Information Bulletin | Physics 30

2011 – 2012 Diploma Examinations Program

Government of Alberta

Alberta
Freedom To Create. Spirit To Achieve.

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.

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 2011	Registration for field tests to be administered in December 2011 or January 2012
February 2012	Registration for field tests to be administered in May or June 2012

Periodically we send out information to those Physics 30 teachers who are on our contact list. If you would like to be added to this list, contact Laura Pankratz, the Physics 30 Assessment Standards Team Leader, at 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.

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 require students to recall facts or identify characteristics. The Assessment Sector classifies these as "knowledge" level verbs. Examples of these verbs are listed in the yellow column below. Some verbs require students to apply their knowledge and skills in conventional situations. The Assessment Sector classifies these as "comprehension and application" verbs. Examples of these verbs are listed in the green column below. Some verbs require students to build new connections, to create relationships between concepts, to apply models to new and unusual situations. The Assessment Sector classifies these as "higher mental activities." Examples of these 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 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 Design a procedure for a known experiment	Assess, compare*, differentiate, compile, compose, conclude, create, defend, evaluate, explain*, interpret*, judge, justify, organize, plan, summarize Transfer methods from one area to another Use generalized methods to solve problems Design a new procedure for an unfamiliar experiment
Attitudes and Skills Appreciate, collect, conduct, develop, gather, measure, observe, plot, work collaboratively		

*These 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

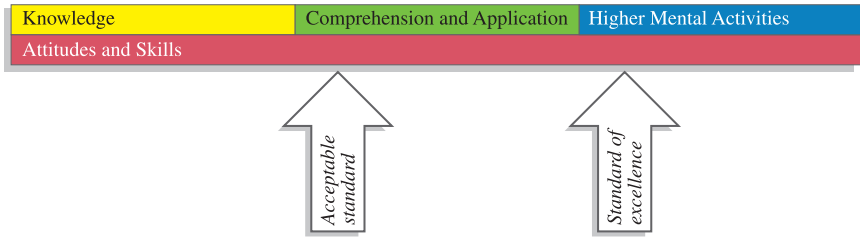
situations: algebraically, experimentally, etc. In addition, these students can connect their understanding of physics to real-world situations that include technological applications and implications beyond the classroom setting.

Examination Specifications and Design

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

Performance Standards

Approximately 45% of the items are designed to assess at the *Acceptable Standard* and approximately 25% of the items are designed to assess at the *Standard of Excellence.*



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/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 Content Formatting

The formatting of content in some examination booklets has changed slightly. The instruction pages now begin on the inside front cover, and the side, top and bottom page margins are narrower than before. **The changes are not a misprint.** As a result of these changes, the total amount of paper used each year in printing the examinations will decrease by several tonnes.

The format changes do not apply to all diploma examination booklets. French-language booklets, Part A booklets, and Readings booklets still use the old format. Also, the size of the print and the font are unchanged in all booklets except Biology 30, which is increasing font size inside context boxes.

Examination Security

- The January 2012 and June 2012 Physics 30 Diploma Examinations are secured at the time of writing.

Maintaining Consistent Standards over Time on Diploma Examinations

A baseline examination will be established, and equating will be reestablished as a result of the standard setting associated with the change in the program of studies.

Publications and Supporting Documents

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 Classroom-Based Performance Standards* available on education.alberta.ca, via this pathway:
  Administrators > Provincial Testing > Diploma Examinations > Diploma Examination Information Bulletins
- *Physics 30 Information Bulletin 2011–2012* 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
- *Assessment Highlights* available on education.alberta.ca, via this pathway:
  Teachers > (Additional Programs and Services) > Diploma Exams > Assessment Highlights
- *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.

Reminders and Explanations

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 which 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.

Directions

Students should be able to use and interpret conventions for directions perpendicular to the page:
• indicates out of 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.

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 Straight-Edges

Students should be encouraged to use a ruler or straight-edge when drawing the line of best fit.

