# Information Bulletin | Physics 30

## 2014 – 2015 Diploma Examinations Program

This document was written primarily for:

| | |
|---|---|
| Students | ✓ |
| Teachers | ✓ of Physics 30 |
| Administrators | ✓ |
| Parents | |
| General Audience | |
| Others | |

Distribution: This document is posted on the Alberta Education website at education.alberta.ca.

# *Contents*



You can find diploma-examination-related materials on the Alberta Education website at education.alberta.ca.

# *Field Testing*

**Online Field Testing**

All Grade 12 science and mathematics field tests are offered exclusively through an enhanced Quest A+ online delivery system.

Students should use paper data booklets, data pages, or formula sheets for all science and mathematics field tests. These resources will also appear in the online delivery system. Students should also have scrap paper, which may be accessed and downloaded from the "Teacher Resources" section on the home page of the Field Test Request System: http://public.education.alberta.ca/FieldTestScheduler. All paper data sheets or scrap paper with markings must be securely shredded at the end of the field test administration.

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

Teachers have a 24-hour window to peruse the field test and are provided with data on how their students performed. These data include the proportion of students who chose each alternative on multiple-choice items and the proportion who left a numerical-response item blank. Test items are blueprinted to program of studies outcomes. This allows teachers to use field test results to learn more about their students' strengths and weaknesses.

Once logged into the field test, teachers have the same length of time to peruse the test as their students did to write it. Teachers might choose to log into the field test, submit the confidentiality form, and then log out of the test, so that they can finish perusing the test after receiving their students' data.

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

Finally, online administration enables every school, large or small, to participate. Historically, it was impractical to send field test administrators to remotely located schools, or schools with small classes. Now, all Alberta schools can participate in 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 commit to maintaining the security of field test items.

**Further Information**

Teachers who intend to request field tests must have a Public Authentication System (PAS) account. All requests are made through the Field Test Request system. Further information about field testing, including the closing dates to request a field test, may be obtained by contacting Field.Test@gov.ab.ca, or from the General Information Bulletin at http://education.alberta.ca/media/6446764/11-dip-gib-2013-14_field%20testing-2013-11-25.pdf. Practice items are available at https://questaplus.alberta.ca/.

For more information, contact

Deanna Shostak
Director, Diploma Programs
780-422-5160 or Deanna.Shostak@gov.ab.ca

or

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

## *Survey Questions in Diploma Examinations*

The Biology 30, Chemistry 30, Physics 30, and Science 30 diploma examinations 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.

## *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 or to place an order, contact

Laura LaFramboise
Distribution Officer Coordinator, Examination Administration
780-415-2485 or Laura.LaFramboise@gov.ab.ca

# *Teacher Involvement in the Diploma Examination Process*

High-quality diploma examinations are the product of close collaboration between classroom teachers and Alberta Education. Classroom teachers from across Alberta are involved in many aspects of diploma-examination development, including the development of raw items; the building, reviewing, and administering of field tests; and the reviewing of diploma examinations.

Alberta Education values the involvement of the teachers and often asks school jurisdictions for the names of teachers who are interested in participating. Teachers who are interested in developing raw items or building and/or reviewing field tests are encouraged to ask their principals to submit their names, through proper channels, to the Assessment Sector. The list of teachers interested in these aspects of the development process remains open all year long, and teachers are welcome to have their names submitted at any time.

Other opportunities to be involved, such as field testing, have specific closing dates. General dates to be aware of include:

| | |
|---|---|
| September 2014 | Registration for field tests to be administered in December 2014 or January 2015 |
| February 2015 | Registration for field tests to be administered in May or June 2015 |

Periodically we send out information to those Physics 30 teachers who are on our contact list.

For more information, contact

Laura Pankratz
Team Leader, Physics 30 Assessment Standards
780-422-5465 or Laura.Pankratz@gov.ab.ca

# *Course Objectives*

Physics 30 is intended to further students' understanding and application of fundamental physics concepts and skills. The focus of the course is on understanding the physics principles behind the natural events that students experience and the technology that they use in their daily lives. The course encourages enthusiasm for the scientific enterprise and develops positive attitudes about physics as an interesting human activity with personal meaning. It develops knowledge, skills, and attitudes to help students become capable of and committed to setting goals, making informed choices, and acting in ways that will improve their own lives as well as life in their communities.

To develop the required knowledge, skills, and attitudes in Physics 30, students must have successfully completed Science 10 and Physics 20.

Although there is no mathematics prerequisite for Physics 20, students who have successfully completed Mathematics 20–1 or Mathematics 20–2 will have better algebra skills.

# *Performance Expectations*

**Curriculum Standards**

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

**Linking Program Verbs to Cognitive Expectations**

Some verbs used in the programs of study carry expectations that require students to recall facts or identify characteristics. For the development of the Physics 30 diploma examination, these verbs are classified as "knowledge" level. Examples of these verbs are listed in the yellow column below. Some verbs carry expectations that require students to apply their knowledge and skills in conventional situations. For the development of the Physics 30 diploma examination, these verbs are classified as "comprehension and application" verbs. Examples of these verbs are listed in the green column below. Some verbs carry expectations that require students to build new connections, to create relationships between concepts, and to apply models to new and unusual situations. For the development of the Physics 30 diploma examination, these verbs are classified as "higher mental activities." Examples of these verbs are in the blue column below.

The *Physics 20–30 Program of Studies, 2007* also contains attitude and skill verbs 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, list, label, match, name, outline, predict*, recall, select, state, what, when, who<br><br>Use memorized or algorithmic methods to solve problems | Apply, analyze, calculate, change, compare*, contrast, determine, estimate (interpolate or extrapolate), explain*, generalize, interpret*, infer, relate, translate, solve<br><br>Design a procedure for a known experiment | Assess, compare*, differentiate, compile, compose, conclude, create, defend, evaluate, explain*, interpret*, judge, justify, organize, plan, summarize<br><br>Transfer methods from one area to another<br><br>Use generalized methods to solve problems<br><br>Design a new procedure for an unfamiliar experiment |
| **Attitudes and Skills**<br>Appreciate, collect, conduct, develop, gather, measure, observe, plot, work collaboratively | | |

*These verbs 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.

