June 1997

Chemistry 30

Grade 12 Diploma Examination

Alberta EDUCATION

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Chemistry 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar is used to indicate the end of a set.

A chemistry data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. chemistry
B. biology
C. physics
D. science

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

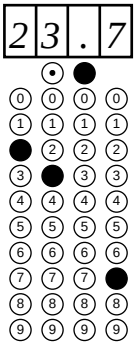
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



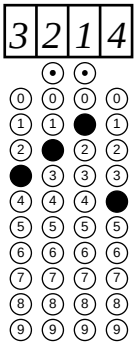
Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet →



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

Use the following information to answer the next question.

$$Al_{(s)} + \frac{3}{2} I_{2(s)} \rightarrow AlI_{3(s)} \qquad \Delta H = -310.0 \text{ kJ}$$

1. The value –310.0 kJ/mol is a molar heat of

A. fusion

B. decomposition

C. solidification

D. formation

---

2. The primary reaction that occurs in the Sun is

A. $^{14}_{7}\text{N} \rightarrow {}^{13}_{6}\text{C} + {}^{1}_{1}\text{H} + \text{energy}$

B. $^{6}_{3}\text{Li} + {}^{2}_{1}\text{H} \rightarrow 2\,{}^{4}_{2}\text{He} + \text{energy}$

C. $^{2}_{1}\text{H} + {}^{3}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + {}^{1}_{0}\text{n} + \text{energy}$

D. $^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{90}_{38}\text{Sr} + {}^{143}_{54}\text{Xe} + 3{}^{1}_{0}\text{n} + \text{energy}$

Numerical Response

1. As Freon-12, $CCl_2F_{2(l)}$, absorbs energy from the foodstuffs in your refrigerator, it vaporizes. The vaporization of 5.00 g of freon-12 requires 1.45 kJ of energy. The molar heat of vaporization of freon-12 is _____ kJ/mol.

(Record your answer to three digits on the answer sheet.)

Decaying matter may provide energy directly through combustion or indirectly through decomposition to form methane, which can then be burned.

$$CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(g)}$$

3. The burning of methane is an example of an

A. exothermic reaction in which carbon is oxidized
B. exothermic reaction in which carbon is reduced
C. endothermic reaction in which carbon is reduced
D. endothermic reaction in which carbon is oxidized

4. The molar enthalpy of combustion for methane is

A. –560.5 kJ/mol
B. –710.1 kJ/mol
C. –802.3 kJ/mol
D. –951.9 kJ/mol

*Use the value selected for **Multiple Choice 4** to answer **Numerical Response 2**.*

Numerical Response

2. A mid-efficiency gas furnace distributes 78.0% of the energy available from burning methane. The amount of energy distributed for heating a home when 12.5 mol of $CH_{4(g)}$ burns in the furnace is _____ MJ.

(Record your answer to three digits on the answer sheet.)

5. In scientific terms, which of the following statements best describes what occurs when a bowl of cooked soup is warmed from 20°C to 50°C in a microwave oven?

A. The bond energies between the atoms increase.

B. The potential energy of the soup increases.

C. The kinetic energy of the soup increases.

D. The atoms are rearranged into new combinations.

6. An equation that represents an endothermic change is

A. $C_2H_5OH_{(l)} + 2\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)}$

B. $2\ C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)}$

C. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

D. $CO_{2(g)} \rightarrow CO_{2(s)}$

7. Sulphuric acid is used to dissolve copper ore in many mining operations. Sulphuric acid may be produced on site by burning sulphur and dissolving the products in water. The overall equation for this reaction is

$$S_{8(s)} + 12\ O_{2(g)} + 8\ H_2O_{(l)} \rightarrow 8\ H_2SO_{4(l)} + 4225.6\ kJ$$

In this process, what is the heat of reaction for the production of one mole of sulphuric acid?

A. +4225.6 kJ

B. +528.2 kJ

C. –528.2 kJ

D. –4225.6 kJ

8. Which of the following statements is **false**?

A. Light energy is converted into chemical energy during photosynthesis.

B. Chemical energy is converted into heat and light energy during the combustion of hydrocarbons.

C. Light energy is converted into chemical energy to produce a firefly's glow.

D. Chemical energy is converted into electrical energy as a voltaic cell discharges.

Use the following information to answer the next question.

