DOCUMENT RESUME

ED 409 191 SE 060 383

TITLE	Chemistry 30 Diploma Examination Results. Examiners' Report for January 1997.
INSTITUTION	Alberta Dept. of Education, Edmonton. Student Evaluation Branch.
PUB DATE	97
NOTE	9p.; For the Chemistry 30 Examination, see ED 407 273. Printed on colored paper.
AVAILABLE FROM	Alberta Dept. of Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2, Canada.
PUB TYPE	Reports - Evaluative (142)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Achievement; *Chemistry; Foreign Countries; High Schools; Science Education; Standards; Student Evaluation; *Test Results
IDENTIFIERS	*Alberta

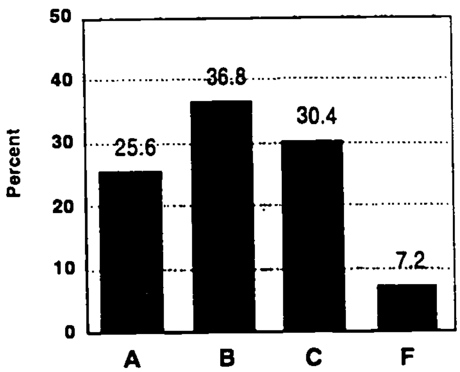
ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of the results from the January 1997 administration of the Chemistry 30 Diploma Examination by the Alberta Department of Education in Canada. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. Findings indicate that 89.4% of the 6,950 students who took the test achieved the acceptable standard and 18.6% of these students achieved the standard of excellence. Topics discussed include a description of the examination, achievement of standards, results and examiners' comments, multiple-choice and numerical-response questions, and written-response questions. (JRH)

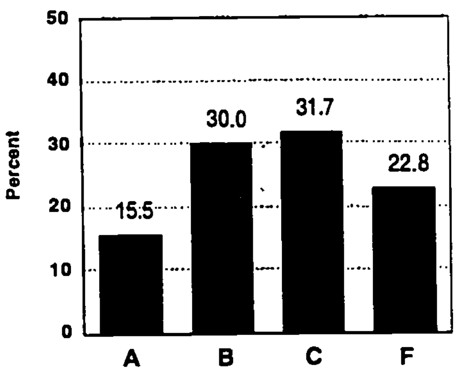
Chemistry 30

Diploma Examination Results
Examiners' Report for January 1997

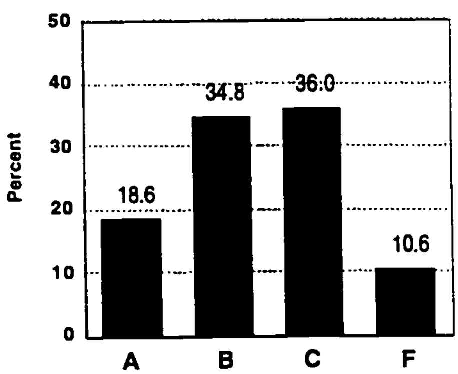
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Chemistry 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, June, and August results is made available annually.

Description of the Examination

The Chemistry 30 Diploma Examination consists of 44 multiple-choice questions worth 55%, 12 numerical-response questions worth 15%, and 2 written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 6 950 students in Alberta who wrote the January 1997 examination. This represents a decrease of 259 compared with January 1996.

- 89.4% of the 6 950 students achieved the acceptable standard (a final course mark of 50% or higher).
- 18.6% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Chemistry 30 was acceptable, particularly in knowledge of core concepts. However, students had difficulty in responding to written questions where there is more than one correct response.

Approximately 51.9% of the students who wrote this examination were female, which is similar to the percentage of females in the population at this age group. The acceptable standard in the course was achieved by approximately 89.1% of this female population, compared with 89.7% of the male population. Approximately 17.6% of the female population achieved the standard of excellence in the course, compared with 19.7% of the male population.

Students First!
Student Evaluation

Alberta
EDUCATION

BEST COPY AVAILABLE

Provincial Averages

- The average school-awarded mark was 68.7%.
- The average diploma examination mark was 62.1%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 65.7%.

