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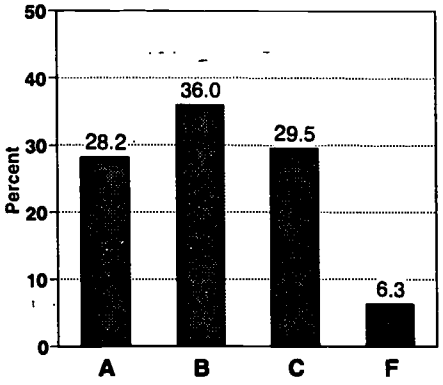
ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of the results from the June 1998 administration of the Biology 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 are provided to schools and school jurisdiction offices. Findings indicate that 90.8% of the 8,813 students who took the test achieved the acceptable standard, and 27.7% of those 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. (ASK)

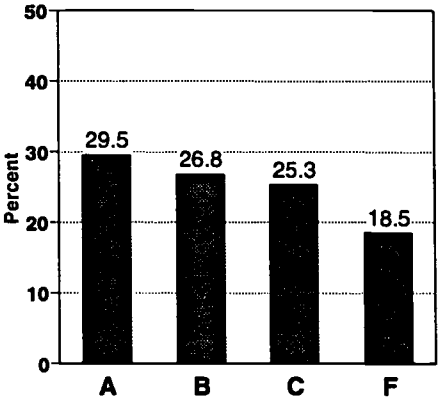
Biology 30

Diploma Examination Results
Examiners' Report for June 1998

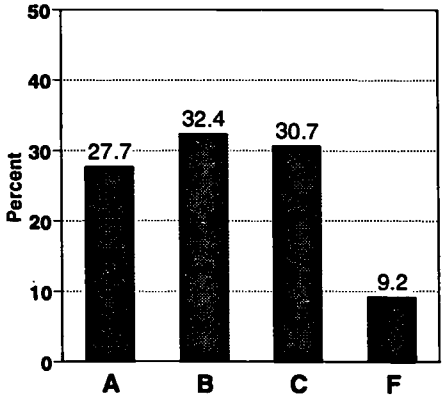
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, and students with an overview of results from the June 1998 administration of the Biology 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that have been provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, April, June, and August results is made available annually.

Description of the Examination

The Biology 30 Diploma Examination consists of 48 multiple-choice questions worth 60%, eight numerical-response questions worth 10%, and two 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 8 813 students in Alberta who wrote the June 1998 examination. This represents a decrease of 209 students compared with June 1997 and a decrease of 772 students compared with June 1996. (The total number of students writing in the year has remained stable. The April examination sitting has decreased the number of students writing both January and June examinations over these three years.)

- 90.8% of the 8 813 students achieved the acceptable standard (a final course mark of 50% or higher).
- 27.7% of the 8 813 students achieved the standard of excellence (a final course mark of 80% or higher).

Generally, student achievement in Biology 30 was good. The percentage of students who achieved the acceptable standard (90.8%) was nearly identical to the percentage for June 1997 (90.6%). Most students demonstrated a very good understanding of human reproductive, endocrine, and nervous systems. They demonstrated a good understanding of concepts related to the interaction of populations. Some students had difficulty with concepts related to cell division, molecular genetics, and population genetics, and to the links between these concepts. The majority of students were able to demonstrate a very good understanding of science, technology, and society connections.

Approximately 61.0% of the students who took the course were female. Of these female students, approximately 91.5% achieved the acceptable standard on the course, compared with 89.9% of the male students. The standard of excellence was achieved by approximately 28% of these female students, compared with 27% of the male population.

Provincial Averages

- The average school-awarded mark was 69.6%.
- The average diploma examination mark was 67.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 68.7%.

Approximately 6.3% of the students who wrote the examination in June 1998 and received a school-awarded mark had written at least one other Biology 30 Diploma Examination during the January 1996 to June 1998 period. This subpopulation (563) achieved an examination average of 59.5%, compared with 67.8% for the population (8 250) who first wrote the Biology 30 examination in June 1998. However, the group of students who rewrote increased their examination average score from 47.4% to 59.5%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students achieving the acceptable standard will obtain a mark of 50% or higher, and students achieving the standard of excellence will obtain a mark of 80% or higher.