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

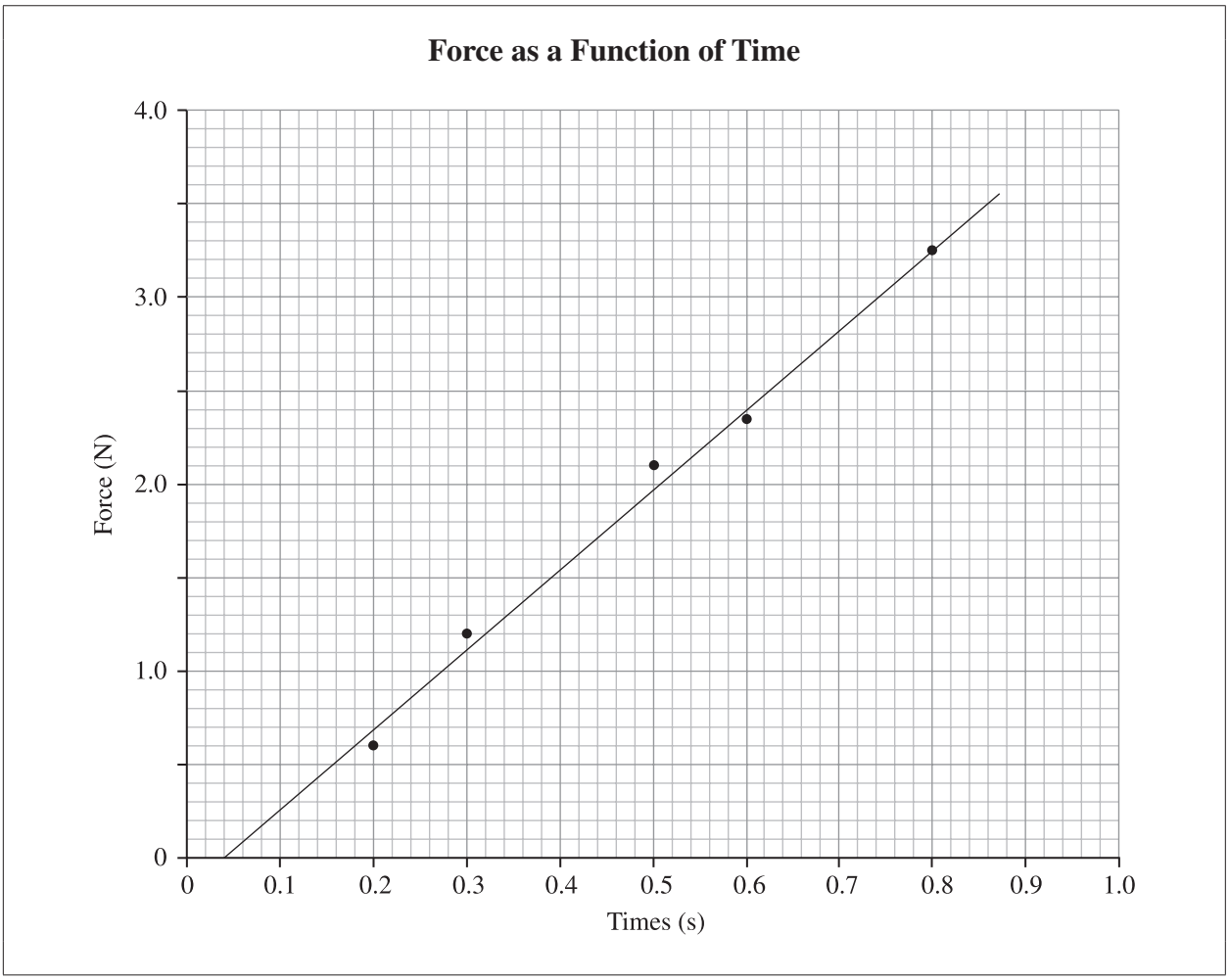
Students should be familiar with the different formats of numerical-response items and the procedure for completely filling in the bubbles on the answer sheet.

Sets of questions showing Acceptable Standard, Intermediate, and Standard of Excellence questions

The purpose of these four sets of questions is to model the performance standards using machine-scored items.

Physics 30 A1.2k *Students will* **explain**, quantitatively, the concepts of impulse and change in momentum, using Newton's laws of motion.

Use the following information to answer the next question.



Acceptable Standard

1. The physics significance of the area under the line of best fit from $t = 0.04$ s to $t = 0.86$ s is

*__A__. impulse

B. work done

C. momentum

D. change in impulse

Acceptable Standard

Numerical Response

2. The magnitude of the impulse of the object that experiences the force from $t = 0.04$ s to $t = 0.86$ s is _____ N·s.

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

Key answer: 1.44

Intermediate

Numerical Response

3. If the mass of the object was 0.500 kg and it started from rest, then the object's final speed at the end of 0.86 s would be _____ m/s.