Equations	Key
$H_{(g)} + Br_{(g)} \rightarrow HBr_{(g)} + 366\ kJ$	**1** $HBr_{(g)}$
$H_{(g)} + F_{(g)} \rightarrow HF_{(g)} + 565\ kJ$	**2** $HF_{(g)}$
$H_{(g)} + I_{(g)} \rightarrow HI_{(g)} + 299\ kJ$	**3** $HI_{(g)}$
$H_{(g)} + Cl_{(g)} \rightarrow HCl_{(g)} + 431\ kJ$	**4** $HCl_{(g)}$

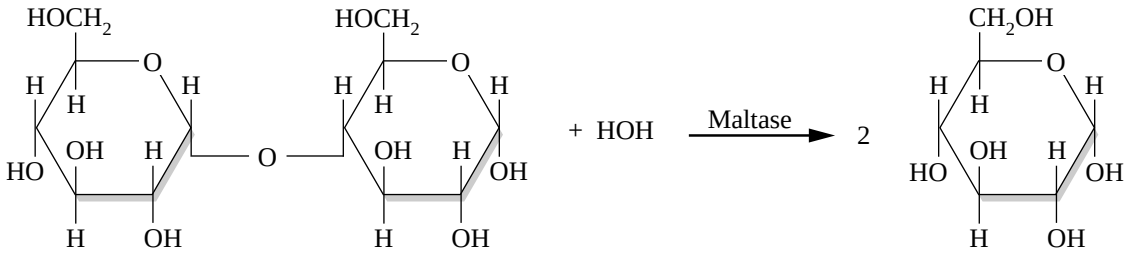
Numerical Response

3. When the hydrogen-halide bond strengths are ordered from strongest to weakest, the order is _____.

(Record all four numbers on the answer sheet.)

Use the following information to answer the next question.

The sugar maltose, in the presence of the enzyme maltase, is broken down in our bodies into glucose.



9. Without maltase, the reaction would

A. release more energy

B. release less energy

C. occur at a faster rate

D. occur at a slower rate

Use the following information to answer the next question.

I. The development of Volta's battery of cells allowed for the electrolysis of water, which revealed that water is not an element.

II. Measurements from satellite sensors show significant changes occuring in the ozone layer.

III. Before the First Word War, Fritz Haber was able to devise a technique to produce ammonia for use in the manufacture of explosives.

IV. Dorothy Hodgkin used X-ray diffraction techniques to discover the arrangement of atoms in penicillin and vitamin B_{12}.

10. Technological advances leading to scientific understandings are directly demonstrated by

A. I, II, III

B. I, III, IV

C. I, II, IV

D. II, III, IV

Numerical Response

4. The oxidation numbers of sulphur in $SO_{2(g)}$, $SO_{3(g)}$, $H_2SO_{3(aq)}$, and $H_2SO_{4(aq)}$, respectively, are _____.

(Record all four numbers on the answer sheet.)

Use the following chemical equations to answer the next question.

I. $H_2O_{(l)} + H_2SeO_{3(aq)} \rightarrow SeO_4^{2-}{}_{(aq)} + 4\,H^+_{(aq)} + 2\,e^-$

II. $2\,H^+_{(aq)} + N_2O_{(g)} + 2\,e^- \rightarrow N_{2(g)} + H_2O_{(l)}$

III. $H_{2(g)} + N_2O_{(g)} + 2\,e^- \rightarrow N_{2(g)} + H_2O_{(l)}$

IV. $H_2SeO_{3(aq)} + 4\,H^+_{(aq)} + 2\,O_{2(g)} + 6\,e^- \rightarrow SeO_4^{2-}{}_{(aq)} + 3\,H_2O_{(l)}$

11. The two chemical equations for the half-reactions that would occur in the net redox reaction $N_2O_{(g)} + H_2SeO_{3(aq)} \rightarrow N_{2(g)} + SeO_4^{2-}{}_{(aq)} + 2\,H^+_{(aq)}$ are

A. I and II

B. I and III

C. II and III

D. II and IV

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12. An oxidation-reduction reaction that occurs in the human body is

A. $H_2CO_{3(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

B. $CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(g)}$

C. $C_{12}H_{22}O_{11(s)} + 12\,O_{2(g)} \rightarrow 12\,CO_{2(g)} + 11\,H_2O_{(g)}$

D. $C_6H_{12}O_{6(aq)} + 6\,O_{2(aq)} \rightarrow 6\,CO_{2(aq)} + 6\,H_2O_{(l)}$

Numerical Response

5. Using the Table of Standard Electrode Potentials, the numbered oxidizing agents, listed from strongest to weakest, are _____.

1 $Sn^{2+}_{(aq)}$
2 $Cu^{2+}_{(aq)}$
3 $Zn^{2+}_{(aq)}$
4 $Pb^{2+}_{(aq)}$

(Record all four numbers on the answer sheet.)

13. In balancing redox reactions, the coefficients assigned to the oxidizing agents and reducing agents make the equation consistent with which of the following statements?