Approximately 10.6% of the students who wrote the examination in January 1997 and received a school-awarded mark had written at least one other Chemistry 30 Diploma Examination during the August 1995 to August 1996 period. This sub-population (736) achieved an examination average of 58.8%, compared with 62.5% for the population (6 214) who first wrote the Chemistry 30 examination in January 1997. However, the group of students who rewrote the chemistry examination increased their exam score, on average, 7.7%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a minimum mark of 50%, and students capable of achieving the standard of excellence will obtain a minimum mark of 80%. Future examinations will continue to require students to demonstrate clarity in their thinking and an understanding of concepts by applying their knowledge to new and novel situations. Students will also continue to be required to present their answers in a clear, concise, organized fashion and to respect the conventions of the mode of communication selected. Those who achieved these expectations were successful in this examination.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer.

For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, "Difficulty" is the mean score achieved by students who wrote the examination.

Questions are also classified by general learner expectations.

Knowledge:

- GLE 1 Quantitatively Predicting Outcomes
- GLE 2 Qualitatively Analyzing Systems
- GLE 3 Relationships in Energy Transfer
- GLE 4 Relationships in Electron Transfer
- GLE 5 Relationships in Equilibrium Systems
- GLE 6 Relationships in Proton Transfer

Skills:

- SPSC Scientific Process Skills and Communication Skills

Science, Technology, Society:

- STS Connections Among Science, Technology, & Society

Blueprint

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
NR 1	7.13	0.899	√		√				√	
NR 2	2468	0.904		√	√				√	√
MC 1	C	0.771	√		√				√	√
NR 3	68.5	0.417	√		√				√	√
MC 2	B	0.772		√	√					√
MC 3	D	0.804		√	√					√
MC 4	D	0.355		√	√		√	√		√
MC 5	D	0.736	√		√				√	√
MC 6	A	0.741	√		√				√	
NR 4	32.60	0.874	√		√				√	
MC 7	B	0.446		√	√				√	
MC 8	B	0.783		√	√					
MC 9	A	0.747		√	√				√	
MC 10	B	0.835		√	√				√	
MC 11	C	0.507		√	√					

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
MC 12	C	0.309	√		√				√	√
NR 5	*	0.713	√		√				√	√
MC 13	C	0.573		√		√			√	√
MC 14	A	0.324	√			√			√	√
MC 15	B	0.513		√				√	√	√
MC 16	C	0.719		√	√	√	√	√	√	√
MC 17	D	0.821		√		√			√	
NR 6	1	0.551	√			√			√	√
MC 18	D	0.902		√		√			√	
MC 19	A	0.810		√		√			√	
MC 20	A	0.744		√		√			√	√
NR 7	3147	0.604		√		√			√	
MC 21	C	0.848		√		√				
NR 8	1284	0.491		√		√			√	
NR 9	4123	0.572		√		√			√	
MC 22	A	0.422	√			√			√	√
MC 23	A	0.726		√		√				√
MC 24	B	0.492	√			√			√	√
NR 10	0453	0.649	√			√				√
MC 25	D	0.902	√				√			√
MC 26	D	0.677		√			√		√	√
NR 11	92.2	0.599	√		√				√	√
MC 27	A	0.758		√	√	√		√		√
MC 28	C	0.823	√				√		√	√
NR 12	**	0.417	√				√		√	√
MC 29	C	0.216		√			√		√	√
MC 30	A	0.240	√					√	√	√
MC 31	A	0.749		√			√	√		
MC 32	B	0.710	√				√	√	√	
MC 33	A	0.800		√			√	√		
MC 34	B	0.821	√					√	√	
MC 35	D	0.955		√		√		√		
MC 36	D	0.786		√				√		
MC 37	B	0.638		√				√		
MC 38	A	0.854		√				√	√	
MC 39	B	0.883		√			√	√		
MC 40	D	0.536	√				√	√	√	√
MC 41	C	0.457	√					√	√	
MC 42	B	0.825	√					√	√	
MC 43	C	0.708	√					√	√	√
MC 44	D	0.668		√			√		√	√
WR 1	—	0.553	√	√		√	√		√	√
WR 2	—	0.441		√				√	√	√

* NR5: 66.9 if A or D was selected from MC12; 33.5 if B or C was selected from MC12
** NR12: 0.00 if A was selected from MC28; 0.06 if B was selected; 0.40 if C or D was selected

Subtests

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine Scored: 37.4 out of 56

Written Response: 12.1 out of 24

GLE 1	Quantitatively Predicting Outcomes	21.6	out of	36
GLE 2	Qualitatively Analyzing Systems	32.8	out of	52
GLE 3	Relationships in Energy Transfer	13.7	out of	20
GLE 4	Relationships in Electron Transfer	18.6	out of	30
GLE 5	Relationships in Equilibrium Systems	12.1	out of	21
GLE 6	Relationships in Proton Transfer	16.0	out of	26
SPSC		33.3	out of	55
STS		28.4	out of	50

Use the following information to answer the next question.