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

Key answer: 2.87

Intermediate

4. The mass of the toy car experiencing the force described by the graph on the previous page is 5.00 kg. If it has an initial velocity of 4.50 m/s, south, and the direction of the force is south, then the final velocity of the car is

A. 4.21 m/s, north

B. 4.21 m/s, south

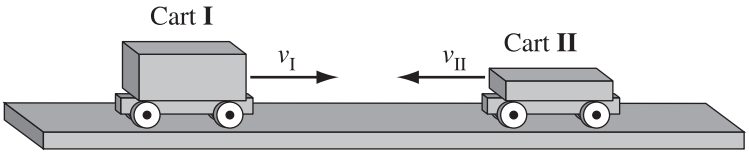
C. 4.79 m/s, north

***D.** 4.79 m/s, south

Use the following information to answer the next question.

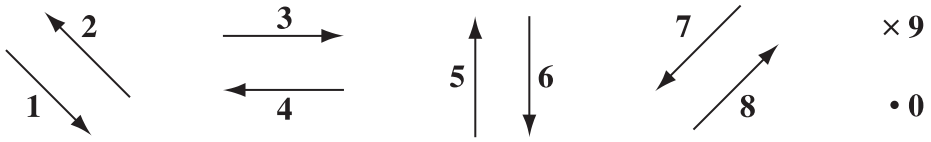
Two carts, travelling at the same initial speed, move toward each other on a table, as shown below. Cart I has a total mass of 500 g and Cart II has a total mass of 250 g.

Side View of Colliding Carts



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

Directions



Relative Sizes

1 Twice as large
2 Same size
3 Half as large

Standard of Excellence

Numerical Response

5. For the time interval when the two carts are in contact, match the directions and relative sizes as numbered above with the descriptions given below.

Number:	_____	_____	_____
Description:	**Direction of the force of Cart II on Cart I**	**Direction of the impulse of Cart I**	**Magnitude of the impulse of Cart I compared to Cart II**

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

Key answer: 442

Physics 30 C1.10k *Students will* **solve** double-slit and diffraction grating questions using $\lambda = \frac{d \sin\theta}{n}$, $\lambda = \frac{xd}{nl}$.

Use the following information to answer the next question.

In an investigation, a group of students directs light from a laser pointer at a diffraction grating that has a line spacing of 1.00×10^{-5} m. A series of bright spots appears on a screen placed 1.00 m away from the grating. The students measure a distance of 5.56 cm between the central bright spot and the first order bright spot.

Acceptable Standard

Numerical Response

6. Based on the students' measurements, the wavelength of the light emitted by the laser pointer, expressed in scientific notation, is $\boldsymbol{a.bc} \times 10^{-\boldsymbol{d}}$ m. 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.)

Key answer: 5567

Use the following information to answer the next question.

In an investigation, a group of students directs light from a laser pointer at a diffraction grating that has a line spacing of 1.67×10^{-6} m. A series of bright spots appears on a screen placed 1.00 m from the grating. The students measure a distance of 43.9 cm between the central bright spot and the first order bright spot.

Intermediate

Numerical Response

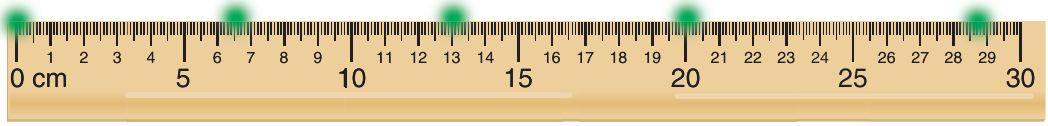
7. Based on the students' measurements, the wavelength of the light emitted by the laser pointer, expressed in scientific notation, is $\boldsymbol{a.bc} \times 10^{-\boldsymbol{d}}$ m. The values of $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$, and $\boldsymbol{d}$ are _____, _____, _____, and _____.

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

Key answer: 6717 (Note that 7337 is not a good value)

Use the following information to answer the next question.

Students use a green laser pointer and an optical apparatus to produce an interference pattern on a ruler, as shown below.



