

Science 30

Released Items

2017 Released Diploma Examination Items



For further information, contact

Stan Bissell, Science 30 Exam Manager, at
780-422-5730
Stan.Bissell@gov.ab.ca,

Mark Haak, Science 30 Examiner, at
780-422-3337
Mark.Haak@gov.ab.ca, or

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

Provincial Assessment Sector: 780-427-0010.
To call toll-free from outside Edmonton, dial 310-0000.

The [Alberta Education website](http://education.alberta.ca) is found at education.alberta.ca.

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Introduction

The questions presented in this booklet are from the August 2016 and April 2017 Science 30 Diploma Examinations. This material, along with the program of studies and the [Science 30 Information Bulletin](#), can assist you with instructional programming.

These examination items are released by the Provincial Assessment Sector. They may be used by the classroom teacher as an examination, a quiz, or a review for students.

Additional Documents

The Provincial Assessment Sector supports the instruction of Science 30 in classrooms with the following documents available online:

- [School Reports and Instructional Group Reports](#)
available at <https://phoenix.edc.gov.ab.ca/login>
Detailed statistical information is provided on provincial, group, and individual student performance on the entire examination.
- [Science 30 Information Bulletin](#)
available at education.alberta.ca
Contains information about the diploma examinations for the upcoming school year, sample questions, assessment samples for classroom use with student exemplars, and scoring criteria.
- [Science 30 Previous Examinations](#)
A selection of items from the January 2008, June 2008, and January 2009 Diploma exams are released and are available in PDF format.
The August 2015 Diploma Examination is also released in PDF format and is on Quest A+. <https://questaplus.alberta.ca>

Science 30 Diploma Examination August 2016— Blueprint Summary

Key: MC—Multiple Choice; NR—Numerical Response

| | Diff.* | Key | K | STS | Skill |
|------|---------------|------------|----------|------------|--------------|
| MC1 | 0.765 | B | A1.1k | | |
| MC2 | 0.810 | A | A1.4k | A1.1sts | A1.2s |
| MC3 | 0.836 | C | A1.4k | A1.1sts | A1.2s |
| MC4 | 0.823 | C | A1.4k | A1.1sts | A1.2s |
| MC5 | 0.841 | B | | A1.1sts | A1.1s |
| MC6 | 0.811 | C | A2.5k | A2.1sts | |
| MC7 | 0.591 | D | A31.k | | |
| MC8 | 0.891 | B | A3.2k | | A3.3s |
| MC9 | 0.558 | C | | | A3.3s |
| MC10 | 0.825 | A | A3.9k | A3.1sts | |
| MC11 | 0.574 | C | B1.1k | | |
| MC12 | 0.536 | C | B1.3k | | |
| MC13 | 0.851 | C | B1.3k | | B1.3s |
| MC14 | 0.755 | D | B1.6k | | |
| MC15 | 0.507 | D | | | B1.2s |
| MC16 | 0.437 | A | B1.4k | | |
| MC17 | 0.586 | C | B2.6k | | |
| MC18 | 0.506 | D | B2.5k | B2.1sts | |
| MC19 | 0.614 | B | C1.2k | | C1.2s |
| MC20 | 0.807 | B | C1.4k | | C1.3s |
| MC21 | 0.408 | D | C1.6k | | C1.3s |
| MC22 | 0.436 | A | | | C1.2s |
| MC23 | 0.846 | A | C1.6k | | C1.3s |
| MC24 | 0.713 | B | C1.5k | C1.1sts | |
| MC25 | 0.741 | C | C1.7k | C1.1sts | C1.3s |

*Difficulty—proportion of students answering the question correctly

Key: MC—Multiple Choice; NR—Numerical Response

| | Diff.* | Key | K | STS | Skill |
|------|---------------|-----------------|----------|------------|--------------|
| MC26 | 0.772 | A | C2.1k | C2.1sts | |
| MC27 | 0.672 | D | C2.4k | | C2.2s |
| MC28 | 0.607 | C | C2.10k | C2.1sts | |
| MC29 | 0.592 | A | D2.4k | D2.1sts | D1.3s |
| MC30 | 0.650 | A | D2.5k | | |
| MC31 | 0.383 | D | | | D1.3s |
| MC32 | 0.763 | B | D1.1k | | D1.3s |
| NR1 | 0.765 | 167, 259, 348 | A1.3k | | A1.2s |
| NR2 | 0.359 | 567 (any order) | A3.4k | | |
| NR3 | 0.659 | 4231 | A3.7k | | |
| NR4 | 0.648 | 2431 | B1.7k | | B1.1s |
| NR5 | 0.370 | 3.75 | | | B1.3s |
| NR6 | 0.801 | 4231 | B2.1k | | |
| NR7 | 0.670 | 289 | C1.9k | | |
| NR8 | 0.794 | 3214 | C2.2k | C2.1sts | |
| NR9 | 0.780 | 2134 | C2.7k | C2.2sts | |
| NR10 | 0.855 | 147, 258, 368 | D2.3k | | |
| NR11 | 0.660 | 6028 | D2.5k | | |
| NR12 | 0.533 | 1.05 | | | D2.3s |
| NR13 | 0.640 | 84.2 | | D1.1sts | D2.3s |

