Information Bulletin | Chemistry 30

2013 – 2014 Diploma Examinations Program

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Alberta Government

This document was written primarily for:

Students	✓
Teachers	✓ of Chemistry 30
Administrators	✓
Parents	
General Audience	
Others	

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Please note that if you cannot access one of the direct website links in this document, you can find diploma examination-related materials on the Alberta Education website at education.alberta.ca.

*NEW *Online Field Testing*

Beginning in the 2013–2014 school year, all Grade 12 math and science field tests will be offered exclusively through an enhanced QuestA+ online delivery system rather than in a paper format.

Enhanced online field tests offer many advantages over conventional paper field tests, or the earlier online field tests. Above all, the new tests will be much more useful as a formative measurement of student progress and achievement.

Teachers will have time to peruse the field test and will be provided with data on how students in their classes performed on the field test, including the proportion of students in the class who chose each alternative on the multiple-choice items and the proportion who left a numerical-response item blank. The items will be blueprinted to program of studies outcomes so that the teacher can use field test results to learn more about the strengths and weaknesses of their students.

In addition, teachers will have greater flexibility in selecting the time and date when students write, rather than being bound to a pre-determined date.

Finally, online administration will mean that every school, large or small, can participate. Historically it was impractical to send field test administrators to remotely located schools, or schools with small classes. Online administration will offer all Alberta schools access to field tests.

It is important to note that the security of field test items remains vital to the administration of diploma examinations. Participating teachers must make a commitment to maintaining the security of field test items.

Detailed information about the online administration of Grade 12 math and science field tests will be provided by the late summer of 2013.

For more information about this policy change, please contact

Tim Coates
Director, Diploma Program Branch
780-422-5160 or Tim.Coates@gov.ab.ca

or

Dan Karas
Director, Examination Administration
780-415-0666 or Dan.Karas@gov.ab.ca

*NEW

Diploma Examinations: Multiple Forms

As part of Alberta Education's commitment to fairness to students and to expanded flexibility in the writing of diploma examinations, the number of distinct examination forms will increase. Beginning in the 2013–2014 school year, in some subjects there will be two forms of diploma examination during major administrations. The two forms will each be equated to baseline examinations to ensure that whichever form a student writes, the same standard is applied. Both forms will adhere to the established blueprint specifications and be subject to the same thorough review by a technical review committee.

To make school-level results easier to analyze, no school will receive more than one form per subject. In some subjects offering a translated French-language examination, the two forms will be administered in both English and French to ensure that all future administrations outside January and June are available in both languages in those subjects.

For more information about this policy change, please contact

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*NEW

Survey Questions in Diploma Examinations

The Biology 30, Chemistry 30, Physics 30, and Science 30 diploma examinations will include two survey questions at the end of the examination booklets. The purpose of these questions is to gather information about the time students take to complete these examinations. Students should record their answers to these survey questions at the bottom of the examination answer sheet. We ask that teachers encourage all students writing the examinations to take a moment to answer these questions.

These survey questions will appear in all administrations of each examination except for the November 2013 examinations in Chemistry 30 and Physics 30.

*NEW *Special-Format Practice Tests*

To provide students an opportunity to practice diploma examination-style questions and content in Braille, audio, large print, or coloured print versions, Alberta Education is making special-format practice tests available. Tests are offered in all subjects with a corresponding diploma examination. Alberta schools with registered Alberta K-12 students may place orders for these tests. Braille tests are available in English, and by request in French. All tests are provided free of charge, but limits may be placed on order volumes to ensure access for everyone. For more information, contact 780-427-0010.

Course Objectives

Chemistry 30 is intended to develop students' understanding of the interconnecting ideas and chemistry principles that transcend and unify the natural-science disciplines and their relationship to the technology that students use in their daily lives. It is of utmost importance to remember that Chemistry 30 is an experimental discipline that develops the knowledge, skills, and attitudes to help students become capable of and committed to setting career and/or life goals, make informed choices, and act in ways that will improve the level of scientific awareness essential for a scientifically literate society. Laboratory experience is an essential component of the Chemistry 30 course.

Students of Chemistry 30 are expected to develop an aptitude for collecting data, observing, analyzing, forming generalizations, hypothesizing, and making inferences from observations. The course is designed to promote students' understanding of chemistry concepts, and their ability both to apply these concepts to relevant situations and to communicate in the specialized language of chemistry.

Success in Chemistry 30 requires the successful completion of Science 10, Chemistry 20, and concurrent mathematics courses that develop the requisite knowledge and skills.

Performance Expectations

Curriculum Standards

Provincial curriculum standards help to communicate how well students need to perform to be judged as having achieved the objectives specified in the *Chemistry 20–30 Program of Studies*, 2007. The specific statements of standards are written primarily to inform Chemistry 30 teachers as to what extent students must know the Chemistry 30 content and demonstrate the required skills to pass the examination.

Acceptable Standard

Students who meet the *acceptable standard* in Chemistry 30 will receive a final course mark of 50% to 79%. These students demonstrate a basic understanding of the nature of scientific investigation by designing, observing, performing, and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs, tables, and diagrams, and can translate symbolic representations into word descriptions. They are able to recognize and provide definitions for key chemical terms, and can predict the physical and chemical properties of compounds. They are able to balance simple equations (combustion, formation, neutralization, or oxidation–reduction) and can solve standard, single-step, stoichiometric problems based upon these equations. Following laboratory procedures does not present a problem for these students, nor does using the data booklet to extract relevant information. These students compose clear and logical descriptive or explanatory statements to answer closed-response questions that involve individual chemistry concepts.

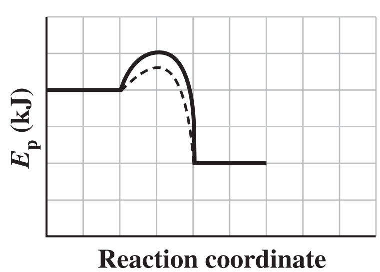
Examples of Acceptable-Standard Questions

Use the following information to answer the next question.

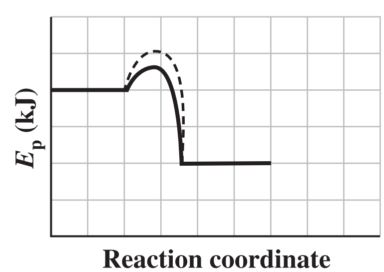
Dr. Richard Trotter has developed what could be the first cost-effective process for limiting methane emissions from underground coal mines. In this process, methane and oxygen are reacted at 800 °C in the presence of a catalyst. The products of this process are carbon dioxide gas and liquid water.

1. Which of the following enthalpy diagrams represents both the catalyzed (**----**) and uncatalyzed reactions (**—**) for this process?

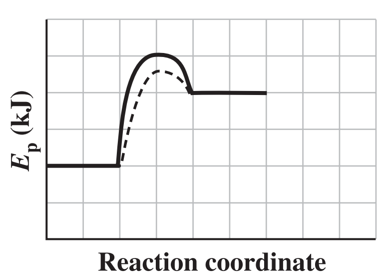
A.



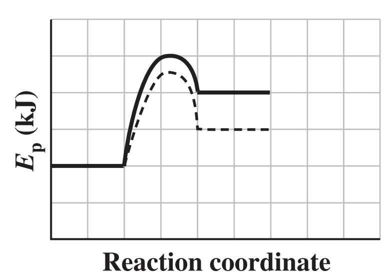
B.