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, the "Difficulty" is the mean score (out of 1) achieved by students who wrote the examination.

Questions are also classified by general learner expectations.

Knowledge:

GLE 1 Nervous & Endocrine Systems
GLE 2 Reproductive Systems & Hormones
GLE 3 Differentiation & Development
GLE 4 Cell Division & Mendelian Genetics
GLE 5 Molecular Genetics
GLE 6 Population Genetics & Interaction

Skills:

SPC 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	SPC	STS
MC1	A	0.661	✔							
MC2	A	0.871	✔							
MC3	D	0.696	✔							✔
MC4	A	0.746	✔							
MC5	C	0.664	✔							
NR1	5462	0.353	✔							
MC6	C	0.786	✔							
MC7	D	0.671	✔							✔
MC8	C	0.585	✔							
MC9	A	0.819	✔							
MC10	B	0.646	✔							
MC11	A	0.740	✔							
MC12	D	0.821	✔							
MC13	A	0.646	✔							
MC14	C	0.650	✔							✔
MC15	D	0.764	✔							✔
MC16	D	0.757		✔						
MC17	B	0.676				✔				

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPC	STS
MC18	C	0.606		✔						
MC19	D	0.377		✔						
NR2	46	0.762		✔						
MC20	D	0.731			✔					✔
MC21	C	0.749			✔					
MC22	C	0.753			✔					
NR3	4213	0.669			✔					
MC23	C	0.699				✔				
MC24	D	0.699				✔				
NR4	1246	0.391				✔				
MC25	D	0.677				✔				
MC26	D	0.544				✔				✔
MC27	D	0.779				✔			✔	✔
MC28	C	0.632				✔			✔	
MC29	B	0.839				✔				✔
MC30	A	0.722				✔				✔
MC31	C	0.858				✔				✔
NR5	12.5	0.666				✔			✔	✔
MC32	A	0.879				✔			✔	✔
MC33	B	0.569				✔			✔	
MC34	C	0.641	✔						✔	
MC35	D	0.772				✔			✔	✔
MC36	A	0.718				✔				✔
NR6	1342	0.572				✔			✔	
NR7	18	0.432						✔	✔	
MC37	A	0.755					✔			
MC38	B	0.827					✔		✔	
MC39	B	0.836					✔			
MC40	B	0.725					✔		✔	
MC41	A	0.600					✔			
MC42	D	0.635					✔			
MC43	D	0.484					✔			
MC44	B	0.563					✔			
MC45	B	0.666				✔				
NR8	2314	0.800					✔			
MC46	C	0.909						✔		
MC47	A	0.902						✔		
MC48	A	0.599						✔		
WR1	—	0.597						✔(12)	✔(12)	✔(5)
WR2	—	0.637		✔	✔	✔			✔	✔

Subtests: Machine Scored and Written Response (Average by Subtest)

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

Machine scored: 38.6 out of 56
Multiple choice: 34.0 out of 48
Numerical response: 4.6 out of 8

Written Response: 15.0 out of 24
Question 1: 7.2 out of 12
Question 2: 2.6 out of 4 (weighted)

Raw Score Averages for Machine-Scored Items and Written-Response Question 1 by General Learner Expectations

General Learner Expectations:

GLE 1	Nervous & Endocrine Systems	11.8	out of	17
GLE 2	Reproductive Systems & Hormones	2.5	out of	4
GLE 3	Differentiation & Development	2.9	out of	4
GLE 4	Cell Division & Mendelian Genetics	12.4	out of	18
GLE 5	Molecular Genetics	6.2	out of	9
GLE 6	Population Genetics & Interaction	10.0	out of	16
SPC	Scientific Process and Communication Skills	14.7	out of	23
STS	Connections in Science, Technology, and Society	13.5	out of	19

Multiple-Choice and Numerical-Response Questions

Questions on the examination are organized into scenarios or practical situations that occur in real life. For the June 1998 Mathematics 33 Examination, personnel from the Northern Alberta Institute of Technology, Fairview College, Olds College, and Alberta Power (Forestburg) assisted teachers in the development of questions and scenarios. The multiple-choice, numerical-response, and written-response questions were mixed within each scenario of the examination, and where appropriate, questions from the same unit of the course were organized together.