A. Electron gain equals electron loss.

B. Moles of reactants equals moles of products.

C. Energy change of products equals energy change of reactants.

D. Number of reactant molecules equals number of product molecules.

14. The electrical potential for the reaction between nitric acid and copper, under standard conditions, is

A. +0.34 V

B. +0.46 V

C. +0.80 V

D. +1.14 V

An iron ore sample was crushed and treated in order to convert all the iron to $Fe^{2+}_{(aq)}$. This solution was then titrated with $KMnO_{4(aq)}$. The unbalanced redox equation for the reaction is

$$MnO_4^-{}_{(aq)} + H^+_{(aq)} + Fe^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + H_2O_{(l)} + Fe^{3+}_{(aq)}$$

15. The lowest whole number coefficients for the reactants in the balanced equation, in the order given, are

A. 1, 8, 1

B. 1, 8, 5

C. 2, 16, 5

D. 5, 16, 2

*Use the values selected from **Multiple Choice 15** to answer **Multiple Choice 16**.*

16. The titration required 55.0 mL of 0.100 mol/L $KMnO_{4(aq)}$ to react completely with the $Fe^{2+}_{(aq)}$. The mass of iron in the ore sample was

A. 0.123 g

B. 0.307 g

C. 0.768 g

D. 1.54 g

17. During the titration,

A. the pH increases

B. $Fe^{2+}_{(aq)}$ gains electrons

C. $Fe^{2+}_{(aq)}$ acts as an oxidizing agent

D. the acidified $MnO_4^-{}_{(aq)}$ acts as a reducing agent

Corrosion of iron causes billions of dollars in damage every year. A reaction that occurs during corrosion is

$$4\ Fe_{(s)} + 3\ O_{2(g)} + 6\ H_2O_{(l)} \rightarrow 4\ Fe(OH)_{3(s)} + \text{energy}$$

18. The oxidizing agent in this reaction is

A. $Fe_{(s)}$
B. $O_{2(g)}$
C. $H_2O_{(l)}$
D. $Fe(OH)_{3(s)}$

Numerical Response

6. If 6.98 g of iron corroded, then the volume of oxygen gas consumed at SATP is _____ L. (Note: 1 mol of oxygen at SATP occupies 24.8 L)

(Record your answer to three digits on the answer sheet.)

19. One reason that copper pipes rather than iron pipes are used in household plumbing is that

A. iron has a greater tendency to be oxidized than copper
B. iron will react with dissolved minerals such as calcium salts
C. copper is a better conductor of heat energy than iron
D. commercial drain cleaners containing sodium hydroxide will react with iron

Galvanizing, a process used to prevent corrosion, involves coating iron metal with a thin layer of zinc metal.

20. Iron nails can be galvanized using an electrolytic process. The nails to be galvanized would be attached to the

A. anode

B. electrode at which anions react

C. electrode at which oxidation occurs

D. electrode at which reduction occurs

21. A galvanized nail was placed in a copper(II) sulphate solution. After a day, the blue colour of the solution disappeared and copper metal was produced. The procedure was repeated with objects made of other metals. Similar results would **not** be predicted for

A. an uncoated iron nail

B. a chromium-plated spoon

C. a nickel-plated coin

D. a gold-plated bracelet

Numerical Response

7. In an electrolytic cell, 61.0 g of $Zn_{(s)}$ was plated in 10.0 min. The mass of $Cr_{(s)}$ that could be plated in the same time using the same current from a solution of $Cr^{3+}_{(aq)}$ is _____ g.

(Record your answer to three digits on the answer sheet.)

22. In a voltaic cell,

A. chemical energy is converted to electrical energy in a spontaneous change

B. chemical energy is converted to electrical energy in a non-spontaneous change

C. electrical energy is converted to chemical energy in a spontaneous change

D. electrical energy is converted to chemical energy in a non-spontaneous change

23. One way in which voltaic cells differ from electrolytic cells is that

A. anions migrate to the anode in one but to the cathode in the other

B. oxidation occurs at the cathode in one but at the anode in the other

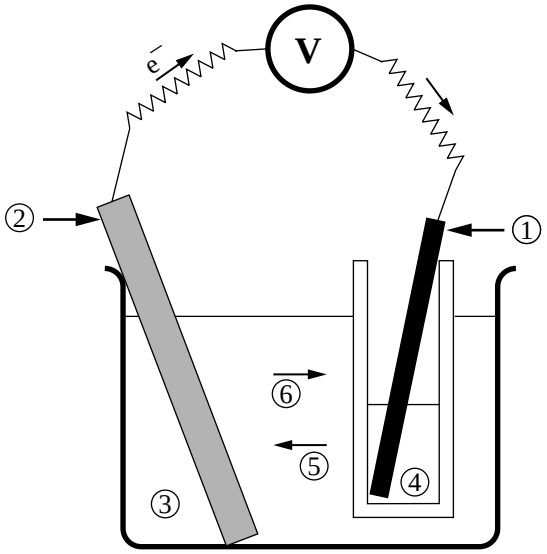
C. voltaic cells have an external circuit but electrolytic cells do not

D. the cell potential for one is positive but negative for the other

Use the following information to answer the next question.

The diagram represents the voltaic cell

$Ni_{(s)} / Ni^{2+}_{(aq)} // MnO_4^-{}_{(aq)}, Mn^{2+}_{(aq)}, H^+_{(aq)} / C_{(s)}$.