C.



D.



------- Catalyzed —— Uncatalyzed

Use the following information to answer the next question.

To determine the concentration of a $Sn^{2+}(aq)$ solution, a student titrated a 50.00 mL sample of acidified $Sn^{2+}(aq)$ with 1.44 mmol/L $KMnO_4(aq)$. The titration required 24.83 mL of $KMnO_4(aq)$ in order to reach a pale pink endpoint.

2. The balanced net ionic equation for this titration reaction is

A. $2\,MnO_4^-(aq) + 16\,H^+(aq) + 5\,Sn^{2+}(aq) \rightarrow 2\,Mn^{2+}(aq) + 8\,H_2O(l) + 5\,Sn^{4+}(aq)$

B. $2\,MnO_4^-(aq) + 16\,H^+(aq) + 5\,Sn^{2+}(aq) \rightarrow 2\,Mn^{2+}(aq) + 8\,H_2O(l) + 5\,Sn(s)$

C. $MnO_4^-(aq) + 8\,H^+(aq) + Sn^{2+}(aq) \rightarrow Mn^{2+}(aq) + 4\,H_2O(l) + Sn^{4+}(aq)$

D. $MnO_4^-(aq) + 8\,H^+(aq) + Sn^{2+}(aq) \rightarrow Mn^{2+}(aq) + 4\,H_2O(l) + Sn(s)$

Standard of Excellence

Students who achieve the *standard of excellence* in Chemistry 30 will receive a final course mark of 80% or higher. In addition to meeting the expectations for the *acceptable standard* of performance, these students demonstrate an interest in chemistry and can articulate chemistry concepts well. They can readily interpret interrelated sets of data such as complex graphs, tables, and diagrams. When presenting scientific data, they select the most appropriate and concise format. These students can analyze and evaluate experimental designs. They generate their own laboratory procedures when given a clearly defined problem, recognize weaknesses in laboratory work, and find ways to correct the weaknesses. They are able to formulate their own equations for formation, combustion, neutralization, redox, and equilibrium reaction expressions, and can solve many variations of stoichiometric problems based upon these equations. They transfer what they observe in a laboratory setting into equation form and express scientific ideas clearly. They solve problems that involve the overlapping of two or more concepts. The most significant characteristic of this group is that they solve problems of a new and unique nature, and extrapolate these solutions to higher levels of understanding. Open-ended questions do not pose problems for them. These students communicate clearly and concisely, using appropriate scientific vocabulary and conventions.

Examples of Standard of Excellence Questions

Use the following information to answer the next question.

Four Reaction Equations	Key			
$In(s) + La^{3+}(aq) \rightarrow$ no reaction	**1**	$In(s)$	**5**	$In^{3+}(aq)$
$Np(s) + La^{3+}(aq) \rightarrow Np^{3+}(aq) + La(s)$	**2**	$Np(s)$	**6**	$Np^{3+}(aq)$
$Np(s) + Nd^{3+}(aq) \rightarrow Np^{3+}(aq) + Nd(s)$	**3**	$Nd(s)$	**7**	$Nd^{3+}(aq)$
$La(s) + Nd^{3+}(aq) \rightarrow$ no reaction	**4**	$La(s)$	**8**	$La^{3+}(aq)$

Numerical Response

1. Arranged in order from **strongest** to **weakest**, the oxidizing agents above are numbered _____, _____, _____, and _____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

$$CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g) \qquad K_c = 0.137$$

3. If the temperature of the system at equilibrium is increased, then the concentration of the carbon dioxide and the value of K_c will

A. decrease and stay the same, respectively

B. increase and stay the same, respectively

C. increase and decrease, respectively

D. decrease and increase, respectively

For more details on the relationship between the Program of Studies and the performance standards, see the Student-Based Performance Standards for Chemistry 30, available on the Alberta Education website.

Linking Program Expectations to Cognitive Expectations

Some expectations require students to recall facts or identify characteristics. The Assessment Sector classifies these as "knowledge" level expectations. Examples of these expectations are listed in the yellow column below. Some expectations require students to apply their knowledge and skills in conventional situations. The Assessment Sector classifies these as "comprehension and application" expectations. Examples of these expectations are listed in the green column below. Some expectations require students to build new connections, to create relationships between concepts, to apply models to new and unusual situations. The Assessment Sector classifies these as "higher mental activities." Examples of these expectations are in the blue column below.

The *Chemistry 20–30 Program of Studies, 2007* also contains attitude and skill expectations that are listed in the pink row at the bottom of the chart. The attitudes and skills are foundations of a science education.

Cognitive Expectations		
Knowledge	**Comprehension and Application**	**Higher Mental Activities**
Choose, classify, define, describe, identify*, label, list, match, name, outline, predict*, recall, select, state, what, when, who Use memorized or algorithmic methods to solve problems	Analyze*, apply, calculate, change, compare*, contrast, determine, estimate (extrapolate or interpolate), explain*, generalize, identify*, infer, interpret*, predict*, relate, solve, translate Design a procedure for a known experiment	Analyze*, assess, compare*, differentiate, compile, compose, conclude, create, defend, evaluate, explain*, interpret*, judge, justify, organize, plan, summarize Transfer methods from one area to another Use generalized methods to solve problems Design a new procedure for an unfamiliar experiment
Attitudes and Skills Appreciate, collect, conduct, develop, gather, measure, observe, plot, work collaboratively		

*These expectations are ambiguous because they have multiple connotations. The cognitive expectation is communicated by the context. If it is a very familiar context, the expectation is knowledge or comprehension and application; if it is unfamiliar, the expectation is comprehension and application or higher mental activity.

Reminders and Explanations

All Units

Chemistry is a laboratory science, and an essential part of laboratory activity is the design of effective tests for different hypotheses. The truth of some hypotheses will be within the scope of the program of studies, while the truth of other hypotheses may be slightly beyond the program of studies. However, for all hypotheses, the design elements of the laboratory experiment will be within the program of studies. An example of a multiple-choice item and an example of a numerical-response item follow.

Outcomes being assessed: C1.3k, C1.1s

Use the following information to answer the next question.

> A student looked at the structural formulas of different hydrocarbons and proposed the following hypothesis:
>
> *The more unsaturated a hydrocarbon is, the more carbon dioxide is released when the hydrocarbon is burned.*

4. To test this hypothesis, the best hydrocarbons to use are

A. Propane, butane, and pentane

B. **Butane, but-1-ene, and but-1-yne**

C. Propane, but-1-ene, and pent-1-yne

D. Pentane, 2-methylbutane, and 2,2-dimethylpropane

Rationales:

For A, longer chains will give more carbon dioxide, but cannot be used for testing this hypothesis on saturation levels, as all three are saturated hydrocarbons.

For B, this is correct, with the control variable of equal lengths of carbon chain.

For C, these have different degrees of saturation, but the length of the carbon chain is not controlled.

For D, these hydrocarbons are all isomeric forms of each other, so they have the same degree of saturation.

Outcomes being assessed: D1.4k, D1.1s

Use the following information to answer the next question.

A student wants to test the following hypothesis about the strength of chlorinated carboxylic acids:

If the number of chlorine atoms in a chlorinated carboxylic acid increases, then so does the strength of the acid.