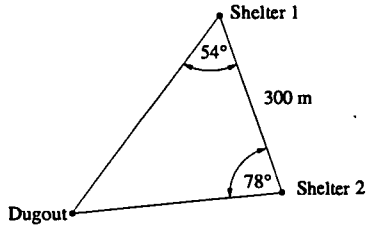
The machine-scored section of the examination requires mathematics students to demonstrate conceptual, procedural, and problem-solving understanding of the mathematical content of the course. During the marking session, markers agreed that these questions on the examination were fair, appropriate, and easy to read. Although it is difficult to fully assess problem-solving in machine-scored questions, students must use problem-solving strategies in order to solve a number of machine-scored questions. These problem-solving questions usually discriminate well between students who achieved the acceptable standard and students who achieved the standard of excellence. A table and discussion on how students performed on four of the ten questions requiring students to use problem-solving skills follow.

Percentage of Students Correctly Answering Machine-Scored Questions

	Question Number			
Student Group	**MC2**	**MC6**	**MC9**	**MC10**
All Students	69.3	63.2	58.4	64.5
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	94.4	85.4	88.3	86.4
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	75.7	69.6	63.1	70.7
Students who have not achieved the *acceptable standard* (49% or less, or F), on the whole examination	50.2	44.7	40.6	46.7

Use the following information to answer the next question.

The farmer analyzed the distances between a dugout and two shelters. The two shelters are located 300 m apart and form a triangle with the dugout, as shown below.



2. To the nearest metre, the distance between the dugout and the closer shelter is

   A. 242 m

   B. 293 m

   ***C.** 327 m

   D. 395 m

For the problem-solving questions related to Trigonometry, students had to be able to analyze information from diagrams of oblique and right triangles and utilize their understanding of the interrelationships of sides and angles to formulate the steps needed to find the correct answer. For **multiple-choice question 2,** students had to find the shorter of two sides of an oblique triangle by determining the missing angle and then applying the sine law correctly. Almost 70% of all students successfully answered this question.

Students also had similar success in answering multiple-choice question 34, where, again, the missing angle and the correct sine law formulation had to be identified. In contrast, most students had great difficulty using appropriate problem-solving strategies to solve the multiple triangle question presented in numerical-response question 12. Markers recognized solving multiple triangle questions is an area for improvement.

Use the following information to answer the next question.

During his study of genetics, Gregory Mendel cross-pollinated many pea plants. He recorded the number and types of offspring produced and applied his knowledge of mathematics to create explanations for his observations. He hypothesized that factors are inherited separately and proposed the law of segregation.

26. The modern-day interpretation of Mendel's law of segregation is that

- **A.** alleles are expressed independently during mitosis
- **B.** alleles are expressed independently during meiosis
- **C.** paired alleles separate during mitosis and are distributed into different gametes
- ***D.** paired alleles separate during meiosis and are distributed into different gametes

Use the following information to answer the next question.

In cattle, hornless or polled (P) is dominant over the horned (p) condition. This is an autosomal trait. The semen of a polled bull is used to artificially inseminate three cows. Cow 1 (horned) produces a horned calf, cow 2 (polled) produces a horned calf, and cow 3 (polled) produces a polled calf.

28. Which of the above cattle could have two possible genotypes?

- **A.** Cow 1
- **B.** Cow 2
- ***C.** Cow 3
- **D.** The polled bull

Use the following information to answer the next question.

In *Drosphila* (fruit flies), the genes for pink eyes, rough eyes, curled wings, and hairless bristles are located on chromosome 3.

