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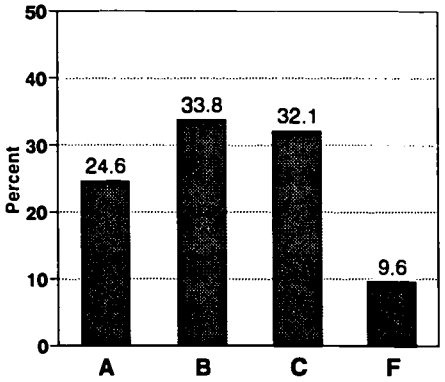
ABSTRACT

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 Mathematics 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 88.7% of the 8,432 students who took the test achieved the acceptable standard, and 20.5% 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)

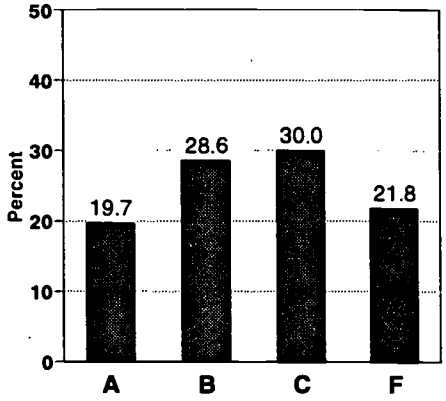
Mathematics 30

Diploma Examination Results
Examiners' Report for June 1998

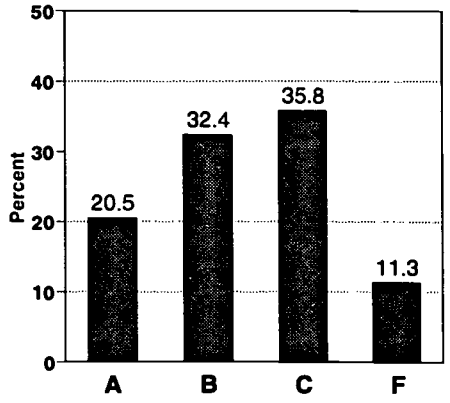
School-Awarded Mark



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 Mathematics 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that are provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 30 Diploma Examination consists of 40 multiple-choice questions worth 57.1%, 9 numerical-response questions worth 12.9%, and 3 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 8 432 students who wrote the June 1998 examination.

- 88.7% of the 8 432 students achieved the acceptable standard (a final course mark of 50% or higher).
- 20.5% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50.6% of the students who wrote the June 1998 examination were female.

- 88.5% of the female students achieved the acceptable standard (a final course mark of 50% or higher).
- 18.6% of these female students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 49.4% of the students who wrote the June 1998 examination were male.

- 88.8% of the male students achieved the acceptable standard (a final course mark of 50% or higher).
- 22.3% of these male students achieved the standard of excellence (a final course mark of 80% or higher).

Provincial Averages

- The average school-awarded mark was 67.6%.
- The average diploma examination mark was 63.5%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 65.9%.

Of the 8 432 students who wrote the June 1998 examination, 16% had written at least one Math 30 exam previously.

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%.

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.

Questions are classified by unit topic and mathematical understanding.

Unit Topic:

Poly. Fn.	Polynomial Functions
Trig. Fn.	Trigonometric & Circular Functions
Stat.	Statistics
Quad. Rltns.	Quadratics Relations
Exp. & Log.	Exponential & Logarithmic Functions
Perm. & Com.	Permutations & Combinations
Seq. & Series	Sequences & Series

Mathematical Understandings:

P	Procedure
C	Concept
PS	Problem-solving

Blueprint

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 1	D	0.763	✔							C
MC 2	C	0.740	✔							PS
MC 3	C	0.473	✔							PS
MC 4	B	0.722	✔							C
MC 5	B	0.539	✔							PS
MC 6	D	0.499	✔							PS
MC 7	A	0.787	✔							C
NR 1	2314	0.873	✔							C
MC 8	C	0.670		✔						PS
MC 9	C	0.522		✔						PS
MC 10	C	0.447		✔						P
MC 11	D	0.459		✔						PS
MC 12	B	0.844		✔						C
MC 13	A	0.745		✔						C
NR 2	0.95	0.477		✔						C
NR 3	1243	0.435		✔						P
MC 14	C	0.878					✔			C
MC 15	C	0.407					✔			C
MC 16	A	0.820					✔			P
MC 17	D	0.592					✔			PS
MC 18	D	0.777					✔			P
MC 19	B	0.814					✔			PS
MC 20	B	0.653					✔			P
NR 4	729	0.681					✔			P
MC 21	A	0.862				✔				C
MC 22	B	0.743				✔				C
MC 23	B	0.409				✔				PS