She identifies the following possible variables:

1 The pH of the acid sample
2 The molar mass of the acid
3 The mass of acid in the sample
4 The volume of acid in the sample
5 The molar concentration of the acid sample
6 The number of carbon atoms in the acid molecule
7 The number of chlorine atoms in the acid molecule

Numerical Response

2. In an effective experimental design for testing this hypothesis,

the manipulated variable is numbered ________ (Record in the **first** column)
the responding variable is numbered ________ (Record in the **second** column)
one controlled variable is numbered ________ (Record in the **third** column)
another controlled variable is numbered ________ (Record in the **fourth** column)

(Record your answer in the numerical-response section on the answer sheet.)

Answer: 7156 or **7165**

Unit A

In the assessment of outcomes A1.8k and A1.1s:

- The term *calorimeter* does not always refer to a bomb calorimeter. Students should be familiar with different designs that can be used for the measurement of energy changes in a chemical system. These include designs where the temperature change of the container is accounted for, not just that of its contents.
- Some detailed calculations will include the temperature change of the calorimeter, but many should be answered qualitatively. As one example, a calorimeter composed of a material with a large specific heat capacity will undergo a smaller temperature change than a calorimeter composed of a material with a significantly lower specific heat capacity. Another example relies on the insulating properties of polystyrene to predict that any temperature change of the cup calorimeter can be assumed to be negligible.

In the assessment of outcomes A1.8k and A1.9k:

- There appears to be some confusion as to whether an enthalpy of combustion should form $H_2O(l)$ or $H_2O(g)$. When most substances undergo combustion, sufficient heat is released to convert any water produced from the reaction into water vapour. When enthalpies of combustion are determined empirically, they are determined in a bomb calorimeter, and because of the low temperature change, the water produced is in liquid form. Often, a diploma examination question refers to an enthalpy of combustion for a fuel such as propane in a barbecue or butane in a lighter. These examples represent reactions that are performed in an open environment, and students should use water vapour as a product to determine acceptable values for the enthalpy of combustion.
- On diploma examinations, the general principle that will be followed is that if combustion reactions are performed empirically in a bomb calorimeter, liquid water will be the product, and if the combustion occurs in an ambient environment and a theoretical enthalpy of combustion is to be determined, the product will be water vapour. Students are **not** required to have existing knowledge or exposure to a bomb calorimeter.

In the assessment of outcomes A2.3k, A1.3s, and A2.3s:

- On the diploma examination, enthalpy diagrams will be similar to the two figures shown on the next page. Enthalpy diagrams can be used to indicate relative positions for exothermic or endothermic reactions (refer to Figure 1). We cannot determine an exact value for the potential energy of a substance, but we can determine values for enthalpies of formation (refer to Figure 2). For the French translation of the diploma examination, the term *évolution de la réaction* will be used on the *x*-axis of enthalpy diagrams.

Figure 1

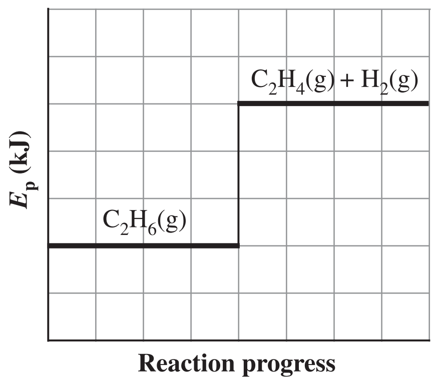
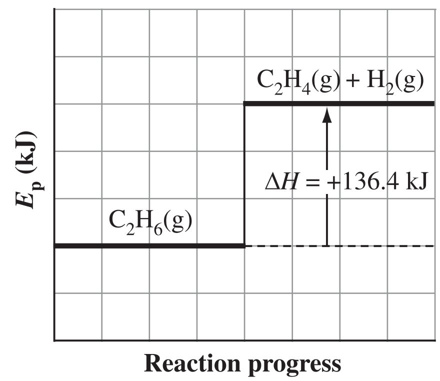


Figure 2



In the assessment of outcome A2.3s:

- Students will be expected to calculate the efficiency of a thermal energy source, and to explain the discrepancies between theoretical and measured values obtained from calorimetry experiments. They are expected to predict whether a given source of error will lead to a lower or to a higher calculated value for an enthalpy of reaction, as well as to predict whether an observed enthalpy or temperature change is lower or higher than the theoretical enthalpy or temperature change.

- Teachers should use all the approved resources to cover this outcome, and not rely wholly on any single source for information.

Unit B

In the assessment of outcome B1.2k:

- Only the term *disproportionation* will be used to describe a substance undergoing both an oxidation and a reduction. For the French translation of the diploma examination, the term *dismutation* will be used.

In the assessment of outcomes B1.2k and B1.7k:

- The term *oxidation number* will be the only term used.
- For assigning oxidation numbers, the Assessment Sector will use the following guidelines:
  - Oxygen always has an oxidation number of –2, except for peroxides, where its oxidation number is –1.
  - Hydrogen always has an oxidation number of +1, except for hydrides of metals in Groups 1 and 2 of the Periodic Table, where its oxidation number is –1.
  - Carbon can have fractional oxidation numbers, and the oxidation number of carbon in any of its compounds will represent an average oxidation number. For example, in the case of propane, C_3H_8, the oxidation number is taken as $-\frac{8}{3}$. Considering the oxidation number of each of the two end carbons as –3, and of the middle carbon as –2, is beyond the scope of the program of studies.

In the assessment of outcome B1.7k:

- Students are expected to devise a balanced half-reaction in an acidic or neutral, but **not** basic, solution. They are expected to balance chemical equations that occur in basic environments given the species, but not to devise their own half-reactions. Students are expected to balance disproportionation reaction equations.

In the assessment of outcomes B2.1k and B2.3k:

- Line or cell notation is used to describe electrochemical cells. The convention that is used is that the substance constituting the anode is listed at the far left, and the substance constituting the cathode is listed at the far right.

In the assessment of outcome B2.3k:

- For half-cells containing acidified solutions (such as acidified potassium permanganate and an inert electrode), each half-cell should include **all** the active components in their standard state; that is, 1.0 mol/L H^+(aq) and 1.0 mol/L MnO_4^- (aq). Together with an iron–iron(II) half-cell, the line notation is represented as

$$Fe(s)\,|\,Fe^{2+}(aq)\,||\,MnO_4^-\,(aq),\,H^+(aq)\,|\,Pt(s)$$

In the assessment of outcome B2.4k:

- One of the most common and demonstrable examples to illustrate this objective is the chloride anomaly. It is reasonable to expect students to be familiar with this. For further clarification please review the explanation below (taken from the *Archived Chemistry 30 Information Bulletin*).
- Students are expected to recognize that predicted reactions do not always occur; for example, the chloride anomaly occurs during the electrolysis of solutions containing chloride ions and water as the strongest reducing agents. A common misconception is that if the minimum voltage for the electrolysis of water were applied, then the oxidation of water would occur rather than the oxidation of chloride ions. This is not correct. The reduction potentials found on the reduction potential table are determined by comparing the reduction potential of a given half-cell to the standard hydrogen half-cell. The standard hydrogen reduction potential is the reference potential against which all half-reaction potentials are assigned. This is how the reduction potentials for oxygen and hydrogen ions (+1.23 V) and chlorine (+1.36 V) half-cells are obtained. During electrolysis, the theoretical minimum voltage is the difference in reduction potential between the oxidizing agent and the reducing agent. An excess voltage, called the overvoltage, is required in order for a reaction to occur. For example, as the voltage to a standard sodium chloride electrolytic cell is increased, the chloride ions are oxidized first. The reason for this is that the overvoltage for the oxidation of water is greater than the overvoltage for the oxidation of chloride ions. A much higher potential than expected is required to oxidize water. Basically, the phenomenon is caused by difficulties in transferring electrons from the species in the solution to the atoms of the electrode across the electrode-solution interface. Because of this situation, $E°$ values must be used cautiously when one is predicting the actual order of oxidation or reduction of species in an electrolytic cell.

