85}Rb D. ^{87}Rb E. ^{95}Rb
10. A double bond between two carbon atoms is formed when:
- A. one electron is shared B. two electrons are shared
C. four electrons are shared D. one electron is transferred
E. two electrons are transferred
11. Which of the following molecules forms no intermolecular hydrogen bonds?
- A. $\text{CH}_3\text{CH}_2\text{OH}$ B. HF C. H_2O D. CH_3COOH E. H_2
12. Acetylene ($\text{HC}\equiv\text{CH}$) can add two molecules of hydrogen according to the equation $\text{C}_2\text{H}_2 + 2\text{H}_2 \rightarrow \text{C}_2\text{H}_6$. Find the heat released (in kJ/mol) during this reaction, using the required bond energies from the following list:
- C-H 413 C-C 347 C=C 614 C C 839 H-H 432
- A. 1160 B. 521 C. 563 D. 296 E. 788
13. A rigid balloon with a volume of 50.0 cm³ is kept at 18°C and contains air at a pressure of 101.3 kPa initially. If 0.223 g of krypton is now introduced, what will be the pressure of krypton inside the balloon?
- A. 128.8 kPa B. 64.4 kPa C. 27.5 kPa D. 230.1 kPa E. 7.97 kPa

14. Air is a mixture whose principal components are N_2 and O_2 . According to the kinetic-molecular theory of gases, at what temperature is the average speed of N_2 molecules equal to the average speed of O_2 molecules at 0°C ?
- A. $+39^\circ\text{C}$ B. $+84^\circ\text{C}$ C. $+19^\circ\text{C}$ D. -18°C E. -34°C
15. Which of the following formulas could NOT be that of an alcohol?
- A. CH_4O B. $\text{C}_2\text{H}_6\text{O}_2$ C. $\text{C}_2\text{H}_7\text{NO}$ D. $\text{C}_2\text{H}_7\text{N}$ E. $\text{C}_2\text{H}_4\text{O}_3$
16. Commercial chemical suppliers sell perchloric acid (HClO_4) as a 70.0% solution (by mass) in water. If the density of this reagent is 1.664 g/mL, what is the molar concentration of HClO_4 in the solution?
- A. 6.97 mol/L B. 16.6 mol/L C. 4.97 mol/L D. 23.2 mol/L E. 11.6 mol/L
17. The gas NO_2 reacts to form a dimer N_2O_4 according to the equation
- $$2 \text{NO}_2 (\text{g}) \rightleftharpoons \text{N}_2\text{O}_4 (\text{g}); \quad H = -57.2 \text{ kJ}$$
- There will be more N_2O_4 present at equilibrium if:
- A. the temperature is increased or the volume is increased
B. the temperature is increased or the volume is decreased
C. the temperature is decreased or the volume is increased
D. the temperature is decreased or the volume is decreased
E. the temperature is increased, while a change in volume has no effect
18. In a properly functioning automobile engine, the two principal products of the combustion of the gasoline are:
- A. CO and H_2O B. CO_2 and H_2O C. H_2O and NO
D. CO and NO E. CO_2 and NO
19. Which oxide is the principal component of glass?
- A. TiO_2 B. Al_2O_3 C. K_2O D. Fe_2O_3 E. SiO_2
20. If two mol of lithium hydroxide are neutralized by one mol of an acid in aqueous solution, then
- A. the acid is twice as concentrated as the lithium hydroxide solution.
B. the lithium hydroxide solution is twice as concentrated as the acid.
C. two mol of acid supply one mol of hydrogen ions.

- D. one mol of acid supplies two mol of hydrogen ions.
E. one mol of acid supplies one mol of hydrogen ions.
21. The ion H_3O^+ is an acid according to the Brønsted-Lowry definition. What is the conjugate base of this acid?
A. another H_3O^+ B. H^+ C. H_2O D. OH^- E. H_3O^+ has no conjugate base
22. A 0.1 mol/L solution of potassium acetate, $\text{KC}_2\text{H}_3\text{O}_2$, has a lower pH than a 0.1 mol/L solution of potassium cyanide, KCN. From this, you can correctly conclude that
A. hydrocyanic acid, HCN, is a weaker acid than acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$.
B. hydrocyanic acid, HCN, is less soluble in water than acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$.
C. the cyanide ion, CN^- , is a weaker base than the acetate ion, $\text{C}_2\text{H}_3\text{O}_2^-$.
D. cyanides are less soluble in water than acetates.
E. acetate ion, $\text{C}_2\text{H}_3\text{O}_2^-$, partially dissociates to form hydronium ion, H_3O^+ .
23. The catalyst in a chemical reaction:
A. decreases the activation energy of the forward reaction and increases the activation energy of the reverse reaction
B. increases the activation energy of the forward reaction and decreases the activation energy of the reverse reaction
C. increases the activation energies of both the forward reaction and the reverse reaction
D. decreases the activation energies of both the forward reaction and the reverse reaction
E. increases the activation energy of the forward reaction and does not change the activation energy of the reverse reaction
24. Hydrazine is a liquid of formula N_2H_4 which has been used as a rocket fuel. What is the oxidation number of N in hydrazine?
A. +5 B. -3 C. +2 D. 0 E. -2
25. A metal M displaces copper from an aqueous solution of copper(II) sulfate but does not react with an aqueous solution of zinc nitrate. Which one of the following lists gives the metals in order of increasing strength as a reducing agent?
A. $\text{Cu} < \text{Zn} < \text{M}$ B. $\text{Cu} < \text{M} < \text{Zn}$ C. $\text{Zn} < \text{M} < \text{Cu}$
D. $\text{M} < \text{Cu} < \text{Zn}$ E. $\text{Zn} < \text{Cu} < \text{M}$

NATIONAL HIGH SCHOOL CHEMISTRY EXAMINATION (1997)

PART B - ESSAY QUESTIONS (Choose 2)

Answer TWO questions only in the form of scientific essays including any appropriate equations, formulas and diagrams. The judging of the essays will be based on both factual accuracy and presentation. A clear, concise and well-organized essay will be rated higher than a long rambling one which contains the same information.

1. Canadian mining has been in the news with the 1996 discovery of ore deposits in Labrador. Select any **three** of aluminum, copper, iron, gold or nickel, which are all important in Canadian mining. Discuss the natural form in which these three metals are found, and the chemistry needed to bring them into the metallic form. Describe the corrosion of these metals, and how they may be protected from corrosion or recycled.
2. The chemistry of life is called biochemistry, a field which combines both chemistry and biology. Discuss some of the chemical substances found in living organisms? Describe their role in biology.
3. Many chemists have studied solutions which conduct electricity. Why do solutions conduct electricity and why do some conduct better than others? What chemical information can be learned from measurements of electrical conductivity? Describe some useful applications of conducting solutions in everyday life.