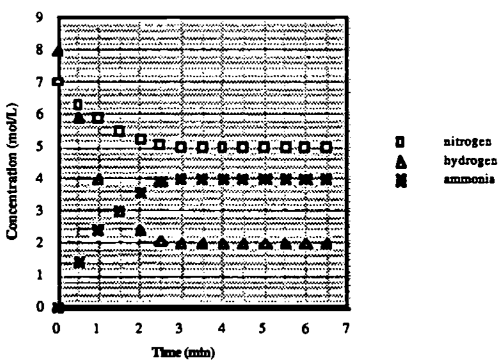
I. Production of thermal energy
II. Production of $CO_{2(g)}$
III. Consumption of $O_{2(g)}$
IV. Consumption of $H_2O_{(g)}$

2. Combustion of fossil fuels in a steam plant and cellular respiration are similar in terms of

   A. I, II, IV
   *B. I, II, III
   C. I, III, IV
   D. II, III, IV

Use the following information to answer the next two questions.

An experiment designed to investigate this reaction yielded the data plotted below.



28. At what time was equilibrium first reached in this experiment?

   A. 0.0 min
   B. 1.5 min
   *C. 3.0 min
   D. 6.5 min

*Use the value selected for **Multiple Choice 28** to answer **Numerical Response 12.***

Numerical Response

12. The K_{eq} for this reaction is __________.
(Record your answer to three digits on the answer sheet.)
Answer: **A then 0.00, B then 0.06, C or D then 0.40**

29. The value of the equilibrium constant for this system will change if the system is subjected to a change in

   A. volume
   B. pressure
   *C. temperature
   D. concentration

Multiple-Choice and Numerical-Response Questions

The following questions were selected for discussion because they exemplify what is required to meet, minimally, the acceptable standard and the standard of excellence.

Students just achieving the acceptable standard were capable of answering questions such as multiple-choice questions 1, 2, 3, 8, 10, 17, 19, 28, 33, 34, 36, and 42. For example, in **multiple-choice question 2**, almost all students were able to identify that the production of thermal energy (88.5%) and the consumption of oxygen (95.0%) were common to the combustion of fossil fuels and cellular respiration. Most students were also able to identify the production of carbon dioxide (83.4%) as being common to these processes. As a result, 77.2% of all the students were able to combine these three pieces of information and arrive at a correct answer. The majority of students who achieved the acceptable standard (80.6%) and most of the students who achieved the standard of excellence (95.0%) had success on this question, while students who did not achieve the acceptable standard had limited success (56.1%). The most common error (11.5%) was in not realizing that both processes produced thermal energy. This error was especially common (22.5%) among the students who did not attain the acceptable standard.

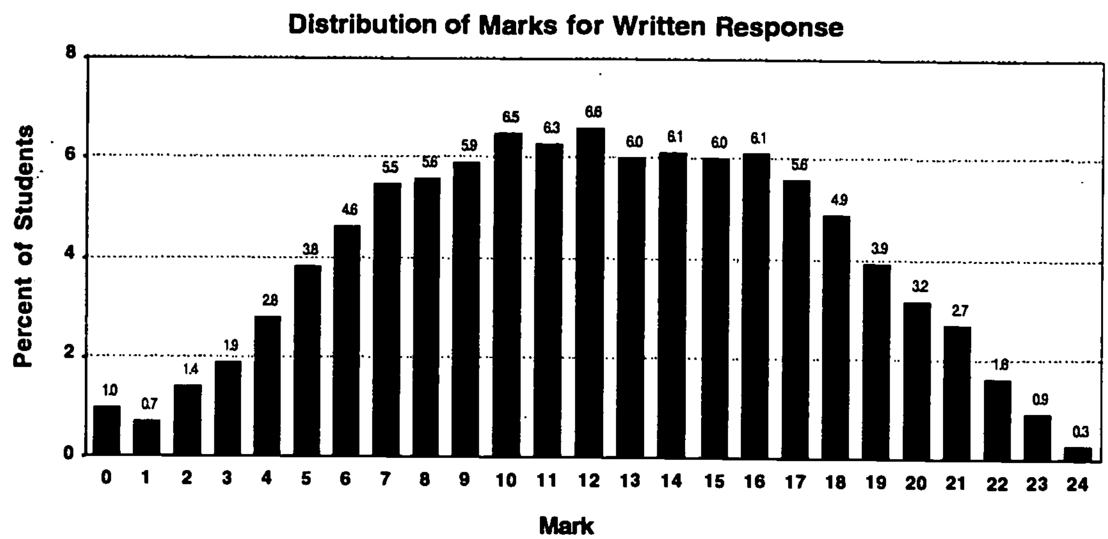
The results from this question suggest that students who do not achieve the acceptable standard have difficulty in identifying similarities in two or more processes, while students capable of identifying characteristics relevant to more than one situation will achieve the acceptable standard.