In the assessment of outcomes B2.5k and B2.6k:

- All $E°$ values refer to reduction potentials, whether associated with an oxidation half-reaction equation or a reduction half-reaction equation.

In the assessment of outcomes B2.5k and B2.3s:

- Standard state conditions and corresponding potential difference values imply the use of 1.0 mol/L reagents. The larger the concentration of the reactants, the larger the potential difference value. The Nernst equation would be required to calculate potential difference values as a function of reactant and product concentrations in a redox reaction and is beyond the scope of the *Chemistry 30 Program of Studies, 2007*. However, students should know that as the reaction proceeds, the voltage generated will decrease as reactants are converted to products until reaching equilibrium, at which point the battery dies.

Unit C

Questions in all units of the course may include contexts involving organic compounds.

In the assessment of outcome C1.3k:

- The term *hydrocarbon* should be strictly limited to describing molecules composed of only carbon and hydrogen atoms. For organic molecules composed of other atoms, including oxygen and halogens, the term *hydrocarbon derivative* is appropriate.
- An aromatic molecule is a molecule containing one or more benzene rings. The benzene ring may be represented in any of four ways, and students are expected to recognize any of the four representations shown in Diagrams 1–4 below as being a diagram of a benzene molecule. However, students are not expected to know the strengths and weaknesses of each representation.

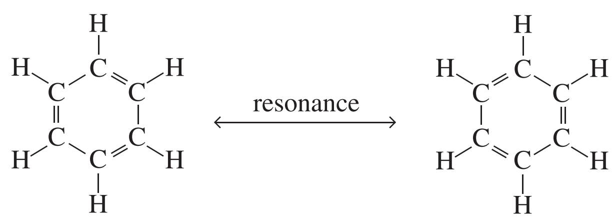


Diagram 1 **Diagram 2**

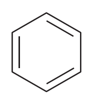


Diagram 3

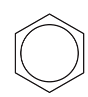


Diagram 4

– Diagram 1 uses a ring structure, and the bonding capacity of four for each carbon atom is satisfied by having alternating double and single bonds. As it stands, this compound would be named cyclohexa-1,3,5-triene, and the compound would undergo addition reactions easily. The compound, if it existed in this single form, would be highly unstable.

– Diagram 2 uses a ring structure, and the bonding capacity of four for each carbon atom is satisfied by having alternating double and single bonds. However, to explain the experimental difficulty of benzene undergoing addition reactions, and to explain the stability of benzene, there is a continuous sequence of rapid conversions between the state on the left (Diagram 1) and the state on the right (Diagram 2). This resonance model provides for a benzene molecule that is stable, and extremely resistant to possible addition reactions.

– Diagram 3 is a line diagram that is most commonly used in reference indexes and outside publications when showing representations of aromatic compounds.

– Diagram 4 is a line diagram that is used in both approved resources. This representation does indicate that all bonds in the ring are equivalent, and are distinct from single bonds or double bonds. However, up to now, its use has been limited in outside publications and reference indexes.

- When naming esters such as methyl pentanoate, a space is left between methyl and pentanoate, whereas for the organic compound methylcyclohexane, no space is left between methyl and cyclohexane. This is done because, with the ester methyl pentanoate, methyl is not considered a prefix but part of the naming system for this class of organic compounds.

- When one of the hydrogen atoms in a hydrocarbon is replaced by a hydroxyl group, either an alcohol or a phenol may be produced. The term *alcohol* will be used whenever the original hydrocarbon is aliphatic. The term *phenol* will be used whenever the hydroxyl group is attached directly to the benzene ring. Benzyl alcohols, where there is both a benzene ring and a hydroxyl group attached to a straight side chain, and not to the benzene ring, are outside the scope of the program of studies.

- When determining whether a compound is saturated or unsaturated, only the presence of carbon-carbon double or triple bonds makes a compound unsaturated. Double bonds in a functional group do not make a compound unsaturated. For example, propanoic acid is classified as a saturated compound because all of its carbon atoms are joined to each other by single bonds. The double bond between carbon and oxygen does not make propanoic acid unsaturated. Aromatic compounds are not considered to be either saturated or unsaturated. Compounds with both benzene rings and carbon-carbon double bonds, such as phenylethene, are outside the scope of the program of studies.

In the assessment of outcome C1.4k:

- R represents any saturated chain of carbon and hydrogen atoms. For example, propanol can be represented by R–OH; R–OH would also represent any other alcohols containing a saturated chain of carbon and hydrogen atoms.

In the assessment of outcome 30-C1.5k:

- Formulas such as C_2H_6(g), C_2H_5Cl(l), and C_6H_6(l) will be referred to as *molecular formulas*. The term *empirical formula* will not be used on any diploma examination.

In the assessment of outcomes C2.1k and C2.2k:

- For the diploma examination, *elimination* is considered a type of chemical reaction in which atoms are removed from adjacent carbons in a single reactant. Cracking reactions, in which alkanes are reduced to alkenes, are included as elimination reactions. The definition distinguishes this reaction type from a condensation reaction, in which two molecules react and their interaction produces a water molecule.

In the assessment of outcome C2.2k:

- For the diploma examination, students are expected to know two types of substitution reaction. The first is a reaction in which a hydrogen atom in a hydrocarbon or a hydrocarbon derivative is replaced by another atom or by a functional group. One such example is the production of chloromethane and hydrogen chloride from the reaction of methane and chlorine. The second is a reaction in which an atom or functional group in a hydrocarbon derivative is replaced by another atom or functional group. One such example is the hydrolysis of 1-bromoethane in alkaline solution to produce ethanol and hydrogen bromide.

- The term *nucleophilic substitution* given to this second type of reaction will not be part of the diploma examination.

In the assessment of outcome C2.3k:

- Knowledge of both types of polymerization reaction (addition and condensation) will be tested.

Unit D

In the assessment of outcome D1.3k:

- There is some confusion about the ways in which pressure can be increased and how it will affect an equilibrium system. Three methods to increase pressure are: reducing the volume of the reaction container, adding an inert gas, and adding a reactant or product gas.
  - Increasing the pressure by reducing the volume of the container causes the system to alleviate the increased pressure by reducing the total number of gaseous molecules in the system. Equilibrium will therefore shift to the side with the lesser number of gas molecules.
  - Adding an inert gas increases the total pressure but has no effect on the concentration or partial pressures of the individual reactants or products. Therefore, there is no shift in the equilibrium.
  - Adding a reactant or product gas will shift the equilibrium away from what is added, whereas removing a reactant or product gas will shift the equilibrium toward what is removed.
- If the total volume available to an equilibrium system is adjusted, the value of the equilibrium constant for that system will not change, providing there is not a corresponding change in temperature. The only stress that can change the value of the K_c for an equilibrium is a change in the system temperature. Although the equilibrium constant does not change when a system undergoes a change in pressure due to a change in volume, the position of the equilibrium can still change. A particular equilibrium set of reactant and product equilibrium concentrations is called an equilibrium position. At any particular temperature, there are many equilibrium positions but only one value for K_c.
- A change in temperature of an equilibrium system changes the value of the equilibrium constant, which is a measure of the extent to which a given reaction occurs. If the temperature of the equilibrium system below is decreased, the equilibrium constant value will increase.

  $$A(g) + B(g) \rightleftharpoons C(g) + \text{heat}$$

  If the temperature of the equilibrium system above is increased, the equilibrium constant value will decrease.