# *Performance Standards*

**Acceptable Standard**

Students who achieve the acceptable standard in Physics 30 will receive a final course mark of 50% or higher. Students achieving the acceptable standard have gained new skills and knowledge in physics but may encounter difficulties if they choose to enroll in post-secondary physics courses. These students are able to define basic physics terms: for example, scalar, vector, momentum, force, field, charging by conduction or by induction, refraction, diffraction, interference, the photoelectric effect, the Compton effect, matter-energy equivalence, nucleons, nucleus, decay, half-life, and stable energy states. These students are able to state and use formulas as they appear on the equation sheet: for example, momentum of a single object, linear momentum analysis, electric force, electric field, magnetic deflecting force, motor force, angle of refraction, index of refraction, focal length, magnification, photon energy, work function, mass (activity or percentage) remaining of a radioactive nuclide, photon energy, and energy change associated with photon emission or absorption. They can do this in situations where they need to sort through a limited amount of information. Their laboratory skills are limited to following explicit directions and to using laboratory data to verify known physics information. They are able to identify manipulated and responding variables, but not relevant controlled variables. These students are able to relate graph shape to memorized relationships, but their analysis of graphs is limited to linear data. These students tend to use item-specific methods in their problem solving and rarely apply the

major principles of physics in their solutions: for example, conservation laws, balanced or unbalanced forces, and type of motion. When explaining the connections between science, technology, and society, these students tend to use examples provided from textbooks. These students have difficulty connecting physics to real-life scenarios beyond the classroom.

**Standard of Excellence**

Students who achieve the standard of excellence in Physics 30 receive a final course mark of 80% or higher. They have demonstrated their ability and interest in both mathematics and physics, and feel confident about their scientific abilities. These students should encounter little difficulty in post-secondary physics programs and should be encouraged to pursue careers in which they will utilize their talents in physics. Students who achieve the standard of excellence show flexibility and creativity when solving problems, and minor changes in problem format do not cause them major difficulties. These students are capable of analyzing situations that involve two-dimensional vectors, charge motion initially perpendicular to an external electric field, charge motion perpendicular to an external magnetic field, and energy-level values above or below given values based on photon characteristics, etc. They seek general methods to solve problems and are not afraid to use physics principles as a framework for their solutions. In the laboratory, students who achieve the standard of excellence can deal with data that are less than perfect or with instructions that are incomplete. These students are able to explicitly relate graph shape to mathematical models and to physics equations. They transfer knowledge from one area of physics to another and can express their answers in clear and concise terms. These students are able to apply cause-and-effect logic in a variety of situations: algebraically, experimentally, etc. In addition, these students can connect their understanding of physics to real-world situations that include technological applications and implications beyond the classroom setting.

# *Examination Specifications and Design*

Each Physics 30 diploma examination is constructed as closely as possible to the following specifications.

**Program of Studies Outcomes**

The design supports the integration of all Physics 30 general outcomes (GOs) as mandated in the *Physics 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 outcome. As a result, the examination is not necessarily 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 (Curricular Fit)** |
|---|---|---|
| GO A | **Momentum and Impulse:** Students will explain how momentum is conserved when objects interact in an isolated system. | 10–20% |
| GO B | **Forces and Fields:** Students will explain the behaviour of electric charges using the laws that govern electrical interactions. They will describe electrical phenomena using the electric field theory. They will explain how the properties of electric and magnetic fields are applied in numerous devices. | 25–35% |
| GO C | **Electromagnetic Radiation:** Students will explain the nature and behaviour of electromagnetic radiation using the wave model. They will explain the photoelectric effect using the quantum model. | 25–35% |
| GO D | **Atomic Physics:** Students will describe the electrical nature of the atom. They will describe the quantization of energy in atoms and nuclei. They will describe nuclear fission and fusion as powerful energy sources in nature. They will describe the ongoing development of models of the structure of matter. | 20–30% |

Questions on the diploma examination will require students to demonstrate knowledge of physics concepts and to apply skills in a context that supports making Science, Technology, and Society (STS) connections.

***Scientific Process and Communication Skills***

Students will

- formulate questions about observed relationships and plan investigations into questions, ideas, problems, and issues
- use a broad range of tools and techniques to record data and information
- analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- 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 concepts, models, and theories are often used in interpreting and explaining observations, and in predicting future observations
- explain that scientific knowledge may lead to the development of new technologies and that 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 is subject to change as new evidence becomes apparent, and as laws and theories are tested and subsequently revised, reinforced, or rejected
- 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, and that the appropriateness, risks, and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability

The Physics 30 diploma examination consists of 36 multiple-choice and 14 numerical-response items, of equal weight. Fewer than half the items require a calculation.

**Machine-Scored Questions**

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

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet. 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 that is 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 more than one numerical-response question.

**Numerical-response questions** are of three types: calculation of numerical values; selection of numbered events, structures, or functions from a diagram or list; and determination of a sequence of events.

**Assessment of Skills and STS Connections**

Physics 30 examination questions are designed to measure students' understanding of physics concepts mandated by the *Physics 20–30 Program of Studies, 2007.* Some questions also measure students' understanding and use of skills associated with scientific inquiry, and some questions have been designed to measure students' understanding of the connections among 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.

# *Examination Security*

All Physics 30 diploma examinations are secured.

# *Maintaining Consistent Standards over Time on Diploma Examinations*

Student scores on Physics 30 diploma examinations are now equated to the baseline examination. This is done to support fairness to students: each examination score is what the student would have received had he/she written the baseline examination.

# *Diploma Examinations: Multiple Forms*

As part of Alberta Education's commitment to fairness to students, and to expand flexibility in the writing of diploma examinations, the number of distinct examination forms (versions) has increased. There are now two forms of diploma examinations in some subjects during major administrations (January and June). The two forms are equated to baseline examinations to ensure that the same standard applies to both forms. Both forms adhere to the established blueprint specifications and are thoroughly reviewed by a technical review committee.

To facilitate the analysis of school-level results, each school receives only one examination form per subject. In subjects offering a translated French-language examination, both forms are administered in English and in French.

For more information, contact

Deanna Shostak
Director, Diploma Programs
780-422-5160 or Deanna.Shostak@gov.ab.ca

or

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

# *Publications and Supporting Documents*

In addition to this bulletin, the following documents are published by Alberta Education.