Students just achieving the standard of excellence were capable of answering questions such as multiple-choice questions 4, 7, 12, 14, 22, 29, and 30 and numerical-response questions 3 and 12. For example, in **numerical-response question 12**, 41.7% of the students answering the question did so correctly. The majority of students achieving the standard of excellence (83.7%) were able to write an equilibrium expression and substitute appropriate values consistent with the previous question, multiple-choice question 28, to determine the value of the equilibrium constant. Almost half of the students (42.5%) who achieved the acceptable standard were able to calculate a value for the equilibrium expression. Very few of those who did not achieve the acceptable standard (11.2%) were able to calculate an appropriate value. The most common mistake (32.4%) made by all students was inverting the equilibrium expression by writing the expression as reactants over products rather than products over reactants; 10.4% of these students would have calculated a correct value had they not made this mistake. Other identified errors include doubling the "correct answer" because of the ammonia's coefficient (3.9%), selecting the point of intersection and then using time or concentration as the value for K_{eq} (4.2%), ignoring the coefficients from the balanced chemical equation (1.3%), and, most interestingly, summing the equilibrium concentrations and dividing by the time (2.3%). The results for this question suggest that students achieving the standard of excellence do so because they are able to extract relevant information from a graph, write an equilibrium expression, and calculate an appropriate value. Thus, they are capable of combining concepts and solving multistep problems.

In **multiple-choice question 29**, very few students (21.6%) were able to identify that the value of the equilibrium constant is dependent upon the temperature of the system. The major misconception held by most students (60.2%) was that the value of the equilibrium constant varied with concentration. Only 38.0% of the students achieving the standard of excellence were successful, while the results for students achieving the acceptable standard (18.6%) and not achieving the acceptable standard (18.5%) were similar. These results may indicate that students are unfamiliar with the factors that affect equilibrium and their effect on the value of the equilibrium constant.

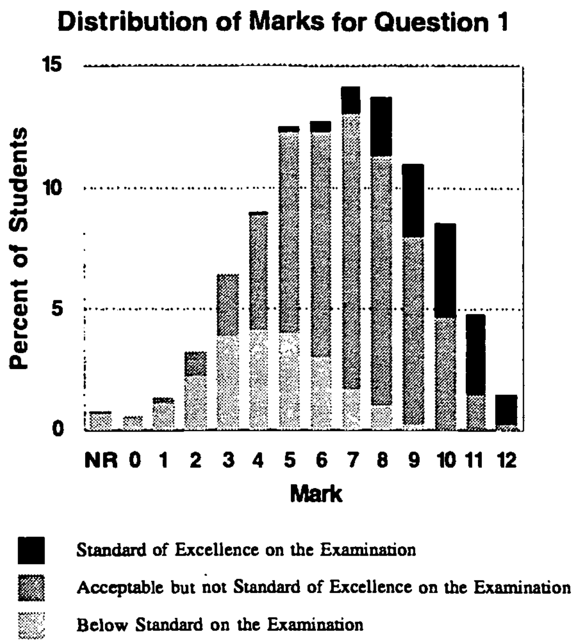
Written-Response Questions

The overall level of achievement on the written-response section was less than expected: a little over half (54.0%) achieved a mark of 12 or higher out of 24. The average mark on the written-response section was 12.1 or 50.4% of the available marks.



Students answered **written-response question 1** much better than expected. This question was designed to measure students' ability to design and apply their knowledge of electrolytic cells. Most students were able to identify the necessary components of a basic electrochemical cell, but had some difficulty specifying all the components and the operation of an electolytic cell. Many students did not address all parts of the question and/or failed to support their responses well.

Students who did not meet the acceptable standard were expected to score up to 5, and 26.9% exceeded this expectation. They averaged 4.20 because they had difficulty selecting suitable chemicals and materials to build a viable cell. The diagrams were poorly labelled in terms of cell operation i.e. electron and ion flow. Classically, students were unable to provide the name of an industry or a product of electrolysis. Identified concerns often illustrated a confusion between sacrificial anode and electroplating.