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 24	D	0.771				✔				C
MC 25	A	0.832				✔				C
MC 26	C	0.646				✔				C
NR 5	17.0	0.300				✔				P
MC 27	B	0.784							✔	P
MC 28	C	0.468							✔	PS
MC 29	D	0.531							✔	PS
MC 30	A	0.721							✔	PS
MC 31	A	0.651							✔	C
MC 32	A	0.597							✔	PS
NR 6	75.0	0.628							✔	P
MC 33	D	0.786						✔		C
MC 34	A	0.862						✔		C
MC 35	C	0.712						✔		P
MC 36	B	0.730						✔		P
MC 37	A	0.591						✔		C
NR 7	720	0.846						✔		P
NR 8	6720	0.510						✔		P
MC 38	D	0.843			✔					C
MC 39	B	0.671			✔					P
MC 40	A	0.734			✔					PS
NR 9	0.02	0.493			✔					P
WR 1	-									P/C/PS
WR 2	-									P/C/PS
WR 3	-									P/C/PS

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: 32.2 out of 49

Written response: 8.7 out of 15

Raw Score Average for Machine-Scored Questions by Course Emphasis

Poly. Fn	Polynomial Functions	5.3 out of 8
Trig. Fn	Trigonometric & Circular Functions	4.6 out of 8
Stat	Statistics	2.7 out of 4
Quad. Rltns	Quadratic Relations	4.6 out of 7
Exp. & Log.	Exponential & Logarithmic Functions	5.6 out of 8
Perm. & Com.	Permutations and Combinations	5.0 out of 7
Seq. & Series	Sequences and Series	4.4 out of 7

Raw Score Average for Machine-Scored Questions by Mathematical Understandings*

- Procedural (P): 9.5 out of 15
- Conceptual (C): 14.0 out of 19
- Problem Solving (PS): 8.7 out of 15

* Refer to Appendix C of the 1997–98 *Mathematics 30 Information Bulletin, Diploma Examinations Program* for an explanation of mathematical understandings.

Multiple-Choice and Numerical-Response Questions

The following table gives results for four questions selected from the examination and shows the percentage of students in four groups that answered the question correctly. The comments following the table discuss some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

Student Group	Question Number NR 3	MC 9	MC 23	MC 24
All Students	43.5	52.2	40.9	77.1
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	80.8	85.7	73.4	87.9
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	41.7	51.7	36.8	76.6
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	14.5	23.1	22.6	68.4

Multiple-Choice and Numerical-Response Questions

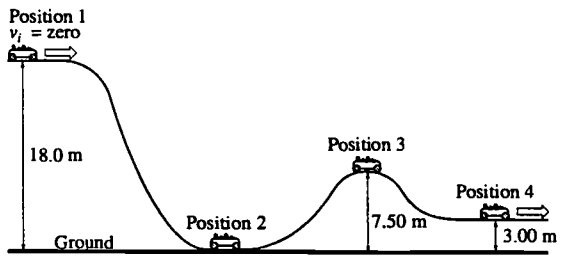
The following table gives results for four questions selected from the examination. The table shows the percentage of students in four groups that answered the question correctly. The comments following the table discuss some of the understandings and skills the students may have used to answer these questions.

Percentage of Students Correctly Answering Selected Machine-Scored Questions

Student Group	Question Number			
	MC 1	MC 13	MC 18	MC 20
All Students	75.6	60.8	51.9	51.8
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	95.0	89.6	82.6	78.3
Students achieving the *acceptable standard* (between 50% and 79%, B or C) on the whole examination	74.0	55.2	43.7	44.3
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	43.9	25.5	23.0	28.8

Use the following information to answer the next question.