*Difficulty—proportion of students answering the question correctly

Science 30 Diploma Examination April 2017— Blueprint Summary

Key: MC—Multiple Choice; NR—Numerical Response

| | Diff.* | Key | K | STS | Skill |
|------|---------------|------------|----------|------------|--------------|
| MC1 | 0.819 | C | A1.1k | A1.1sts | |
| MC2 | 0.685 | A | A2.2k | | |
| MC3 | 0.549 | B | A3.1k | | |
| MC4 | 0.446 | A | A3.4k | A3.1sts | |
| MC5 | 0.802 | C | A1.3k | | |
| MC6 | 0.773 | C | A3.2k | | A3.2s |
| MC7 | 0.471 | A | A3.8k | | |
| MC8 | 0.858 | D | A3.9k | | |
| MC9 | 0.669 | C | B1.1k | | |
| MC10 | 0.738 | D | | | B1.2s |
| MC11 | 0.852 | D | B1.2k | | |
| MC12 | 0.758 | D | B1.3k | | B1.3s |
| MC13 | 0.701 | A | B1.7k | B1.2sts | B1.3s |
| MC14 | 0.664 | D | B1.6k | | |
| MC15 | 0.553 | A | B2.1k | | |
| MC16 | 0.401 | B | B2.2k | | |
| MC17 | 0.643 | A | A3.2k | | |
| MC18 | 0.565 | C | | B2.1sts | B2.2s |
| MC19 | 0.823 | C | B2.3k | | |
| MC20 | 0.579 | B | B2.5k | B3.2sts | |
| MC21 | 0.725 | D | C1.3k | | C1.2s |
| MC22 | 0.366 | A | | C1.1sts | C1.2s |
| MC23 | 0.586 | B | C1.8k | | |
| MC24 | 0.776 | A | C1.12k | | |
| MC25 | 0.791 | D | C2.2k | C2.1sts | |

*Difficulty—proportion of students answering the question correctly

Key: MC—Multiple Choice; NR—Numerical Response

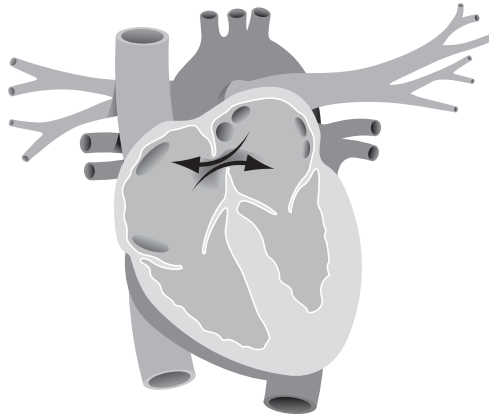
| | Diff.* | Key | K | STS | Skill |
|------|---------------|--------------------|--------------|------------|--------------|
| MC26 | 0.722 | B | C2.3k | | |
| MC27 | 0.752 | A | C2.6k | | C2.1s |
| MC28 | 0.782 | B | C2.7k | C2.1sts | |
| MC29 | 0.725 | C | D2.1k | | D2.3s |
| MC30 | 0.631 | D | D2.2k | | |
| MC31 | 0.798 | C | | | D2.3s |
| MC32 | 0.610 | A | D2.3k | D2.2sts | |
| MC33 | 0.697 | A | D2.6k | D2.2sts | |
| MC34 | 0.600 | D | D2.8k | | |
| NR1 | 0.777 | 132 | A1.4k | | |
| NR2 | 0.706 | 1324 | A1.1k | A1.1sts | A1.3s |
| NR3 | 0.562 | 148, 149, 267, 358 | A2.3k | | |
| NR4 | 0.804 | 50 | A3.2k | | A3.3s |
| NR5 | 0.323 | 5.65 | | | B1.3s |
| NR6 | 0.873 | 157, 249, 269, 348 | B1.8k, B3.2k | B1.2sts | |
| NR7 | 0.637 | 9.80 | C1.4k | | C1.3s |
| NR8 | 0.656 | 1963 | C1.6k | C1.1sts | C1.3s |
| NR9 | 0.228 | 136 (any order) | C1.9k | | |
| NR10 | 0.758 | 146, 235 | C1.11k | | |
| NR11 | 0.900 | 157, 269, 348 | C2.1k | STS | |
| NR12 | 0.486 | 321 | C2.11k | | |
| NR13 | 0.514 | 1257 (any order) | D1.3k | D1.1sts | |
| NR14 | 0.836 | 3241 | D2.4k | D2.1sts | |
| NR15 | 0.450 | 2413 | D1.5k, D2.4k | D2.1sts | |
| NR16 | 0.331 | 7.09 | D2.7k | | D2.3s |

*Difficulty—proportion of students answering the question correctly

Science 30 Diploma Examination August 2016— Released Items

Use the following information to answer question 1.