These students did, however, have an idea of a general cell setup and could pick an industry and a product, although these were frequently related to voltaic rather than electrolytic cells. The concerns they related were usually general in nature and not related to the parts of the question requested; for example, pollution and poor health. Specifics of health hazards, what caused the pollution, or the identity of the pollutants were not clearly stated. Comments like. "... throwing out batteries causes pollution ..." required the markers to interpret the pollution connection. Many students simply linked any substance whose destiny is the local landfill to pollution, with no explanation. Students who did not achieve the acceptable standard seldom provided appropriate half-reactions or a net reaction for their industry of choice. Explanations were poorly stated, using fragmented ideas/sentences. These students exhibited little transfer of chemistry theory to practical application.

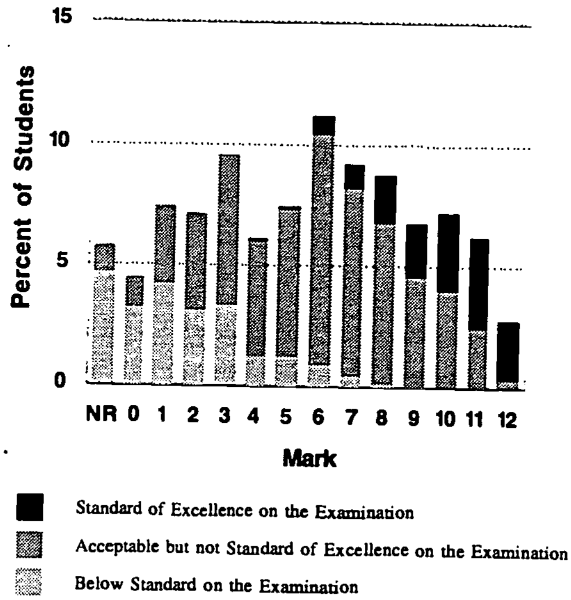
Students who achieved the acceptable standard but not the standard of excellence were expected to score in the range of 5 to 8, and 63.5 % did so, while 22.5% exceeded this expectation. They averaged 6.8 because they could design electrochemical cells that were well labelled but often lacked a power supply. Generally, these students made an effort to address all parts of the question. They tried to support their industry and product choices with half-reactions or a net reaction. The half-reactions, however, tended to be incorrect and/or written backward ($Cu_{(s)} \longrightarrow Cu^{2+}{}_{(aq)} + 2\,e^-$ to illustrate copper plating), or written as a spontaneous net equation rather than the appropriate non-spontaneous equation. Concerns identified could be classified as consumer problems rather than concerns regarding electrolytic cell use or the electrolytic process. A common choice for an industry was a battery manufacturer and, for the product, recharged batteries. Students failed to understand that industry makes batteries that may be recharged by consumers, not by industry. Thus, battery making is not an industry that utilizes the electrolytic process to manufacture batteries. These students also identified many other concerns, but were unable to explain why these issues were of concern. Communication conventions were problematic when they bordered on chemistry content. Students confused plating reactions that usually occur in aqueous environments with molten electrolytes used in ore refining. They used the subscript (l) —> (s) rather than the (aq) —> (s) expected for electroplating.

Students who achieved the standard of excellence were expected to score 10 or better, and 54.2% did so. They averaged 9.48 because they understood and could explain the electrolytic/voltaic cell distinction. Their entire responses were coherent and well written. Students frequently selected electroplating as a practical industry that utilized electrolysis, and could connect and elaborate on a concern directly related to the industry they chose.

Overall, students at all levels of achievement had trouble differentiating between electrolytic and voltaic cells. They often selected a voltmeter rather than a power source. Students are becoming more test-wise. Many were clever enough to copy/utilize the diagrams from numerical-response question 8 and multiple-choice question 21 to 'design' their cell diagram. However, they failed to realize that these diagrams were for voltaic cells rather than electrolytic cells and, as a result, were not eligible for full marks.

On this 12-mark question, the average mark was 6.63 or 55.3% of the available mark.