Genes	Crossover Frequency
• pink eyes and hairless bristles	21.5
• hairless bristles and curled wings	19.5
• rough eyes and curled wings	41.1
• pink eyes and rough eyes	43.1
• rough eyes and hairless bristles	21.6

Legend

Pink eyes – 1
Rough eyes –2
Curled wings – 3
Hairless bristles – 4

—from *Griffiths*, 1993

Numerical Response

6. Use the legend to indicate the order of these genes along a chromosome.

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

Answer: 1342

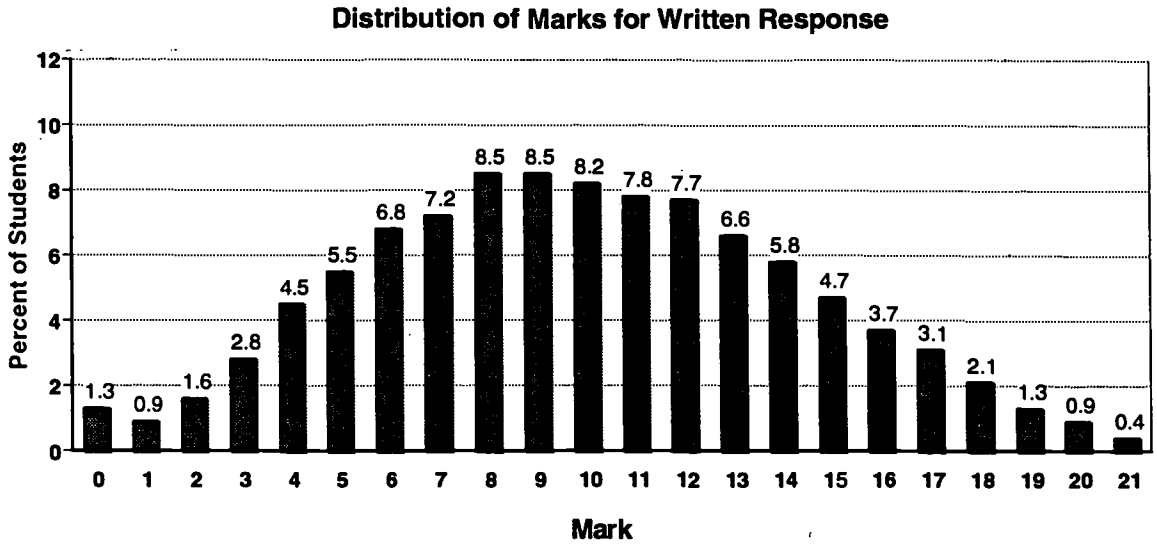
Multiple-choice question 26 required students to apply Mendel's law of segregation to modern–day knowledge of the process of meiosis and its relationship to genetic inheritance. In general, most students were able to identify that segregation occurred during meiosis. The most common error was that students incorrectly identified the description of the process of segregation. This indicates that these students do not recognize the links between separation of homologous pairs of chromosomes and their alleles, the production of non-identical gametes, and the inheritance of genetic traits.

Multiple-choice question 28 required students to determine the possible genotypes of three cows and a bull and then select the animal that could have two possible genotypes. Students achieving at the standard of excellence were readily able to identify Cow 3 as the animal with two possible genotypes (Pp or PP); however, most of the other students had some degree of difficulty. The most common error was that students chose Cow 2, which only has one possible genotype (Pp). This indicates that these students do not recognize that an individual that does not have a recessive traits must be a carrier of that trait's allele in order to pass the trait on to their offspring.

Numerical-response question 6 required students to create a gene map from crossover frequencies for four *Drosophila* genes in order to determine the order of those genes. Students achieving at the standard of excellence were readily able to create an accurate gene map in order to sequence these genes from the data provided; however, most other students had some degree of difficulty. The most common error was that students placed pink eyes and rough eyes closest together in the sequence instead of farthest apart. This indicates that these students do not understand that the higher the crossover frequency, the farther apart two genes must be. Genes that are closest to each other on a chromosome are most likely to stay together.

Written-Response Questions

The graph below shows the percentage of students achieving various marks on the written-response questions. The maximum mark obtainable was 21. Questions in the written-response section dealt with four of the seven course units for Mathematics 33. Of the students who wrote the examination, 1.3% received no marks for the written-response questions, 44.1% received 11 marks or more (acceptable standard), and 7.8% received 17 marks or more (standard of excellence) out of 21.