Numerical Response

8. The nickel electrode is represented by number _____. (Record in first column)

The acidic permanganate solution is represented by number _____. (Record in second column)

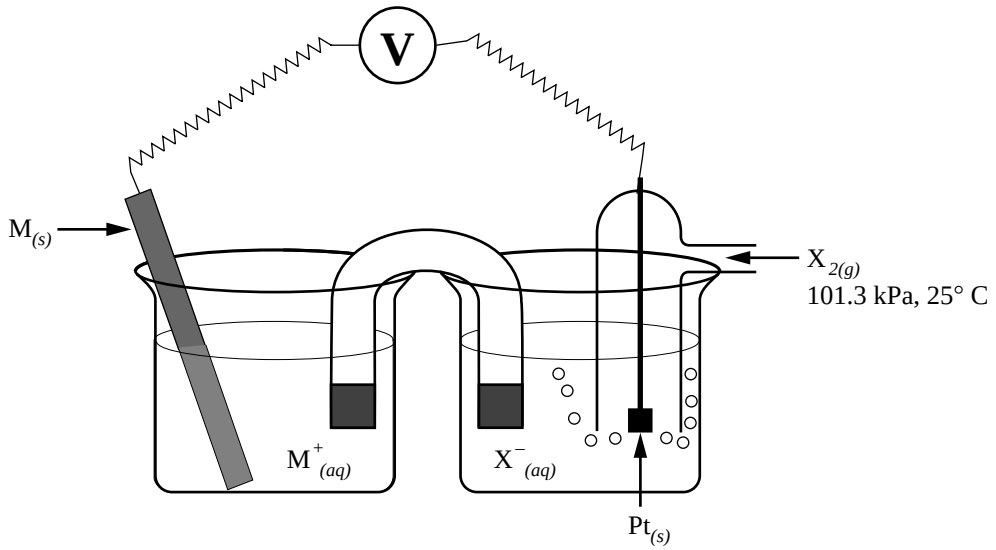
The cation migration is represented by number _____. (Record in third column)

The cathode is represented by number _____. (Record in fourth column)

Use the following information to answer the next two questions.

A student constructed the following cell and recorded her observations.

Observations:
I. The voltmeter registers 1.32 V.
II. The mass of electrode M decreases.
III. The colour of $X^-_{(aq)}$ becomes more intense.
IV. The colour of the $M^+_{(aq)}$ ion becomes more intense.



24. The oxidation half-reaction for the voltaic cell shown would be

A. $2\ X^-_{(aq)} \rightarrow X_{2(g)} + 2\ e^-$
B. $X_{2(g)} + 2\ e^- \rightarrow 2\ X^-_{(aq)}$
C. $M_{(s)} \rightarrow M^+_{(aq)} + e^-$
D. $M^+_{(aq)} + e^- \rightarrow M_{(s)}$

25. Which of the following observations would **not** identify the oxidizing agent?

A. Observation I
B. Observation II
C. Observation III
D. Observation IV

Nitrogen fixation occurs slowly in the atmosphere. The equation for this reaction is

$$N_{2(g)} + O_{2(g)} + 180.4\ kJ \rightleftharpoons 2\ NO_{(g)} \qquad K_{eq} = 4.0 \times 10^{-31} \text{ at } 25.0°C$$

26. The equilibrium expression for this reaction is

A. $K_{eq} = \dfrac{2[NO_{(g)}]}{[N_{2(g)}][O_{2(g)}]}$

B. $K_{eq} = \dfrac{[NO_{(g)}]^2}{[N_{2(g)}][O_{2(g)}]}$

C. $K_{eq} = \dfrac{[N_{2(g)}][O_{2(g)}]}{2[NO_{(g)}]}$

D. $K_{eq} = \dfrac{[N_{2(g)}][O_{2(g)}]}{[NO_{(g)}]^2}$

27. Equilibrium has been achieved when the

A. total pressure does not change
B. rate of the forward reaction equals the rate of the reverse reaction
C. rate of the forward reaction is twice that of the rate of the reverse reaction
D. total energy changes

28. At equilibrium, if the $[O_{2(g)}] = [N_{2(g)}]$, then

A. $[NO_{(g)}] = [N_{2(g)}]$
B. $[NO_{(g)}] > [N_{2(g)}]$
C. $[NO_{(g)}] = 2\ [N_{2(g)}]$
D. $[NO_{(g)}] < [N_{2(g)}]$

Large quantities of ammonia are produced by the Haber–Bosch method. The essential reaction in this process involves the equilibrium

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.2\ kJ$$

29. In aqueous solution, ammonia is a

A. weak base
B. strong base
C. weak triprotic acid
D. weak monoprotic acid

30. The Brønsted–Lowry equation that best represents the equilibrium in an aqueous solution of ammonia is

A. $NH_{3(aq)} \rightleftharpoons 3H^{+}_{(aq)} + N^{3-}_{(aq)}$
B. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4OH_{(aq)}$
C. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^{+}{}_{(aq)} + OH^{-}{}_{(aq)}$
D. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^{+}{}_{(aq)} + NH_2^{-}{}_{(aq)}$

31. A catalyst is utilized in the Haber–Bosch process because the

A. reaction is exothermic
B. heat of formation of ammonia is high
C. mole ratio of the reactants is 1:3
D. reaction is slow

