JUNE 2011

CHEMISTRY

Secondary 5

551-504

Theory Examination



Administration and Marking Guide

## Administration and Marking Guide

|  |  |
| --- | --- |
| **Design Team**Sue Christiano, English Montreal S. B.Gary Mallalieu, Lester B. Pearson S. B.Heather McPherson, Sir Wilfrid Laurier S. B.Jessica Poliforni, English Montreal S. B.**Coordination**Katherine Davey, Educational Consultant,Lester B. Pearson S. B.Imma Ienaro, Educational Consultant,English Montreal S. B. | **Editing**Barbara Choquette, BIM, Société GRICS**Layout and Computerization**Diane Nadeau, BIM, Société GRICS |

## Table of Contents

1. Presentation of the Examination 2

2. Description of the Examination 2

2.1 General description 2

2.2 Time allotted 2

2.3 Chemistry competencies evaluated 2

2.4 Compulsory concepts 3

2.5 Other knowledge evaluated 3

2.6 Examination documents 4

2.7 Permitted materials 4

3. Procedure for Administrating the Examination 4

3.1 Initial preparation 4

3.2 Carrying out the task 4

4. Evaluation 5

4.1 Determination of final mark 5

4.2 Evaluation tools 5

4.3 Marking guide 5

4.4 Appropriate responses and marking scale 6-17

Appendix

Feedback Questionnaire

**1. Presentation of the Examination**

This document provides all the necessary information concerning the *Chemistry* Examination for Competency 2 for the end of Secondary Cycle 2, Year 3. This examination was developed by a group of teachers and coordinated by MaST and edited by GRICS.

The examination provides teachers with information that can help them evaluate the extent to which students have developed essential knowledge and subject-specific Competency 2 in the *Chemistry* program.

Examples of appropriate responses and marking scales are provided for each question to help teachers assess a student’s level of Knowledge aquisition and Competency development.

**2. Description of the Examination**

**2.1 General description**

This examination requires students to analyze chemical phenomena and applications. Students will have to solve different problems on their own by using their knowledge of gases, energy changes in reactions, reaction rates and chemical equilibrium, which are general concepts in the *Chemistry* program.

This examination, which is worth 60 marks, includes 13 extended answer questions pertaining to four different themes.

**2.2 Time allotted**

⦁ 180 minutes (3 hours)

**2.3 Chemistry competencies evaluated**

The examination consists of questions related to evaluation criteria associated with Competency 2. The three criteria to be considered in this examination are as follows:

⦁ Appropriate use of concepts, laws and models of chemistry

⦁ Relevant explanations

⦁ Suitable justification of explanations

Note that the first criterion associated with Competency 2, *Formulation of appropriate questions*, will not be considered.

**2.4 Compulsory concepts**

|  |  |
| --- | --- |
| **General Concept** | **Compulsory Concept** |
| **Gases** | Physical properties of gases* Kinetic theory of gases
* General Gas law
* Ideal Gas law
* Dalton’s Law
* Avogadro’s Hypothesis
* Molar Volume of a Gas
 |
| **Energy Changes in Reactions** | Energy DiagramActivation EnergyEnthalpy ChangeMolar Heat of reaction |
| **Reaction rate** | Factors that influence reaction rateRate Law |
| **Chemical Equilibrium** | Factors that influence the state of equilibriumLe Chatelier’s PrincipleEquilibrium Constant* Acidity and Alkalinity constants
* Solubility-product constant

Relationship between pH and the molar concentration of hydronium and hydroxide ions |

**2.5 Other knowledge evaluated**

* Significant figures and uncertainty of measurements

A total of 2 marks have been allocated to the consistent use of significant figures throughout the examination. A marking scale to assess the use of significant figures has been provided at the end of the marking guide in this document.

**2.6 Examination documents**

⦁ Question Booklet

⦁ Answer Booklet

⦁ Administration and Marking Guide

**2.7 Permitted materials**

Only the following materials are permitted during the examination:

⦁ Writing instruments

⦁ Rulers

⦁ Scientific calculator with or without graphic display

**3. Procedure for Administering the Examination**

**3.1 Initial preparation**

No initial preparation is required. You may choose to review the evaluation criteria with the students prior to examination.