- *Physics 20-30 Program of Studies, 2007* available on education.alberta.ca, via this pathway:
  Teachers > Programs of Study > (Programs of Study) Science > Programs of Study > (Senior High) Physics 20-30
- *Physics 20 and 30 Student-Based Performance Standards* available on education.alberta.ca, via this pathway:
  Administrators > Provincial Testing > Diploma Examinations > Diploma Examination Information Bulletins
- *Written Response Archive* available on education.alberta.ca, via this pathway:
  Administrators > Provincial Testing > Diploma Examinations > Diploma Examination Information Bulletins
- *Physics 30 Data Booklet* available on education.alberta.ca, via this pathway:
  Administrators > Provincial Testing > Diploma Examinations
- *Archived* Physics 30 Information Bulletins available on education.alberta.ca, via this pathway: Administrators > Provincial Testing > Diploma Examinations > Diploma Examination Information Bulletins
- *Calculator Policy* available on education.alberta.ca, via this pathway:
  Administrators > Provincial Testing > Diploma Examinations > Diploma Examination Information Bulletins
- *Diploma Examination Detailed Reports*, available on the Alberta Education Extranet

The Assessment Sector supports online assessment with the testing platform QuestA+ at http://questaplus.Alberta.ca.

## *NEW *Teacher Comments on Diploma Examinations and Online Field Tests*

On the online perusal copies of the diploma examinations administered in January 2014 and June 2014, and on the online field tests, teachers had the opportunity to digitally input comments and concerns. The comments were greatly appreciated and, in some cases, resulted in action.

## *Reminders and Explanations*

**Definitions of Systems**

An isolated system is a system on which no external forces act (this is equivalent to: no external forces do work on the system; or external forces are balanced; or no external forces exist); an open system allows matter and energy to cross the boundary; a closed system allows energy but not matter to cross the boundary. Since the definition of a closed system is inconsistent with matter-energy equivalence, the diploma examination will use "closed" as an adjective for the quantity that doesn't cross the system's boundary. For example, a charged particle accelerating in a uniform electric field is a system that is closed to energy.

**Interference Pattern Equations**

The program of studies mandates that students apply two equations for interference: $\lambda = \frac{xd}{nl}$ and $\lambda = \frac{d \sin\theta}{n}$. Many students use $\lambda = \frac{xd}{nl}$ exclusively and do not realize that it is a special-case equation that can be applied validly only when $x \ll l$ or $\theta < 10°$.

**Lenses**

The Physics 30 Diploma Examination will use the terms *diverging* and *converging* when describing or classifying a lens.

**Mirrors**

The Physics 30 Diploma Examination will use the terms *plane*, *convex*, and *concave* when describing or classifying a mirror.

**Directions**

Students should be able to use and interpret conventions for directions perpendicular to the page:

- • indicates out of the page
- × indicates into the page

**Nuclear Equations**

The curriculum specifies that students should be able to write nuclear equations for alpha and beta decay. This includes both beta positive and beta negative decay with the appropriate neutrino and antineutrino.

| | |
|---|---|
| **Wave-particle Duality** | Students will be expected to know and apply $p = \frac{h}{\lambda}$ and $E = pc$ to determine the particle-like characteristics of photons.<br><br>Students are expected to know the wave-like characteristics of matter but **not** to derive $\lambda = \frac{h}{mv}$. |
| **Positrons** | Students are expected to know and use the term *positron* to describe the antimatter particle corresponding to the electron. |
| **Use of Rulers or Straightedges** | Students should be encouraged to use a ruler or straightedge when drawing the line of best fit. |
| **Use of Protractors** | Students may use protractors to measure angles on the diploma examination. |
| **Default Angle Units and Graphing Calculators** | Students who use graphing calculators on Physics 30 field tests and diploma examinations often fail to realize that the units for angle measure default to radians when the calculator memory is reset. As a result, these students will provide incorrect answers to questions that involve trigonometric functions. |
| **Constants** | Students should use constants provided on the data sheet and recorded to three significant digits rather than constants stored in calculators. This is important in order to obtain correct numerical-response answers. |
| **Numerical-Response Questions** | Students should be familiar with the different formats of numerical-response items and the procedure for completely filling in the bubbles on the answer sheet. |

# *Illustrative Numerical-Response Items Assessing Mandated Skills*

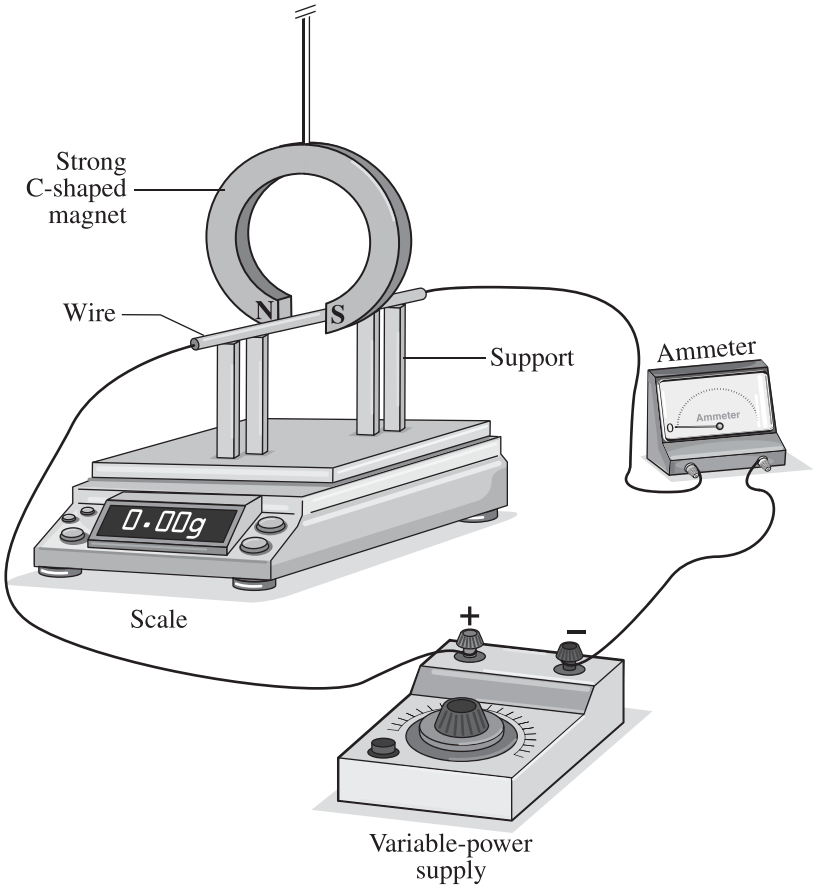
This item illustrates the design-an-experiment skill mandated in the program of studies outcome B3.1s.