32. The conditions that theoretically favour the formation of ammonia in the Haber–Bosch process are

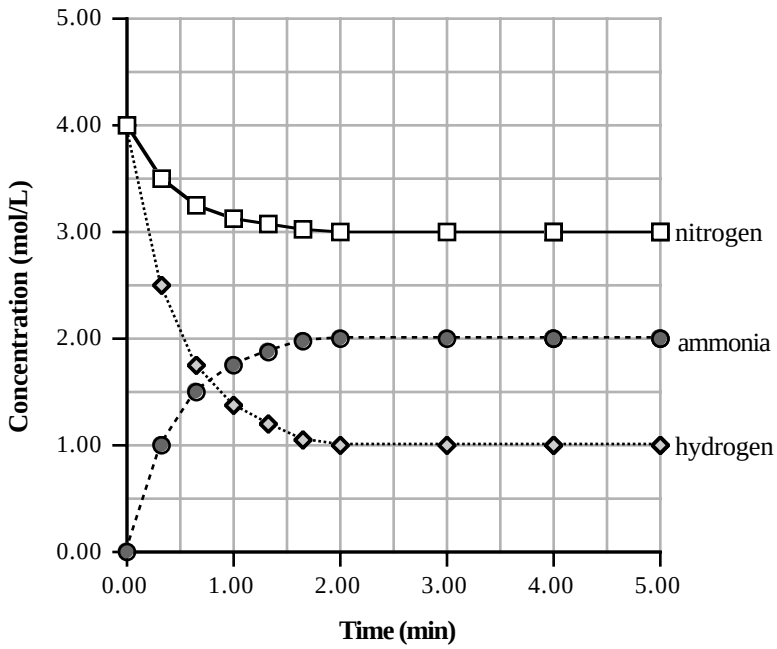
A. high pressure and high temperature
B. high pressure and low temperature
C. low pressure and high temperature
D. low pressure and low temperature

Use the following information to answer the next two questions.

The overall reaction in the Haber–Bosch process for the production of ammonia is

$$N_{2(g)} + 3\,H_{2(g)} \rightleftharpoons 2\,NH_{3(g)}.$$

Data for this equilibrium system was collected and plotted on a graph by a student.



Numerical Response

9. The minimum time, in minutes, required to establish equilibrium is _____ min.

(Record your answer to three digits on the answer sheet.)

Numerical Response

10. The equilibrium constant for this system is _____.

(Record your answer to three digits on the answer sheet.)

33. The hydrogen used in the Haber–Bosch process is produced by

$$CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}.$$

If 1.00 t of $H_{2(g)}$ is required daily, then the mass of $CH_{4(g)}$ required, assuming 100% reaction, is

A. 0.333 t

B. 2.65 t

C. 7.95 t

D. 23.8 t

Use the following information to answer the next question.

Large amounts of ammonia are used in the production of nitric acid, $HNO_{3(aq)}$. One step in the production of nitric acid is represented by the equation

$$4\ NH_{3(g)} + 5\ O_{2(g)} \rightarrow 4\ NO_{(g)} + 6\ H_2O_{(g)}$$

34. The change in enthalpy for the reaction is

A. –105.5 kJ

B. –197.7 kJ

C. –905.6 kJ

D. –1274.4 kJ

Use the following information to answer the next three questions.

Nitric acid is used in the production of ammonium nitrate, $NH_4NO_{3(s)}$, an important fertilizer. The equations for its production are

I. $HNO_{3(aq)} + NH_{3(aq)} \rightarrow NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$

II. $NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)} + \text{heat} \rightarrow NH_4NO_{3(s)}$

35. Reaction I would be classified as

A. acid–base

B. oxidation–reduction

C. both acid–base and oxidation–reduction

D. neither acid–base nor oxidation–reduction

36. Aqueous solutions of ammonium nitrate are acidic. A 0.20 mol/L solution of $NH_4NO_{3(aq)}$ would have a pH of

A. 0.70

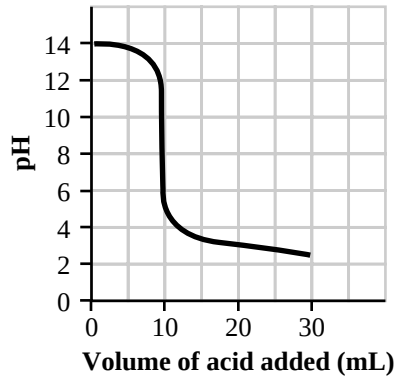
B. 4.47

C. 4.97

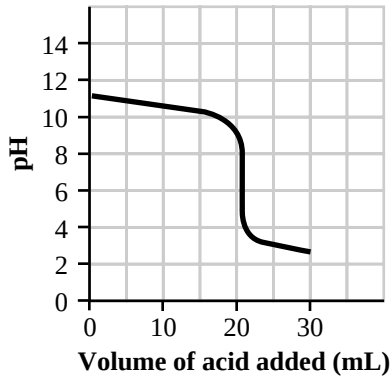
D. 5.12

37. The sketch that indicates the change that occurs when 1.0 mol/L $HNO_{3(aq)}$ is added to 20 mL of 1.0 mol/L $NH_{3(aq)}$ is