Roller-Coaster Ride



A 250 kg roller-coaster car starts at position 1 and continues through the entire track. The brakes are applied after the car passes position 4. Assume that the effects of friction on the roller-coaster car are negligible between positions 1 and 4.

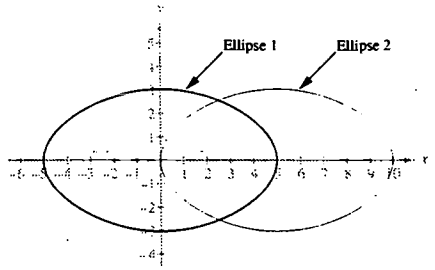
1. The roller-coaster car's speed at position 4, immediately before the brakes are applied, is

   A. 18.8 m/s
   ***B.** 17.2 m/s
   C. 13.3 m/s
   D. 12.1 m/s

For **Multiple-choice question 1**, most students who achieved the acceptable standard on the examination correctly answered this question. In order to obtain the correct answer, students had to apply the law of conservation of mechanical energy. Since the car moves from position 1 to position 4 with negligible frictional effects, the potential energy of the car at position 1 is equal to the sum of its potential and kinetic energy at position 4. Alternative A was chosen by students who assumed that the potential energy at position 1 was equal to the car's kinetic energy at position 4. Alternative D was chosen by students who assumed that the potential energy at position 3 was equal to the car's kinetic energy at position 4.

Use the following information to answer the next question

Two ellipses with identical shapes are shown below. The graph of ellipse 2 is obtained by moving the graph of ellipse 1 five units to the right.



24. Which of the following statements about the ellipses is **true**?

A. The values of the eccentricities of the ellipses are different.

B. The general equation of each ellipse is $Ax^2 + Cy^2 + Dx + Ey + F = 0$, where the values for parameters A, C, and F are the same.

C. The foci are closer together in the first ellipse than in the second.

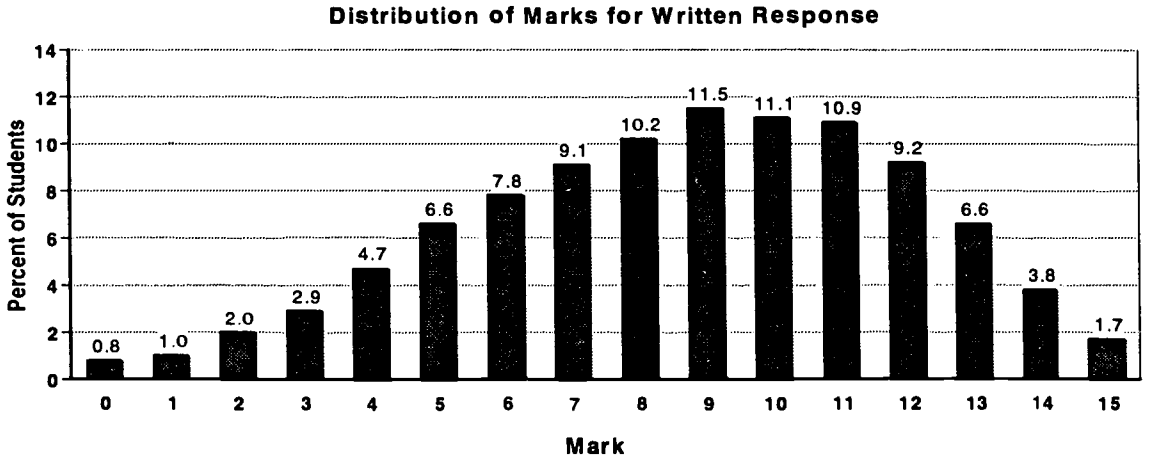
***D.** The sum of the distances from a point on an ellipse to its foci is the same for each ellipse.

relation formed when given the locus definition; and the effects on the graph of the quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, when two of the numerical coefficients change. Students are also expected to generate the graphs of quadratic relations with the use of graphing calculators or a graphing utility package; identify and graph the quadratic relation when given a point on the quadratic relation, a fixed point, and the eccentricity; calculate the eccentricity when given a fixed horizontal or vertical line, a fixed point, and a point on the quadratic relation; and identify and graph the quadratic relation when given the eccentricity, a fixed point, and a fixed horizontal or vertical line. Multiple-choice questions 21 to 26 and numerical-response question 5 required students to demonstrate their understanding of this unit.