B3.1s, *Students will* formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues • design an experiment to demonstrate the effect of a uniform magnetic field on a current-carrying conductor

*Use the following information to answer numerical-response question 1.*

A group of students sets up the apparatus shown below.

**Apparatus**



**Research Questions**

**1** Does the length of the wire in the magnetic field affect the magnetic force?

**2** Does the magnitude of the current in the wire affect the magnetic force?

**3** Does the strength of the magnetic field produced by the C-shaped magnet affect the magnetic force?

**4** Does the direction of the electron flow affect the magnetic force?

**5** Does the orientation of the wire relative to the external magnetic field affect the magnetic force?

**Variables**

**6** Force on wire

**7** Length of wire

**8** Strength of the C-shaped magnet

**9** Current in wire

## Numerical Response

**1.** Using the numbers above, choose **one research question** that could be investigated using the apparatus and match three of the variables to their respective roles in the investigation of that research question as given below. (There is more than one correct answer.)

| **Number:** | _____ | _____ | _____ | _____ |
|---|---|---|---|---|
| | **Research question** | **Manipulated variable** | **Responding variable** | **One of the variables that must be controlled** |

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

Answer: 1768, 1769, 2967, 2968, 4967, or 4968

**Numerical-response 1 Statistical Performance:** *This item has not been field tested.*

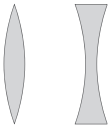
***NEW** This item illustrates how students can design an investigation by selecting apparatus and then analyze the results from their design. This is mandated in program of studies outcomes C1.1s.

C1.1s, *Students will* formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues; C1.2s, *Students will* conduct an investigation to determine the focal length of a … curved mirror; and C1.3s, *Students will* use ray diagrams to describe an image formed by … curved mirrors.

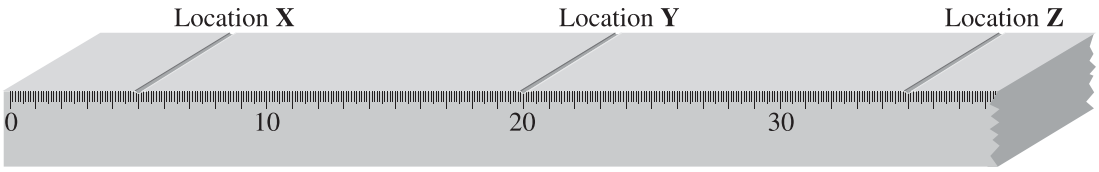
*Use the following information to answer numerical-response question 2.*

Students use three of the optical apparatus illustrated below to produce a **focused, real** image in a darkened room. One of the apparatus has a focal length of 10.0 cm.

**Optical Apparatus**

| Sources | | Lenses | | Mirrors | | | Diffraction grating | Double-slit apparatus | Screen |
|---|---|---|---|---|---|---|---|---|---|
|  | |  | |  | | |  |  |  |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |

The students place one apparatus at each labelled location on an optics bench, as shown below. The optics bench is scaled in millimetres and labelled in centimetres.




**Note:** The diagrams are **not** drawn to scale.

## Numerical Response

**2.** The apparatus placed at location

**X** is numbered _____ (Record in the **first** column)

**Y** is numbered _____ (Record in the **second** column)

**Z** is numbered _____ (Record in the **third** column)

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

Answer: 194, 094, 491, or 490

**Numerical-response 2 Statistical Performance:**

| Group | **Correct** | **Incorrect** | **No Response** |
|---|---|---|---|
| Total: | 0.420 | 0.576 | 0.004 |
| High: | 0.565 | | |
| Mid: | 0.394 | | |
| Low: | 0.309 | | |

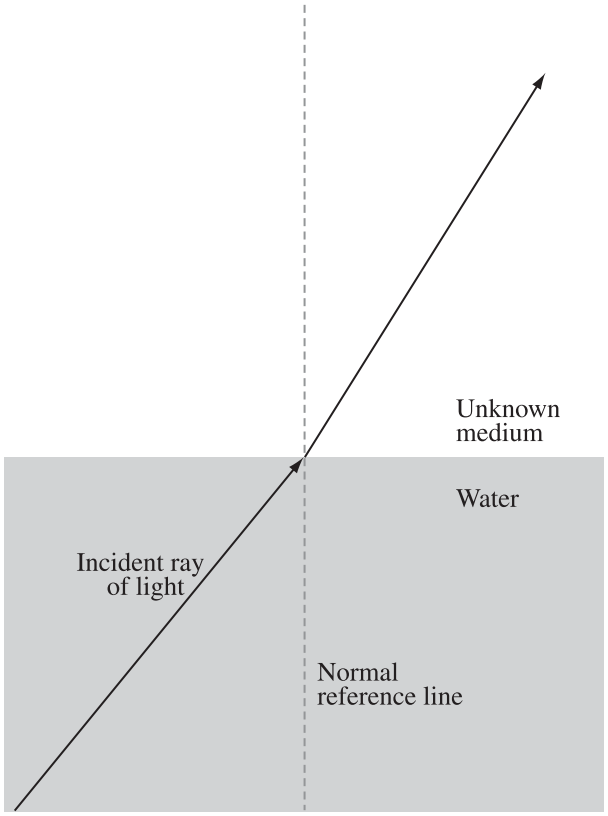
(In the first column, the values represent the proportion of students who provided a response that was scored correct. The high and low groups each contain approximately 25% of the total group. In this case 42.0% of the total provided a correct answer, 56.5% of the high group, 39.4% of the middle group, and 30.9% of the low group answered this question correctly.)

This item illustrates how students can demonstrate the performing and recording skills mandated by program of studies outcome C1.2s,

> C1.2s, *Students will* conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information • perform an experiment to determine the index of refraction of several different substances

*Use the following information to answer numerical-response question 3.*

A ray of light travelling from water into an unknown medium is shown below.