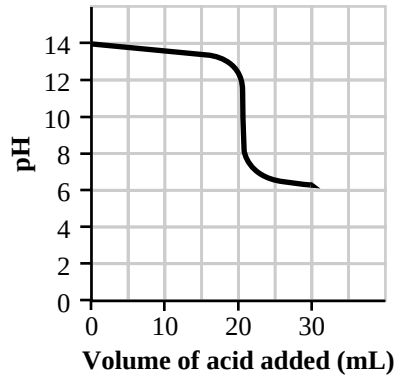
A.



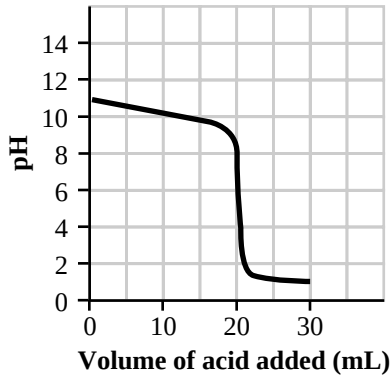
B.



C.



D.



38. A cleaning agent has a pH of 1, and a carbonated beverage has a pH of 5. The cleaning agent is more acidic than the carbonated beverage by a factor of

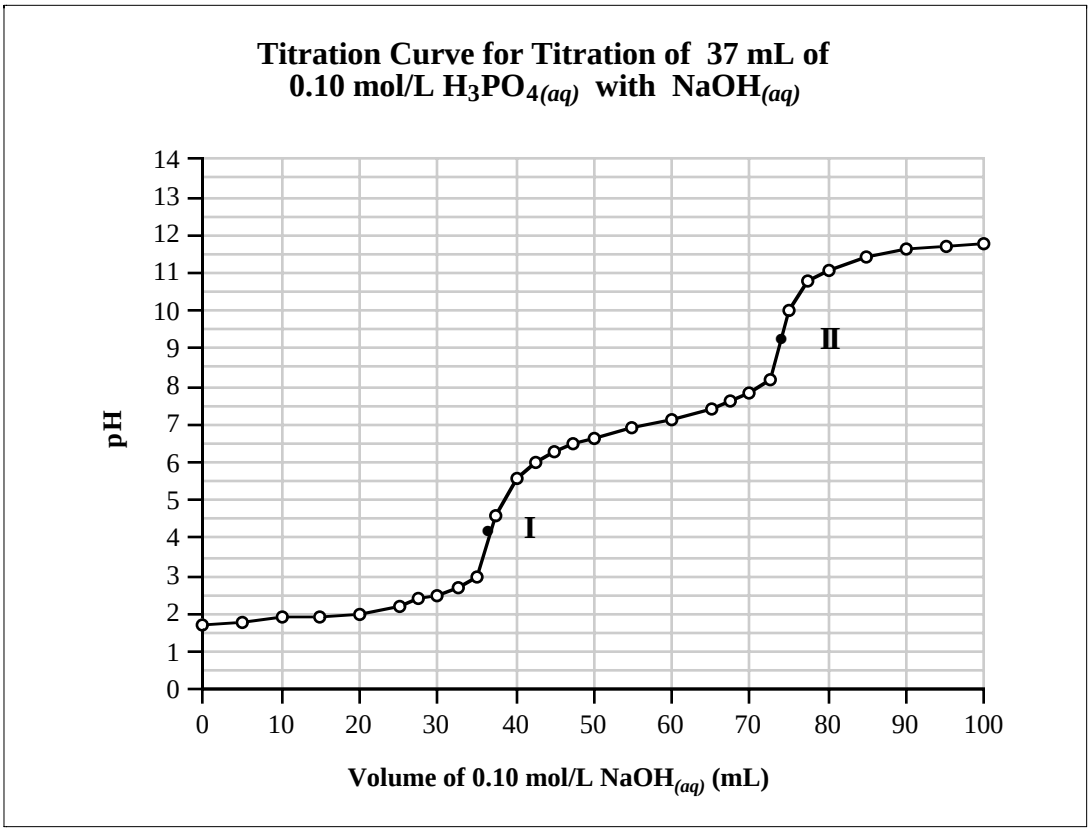
A. 10 000

B. 1 000

C. 100

D. 10

Use the following information to answer the next two questions.