In the assessment of outcomes D1.3k and D1.4k:

- There is a common misconception that when the total pressure of a gaseous equilibrium is changed, the value of the K_c for that equilibrium will also change.

In the assessment of outcome D1.4k:

- Students are expected to predict how a wide range of factors affect equilibrium and/or the equilibrium constant.
- Students are expected to write equilibrium constant expressions for homogeneous and heterogeneous (Brønsted–Lowry acids and bases) equilibria. The diploma examination will employ the convention of including in equilibrium expressions only substances that can vary in concentration. Gases must be included since the concentration of a gas can be altered by varying the pressure on it. For example,

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

$$K_c = \frac{[H_2(g)][CO_2(g)]}{[CO(g)][H_2O(g)]}$$

- Aqueous ions and/or gases in solution must be included since the concentration of aqueous ions and/or gases can be altered by varying the volume of solvent.
- Pure liquids are not included since the concentration (density) cannot be varied. For example,

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

$$K_c = \frac{[CH_3OO^-(aq)][H_3O^+(aq)]}{[CH_3COOH^-(aq)]}$$

Mixtures of liquids must be included since the concentration can be varied by changing the relative amounts of the mixed liquids. For example,

$$C_6H_6(l) + Br_2(l) \rightleftharpoons C_6H_5Br(l) + HBr(l)$$

$$K_c = \frac{[C_6H_5Br(1)][HBr(1)]}{[C_6H_6(1)][Br_2(1)]}$$

- When predicting whether reactants or products are favoured in reversible reactions, the magnitude of the K_c value is only a general guideline. In a number of chemistry textbooks, there is a statement to the effect that a value of K_c greater than one means that the products are favoured and a K_c less than one means reactants are favoured. This is valid if a reaction has the same number of reactant and product molecules in the balanced chemical equation. When the numbers of reactant and product molecules are not the same, the value of the K_c may be misleading in determining the extent of reaction. An analysis of the extent to which reactants are converted to products may be a better indication of whether reactants or products are favoured.
- Students are **not** expected to be able to predict whether or not a reaction is quantitative. However, this is not meant to discourage the teaching of this concept.

In the assessment of outcome D1.6k:

- Some titrations between polyprotic acids and polyprotic bases may go to completion, and stoichiometric methods can then be used to calculate concentrations of acids and bases from the volumes at the equivalence points. Other such titrations do not go to completion, as the acid may not be strong enough to complete all possible proton donations. The words *titrated to completion* will be used in diploma examinations to indicate that all possible proton donations have been made.
- Quantitative calculations of the pH of a buffer using the Henderson–Hasselbalch equation are beyond the program of studies and will not be asked. A qualitative understanding that the K_a value of the buffer must approximate the desired K_a value of the environment to be buffered is required.

In the assessment of outcome D1.7k:

- The terms *amphiprotic substances* and *amphoteric substances* are used synonymously to describe substances that can act as either proton acceptors or proton donors. In the diploma examinations, the term *amphiprotic* will be used.
- Amphiprotic species are species that have an ability to act as either an acid or a base: for example, $H_2PO_4^-(aq)$ or $HCO_3^-(aq)$. Because of this property, the pH of an amphiprotic species cannot be determined with the simple K_a expression used to determine the pH of a weak acid. Students are **not** expected to determine the pH of an amphiprotic species, and will **not** be asked to do so on the diploma examination.

In the assessment of outcome D1.8k:

- Students are required to recognize that a buffer system is composed of relatively equal amounts of a conjugate acid and its base pair and maintains a nearly constant pH when diluted or when small amounts of strong acid or strong base are added. Students are **not** expected to calculate the pH of a buffer solution given the concentration of the conjugate acid and its base pair and/or utilizing the value of K_a.

In the assessment of outcomes D1.8k and D1.3s:

- On a titration curve representing the titration of a weak acid with a strong base (or a strong acid with a weak base), a buffer region or regions occur. This is the flatter portion of the titration curve that occurs before the equivalence point when a buffer is present. In this region, the acid and its conjugate base are present in similar concentrations. Prior to this region, as strong base is added to the weak acid, the acid is converted to its conjugate base, until both are present in similar concentrations. The buffer region does not occur at the start of the titration, but only when a significant amount of strong base has been added to convert the weak acid to its conjugate base (the flat portion of the titration curve). In terms of scoring student responses, we consider buffer regions to be only those regions on the titration curve where a buffer is present.
- Originally, a buffer was defined operationally as being any area on a pH graph where the titration graph of pH as a function of added titrant was essentially flat. With that definition, a strong monoprotic acid–strong monoprotic base titration would exhibit buffering regions at

the beginning of the titration and at the end, separated by a near-vertical portion containing the single equivalence point . However, the only reason that these are flat is that pH is a logarithmic scale. If we have 50.0 mL of 1.00 mol/L NaOH, the pH is essentially 14, and adding 10.0 mL of 1.00 mol/L HCl will produce a pH of 13.82 as the molar concentration of NaOH is now (40.0 mL/60.0 mL) mol/L as 10.0 mL of the NaOH has been neutralized, and the new total volume is 60.0 mL. There is no equilibrium established near the reaction equivalence point, and the pH change is strictly a dilution effect.

- Following the Brønsted–Lowry approach to acid–base equilibrium, the buffer was redefined in terms of requiring the presence of a conjugate acid–base pair that is in an equilibrium state, and which reacts to the stresses applied in the form of small amounts of a strong base or a strong acid. With this more modern and complete definition of buffering, there would be no buffering regions in any strong monoprotic acid–strong monoprotic base titration.

In the assessment of outcomes D2.1k, D2.2k, and D2.4s:

- The values of K_a provided in the table Relative Strengths of Acids and Bases at 298.15 K in the data booklet are experimental values that have two significant figures. As a result, calculated values resulting from the use of these data will generally only be good to two significant figures for a calculation of K_b, and to two decimal places for a calculation of pH or pOH.
- Teachers may find it necessary to review the proper use of scientific notation, and the use of the quantities millimoles, and millimoles per litre, when completing calculation-based problems.

In the assessment of outcome D2.2k:

- Students are expected to be as familiar with calculations involving K_b as they are for K_a.
- Students are expected to know that $K_a \times K_b = K_w$

In the assessment of outcome D2.3k:

- When writing equilibrium law expressions or calculating equilibrium constants, students are **not** required to include units. However, if students choose to include units, they must be correct and consistent. When determining the concentration of a substance from an equilibrium law expression, students are not required to use units within the expression but are required to use units in the final answer.

Example 1

$$K_c = \frac{[NO_2(g)]^2}{[NO_2(g)]^2[O_2(g)]}$$

$$K_c = \frac{(0.20)^2}{(1.0)^2(0.10)} \quad \textbf{or} \quad K_c = \frac{(0.20\text{ mol/L})^2}{(1.0\text{ mol/L})^2(0.10\text{ mol/L})}$$

$$K_c = 0.40 \qquad\qquad K_c = 0.40$$

***Note:** This is a case in which units do not cancel, but because we do not require units with the K_c value, students are not required to include them. Both of these responses are acceptable, and no marks for communication will be deducted.