Distribution of Marks for Question 2



Written-response question 2 was not answered as well as expected. The question was designed to measure how well students could design a viable procedure to distinguish between an unknown monoprotic or polyprotic acid. Students who did not achieve the acceptable standard were expected to score 7 or less, and 99.0% did so. They averaged 1.87 because they often confused the terms polyprotic and amphiprotic, and confused strong acids with polyprotic acids and weak acids with monoprotic acids. They made few correlations between the procedure and the analysis. They were aware that a titration was the necessary procedure and that there is a difference in the shape of the pH curves for monoprotic and polyprotic acids; they could define monoprotic and polyprotic acids, but had difficulty generating a working procedure to match the definitions. The biggest gap in their knowledge was in how their procedure could be used to generate the "definition" curves described or drawn in their response. Students thought that indicators should change colour twice for a polyprotic acid and once for a monoprotic acid. Many students confused pH curves with heating curves; perhaps thinking that the question was cross-unit in nature. Titration procedures did not specify a strong base, and students frequently selected water, weak bases, strong acids such as $HCl_{(aq)}$, strong oxidizing agents, or an indicator as a titrant. Students below acceptable standard tend to write everything they remember about chemistry that may be topical.

Students who achieved the acceptable standard were expected to score in the range of 8 to 10, and only 24.4% did so, with the majority of these students (70.8%) attaining scores of less than 8. They averaged only 5.67 because they knew the mechanics of a titration experiment and selected a strong base to titrate the unknown acid. Students identified appropriate equipment/ reagents to perform the procedure. They had difficulty selecting an appropriate indicator, and tended to explain the theory rather than how the procedure and the data it would generate could be used to address the question. Sometimes the titration experiment was performed backward; i.e., the base titrated with the unknown acid, resulting in an inverted pH curve. Very few students understood the stoichiometric relationship between the strong base and each of the two possible acid types. Most students referred only to the shape of the graph — one "hump" or two. As with the students who did not achieve the acceptable standard, there was a misconception that one or two indicators would generate enough information to plot a pH curve. They did not understand how indicators work and/or how they could be used to generate pH curves. Many selected indicators like thymol blue, assuming two colour changes not knowing the pH at each equivalence point or the strength of the unknown acid.

Students who achieved the standard of excellence were expected to score 11 or better, and only 39.2% did so. They averaged 9.67 because they wrote sequential, well-supported procedures that would generate suitable data for the analysis. These students most often selected the most elegant procedure: using a strong base and a pH meter to monitor the pH changes during the titration. Their procedures were more specifically outlined. Students selected smaller increments between pH measurements, understood the need for duplication of the experiment, used specific glassware, etc. A number of students selected a "generic" indicator, which implied a universal indicator. Some standard of excellence responses included pH meter and colour indicator(s) used in combination for the titration experiment.

Overall, students exhibit weak analysis skills. Students focused on the procedure and the definition of the acids. Selecting a device/reagent to indicate the equivalence point or end-point was problematic. Many students did not mention how the pH data were obtained for the graphs/diagrams provided. The strength of the acid was not a consideration for many students. Very few students realized that the stoichiometric relationship between a strong base and a monoprotic or polyprotic acid species would involve different volumes of the base (i.e. a 1:1 volume relationship for a strong base and a monoprotic acid, and a 2:1 for a strong base and a diprotic acid). It would appear that students had either not performed or were unable to transfer their laboratory experience of single and multistep titration using pH meters to the problem at hand. Few students outlined a concern as to the requirement of a strong base to ensure that a quantitative acid–base reaction would occur. Students simply chose a "base" or $NaOH_{(aq)}$, a familiar titrant. Students from each standard of achievement confused the term equivalence point with equilibrium.

On this 12-mark question, the average mark was 5.29 or 44.1% of the available mark.

Both written-response questions on this diploma exam were very open-ended. They allowed students to use a wide range of chemistry knowledge. In question 1, students had the freedom to design a specific or generic electrolytic cell and to select an industry/product of their choice. As long as they were consistent in their response, students could score full marks for a variety of answers. In question 2, students were asked to select a technique that could distinguish a monoprotic and polyprotic acid. Again, a number of viable alternatives were possible. Teachers marking the examinations found both questions straightforward and based on solid Chemistry 30 content. Interestingly, students at or below the acceptable standard had difficulty with the openness of the questions. Making decisions as to how much information was adequate to answer the question and/or how to manipulate their chemistry knowledge and apply it to the questions posed a challenge. Students tend to score higher marks on more "closed" questions.

For further information, contact Don Loerke (dloerke@edc.gov.ab.ca) or Phill Campbell (pcampbell@edc.gov.ab.ca) at the Student Evaluation Branch, at 403-427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

NOTICE

REPRODUCTION BASIS

☑ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").