**Note:** You will need to make measurements using a ruler or a protractor.

## Numerical Response

**3.** If the index of refraction of the water is 1.33, then the index of refraction of the second medium is _____.

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

Answer: Any value between 1.54 and 1.69

**Numerical-response 3 Statistical Performance:** *This item has not been field tested.*

# *Illustrative Items from Field Testing or Diploma Examinations Showing Word Usage and Exploring Misconceptions*

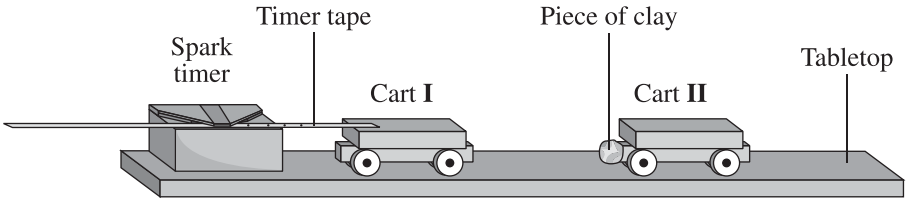
These items have been selected to illustrate students' strongly held misconceptions, word usage on the diploma examination, and how machine-scored items can assess an outcome at different cognitive levels:
K, C/A, HMA.

This first group of three items explores the misconceptions that students hold regarding Newton's third law.

*Use the following information to answer questions 1 and 2.*

Two carts, travelling at the same initial speed move toward each other on a table, as shown below. Cart I has a total mass of 500 g and Cart II has a total mass of 250 g.

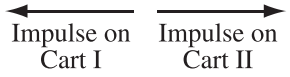
**Side View of Colliding Carts**



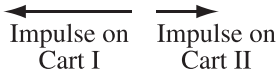

The carts collide. After contact, the carts remain separate from each other and move independently.

**1.** Which of the following vector diagrams, drawn to scale, shows the magnitude and direction of the impulse experienced by each cart during contact?

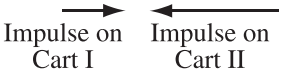
***A.**



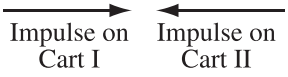

**B.**




**C.**




**D.**




**Multiple-choice 1 Statistical Performance:**

| Group | **A*** | **B** | **C** | **D** |
|---|---|---|---|---|
| Total: | 0.298 | 0.350 | 0.292 | 0.060 |
| High: | 0.391 | | | |
| Mid: | 0.331 | | | |
| Low: | 0.188 | | | |

(In the first column, the values represent the proportion of students who made that selection. The high and low groups each contain approximately 25% of the total group. In this case 29.8% of the total chose A, which is the correct answer. 39.1% of the high group, 33.1% of the middle group, and 18.8% of the low group chose A.)

**2.** *During this collision, momentum* ___***i***___ *conserved and kinetic energy* ***most likely*** ___***ii***___ *conserved.*

The statement above is completed by the information in row

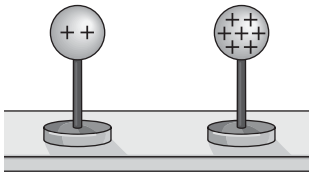
| **Row** | ***i*** | ***ii*** |
|---|---|---|
| **A.** | is not | is |
| **B.** | is not | is not |
| **C.** | is | is |
| ***D.** | is | is not |

**Multiple-choice 2 Statistical Performance:**

| Group | **A** | **B** | **C** | **D*** |
|---|---|---|---|---|
| Total: | 0.068 | 0.086 | 0.239 | 0.607 |
| High: | | | | 0.777 |
| Mid: | | | | 0.669 |
| Low: | | | | 0.403 |

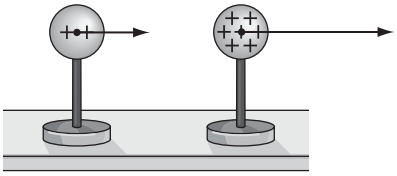
*Use the following information to answer question 3.*

Two identical conducting spheres are fastened to electrically insulated stands. The charge on one of the spheres is greater than the charge on the other.

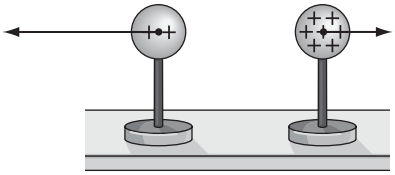


**3.** Which of the following diagrams, drawn to scale, **best** represents the magnitude and direction of the electrostatic forces on each of the charged spheres?

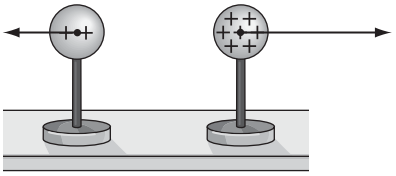
**A.**



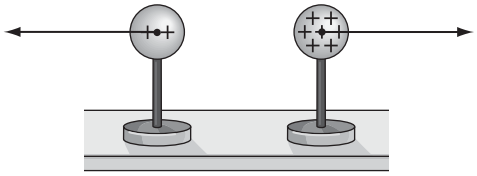

**B.**




**C.**




***D.**



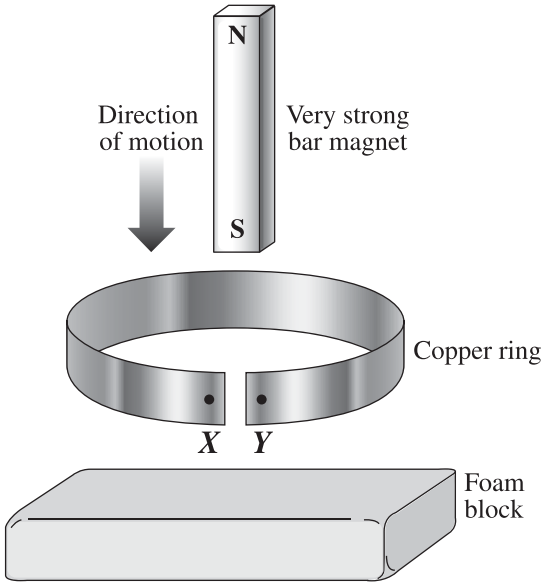

**Multiple-choice 3 Statistical Performance:**

| Group | **A** | **B** | **C** | **D*** |
|---|---|---|---|---|
| Total: | 0.016 | 0.471 | 0.245 | 0.268 |
| High: | | | | 0.573 |
| Mid: | | | | 0.195 |
| Low: | | | | 0.087 |

***NEW** This group of two questions illustrates how the outcome B3.9k can be assessed.

*Use the following information to answer question 4.*

A very strong bar magnet is dropped onto a foam block through a copper ring that has a slit cut into it, as shown below.