**3.2 Carrying out the tasks**

1. Distribute the *Question Booklets* and *Answer Booklets*.

2. Review the evaluation criteria with the students and make sure they understand them.

3. Tell students they are to answer all questions individually in their *Answer Booklet*.

4. Collect all booklets at the end of the evaluation session.

**4. Evaluation**

**4.1 Determination of final mark**

The examination mark is out of 60 and can be converted to a score out of 100. The marks awarded for each question are not percentage values.

**4.2 Evaluation tools**

The questions that comprise this exam are scored using answer keys and marking scales, which are adapted to each question and related to three of the evaluation criteria associated with the competency. The sample answers correspond to the work expected of students if they are to earn the maximum number of marks. Parenthetical information indicated within each sample answer is not regarded as an essential part of the expected answer, but rather as a clarification or as additional information.

**4.3 Marking guide**

**GUIDELINES FOR CORRECTING QUESTIONS**

The marking scale for correcting the answers to the questions of the examination is presented below, along with explanations of the terms used in the scale.

It is **IMPORTANT** that the teacher read this information carefully before correcting the examination.

Questions usually consist of two parts: the **procedure** used to solve the problem and the **answer**. Thus, a question should be corrected in two steps.

***Step 1***

Analyze the work to understand the procedure used by the student, and then decide if the procedure is appropriate or not.

A **procedure** is **appropriate** if the steps presented could lead to the correct answer.

A **procedure** is **partially appropriate** if the steps presented do not lead to the correct answer, but include at least one step that is relevant and correct.

A **procedure** is **inappropriate** if none of the steps presented is relevant or if the student has not shown any work.

***Step 2***

If the procedure is deemed appropriate, then evaluate the answer. If the answer is incorrect, identify the type of error made.

The **error** is considered **minor** if it is an error in calculation or transcription, if the unit of measurement is incorrect or missing, or if the student has rounded off a number incorrectly.

The **error** is considered **major** if a law, rule, or formula has been applied incorrectly.

**No marks are allotted for a correct answer when the procedure used is inappropriate**.

**4.4 Appropriate responses and marking scale**

Part A: Chemistry of Aquarium Gases

**Question 1**

**Example of appropriate responses**

- The oxygen and ammonia gas molecules travel in a straight-line motion.

- The gas volumes of oxygen and ammonia are negligible.

- Collisions between oxygen and ammonia gas molecules are perfectly elastic (that is, no energy is gained or lost during the collision), and there are no attractive or repulsive forces between the oxygen and ammonia gas molecules.

- The average kinetic energy of the oxygen and ammonia gas particles depends only on the temperature of the system.

***Note****: Accept any other appropriate answer.*

|  |
| --- |
| ***Marking Scale***4 marks All four points are stated and are correct.3 marks Only three points are stated and are correct.2 marks Only two points are stated and are correct.1 mark Only one point is stated and is correct.0 marks No correct points or no answer given. |

**Question 2**

**Example of an appropriate response**



**Answer:** The gases in increasing order of rates of diffusion are: O2, N2, H2O, NH3

Justification: The lower the molar mass, the higher the rate of diffusion

|  |
| --- |
| ***Marking Scale***3 marks Justification and order is correct.2 marks Justification is correct but minor error in calculation of a molar mass.1 mark Correct order and no justification.0 marks Incorrect justification or no answer given. |

**Question 3**

**Example of appropriate responses**

a) Partial pressure of ammonia



**Answer:** The partial pressure of ammonia gas is 1.3 kPa.

|  |
| --- |
| ***Marking Scale***2 marks Appropriate procedure and correct answer.1 mark Appropriate procedure, but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.0 marks Inappropriate procedure or did not show the procedure, regardless of the answer. |

b) Moles of dissolved gases

**Step 1: Moles of dissolved oxygen**



**Step 2: Moles of dissolved NH3**



**Answer:** There are 4.42 x 10-3 moles of O2 gas and 1.6 x 10-4 moles of NH3 gas.

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure, but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes.1 mark Partially appropriate procedure, regardless of the answer.0 marks Inappropriate procedure or did not show the procedure, regardless of the answer. |