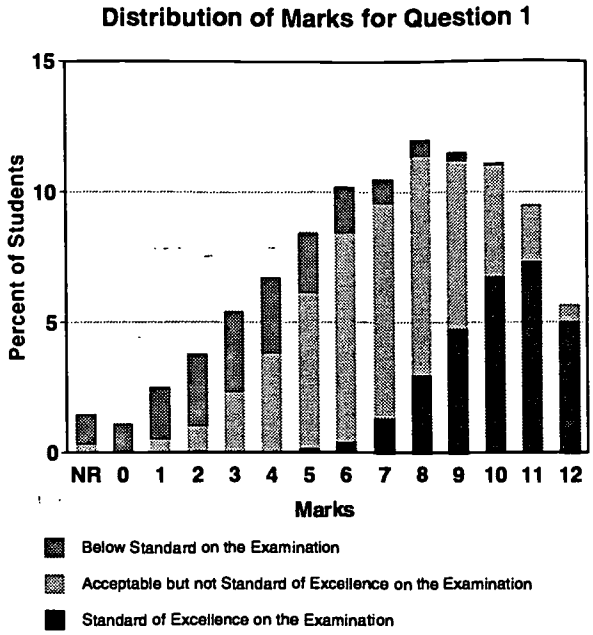


Below, the results of the written-response section of the Mathematics 33 Diploma Examination are tabulated according to the percentage of students from each group attaining the standards on each question.

Percentage of Students Achieving the Standards on Written-Response Questions

	Question Number			
Student Group	**WR 1**	**WR 2**	**WR 3**	**WR 4**
Students at the *standard of excellence* (80% or higher, or A) who achieved 80% or higher on the question	81.7	73.1	59.0	72.7
Students at the *acceptable standard* (50% or higher, or A, B, or C) who achieved 50% or higher on the question	74.5	54.5	53.4	77.8

The written-response section is worth 30% of the total examination mark. Students are expected to use conceptual, procedural, and problem-solving understandings to solve the four written-response questions. Teachers can compare school and jurisdiction results with the provincial results presented in the graphs that follow to determine areas of strength and weakness in the achievement of their students and, consequently, areas of potential strength and weakness in their program.



Question 1 Almost all students (98.4%) who wrote the examination received some marks on this process skill question related to a study on the impact of human activity on grizzly bears in the Bow River Watershed. The population density of grizzly bears in an area, their biotic potential, the effects of habitat fragmentation on genetic diversity and survival of grizzlies, and the effects of overcrowding on reproductive rates for female grizzlies are aspects of the grizzly bears' ecology presented in this question.

The mean of part a was approximately 71%, which indicates that students were able to calculate the population density of grizzly bears in a given area (Banff National Park). Students who had difficulty with this question often failed to provide units or to accurately calculate the density after substitution in the formula.

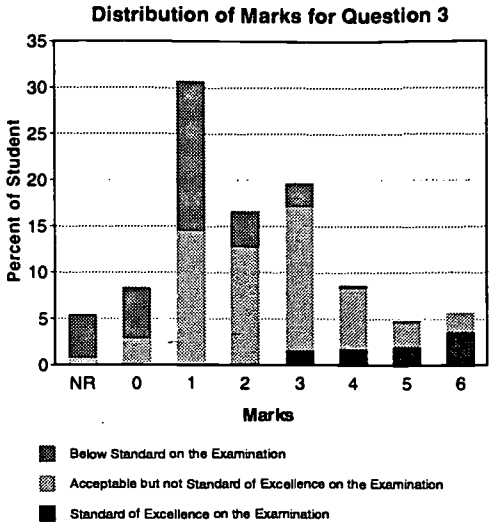
The mean of part b was approximately 62%, which indicates that, in general, students were able to analyze data on the grizzly bear population and range size to make appropriate conclusions about the survival ability of male grizzly bears in Banff National Park. This required that students choose and analyze the appropriate data from the context in order to reach a conclusion. Students did well on this difficult question: most students at least attempted an analysis of the data. Students who had difficulty with this question chose data that would not accurately allow them to reach a conclusion or they were unable to mathematically analyze the data to reach an appropriate conclusion.