Example 2

Given that the value of the equilibrium constant is shown as $K_c = 0.40$, the equilibrium concentration of $NO_2(g)$ is 0.20 mol/L, and the equilibrium concentration of NO(g) is 1.0 mol/L, calculate the equilibrium concentration of $O_2(g)$.

$$0.40 = \frac{(0.20)^2}{(1.0)^2(x)}$$

$$x = [O_2(g)] = 0.10\text{ mol/L}$$

***Note:** Because units are not required in the equilibrium expression, students do not need to include units until they record their final answer. However, if students choose to include units, they must be correct and consistent.

- Students will **not** be expected to solve questions by using the quadratic equation. However, it is expected that students set up the relationship correctly, and only when the mathematical operation is to take place is a statement about approximation to be made and used. However, this is not meant to discourage the teaching of this concept. Furthermore, students are expected to use a quadratic equation in responding to open-ended written-response questions if they select an acid for which an approximation cannot be made. No student will be penalized on any portion of the examination for using the quadratic equation to solve the problem.
- The use of the approximation to solve acid–base equilibrium expressions is acceptable only when solving the equation results in a quadratic expression and the original concentration of the acid or base is one-thousand-fold greater than the value of K_a or K_b.

In the assessment of outcome D1.3s:

- Students are expected to know the terms *equivalence point* and *endpoint*. *Equivalence point* refers to the point at which stoichiometric amounts of reactants are added together. Thus, students may be asked to indicate on a graph where the equivalence point for a reaction occurs. The term *endpoint* will be used within the context of an indicator; for example, 40.2 mL was used to titrate a sample to the bromothymol blue (indicator) endpoint.

Diploma Examinations Program Calculator Policy

Using Calculators

The Chemistry 30 Diploma Examination requires the use of a scientific calculator or an approved graphing calculator. The calculator directives, expectations, criteria, and keystrokes required for clearing approved calculators can be found in the *General Information Bulletin* on the Alberta Education website at education.alberta.ca by following this pathway:
For Teachers > (Additional Programs and Services) Diploma Exams > Diploma General Information Bulletin > Using Calculators & Computers.

Examination Specifications and Design

Each Chemistry 30 Diploma Examination is designed to reflect the core content outlined in the *Chemistry 30 Program of Studies*, 2007. The examination is limited to those expectations that can be measured by a machine-scored paper-and-pencil test. Therefore, the percentage weightings shown below will not necessarily match the percentage of class time devoted to each unit.

The content of the Chemistry 30 Diploma Examinations is emphasized as follows.

General Outcomes (GOs)

Unit A (GO 1 and 2)	Thermochemical Changes
Unit B (GO 1 and 2)	Electrochemical Changes
Unit C (GO 1 and 2)	Chemical Changes of Organic Compounds
Unit D (GO 1 and 2)	Chemical Equilibrium Focusing on Acid-Base Systems

Scientific Process and Communication Skills

Students will

- formulate questions about observed relationships and plan investigations of questions, ideas, problems, and issues
- conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
- analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

Science, Technology, and Society Connections (STS)

Students will

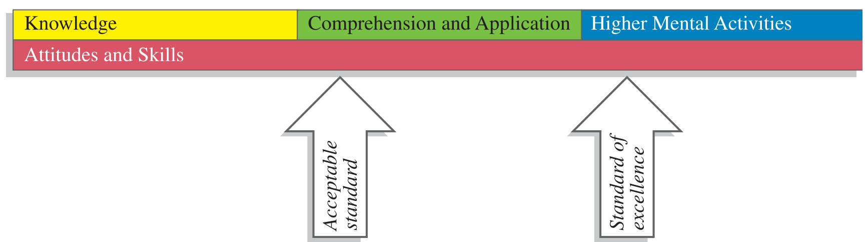
- explain that technological problems often require multiple solutions that involve different designs, materials, and processes, and that have both intended and unintended consequences
- explain that scientific knowledge may lead to the development of new technologies and new technologies may lead to or facilitate scientific discovery
- explain that the goal of technology is to provide solutions to practical problems
- explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation, and the ability to provide explanations
- explain that the goal of science is knowledge about the natural world
- explain that the products of technology are devices, systems, and processes that meet given needs; however, these products cannot solve all problems
- explain that the appropriateness, risks, and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability
- describe science and technology applications that have developed in response to human and environmental needs
- explain that science and technology have influenced, and have been influenced by, historical development and societal needs
- explain how science and technology are developed to meet societal needs and expand human capability
- explain how science and technology have both intended and unintended consequences for humans and the environment
- explain that technological development may involve the creation of prototypes, the testing of prototypes, and the application of knowledge from related scientific and interdisciplinary fields

Examination Specifications

Question Format	*Number of Questions*	*Percentage Emphasis*
Multiple Choice	44	73%
Numerical Response	16	27%

Performance Standards

Approximately 45% of the items are designed to assess at the *Acceptable Standard* and approximately 25% of the items are designed to assess at the *Standard of Excellence*. The remaining items are designed to assess at an intermediate standard, between the *Acceptable Standard* and the *Standard of Excellence*.



Program of Studies Outcomes

The design supports the integration of all Chemistry 30 general outcomes (GOs) as mandated in the *Chemistry 20–30 Program of Studies, 2007.*

Adjustments in the emphasis may be necessary because the examination includes machine-scored scenarios or contexts that cover more than one general or specific outcome. As a result, the examination may not necessarily be arranged sequentially by units but is instead built around scenarios or contexts that support STS connections; a set of questions may assess students’ ability to integrate several GOs.

Emphasis

The approximate emphasis of each unit in the examination is given below.

Machine-Scored Content	***Range of Percentage Emphasis***
Thermochemical Changes	20%–22%
Electrochemical Changes	29%–32%
Chemical Changes of Organic Compounds	18%–20%
Chemical Equilibrium Focusing on Acid-Base Systems	29%–32%

This change in emphasis is designed to reflect the percentage emphasis on chemical changes of organic compounds stated in the program of studies. On examinations up to August 2011, there were insufficient numbers of field-tested questions to enable inclusion of this 18%–20% emphasis on these general outcomes.

Assessment of Skills and STS Connections

Chemistry 30 examination questions are intended to measure students' understanding of chemistry concepts. It is important to remember that some questions will measure students' understanding and use of skills associated with scientific inquiry, and some questions have been designed to measure students' understanding of the connections between science and technology, and between science, technology, and society. As a result, many questions measure how well students can apply the skills and knowledge they have acquired in science to everyday life.

Teachers may find it helpful to use the following acronym when interpreting the program of studies document and planning instruction.

A – attitudes (for learning and inquiry in chemistry, skills, and knowledge)
S – skills
K – knowledge

Specific skills and STS concepts that can be tested are identified within the program of studies in regular typeface.

Teachers and individuals in industries, businesses, and post-secondary institutions have been helpful both in providing real-life contexts for STS questions, and in making connections between real life and the program of studies. The development of test questions, from the writing stage until they appear on an examination, may take a number of years.

Machine-Scored Questions

Each examination contains both multiple-choice and numerical-response questions.

Some examination questions are organized into sets that relate to broad contexts; therefore, a set of questions may assess students' ability to integrate several GOs. Some questions will measure achievement of knowledge and/or skills; some will also measure achievement of scientific process and communication skills outcomes and/or STS outcomes.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet.