**Question 4**

**Example of an appropriate procedure**

**Step 1: Moles of NH3**



**Step 2: Moles of O2**



**Step 3: Volume of O2 (May also be solved usin*g PV*=*nRT.)***



**Answer:** The volume of oxygen gas required is 1.01 x 10-1 L .

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure, but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes.1 mark Partially appropriate procedure, regardless of the answer.0 marks Inappropriate procedure or did not show the procedure, regardless of the answer. |

Part B: Natural Gas and Energy

**Question 5**

**Example of an appropriate procedure**

**Step 1: Find *n* of butane**



**Step 2: Set up ratio between energy and *n* of butane**



**Step 3**



**Answer:** The final temperature of the water is 83 °C.

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure, but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes (ex. Student solved for ∆*T* and did not solve for Tf or students did not convert L to g and kJ to J)1 mark Partially appropriate procedure, regardless of the answer.0 marks Inappropriate procedure or did not show the procedure, regardless of the answer. |

**Question 6**

**Example of an appropriate response**

|  |  |  |  |
| --- | --- | --- | --- |
| Reverse Eq. #1: | CH4 (g) | → C (s) + 2H2 (g) | ∆*H* = +74.6 kJ |
| Use Eq. #2: | C (s) + O2 (g) | → CO2 (g) | ∆*H* = −393.5 kJ |
| Double Eq. # 3: | 2H2 (g) + O2(g) | → 2H2O (g) | ∆*H* = −484 kJ |
| Sum: | CH4 (g) + 2 O2 (g) | → CO2(g) + 2H2O (g) | ∆*H* = −803 kJ |
|  |  |  |  |

**Answer:** The molar heat of combustion of methane is **−803 kJ/mol**.

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure, but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes (ex. incorrect sign on the ∆*H* value(s).1 mark Partially appropriate procedure regardless of the answer.0 marks Inappropriate procedure or did not show the procedure, regardless of the answer. |

**Question 7**

**Example of appropriate responses**

a)



|  |
| --- |
| ***Marking Scale***4 marks Appropriate and correct diagram, includes title, correctly labelled plateaus, axes and Ea, ∆*H* values.3 marks Partially appropriate diagram, omitted one out of the five components of the diagram.2 marks Partially appropriate diagram, but made major omissions such as forgetting two of the five components of the diagram.1 mark Partially appropriate diagram, provided only one or two components.0 marks Inappropriate diagram or did not draw a diagram. |

b) ∆*H* = +1560 kJ

Ea = +1662 kJ

|  |
| --- |
| ***Marking Scale***2 marks Two correct answers.1 mark One correct answer.0 marks No correct answers or no answer given. |

Part C: Reaction Rates and the Human Body

**Question 8**

# Example of appropriate responses

|  |  |
| --- | --- |
| a) 75 kg man: | 100 kg man: |
|  |  |

**Answer: The 75 kg man uses 0.018 moles of glucose in 10 minutes.**

**The 100 kg man uses 0.022 moles of glucose in 10 minutes.**

***Note:*** *There are two different thoughts on the ambiguous zero (significant figures). Please correct your students work based on your teachings.*

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes.1 mark Partially appropriate procedure and incorrect answer.0 marks Inappropriate procedure and incorrect answer. |

b) Rate law expression is **Rate = k[C6H12O6] [O2]6.**

|  |
| --- |
| ***Marking Scale***2 marks Correctly states the rate law expression.1 mark Does not apply.0 marks Incorrectly states rate law expression. |

c) **There are no differences in the rate law expression because both are derived from the cellular respiration equation.**

|  |
| --- |
| ***Marking Scale***2 marks Correct answer and justification.1 mark Correct answer without any justification.0 marks Incorrectly compares rate law expressions. |

**Question 9**

**Example of an appropriate response**

- Use powdered marble chips (calcium carbonate).

Increasing the surface area increases the probability of effective collisions.

- Increase the concentration of HCl.

Increasing the concentration of HCl increases the probability of effective collisions.

- Heat HCl solution.

Increasing the temperature of the reactants increases the kinetic energy of the reactants and therefore increases the probability of effective collisions and the probability that the collisions will have sufficient energy for a transformation to take place.

- Add a catalyst.