In addition to the expectations for the acceptable standard, students who achieve the standard of excellence must also be able to identify and to describe orally, in writing, and by modelling, the position of the plane at which the intersection of a plane and a conical surface defines a degenerate parabola; the changes in the graph of a quadratic relation when the eccentricity changes; the locus definition and use it to verify the equation of each conic section; the effects on the graph of the quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, when two or more of the numerical coefficients change; and the solution to problems that require the analysis of quadratic relations studied in Mathematics 30. Multiple-choice questions 21, 24, and 26 require students to demonstrate these objectives.

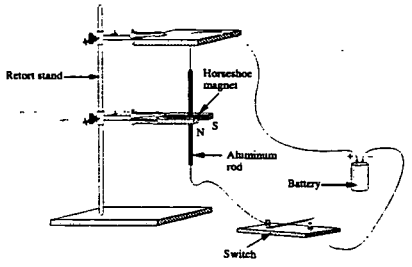
Written-Response Questions

As published in the 1998–99 *Mathematics 30 Diploma Examination Information Bulletin*, the written-response questions assess whether or not students can draw on their mathematical experiences to solve problems and to explain mathematical concepts. Therefore, the written-response questions do not necessarily fall into a particular unit of study but may cross more than one unit or they may require students to make connections among mathematical concepts. Students achieving the acceptable standard are expected to obtain at least 8 out of 15 marks on the written-response questions. Students achieving the standard of excellence are expected to obtain at least 12 out of 15 marks on the written-response questions.



Use the following information to answer the next question.

The diagram below shows an experimental design used to investigate the effect of a magnetic field on a vertical current-carrying conductor. The aluminum rod is able to swing freely.



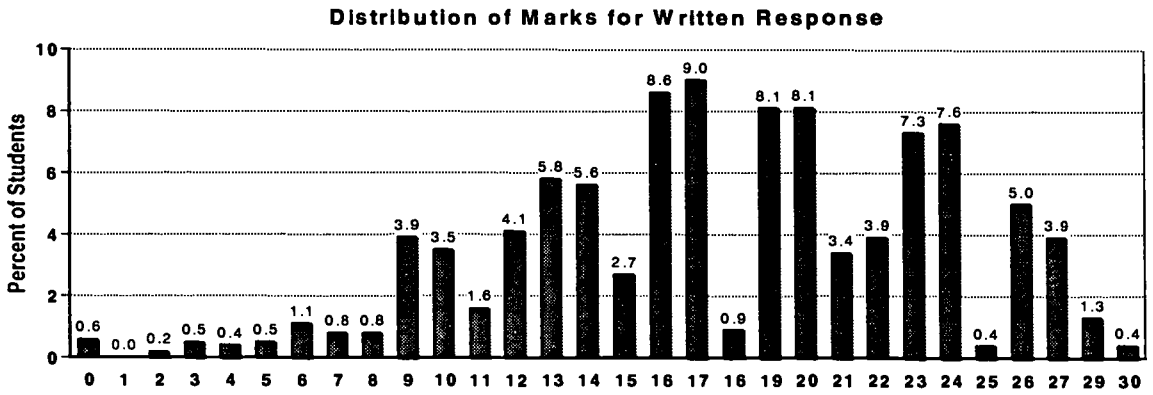
20. When the switch is closed, a current in the circuit causes the bottom end of the aluminum rod to swing

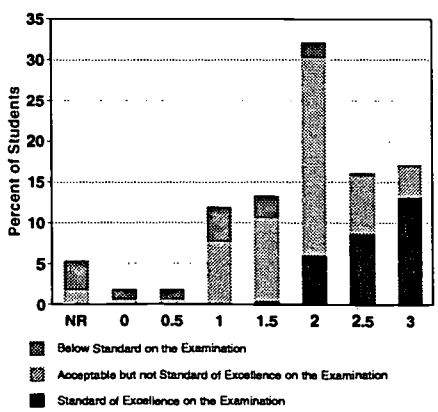
- **A.** toward the retort stand
- ***B.** away from the retort stand
- **C.** toward the south pole of the magnet
- **D.** toward the north pole of the magnet