**4.** *When the south pole of the magnet moves into the ring from above, the direction the electrons inside the copper ring will move is from* ___***i***___ *. Compared to X, the nature of the charge on Y will be relatively* ___***ii***___ *.*

The statements above are completed by the information in row

| **Row** | ***i*** | ***ii*** |
|---|---|---|
| **A.** | *X* to *Y* | negative |
| **B.** | *X* to *Y* | positive |
| **C.** | *Y* to *X* | negative |
| ***D.** | *Y* to *X* | positive |

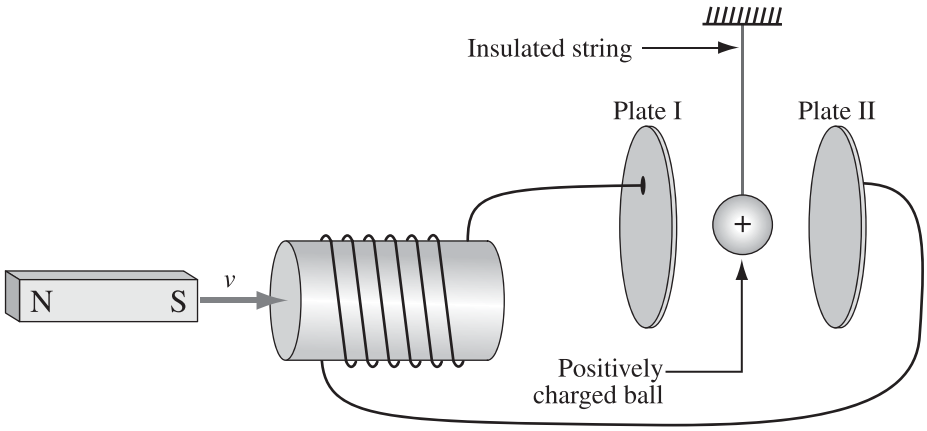
**Multiple-choice 4 Statistical Performance:**

| Group | **A** | **B** | **C** | **D*** |
|---|---|---|---|---|
| Total: | 0.338 | 0.180 | 0.180 | 0.298 |
| High: | | | | 0.402 |
| Mid: | | | | 0.263 |
| Low: | | | | 0.225 |

*NEW

*Use the following information to answer question 5.*

A positively charged sphere is suspended on the end of an insulated string in the region between two vertical, metal, parallel plates that are connected to a coil of wire. A magnet is suddenly thrust into the coil of wire, as illustrated below.




**5.** When the magnet is moved as illustrated above, then the direction of the motion of the positively charged sphere is

**A.** into the page

**B.** toward Plate I

***C.** toward Plate II

**D.** out of the page

**Multiple-choice 5 Statistical Performance:**

| Group | **A** | **B** | **C*** | **D** |
|---|---|---|---|---|
| Total: | 0.042 | 0.420 | 0.472 | 0.065 |
| High: | | | 0.629 | |
| Mid: | | | 0.487 | |
| Low: | | | 0.313 | |

This group of two items illustrates the use of *convex* and/or *concave* for a mirror and *diverging* and/or *converging* for a lens.

These words are chosen to make the items completely unambiguous. A convex mirror can only reflect the light off one face and the ray diagram is clear. However, a convex-convex lens can be either diverging or converging depending on the relative positions of the surfaces. So that students know exactly what is happening, we describe the effect of the lens on the light.

*Use the following information to answer question 6.*

When a girl who is 122 cm tall stands 40 cm in front of a particular mirror, her virtual image in the mirror is upright and 54 cm tall.

**6.** *The mirror is* ___***i***___ *, and the girl's image is located* ___***ii***___ *away from the mirror.*

The statement above is completed by the information in row

| **Row** | ***i*** | ***ii*** |
|---|---|---|
| ***A.** | convex | 18 cm |
| **B.** | convex | 90 cm |
| **C.** | concave | 18 cm |
| **D.** | concave | 90 cm |

**Multiple-choice 6 Statistical Performance:**

| Group | **A*** | **B** | **C** | **D** |
|---|---|---|---|---|
| Total: | 0.556 | 0.088 | 0.310 | 0.046 |
| High: | 0.690 | | | |
| Mid: | 0.564 | | | |
| Low: | 0.395 | | | |

*Use the following information to answer question 7.*

In an investigation, a group of students measures an object to be 10.0 cm tall. They place the object 3.2 cm in front of a thin lens. They observe that a virtual image is formed and measure the distance from the image to the lens to be 4.3 cm.

**7.** The type of lens and its calculated focal length are, respectively,

**A.** diverging, and 1.8 cm

**B.** diverging, and 13 cm

**C.** converging, and 1.8 cm

***D.** converging, and 13 cm

**Multiple-choice 7 Statistical Performance:**

| Group | **A** | **B** | **C** | **D*** |
|---|---|---|---|---|
| Total: | 0.365 | 0.208 | 0.250 | 0.173 |
| High: | | | | 0.326 |
| Mid: | | | | 0.154 |
| Low: | | | | 0.073 |

***NEW** This two-question set illustrates the assessment of unit D outcomes: D3.5k. *Students will* compare and contrast the characteristics of fission and fusion reactions; D3.3s

D3.3s, *Students will* •compare the energy released in a nuclear reaction to the energy released in a chemical reaction, on the basis of energy per unit mass of reactants; and D3.6k. *Students will* relate, qualitatively and quantitatively, the mass defect of the nucleus to the energy released in nuclear reactions, using Einstein's concept of mass-energy equivalence.

*Use the following information to answer question 8 and numerical-response question 4.*

**Nuclear Reactions**

**Reaction I:** $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

**Reaction II:** $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3{}^{1}_{0}\mathrm{n}$

Reaction II is currently used in nuclear reactors in Canada. When 1.00 kg of uranium fuel is burned, $6.11 \times 10^{13}$ J of energy is released.

**8.** Which of the following rows identifies the fission reaction and compares the energy released in the two reactions per kilogram of fuel?

| Row | Fission | Energy per Kilogram |
|---|---|---|
| **A.** | Reaction I | Reaction I releases more than Reaction II |
| **B.** | Reaction I | Reaction I releases less than Reaction II |
| ***C.** | Reaction II | Reaction I releases more than Reaction II |
| **D.** | Reaction II | Reaction I releases less than Reaction II |

**Multiple-choice 8 Statistical Performance:**

| Group | **A** | **B** | **C*** | **D** |
|---|---|---|---|---|
| Total: | 0.104 | 0.156 | 0.284 | 0.432 |
| High: | | | 0.389 | |
| Mid: | | | 0.283 | |
| Low: | | | 0.181 | |

## Numerical Response

**4.** The mass equivalent of the energy released by the burning of uranium fuel in a Canadian nuclear reactor, expressed in scientific notation, is $\boldsymbol{a.bc} \times 10^{-\boldsymbol{d}}$ kg.
The values of $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$, and $\boldsymbol{d}$ are _____, _____, _____, and _____.