Multiple-choice questions are of two types: discrete and context dependent. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Many of the multiple-choice questions are context dependent. A particular context may be used for more than one multiple-choice question as well as for one or more numerical-response questions.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list or diagram, and determination of the sequence of listed events. Students should remember that in some numerical-response questions, a number may be used more than once in an answer and there may be more than one correct answer. Please refer to the questions below as examples of changes to existing NR question types.

Outcomes being assessed: B1.5k, B1.3s

Use the following information to answer the next question.

Reduction Half-Reaction

$Am^{4+}(aq) + e^- \rightleftharpoons Am^{3+}(aq)$	$E° = +2.60$ V
$Tl^{3+}(aq) + 2\,e^- \rightleftharpoons Tl^{+}(aq)$	$E° = +1.25$ V
$Ac^{3+}(aq) + 3\,e^- \rightleftharpoons Ac(s)$	$E° = -2.20$ V
$Cs^{+}(aq) + e^- \rightleftharpoons Cs(s)$	$E° = -3.03$ V

Species

1	$Am^{4+}(aq)$	**5**	$Am^{3+}(aq)$
2	$Tl^{3+}(aq)$	**6**	$Tl^{+}(aq)$
3	$Ac^{3+}(aq)$	**7**	$Ac(s)$
4	$Cs^{+}(aq)$	**8**	$Cs(s)$

Numerical Response

3. Match the species numbered above with the descriptors given below. You may use a number more than once.

Strongest oxidizing agent __________ (Record in the **first** column)
Weakest reducing agent __________ (Record in the **second** column)
Species with the greatest attraction for electrons __________ (Record in the **third** column)
Species that loses three electrons __________ (Record in the **fourth** column)

(Record your answer in the numerical-response section on the answer sheet.)

Answer: 1517

Outcome being assessed: C1.1k

Use the following information to answer the next question.

Carbon-Containing Compounds

1	$CCl_4(l)$	**5**	$CO(g)$
2	$Fe_3C(s)$	**6**	$C_3H_8(g)$
3	$C_2H_2(g)$	**7**	$NaCN(s)$
4	$C_2H_5OH(l)$	**8**	$MgCO_3(s)$

Numerical Response

4. The compounds above that can be classified as organic are numbered _____, _____, _____, and _____.

(Record all **four digits** of your answer in **any order** in the numerical-response section on the answer sheet.)

Answer: 1346 (These digits can be recorded in any order.)

Outcome being assessed: D2.2k

Use the following information to answer the next question.

Chorophenol red is an indicator used to determine the amount of chlorine dioxide disinfectant present in drinking water. The colour change of the indicator allows for an accurate determination of the amount of chlorine dioxide present.

Numerical Response

5. The value of K_b for the conjugate base of chlorophenol red, $Ch^-(aq)$, expressed in scientific notation, is $\boldsymbol{a.b} \times 10^{-\boldsymbol{c}}$. The values of ***a***, ***b***, and ***c*** are ____, ____, and ____.

(Record all **three digits** of your answer in the numerical-response section on the answer sheet.)

Answer : 188

Note: The value of K_a found in the data booklet sets a limit of two significant digits for any calculated value of K_b. As a result, only three boxes can be filled.

Diploma Examination Instructions Pages

January 2012

Chemistry 30

Grade 12 Diploma Examination

Description

Time: 2 hours. This closed-book examination was developed to be completed in 2 h; however, you may take an additional 0.5 h to complete the examination.

- This examination consists of 44 multiple-choice and 16 numerical-response questions, of equal value.
- This examination contains sets of related questions. A set of questions may contain multiple-choice and/or numerical-response questions.
- A chemistry data booklet is provided for your reference.

Instructions

- Turn to the last page of the examination booklet. Carefully fold and tear out the machine-scored answer sheet along the perforation.

Note: *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.*

- Use **only** an **HB** pencil for the answer sheet.
- Fill in the information on the back cover of the examination booklet and the answer sheet as directed by the presiding examiner.
- You are expected to provide your own calculator. You may use any scientific calculator or a graphing calculator approved by Alberta Education.
- You **must** have cleared your calculator of all information that is stored in the programmable or parametric memory.
- You may use a ruler and a protractor.
- Read each question carefully.
- Consider all numbers used in the examination to be the result of a measurement or an observation.
- When performing calculations, use the values of the constants provided in the data booklet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do **not** fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Now turn this page and read the detailed instructions for answering machine-scored 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. Any boxes on the right that are not needed are to remain blank.**

Examples

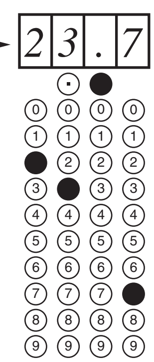
Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _________.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666…
= 23.7 (rounded to one decimal place)

Record 23.7 on the answer sheet →



Correct-Order Question and Solution

Four Subjects

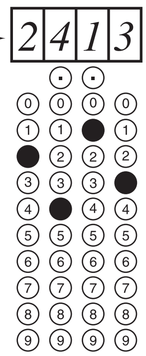
1 Physics
2 Biology
3 Science
4 Chemistry

When the subjects above are arranged in alphabetical order, their order is ____, ____, ____, and ____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Answer: 2413

Record 2413 on the answer sheet →



Selection Question and Solution

Five Elements

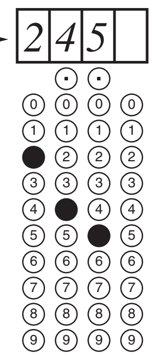
1 Carbon
2 Iron
3 Nitrogen
4 Potassium
5 Tin

The metals in the list above are numbered ___, ___, and ___.

(Record all **three digits** of your answer **in any order** in the numerical-response section on the answer sheet.)

Answer: 245

Record 245 on the answer sheet →



Scientific Notation Question and Solution

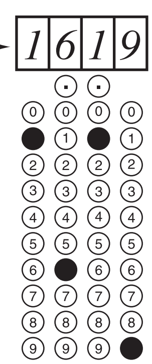
$X(g) + Y(g) \rightarrow XY(g) \qquad \Delta H^\circ = +1.61 \times 10^9$ kJ

The energy transferred when 1.00 mol of X(g) is consumed during the reaction represented by the equation above is $\boldsymbol{a.bc} \times 10^{\boldsymbol{d}}$ kJ. The values of ***a***, ***b***, ***c***, and ***d*** are ____, ____, ____, and ____.

(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Answer: 1.61×10^9 kJ

Record 1619 on the answer sheet →



Exemplars Document

Examples of questions are also posted on the website next to the *Information Bulletin* in the *Exemplars* document. There are examples for each type of question format that either have been used in previous diploma examinations or can be used in classroom assessment.

This document outlines some of the general principles of question construction used by examination developers at the Assessment Sector, contains the Chemistry 30 Program of Studies outcome statements, and provides examples of questions that can be used to assess mastery of these outcomes.

Constructing the Diploma Examination

Working groups of classroom teachers develop questions that meet the program of studies and the technical standards incorporated into the examination blueprint. The diploma examinations are composed of questions and/or question sets that have proven to be valid in field testing.

After a question has been field-tested, feedback provided by students and teachers, in addition to the statistics, are reviewed before the question is deemed acceptable for a diploma examination. Before a question appears on an examination, it is reviewed and edited internally, and then reviewed externally by a working group of teachers and professionals working in the chemistry field.