Most students found **Multiple-choice question 20** difficult. To successfully answer this question, students had to understand that the field produced by the horseshoe magnet interacts with the field produced by the current-carrying wire. This interaction results in the aluminum rod being deflected away from the retort stand. Most students who achieved the standard of excellence on the examination either answered this question correctly, or chose alternative A. They assumed that the rod would be deflected toward the retort stand. Students who did not achieve the acceptable standard on the examination tended to be equally drawn to all four alternatives. This suggests that these students lacked a strategy for evaluating how the current-carrying wire would be effected by an external magnetic field.

Written-Response Questions

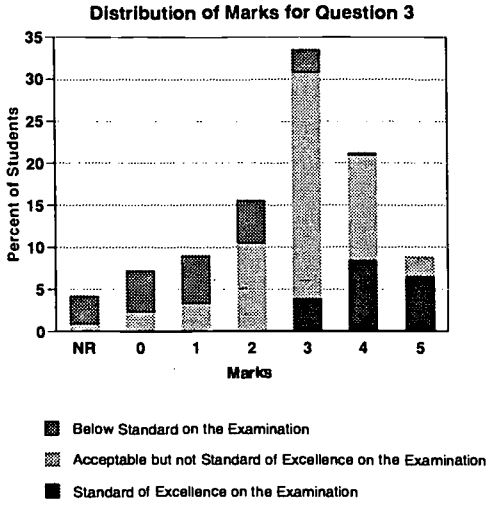
Of all the students who wrote the examination, 70.5% received a mark of 15 or higher, and 18.6% received a mark of 24 or higher out of 30 on the written-response questions. The average mark on the written-response questions was 17.8, or 59.3%.





Results for **Written-response question 1** indicate that the majority of students showed a good understanding of the basic properties of alpha, beta, and gamma decays. In doing so, they demonstrated an understanding of the relative charge and penetrating ability of these particles. Students also showed a good understanding of safety issues. Most students correctly described how to protect the clean-up crew from radiation. However, many students did not address the danger associated with a particular type of radiation.

Students generally demonstrated a correct use of the hand rules to predict the direction of the force applied to a charged particle moving through a magnetic field.



Question 3 provided students with two correctly completed tables involving a geometric sequence t_n. Using the information provided, students were asked to determine an expression for t_n, as well as to find the value of t_{10} and the values of c and d in the expressions $\log_c(t_n)$ and $\log_d(t_n)$. Students were provided with the general geometric sequence of n terms and another sequence that had been formed by finding the logarithm of each term of the given geometric sequence. They were asked to write a logical argument to prove that this sequence of logarithmic expressions was arithmetic. An example of a common flaw in students' solutions included using specific values for the terms in writing a logical argument to show that $\log(a)$, $\log(ar)$, $\ldots\log(ar^{n-1})$ is arithmetic with a common difference of $\log r$.

Of the students who achieved the acceptable standard on the examination, 78% scored 3 or more marks out of 5, and of the students who achieved the standard of excellence on the examination, 78% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.7 or 54%.

Scoring Guide for Written-Response Questions

Credit may be given to students who show unusual insight. If their solutions fall outside *Specific Question Scoring Rubrics*, they were scored against the *General Scoring Guide*.

SPECIFIC QUESTION SCORING RUBRICS

Question 1

5 The student
- identifies the type of graph paper that would be used to sketch Case 1 and Case 2 and clearly outlines the steps required to sketch an ellipse for either Case 1 or 2. The steps are clearly communicated.

4 The student
- identifies the type of graph paper for Case 1 and 2 and outlines the steps for one case. There is a minor flaw in the student's work

or
- identifies the type of graph paper for one case and outlines the steps for one case.