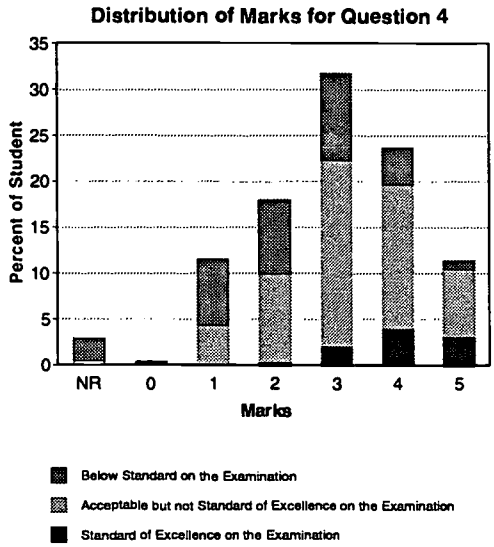
The mean of part c was approximately 55%, which indicates that many students had difficulty explaining how two factors contribute to the low biotic potential of grizzly bears. Many students did not have a good understanding of the term "biotic potential" and therefore did not explain how two selected factors contribute to a relatively low biotic potential for grizzly bears. A common error was that students listed factors that would be used to classify grizzly bears as K-selected instead of explaining how they contributed to a low biotic potential. Most students could correctly classify the grizzly bear as a K-selected species.

The mean of part d was approximately 62%, which indicates that, in general, students were able to predict the effect of the Trans-Canada Highway on genetic diversity of the grizzly bear population. Students had difficulty clearly explaining how genetic diversity would be affected and how change results from a loss or gain of unique alleles in the entire population. Some students confused change in genetic diversity with change in population numbers or gave explanations that were not clearly linked to change in alleles variability in the entire population.

The mean on part e was approximately 74%, which indicates that students were able to correctly describe a technology that could have been used in the study to determine range and migration routes of the grizzly bears.

The mean on part f was 53%, which indicates that students had some difficulty in reading and interpreting the data in the graph provided. Students who had difficulty on f.i. did not use the graph to answer the question, did not use the appropriate population size for the grizzlies in Banff National Park, or were unable to read the graph correctly. Students that had difficulty on f.ii. did not recognize the relationship in the graph as an inverse one. They were, therefore, unable to describe factors such as overcrowding and stress that might lead to a decreased reproductive rate as population size increases.





Question 3 required students to identify significant points on the graph of a quadratic function, explain how these points are used to derive the parameters of its equation in a particular form, and write an equation in expanded form. The question was marked on a six-point anaholistic scale, with one point allocated for the identification of an x-intercept and a five-point scale used for the determination of equations in different forms and the explanations associated with their derivation. The average for this question was 2.16 (35.9%). The markers felt that the strength of the responses included the identification of an x-intercept, writing the equation in its standard form $y = (x - 2)^2 - 9$, and referring the equation's parameters to the vertex. Markers also identified several major weaknesses in student responses. Justification for the value of k and explanations for how the point or points were related to the parameters of a derived equation were often weak or missing; as well, the expansion of an equation into the form $y = ax^2 + bx + c$ was incorrectly completed or simply omitted. In general, student responses lacked clear and logical communication. Markers also noticed that about 15% to 20% of the students misconstrued the instructions in bullet three to mean finding the slope.

Question 4 required students to interpret and analyze a graph based on a real-life scenario in terms of profit and loss and to justify a financial position based on this analysis. The question was marked on a five-point holistic scale, and the average was 2.95 (59.0%). Markers noticed that there were very few "no responses" (3%) and that almost all students provided complete responses for all parts of the question. Students successfully identified months when the business experienced a loss or "broke even," used dollar signs with graphical or calculated values, and provided reasonable explanations for parts c and d. Some of the weaknesses identified by markers were a lack of numerical data to support or justify answers (especially in part d), incorrect use of grammar and misspelled words, and the indication by some students that the words *data* and *justify* (a directing word) were not understood. Some students also incorrectly used values interpolated from the dotted line sections (between months) of the graph in their answers.

Markers also generalized that student performance on the written-response questions would be enhanced if students were engaged in various tasks and assessment instruments throughout the year that expected them to communicate their understanding of Mathematics 33 concepts and processes using correct terminology, logically presented and syntactically correct solutions, and complete sentences.

For further information, contact Ron Zukowski (rzukowski@edc.gov.ab.ca) or Corinne McCabe (cmcabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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