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

Answer: 6794

**Numerical-response 4 Statistical Performance:**

| Group | **Correct** | **Incorrect** | **No Response** |
|---|---|---|---|
| Total: | 0.436 | 0.288 | 0.276 |
| High: | 0.792 | | |
| Mid: | 0.387 | | |
| Low: | 0.153 | | |

This item illustrates the difference between *use* and *derive* in the context of the de Broglie equation. By providing the equation and naming the variables students to use $p = mv$ from A1.1k to solve the problem. Without the equation in the context box, this question is beyond the expectations of the Program of Studies.

*Use the following information to answer question 9.*

Solar wind is hot plasma ejected from the surface of the Sun. The plasma consists, in part, of electrons. de Broglie hypothesized that a moving particle has a wavelength that relates to its momentum, given by the formula below.

$$\lambda = \frac{h}{p}$$

**9.** The wavelength of one solar-wind electron that has a measured speed of $4.0 \times 10^5$ m/s is

**A.** $9.9 \times 10^{-13}$ m

***B.** $1.8 \times 10^{-9}$ m

**C.** $6.2 \times 10^6$ m

**D.** $1.1 \times 10^{10}$ m

**Multiple-choice 9 Statistical Performance:**

| Group | **A** | **B*** | **C** | **D** |
|---|---|---|---|---|
| Total: | 0.016 | 0.927 | 0.024 | 0.032 |
| High: | | 0.994 | | |
| Mid: | | 0.963 | | |
| Low: | | 0.039 | | |

# *Set of Questions Showing Assessment at Various Cognitive Levels*

This group of three items shows how outcome C2.5k can be tested at a knowledge-recall level (K), a comprehension/application level (C/A), and at a higher mental activity level (HMA).

Students achieving the standard of excellence need to be given the opportunity to show their true ability on HMA-level tasks.

*The following is a K-level item.*

*Use the following information to answer numerical-response question 5.*

Classical wave theory and quantum physics make different predictions about the effect of incident electromagnetic radiation on a photoelectric surface.

**Four Photoelectric Effect Predictions**

**1** Low-intensity electromagnetic radiation incident on a photoelectric surface for long periods of time will cause photoemission.

**2** High-intensity electromagnetic radiation will not cause photoemission unless its frequency is greater than the photoelectric surface's threshold frequency.

**3** The energy of the emitted photoelectrons will increase if the intensity of the incident electromagnetic radiation is increased.

**4** The energy of the emitted photoelectrons is independent of the intensity of the incident electromagnetic radiation.

**Numerical Response**

**5.** Match each of the predictions above with the appropriate theory of physics as labelled below. There is more than one correct answer.

| | | | | |
|---|---|---|---|---|
| **Prediction:** | _____ | _____ | _____ | _____ |
| **Appropriate Theory:** | **Classical wave theory** | | **Quantum physic**s | |

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

Answer: 1324, 3124, 1342, or 3142

**Numerical-response 5 Statistical Performance:**

| Group | Correct | Incorrect | No Response |
|---|---|---|---|
| Total: | 0.502 | 0.495 | 0.004 |
| High: | 0.766 | | |
| Mid: | 0.476 | | |
| Low: | 0.279 | | |

*The following is a C/A-level item.*

*Use the following information to answer question 10.*

**Explanations**

**I** Einstein's explanation of the photoelectric effect requires light to travel in bundles.

**II** Young's explanation of the observation from double-slit experiments requires light to interfere with itself.

**III** de Broglie's explanation of stable atomic energy levels requires electrons to exist as standing waves.

**10.** The explanations above are based on light having

**A.** only wave properties

**B.** only particle properties

***C.** both wave and particle properties

**D.** neither wave nor particle properties

**Multiple-choice 10 Statistical Performance:** *This item has not been field tested.*

*This is an HMA-level item.*

*Use the following information to answer question 11.*

A group of students produces the following observations relating to the photoelectric effect for light that is incident on a surface.

**I** Light that has a frequency less than the threshold frequency for that surface will not result in the emission of photoelectrons from the surface, regardless of the intensity of the light.

**II** For light that has a frequency higher than the threshold frequency for that surface, a more intense light produces more photoelectrons than a less intense light.

**III** The intensity of the light has no effect on the kinetic energy of any photoelectrons that are emitted by the surface.

**11.** Using classical wave theory (mechanical-wave model), the students can explain

**A.** observation I only

***B.** observation II only

**C.** observations I and II

**D.** observations II and III

**Multiple-choice 11 Statistical Performance:**

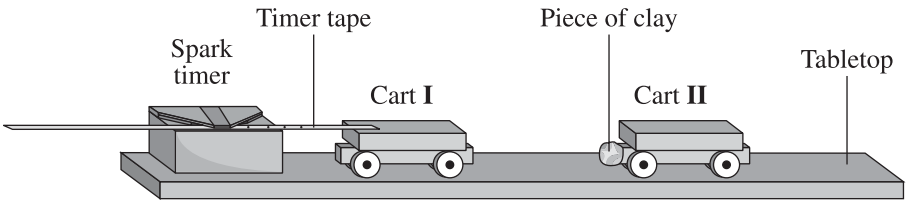
| Group | **A** | **B*** | **C** | **D** |
|---|---|---|---|---|
| Total: | 0.201 | 0.218 | 0.429 | 0.150 |
| High: | | 0.352 | | |
| Mid: | | 0.172 | | |
| Low: | | 0.116 | | |

# *NEW *Illustrative Graphing Skills*

The following set of questions illustrates how graphical analysis can be assessed on the the Physics 30 diploma examination.