The ruler is 50.0 cm from the optical apparatus and the wavelength of the green laser light is 557 nm. The students analyze the observations and calculate the distance between adjacent openings.

Standard of Excellence

8. *In order for the students' analysis to produce the* ***most accurate*** *calculated value of the distance, d, between the adjacent openings, they measure x, the distance from the central maximum to the* ___***i***___ *order maximum. The equation that they use is* ___***ii***___ *and the value that they get is* ___***iii***___ .

The statements above are completed by the information in row

Row	***i***	***ii***	***iii***
A.	first	$\lambda = \frac{xd}{nl}$	4.29×10^{-6} m
B.	first	$\lambda = \frac{d \sin\theta}{n}$	4.32×10^{-6} m
C.	fourth	$\lambda = \frac{xd}{nl}$	3.90×10^{-6} m
***D.**	fourth	$\lambda = \frac{d \sin\theta}{n}$	4.49×10^{-6} m

Physics 30 C2.3k *Students will* **describe** the photoelectric effect in terms of the intensity and wavelength or frequency of the incident light and surface material.

Acceptable

Numerical Response

9. The work function of a surface that has a threshold wavelength of 7.1×10^{-7} m, expressed in scientific notation, is $\boldsymbol{a.b} \times 10^{-\boldsymbol{cd}}$ J. 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.)

Key answer: 2819

Use the following information to answer the next question.

A metallic surface has a threshold frequency of 3.60×10^{14} Hz. A photon that has an energy of 2.80×10^{-19} J is incident on this surface.

Intermediate

Numerical Response

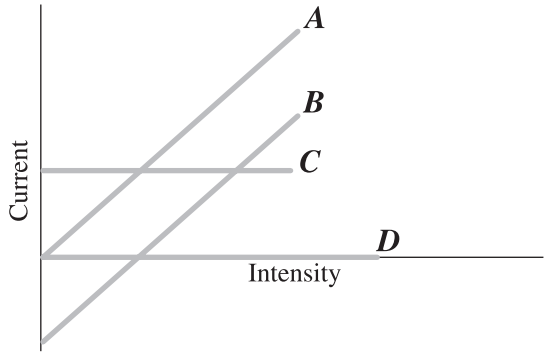
10. The maximum kinetic energy of the emitted electrons, expressed in scientific notation, is $\boldsymbol{a.b} \times 10^{-\boldsymbol{cd}}$ J. The values of $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$, and $\boldsymbol{d}$ are _____, _____, _____, and _____.

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

Key answer: 4120

Use the following information to answer the next question.

In a photoelectric effect experiment, a student observes how changing the intensity of the radiation incident upon a metal affects the observed photoelectric current. The frequency of the incoming radiation is kept constant as a controlled variable.



Intermediate

11. If the radiation incident on the metal has a frequency that is **below** the threshold frequency, which of the lines in the graph given above displays the observed current as a function of intensity?

A. A

B. B

C. C

***D.** D

Use the following information to answer the next question.

In a photoelectric experiment, the current in the apparatus and the kinetic energy of emitted electrons are measured and recorded every 20 seconds over a 4.0 minute time span. The properties of the incident light changed at about 80 seconds and 3.0 minutes. The observations are recorded in the table below.

Time (s)	**Current (A)**	**Kinetic Energy (10^{-19} J)**
20	2.1	5.5
40	2.1	5.4
60	2.0	5.5
80	2.1	8.9
100	2.0	8.9
120	2.1	8.9
140	2.1	9.0
160	2.2	8.9
180	1.5	8.8
200	1.6	9.0
220	1.5	8.9
240	1.7	8.9

Standard of Excellence

12. *The change to the incident light at 80 seconds was likely* ___***i***___ *and at 3.0 minutes was likely* ___***ii***___ .

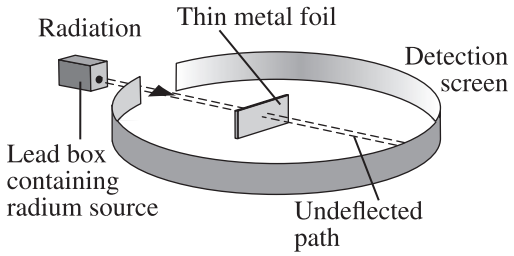
The statement above is completed by the information in row

Row	***i***	***ii***
***A.**	a decrease in wavelength	a decrease in intensity
B.	a decrease in wavelength	an increase in intensity
C.	an increase in wavelength	a decrease in intensity
D.	an increase in wavelength	an increase in intensity

Physics 30 D1.4k *Students will* **explain**, qualitatively, the significance of the results of Rutherford's scattering experiment, in terms of scientists' understanding of the relative size and mass of the nucleus and the atom.