39. The Brønsted–Lowry equation for the reaction which takes place in the region between I and II is

A. $H_2PO_4^-{}_{(aq)} + OH^-{}_{(aq)} \rightarrow HPO_4^{2-}{}_{(aq)} + H_2O_{(l)}$

B. $H_3PO_{4(aq)} + OH^-{}_{(aq)} \rightarrow H_2PO_4^-{}_{(aq)} + H_2O_{(l)}$

C. $HPO_4^{2-}{}_{(aq)} + OH^-{}_{(aq)} \rightarrow PO_4^{3-}{}_{(aq)} + H_2O_{(l)}$

D. $H_3PO_{4(aq)} + 2\ OH^-{}_{(aq)} \rightarrow HPO_4^{2-}{}_{(aq)} + H_2O_{(l)}$

40. In order to obtain accurate data to calculate the concentration of the $H_3PO_{4(aq)}$ solution, all of the indicators listed below could be used **except**

A. thymol blue

B. bromothymol blue

C. bromocresol green

D. phenolphthalein

Use the following information to answer the next question.

The water in a swimming pool was tested to determine its pH. Phenolphthalein was colourless in a sample of the water and bromothymol blue was blue.

41. The approximate pH of the swimming pool water was

A. 6.3

B. 7.0

C. 8.0

D. 12.0

Use the following equation to answer the next question.

$$\underset{\mathbf{1}}{HSO_4^-{}_{(aq)}} + \underset{\mathbf{2}}{HCOO^-{}_{(aq)}} \rightleftharpoons \underset{\mathbf{3}}{HCOOH_{(aq)}} + \underset{\mathbf{4}}{SO_4^{2-}{}_{(aq)}}$$

Numerical Response

11. For the **favoured reaction**, the acid and its conjugate base and then the base and its conjugate acid, listed in that order are _____ .

(Record all four numbers on the answer sheet.)

42. A substance that can act as either an acid or a base is described as

A. amorphous

B. amphoteric

C. isoprotic

D. allotropic

Numerical Response

12. A 30.0 mL sample of 0.200 mol/L $HCOOH_{(aq)}$ is titrated with a solution of 0.180 mol/L $NaOH_{(aq)}$. The volume of $NaOH_{(aq)}$ required to react completely with the $HCOOH_{(aq)}$ is _____ mL.

(Record your answer to three digits on the answer sheet.)

43. When a small amount of base is absorbed into the blood, the $H_2CO_{3(aq)}/HCO_3^{-}{}_{(aq)}$ buffer maintains blood pH at approximately 7.3 because the base reacts with

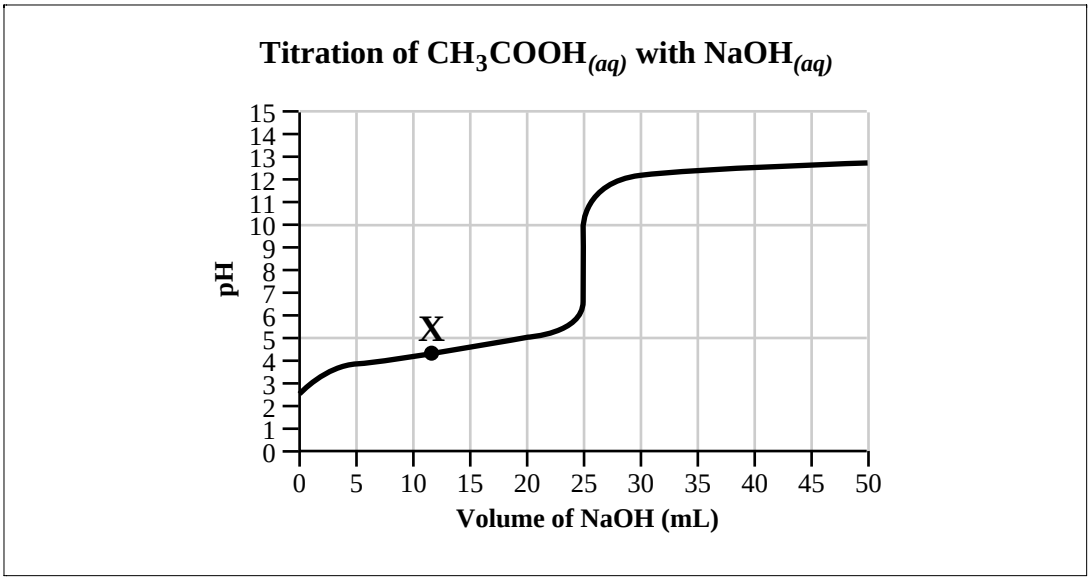
A. $H_2CO_{3(aq)}$

B. $HCO_3^{-}{}_{(aq)}$

C. $CO_3^{2-}{}_{(aq)}$

D. $H_2O_{(l)}$

Use the following information to answer the next question.



44. If the titration is stopped at X, the solution is resistant to a change in pH if a strong base or a strong acid is added to it. This is due to the fact that, at X, the solution contains large amounts of

A. $H_2O_{(l)}$ and $OH^{-}{}_{(aq)}$

B. $CH_3COO^{-}{}_{(aq)}$ and $H_3O^{+}{}_{(aq)}$

C. $CH_3COOH_{(aq)}$ and $OH^{-}{}_{(aq)}$

D. $CH_3COOH_{(aq)}$ and $CH_3COO^{-}{}_{(aq)}$

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Written Response — 12 marks

1. A student wished to determine whether fats or sugars had the higher energy content. Small samples of stearic acid, $C_{18}H_{36}O_{2(s)}$ (a fatty acid) or sucrose, $C_{12}H_{22}O_{11(s)}$ (a sugar) were burned and the data collected as shown below.