*Use the following information to answer question 12 and numerical-response question 6.*

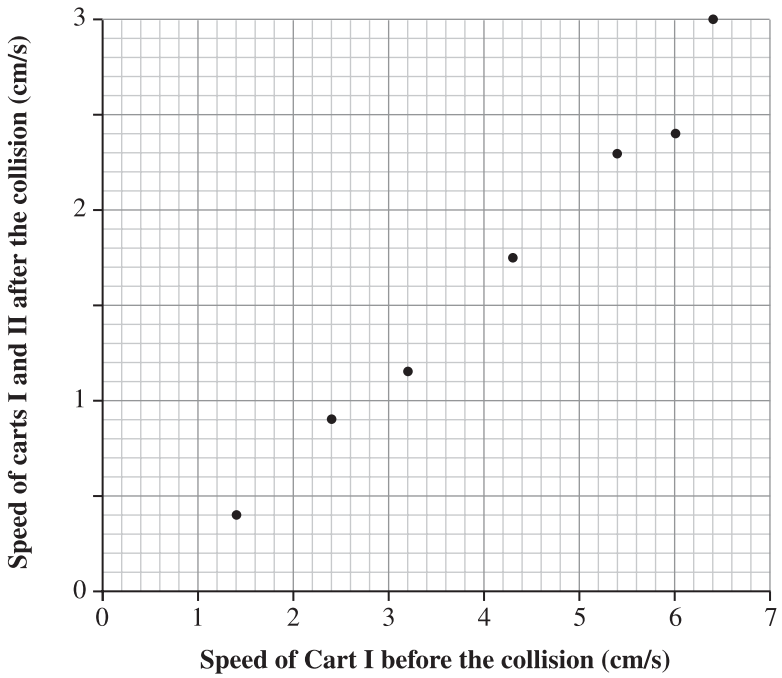
Students perform an experiment using two low-friction laboratory carts. A piece of timer tape is attached to Cart I and fed through a spark timer apparatus. The timer makes a mark on the tape each 0.10 s. Cart I is pushed toward Cart II which is initially at rest. The carts collide, the piece of clay is deformed and holds the carts together as they continue to move. The mass of Cart I is 1.54 kg.




The students repeat the above procedure manipulating the initial speed of Cart I.

The graph of their observations is given below.

**Speed of Carts I and II (After the Collision) as a Function of the Speed of Cart I (Before the Collision)**



**12.** *The collision of the two carts is classified as* ___***i***___ *because* ___***ii***___ .

The statement above is completed by the information in row

| Row | *i* | *ii* |
|---|---|---|
| **A.** | elastic | momentum is conserved |
| **B.** | elastic | kinetic energy is conserved |
| **C.** | inelastic | momentum is not conserved |
| ***D.** | inelastic | kinetic energy is not conserved |

**Multiple-choice 12 Statistical performance:**

| Group | **A** | **B** | **C** | **D*** |
|---|---|---|---|---|
| Total: | 0.174 | 0.147 | 0.080 | 0.598 |
| High: | | | | 0.793 |
| Mid: | | | | 0.590 |
| Low: | | | | 0.400 |

## Numerical Response

**6.** Based on a point on the line of best fit, if Cart I had a speed of 6.0 cm/s before the collision, then the combined speed of the two carts after the collision would be ***a.b*** cm/s. You will need to record the values of ***a*** and ***b***.

Based on the slope of the line of best fit, the **combined** mass of the two carts is ***e.f*** kg. You will need to record the values of ***e*** and ***f***.

The values of ***a***, ***b***, ***e***, and ***f*** are _____, _____, _____, and _____.
***a*** ***b*** ***e*** ***f***

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

Answer: Any answer in which the point and calculated value were consistent with a line of best-fit for this data was scored as correct. For example 2633 is acceptable while 2832 is not.

**Numerical-response 6 Statistical Performance:**

| Group | **Correct** | **Incorrect** | **No Response** |
|---|---|---|---|
| Total: | 0.359 | 0.612 | 0.029 |
| High: | 0.571 | | |
| Mid: | 0.338 | | |
| Low: | 0.162 | | |

# *Instructions Pages for Physics 30 Diploma Examinations*

## *Physics 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 36 multiple-choice and 14 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.

Tear-out data pages are included near the back of this booklet. A Periodic Table of the Elements is also provided.

### *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 on the tear-out data pages.
- 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 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***

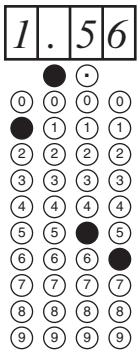
If a 121 N force is applied to a 77.7 kg mass at rest on a frictionless surface, the acceleration of the mass will be _____ $m/s^2$.

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

$$a = \frac{F}{m}$$

$$= \frac{121\ \text{N}}{77.7\ \text{kg}} = 1.557\ \text{m/s}^2$$

**Record 1.56 on the answer sheet** →



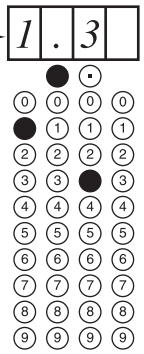
## *Calculation Question and Solution*

A microwave of wavelength 24 cm has a frequency of _____ × $10^{w}$ Hz.

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

$f = c/\lambda$
$= (3.00 \times 10^{8}\ \text{m/s})/(0.24\ \text{m})$
$f = 1.25 \times 10^{9}$ Hz

**Record 1.3 on the answer sheet** →




## *Correct-Order Question and Solution*

**Four Subjects**

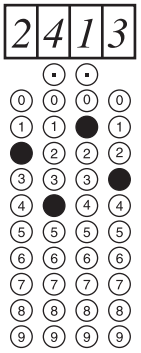
**1** Physics
**2** Biology
**3** Science
**4** Chemistry

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** →



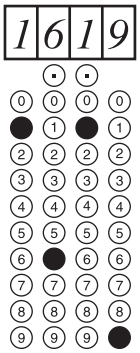

## *Scientific Notation Question and Solution*

The charge on an electron is $-\boldsymbol{a.b} \times 10^{-\boldsymbol{cd}}$ C. The values of $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$, and $\boldsymbol{d}$ are ___, ___, ___, and ___.

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

Answer: $q = -1.6 \times 10^{-19}$ C

**Record 1619 on the answer sheet** →



# *Contacts 2014–15*

**Diploma Programs**

Deanna Shostak, 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

Margot Baril Cooke, Examiner
Chemistry 30
Margot.BarilCooke@gov.ab.ca

Patricia Lim, Examiner
Mathematics 30–2
Patricia.Lim@gov.ab.ca

Ross Marian
Mathematics 30–1
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

Pamela Klebanov, Team Leader
Business Operations and Special Cases
exam.admin@gov.ab.ca

Pamela Klebanov, Acting Coordinator
GED and Field Testing
field.test@gov.ab.ca

Special Cases Team
Examination Administration
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