To participate in our question development, examination review, or French translation working groups, teachers need to be nominated by their schools and their names submitted to Alberta Education.

Examination Security

All Chemistry 30 Diploma Examinations are secured.

More information can be found in the *General Information Bulletin* on the Alberta Education website at education.alberta.ca by following this pathway:
For Teachers > (Additional Programs and Services) Diploma Exams > Diploma General Information Bulletin > Security & Examination Rules.

Maintaining Consistent Standards over Time on Diploma Examinations

The process of examination equating was suspended for the 2008–2009 school year, as it was the year of the introduction of the new program of studies in Chemistry 30. The suspension was continued for the 2009–2010 school year, as there was a major change in format to the diploma examinations, with the removal of the written-response questions.

In the 2010–2011 school year, Alberta Education conducted extensive standard-setting exercises, and examination equating has now been re-introduced.

A goal of Alberta Education is to make scores achieved on examinations within the same subject directly comparable from session to session, thereby enhancing fairness to students across administrations.

In order to achieve this goal, a number of questions called anchor items remain the same from one examination to another. Anchor items are used to find out if the student population writing in one administration differs in achievement from the student population writing in another administration. Anchor items are also used to find out if the unique items (questions that are different on each examination) differ in difficulty from the unique items on the baseline examination (the first examination to use anchor items). A statistical process called equating adjusts for differences in examination form difficulty. Examination marks may be adjusted depending upon the difficulty of the examination written relative to the baseline examination. The resulting equated examination scores have the same meaning regardless of when and to whom the examination was administered. Equated diploma examination marks will be reported to students.

Because of the security required to enable fair and appropriate assessment of student achievement over time, Chemistry 30 diploma examinations will be fully secured and will not be released at the time of writing. For more information about equating, please refer to the Alberta Education website at education.alberta.ca, then follow the pathway *For Administrators > Provincial Testing > Diploma Examinations > Initiative to Maintain Consistent Standards on Diploma Examinations*.

More information can be found in the *General Information Bulletin* on the Alberta Education website at education.alberta.ca by following this pathway:

For Teachers > (Additional Programs and Services) Diploma Exams > Diploma General Information Bulletin > Marks, Results, & Appeals.

Data Booklet

The most current version of the *Chemistry 30 Data Booklet* has a publication date of 2010 and a red cover. This version replaces previous versions, which have an earlier publication date and blue covers.

Field Tests

The chemistry program is thankful to the many teachers and students who have volunteered for field test placements. The table below shows the format, number of questions, and length of time for field tests available for the 2013–2014 school year. Teachers may wish to consider this table when requesting a field test placement.

	Digital (Online)
Number of questions (MC and NR)	20
Test time (min)	65
Administration time (min)	15
Total time (min)	80

Teachers wishing to arrange for a field test must provide an appropriate length of time for the writing and administration of the exam, according to the total time listed above.

As in past years, both unit and semester-end examinations will be available.

Type of Field Test	**Semester 1**	**Semester 2**
Unit Test (20 questions)	Unit A Unit B Unit C Unit D	Unit A Unit B Unit C Unit D
End of Semester (20 questions)	All units	All units

*NEW **_Website Links_**

Publication/Resource (Chemistry 30 Program of Studies)	Website
General Information Bulletin	*education.alberta.ca*, via the pathway: *For Teachers > (Additional Programs and Services) Diploma Exams > Diploma General Information Bulletin*
Chemistry 30 Information Bulletin	*education.alberta.ca*, via the pathway: *For Teachers > (Additional Programs and Services) Diploma Exams > Information Bulletins*
Mathematics and Science Directing Words	*education.alberta.ca*, via the pathway: *For Teachers > (Additional Programs and Services) Diploma Exams > Information Bulletins > Mathematics and Science Directing Words*
Science Process Words	*education.alberta.ca*, via the pathway: *For Teachers > (Additional Programs and Services) Diploma Exams > Information Bulletins > Science Process Words*
Data Booklet	*education.alberta.ca*, via the pathway: *For Teachers > (Additional Programs and Services) Diploma Exams > (Additional Resources–Data Booklets) Chemistry 30*
Chemistry 20–30 Program of Studies	*education.alberta.ca*, via the pathway: *For Teachers > (Programs of Study) > Science > Programs of Study*
Released Items	education.alberta.ca, via the pathway Teachers > (Additional Programs and Services) Diploma Exams > Released Materials
Quest A+	*https://questaplus.alberta.ca* **Note:** Unit and semester-end self-scoring practice tests can be found here, as can four previous diploma examinations (January and June 2009, August and November 2012). The January and June 2009 diploma examinations in Quest A+ now include buttons which provide students with feedback on each of the alternatives for the multiple-choice questions, and hints for the numerical-response questions. For the correct response, the feedback will include the rationale for that answer and if appropriate, supporting calculations. For incorrect responses, the feedback will highlight the common misconception and allow students to review their response more carefully. This feature is available for both English and French versions of these examinations.

Organization	Website
ATA Science Council	*sc.teachers.ab.ca*
Alberta Regional Professional Development Consortia	*arpdc.ab.ca*, via the pathway: *Regional Consortium* > select link to your region, view professional development offerings in your region, or other regions

Contacts 2013–14

Diploma Programs

Deanna Shostak, Acting Director
Diploma Programs
Deanna.Shostak@gov.ab.ca

Nicole Lamarre, Director
French Assessment
Nicole.Lamarre@gov.ab.ca

Assessment Standards Team Leaders

Gary Hoogers
English Language Arts 30–1
Gary.Hoogers@gov.ab.ca

Philip Taranger
English Language Arts 30–2
Philip.Taranger@gov.ab.ca

Monique Belanger
Français 30–1, French Language Arts 30–1
Monique.Belanger@gov.ab.ca

Dwayne Girard
Social Studies 30–1
Dwayne.Girard@gov.ab.ca

Patrick Roy
Social Studies 30–2
Patrick.Roy@gov.ab.ca

Shannon Mitchell
Biology 30
Shannon.Mitchell@gov.ab.ca

Jack Edwards
Chemistry 30
jedwards@gov.ab.ca

Deanna Shostak
Mathematics 30–2
Applied Mathematics 30
Deanna.Shostak@gov.ab.ca

Ross Marian
Mathematics 30–1
Pure Mathematics 30
Ross.Marian@gov.ab.ca

Laura Pankratz
Physics 30
Laura.Pankratz@gov.ab.ca

Stan Bissell
Science 30
Stan.Bissell@gov.ab.ca

Assessment Sector

Neil Fenske, Executive Director
Assessment Sector
Neil.Fenske@gov.ab.ca

Examination Administration

Dan Karas, Director
Examination Administration
Dan.Karas@gov.ab.ca

Sylvia Lepine, Manager
Examination Administration & Marking Centre
exam.admin@gov.ab.ca

Amanda Jackman, Coordinator
GED and Field Testing
field.test@gov.ab.ca

Pamela Klebanov, Coordinator
Special Cases and Accommodations
special.cases@gov.ab.ca

Assessment Sector Mailing Address:

Assessment Sector, Alberta Education
44 Capital Boulevard
10044 108 Street
Edmonton AB T5J 5E6

Telephone: (780) 427-0010
Toll-free within Alberta: 310-0000
Fax: (780) 422-4200
email: LAcontact@edc.gov.ab.ca
Alberta Education website:
education.alberta.ca