	Sucrose	**Stearic Acid**
Mass of sample	1.55 g	1.17 g
Calorimeter constant (heat capacity)	8.57 kJ/°C	8.57 kJ/°C
Initial temperature of calorimeter	24.30°C	26.40°C
Final temperature of calorimeter	27.88°C	30.28°C

a. Use the data collected to calculate the enthalpy of combustion for 1.00 g of each substance.

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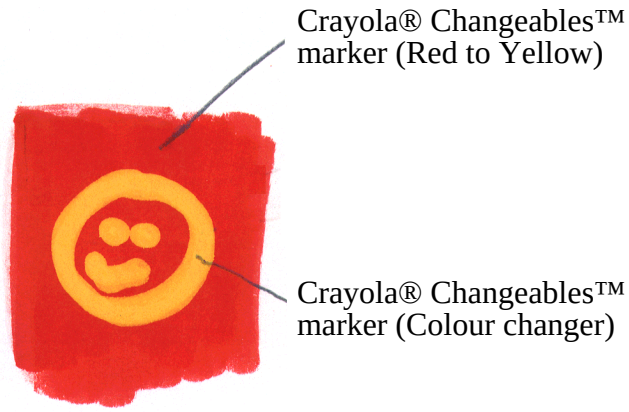
b. The student decided that a diet should consist of food with the highest energy content. Based on your calculations, which food would be better in the student's diet. Explain.

c. Identify one problem/concern with the diet proposed in part **b**.

Written Response — 12 marks

2.



A crayon manufacture is now making markers that change colour when a colourless Changeable™ marker overwrites the coloured Changeable™ marker.

Suggest a possible composition for each of the markers used to produce the graphic shown above. Your response should indicate reagents and reactions involved and should take into account that the markers are intended for use by young children.

You have now compeleted the examination.
If you have time, you may wish to check your answers.

No marks will be given for work done on this page.

No marks will be given for work done on this page.

Fold and tear along perforation.

No marks will be given for work done on this page.

Fold and tear along perforation.

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Credit

Page 24 *Crayola*® and *Changeables*™ are used by permission of Binney & Smith Properties, Inc.

No marks will be given for work done on this page.

CHEMISTRY 30 MULTIPLE-CHOICE KEY

1.	D	23.	D
2.	C	24.	C
3.	A	25.	A
4.	C	26.	B
5.	C	27.	B
6.	B	28.	D
7.	C	29.	A
8.	C	30.	C
9.	D	31.	D
10.	C	32.	B
11.	A	33.	B
12.	D	34.	C
13.	A	35.	A
14.	B	36.	C
15.	B	37.	D
16.	**	38.	A
17.	A	39.	A
18.	B	40.	B
19.	A	41.	C
20.	D	42.	B
21.	D	43.	A
22.	A	44.	D

NUMERICAL-RESPONSE KEY

1.	35.1	7.	32.3
2.	*	8.	2461
3.	2413	9.	2.00
4.	4646	10.	1.33
5.	2143	11.	1423
6.	2.32	12.	33.3

* If MC 4, A – 5.46
B – 6.92
C – 7.82
D – 9.28

** If MC 15, A – B
B – D
C – C
D – A

CHEMISTRY 30 DIPLOMA EXAMINATION – JUNE 1997
SAMPLE ANSWER KEY FOR WRITTEN RESPONSE

1. a. Sucrose molar enthalpy:

$$\Delta H = \frac{8.57 \text{ kJ/° C} \times 3.58 \text{° C}}{1.55 \text{ g}}$$

$$\Delta H = -19.8 \text{ kJ/g}$$

Stearic acid molar enthalpy:

$$\Delta H = \frac{8.57 \text{ kJ/° C} \times 3.88 \text{° C}}{1.17 \text{ g}}$$

$$\Delta H = -28.4 \text{ kJ/g}$$

b. Based on the difference in enthalpy, stearic acid (fat) has the higher energy content. The student would therefore choose foods with high fat content such as butter, ice cream, potato chips, etc.

c. Canada Food Act / medical profession recommend a balanced diet for healthy individuals. Heart disease, etc., can be the ultimate results of poor food choices, especially foods with a high fat content.

2. One possible mechanism for this marker is to use methyl red indicator as the dye in the coloured marker. At a pH of 5 the marker colour would be red, thus the marker would not be strongly acidic and hence relatively safe. The colourless over writer could be a dilute solution of sodium hydroxide. The pH of which could be around 8, thus it would be relatively safe yet basic enough to change the indicator from its red form to the yellow form. The reaction for the colour change is

$$\underset{\text{red}}{HMr_{(aq)}} + OH^-_{(aq)} \rightarrow \underset{\text{yellow}}{Mr^-_{(aq)}} + HOH_{(l)}$$