3 The student
- identifies the type of graph paper for one case and outlines the steps required to sketch an ellipse for this case with a flaw

or
- identifies the type of graph paper for Case 1 and 2 and correctly draws the graph for either Case 1 or 2 with little or no explanation

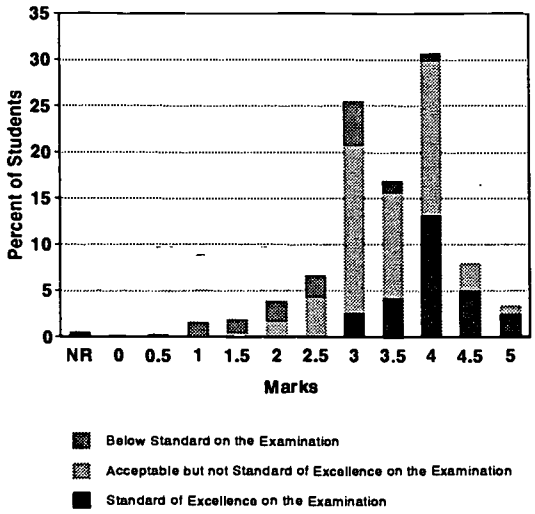
or
- identifies the type of graph paper for Case 1 and 2 and makes significant progress on an explanation for one case.

2 The student
- identifies the type of graph paper for Case 1 and Case 2

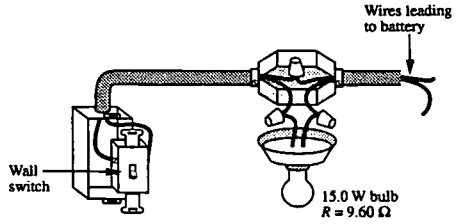
or
- begins to outline the steps for one case, using the correct graph paper.

1 The student explores the initial stages of the problem.

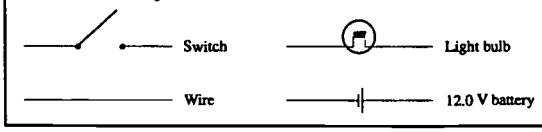
Distribution of Marks for Question 2



The diagram below illustrates how a single light fixture is connected to a battery and switch, as might be found in a recreational vehicle (RV).



The following schematic symbols represent circuit components.



Written Response – 15%

2.

- Using the symbols shown above, draw and label a schematic diagram representing this circuit.
- Draw and label a second schematic diagram containing one switch, the 12.0 V battery, and a 3.0 W nightlight bulb in parallel with the 15.0 W bulb. Design this two-light-bulb circuit so that the switch controls only the 15.0 W bulb.
- Describe what happens to the 3.0 W bulb and the 15.0 W bulb when the switch is open and when it is closed in the two-light-bulb circuit.
- Calculate the total power, total current, and total resistance of the two-light-bulb circuit when the switch is closed.

Clearly communicate your understanding of the physics principles that you are using to solve this question. You may communicate this understanding mathematically, graphically, and/or with written statements.

Markers noted that closer attention needs to be paid to the bold-faced statement that follows all anaholistic questions:

Clearly communicate your understanding of the physics principles that you are using to solve this question. You may communicate this understanding mathematically, graphically, and/or with written statements.

Problems involving calculations require that students use equations from the equation sheet, substitute into these equations, and the answers should be expressed with correct significant digits and units. Problems requiring written answers should include the answer, as well as written support for the answer including physics principles appropriate to the question. Students should recognize that justification for their answer is required at all times.

Many student responses demonstrated common misconceptions regarding the operation of parallel circuits. Examples of these misconceptions are highlighted in the three student quotations that follow:

"The 12 V is split in a parallel circuit, resulting in 6 V for each pathway." In this case, the student should have identified that Kirchhoff's Voltage Law would predict that there would be 12 V for each path of a parallel circuit.

"The 3.0 W bulb will dim when the 15.0 W bulb is lit in the parallel circuit." Once again, applying Kirchhoff's Voltage Law, the student should predict that there will be no reduction in the intensity of the light produced by 3.0 W bulb.

"The current is split equally along each path of a parallel circuit." Using Kirchhoff's Current Law, the student should predict that the total current through the power supply is the sum of the currents through each path of the parallel circuit. When the parallel branch is added to the circuit, the current through the original branch does not change. However, the total current through the power supply will increase.

For further information, contact Bob Shaw (bshaw@edc.gov.ab.ca) or Corinne McCabe (cmccabe@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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