Use the following information to answer the next question.

Rutherford's Experiment



Acceptable Standard

13. *In Rutherford's experiment, illustrated above, the type of radiation directed toward the metal foil was* ___***i***___ *. Based on the observations made using the detection screen, the atom contained* ___***ii***___ *.*

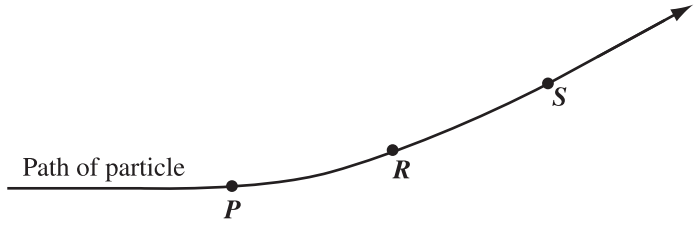
The statements above are completed by the information in row

Row	***i***	***ii***
***A.**	alpha	a small, dense, positively charged nucleus
B.	alpha	electrons in stable, circular orbits
C.	gamma	a small, dense, positively charged nucleus
D.	gamma	electrons in stable, circular orbits

Use the following information to answer the next question.

In Rutherford's experiment, the path of one of the particles in the radiation beam was deflected as shown below.

Path of Deflected Particle



Intermediate

14. The particle experiences the **greatest** electrostatic force at

A. Location *P*

***B.** Location *R*

C. Location *S*

D. Location *P* and Location *S*

Use the following information to answer the next two questions.

In the Rutherford alpha particle scattering experiment, some alpha particles were detected coming straight back from the gold foil. When an alpha particle is emitted by the radium sample, it has a kinetic energy of 1.0×10^{-12} J. The electric potential energy of a charged particle in a radial electric field is modelled as

$$E_p = \frac{kq_1q_2}{r}.$$

Standard of Excellence

Numerical Response

15. The maximum acceleration of an alpha particle at its closest approach to a nucleus of a gold atom, expressed in scientific notation, is $\boldsymbol{a.b} \times 10^{\boldsymbol{cd}}$ m/s^2. 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.)

Key answer: 4127

Standard of Excellence

Numerical Response

16. Two physics principles must be used to determine the maximum acceleration of an alpha particle. Using the numbers on the tear-out data sheet, match the physics principles with the order in which they are used. There is more than one correct answer.

Number:	_____	and	_____
Physics Principle:	**Used first**		**Used second**

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

Key answer: 15, 51, 13, or 31

Instruction 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.

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.*

Instructions

- Turn to the last page of the examination booklet. Carefully fold and tear out the machine-scored answer sheet along the perforation.
- 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 turn this page and read the detailed instructions for answering machine-scored questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. chemistry
B. biology
C. physics
D. science

Answer Sheet

Ⓐ Ⓑ ● Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box. Any boxes on the right that are not needed are to remain blank.**

Examples

Calculation Question and Solution

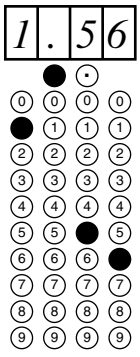
If a 121 N force is applied to a 77.7 kg mass at rest on a frictionless surface, the acceleration of the mass will be _____ m/s^2.

(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 →



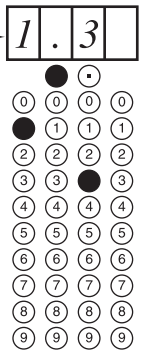
Calculation Question and Solution

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

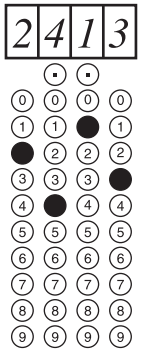
1 Physics
2 Biology
3 Science
4 Chemistry

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 →



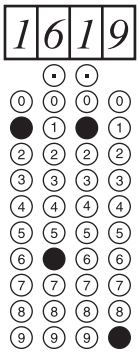
Scientific Notation Question and Solution

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 →



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