The catalyst reduces the activation energy barrier for the reaction and therefore increases the probability of effective collisions.

|  |
| --- |
| ***Marking Scale***3 marks Three correct methods with appropriate use of collision theory are provided.2 marks Two correct methods with appropriate use of collision theory are provided.1 mark One correct method with appropriate use of collision theory is provided OR three correct methods, but did not use collision theory.0 marks Answers are incorrect. |

Part D: Chemical Equilibrium in the Blood

**Question 10**

**Example of appropriate responses**

a) At high altitudes, there is less oxygen in the air. The stress of a reduced oxygen concentration results in a shift in equilibrium to the reactant side, which lowers the concentration of oxyhemoglobin, HbO2.

|  |
| --- |
| ***Marking Scale***1 mark Correct answer.0 marks Incorrect answer or no answer given. |

b) Put the athlete in an environment with an increased concentration of oxygen, which will alleviate the stress, and re-establish a new equilibrium.

|  |
| --- |
| ***Marking Scale***1 mark Correct answer.0 marks Incorrect answer or no answer given. |

**Question 11**

a) **Example of an appropriate response**

H2CO3(aq)  H+(aq) + 



**Answer:** The athlete is suffering from alkalosis.

***Note:*** *As this is the second part of a two part equilibrium reaction, the bicarbonate ion concentration at equilibirum is not equal to the hydrogen ion concentration at equilibrium.*

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure and correct answer.3 marks Appropriate procedure but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure but incorrect answer because of major mistakes.1 mark Partially appropriate procedure and incorrect answer.0 marks Inappropriate procedure and incorrect answer. |

b) **Example of an appropriate response**

Decrease the bicarbonate ion () concentration in the blood. Decreasing the blood's concentration of  shifts the equilibrium reaction toward the right to compensate for the loss in . When the equilibrium shifts to the right, more H+ ions are generated together with  ions. As a result, the pH decreases.

|  |
| --- |
| ***Marking Scale***2 marks Correct answer.1 mark Partially correct answer (ex. does not explain how removal of bicarbonate ion affects blood).0 marks Incorrect answer or no answer given. |

**Question 12**

**Example of an appropriate procedure**

Calculation of fluoride ion concentration in the water



**Answer:** Thefluoride ion concentration is 4.2 × 10-4 mol/L.

|  |
| --- |
| ***Marking Scale***4 marks Appropriate procedure with correct answer.3 marks Appropriate procedure but incorrect answer because of minor mistakes such as a calculation or transcription error, or an incorrect or missing unit of measure.2 marks Appropriate procedure and incorrect answer because of major mistakes.1 mark Partially appropriate procedure but incorrect answer.0 marks Inappropriate procedure and incorrect answer. |

**Question 13**

**Example of appropriate responses**

The volume and uncertainty of measurement of gas in the syringe A is **15 mL ± 5 mL**.

The volume and uncertainty of measurement of gas in the syringe B is **15.0 mL ± 0.5 mL**.

|  |
| --- |
| ***Marking Scale***4 marks Volume of both gases correct with correct significant figures and correct uncertainty.3 marks One error involving significant figures or uncertainty.2 marks Two errors involving significant figures or uncertainty.1 mark Three errors involving significant figures or uncertainty.0 marks Incorrect answer or no answer given. |

**Marking Guide for Significant Figures (for consistent use during the entire exam)**

Use this marking scale to assess the use of significant figures throughout the first 12 questions of the examination. Do not take into account work from question 13 for this mark.

|  |
| --- |
| ***Marking Scale***2 marks Appropriate and consistent use of significant figures.1 mark Partially appropriate use of significant figures and/or inconsistent use of significant figures.0 marks Inappropriate use of significant figures or does not take into account significant figures. |

**Feedback Questionnaire**

**Chemistry Examination – Secondary Cycle 2 Year 3**

**Theory Examination – June 2011**

**Please comment on the following:**

1. Time allotted for theory examination:

2. Students’ level of interest:

3. Level of difficulty:

4. Administration and Marking Guide (quality and clarity):

5. Other comments:

6. Please list any errors or omissions:

***Please return questionnaire to your school board Science and Technology consultant.***

***Thank You.***