A common heart defect occurs when a hole between the left and right sides of the heart does not close before birth. The hole results in abnormal blood flow between chambers, as shown in the diagram below.



1. Which of the following rows identifies the affected heart chambers in the diagram above and describes a result of the heart defect?

| Row | Affected Heart Chambers | Result |
|-----|-------------------------|---|
| A. | Atria | Lower heart rate |
| B. | Atria | Mixing of oxygenated and deoxygenated blood |
| C. | Ventricles | Lower heart rate |
| D. | Ventricles | Mixing of oxygenated and deoxygenated blood |

Use the following information to answer questions 2 to 4.

A researcher makes the following hypothesis:

Athletes who have trained at a high altitude before competing at a low altitude will have greater endurance because they are able to use oxygen more effectively.

The researcher does a search of several studies related to his hypothesis.

Experimental Designs of Some Circulatory System Studies

- I The average red blood cell count of a group of people living at a high altitude was compared with the average red blood cell count of a similar group of people living at a low altitude.
- II The average white blood cell count of runners before a high-altitude marathon race was compared with the average white blood cell count of the runners after the race.
- III The quantity of hemoglobin per millilitre of blood was measured in people who trained at a low altitude and then measured again after these people spent one month training at a high altitude.
- IV The average platelet count of a group of people living at a high altitude was compared with the average platelet count of a similar group of people living at a low altitude.
- V The concentration of antibodies in a group of people living at a high altitude was compared with the concentration of antibodies in a similar group of people living at a low altitude.

2. Two studies described above that would **best** test the researcher's hypothesis are
- A. I and III
 - B. I and IV
 - C. II and V
 - D. III and IV
3. Two of the studies described above helped to establish that altitude has an effect on immunity. The studies that this evidence **most likely** came from are
- A. I and II
 - B. I and IV
 - C. II and V
 - D. III and V

Use the following additional information to answer question 4.

Variables in One of the Circulatory System Studies

Manipulated variable – Altitude
Responding variable – Ability to clot blood
Controlled variable – Age of participants

4. The variables listed above **most likely** came from Study
- A. II
 - B. III
 - C. IV
 - D. V
-

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

| Blood Vessel | Description of Blood Vessel | Function of Blood Vessel |
|--------------------|--|--|
| 1 Pulmonary artery | 4 Walls are only one cell thick | 7 Carries blood from the heart to the lungs |
| 2 Aorta | 5 Carries blood with a relatively high pressure and high oxygen content | 8 Allows nutrients and wastes to be exchanged |
| 3 Capillary | 6 Carries blood with a relatively high pressure and a low oxygen content | 9 Carries blood from the heart to the rest of the body |

Numerical Response

1. Using the numbers above, choose **one blood vessel** and match it with the description of that blood vessel and the function of that blood vessel. (There is more than one correct answer.)

Blood vessel _____ (Record in the **first** column)

Description _____ (Record in the **second** column)

Function _____ (Record in the **third** column)

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

Use the following information to answer question 5.

In a study investigating the effects of caffeine on the circulatory system, heart rate and blood pressure readings of study participants were measured after the participants were given either a caffeine pill or a placebo (sugar pill).

Effects of Caffeine on the Circulatory System

| | Time (h) | | | | |
|--|----------|-----|-----|-----|-----|
| | 0 | 1 | 3 | 5 | 8 |
| Average Heart Rate (beats/min) | | | | | |
| Caffeine | 72 | 77 | 72 | 72 | 72 |
| Placebo | 72 | 72 | 71 | 71 | 72 |
| Average Systolic Pressure (mmHg) | | | | | |
| Caffeine | 121 | 128 | 126 | 126 | 123 |
| Placebo | 120 | 119 | 120 | 120 | 120 |
| Average Diastolic Pressure (mmHg) | | | | | |
| Caffeine | 80 | 83 | 81 | 81 | 80 |
| Placebo | 79 | 80 | 79 | 80 | 80 |

5. The data from the study suggest that
- A. caffeine has the longest-lasting effect on diastolic blood pressure
 - B. caffeine has the longest-lasting effect on systolic blood pressure
 - C. people with high blood pressure should not consume sugar
 - D. people with low blood pressure should not consume sugar

Use the following information to answer question 6.

After a person has been vaccinated against a particular pathogen, he or she often needs to receive injections of the same vaccine, called booster shots, in the future in order to maintain a sufficient level of immunity against that pathogen. Booster shots increase the length of time that the person is immune to that particular pathogen.

6. Each booster shot increases the number and concentration of a person's
- A. amino acids and memory cells
 - B. amino acids and macrophages
 - C. antibodies and memory cells
 - D. antibodies and macrophages

7. A diploid cell produces new diploid cells through the process of *i* . Some diploid cells produce new haploid cells by undergoing the process of *ii* .

The statements above are completed by the information in row

| Row | <i>i</i> | <i>ii</i> |
|-----|----------|---------------|
| A. | meiosis | mitosis |
| B. | meiosis | fertilization |
| C. | mitosis | fertilization |
| D. | mitosis | meiosis |

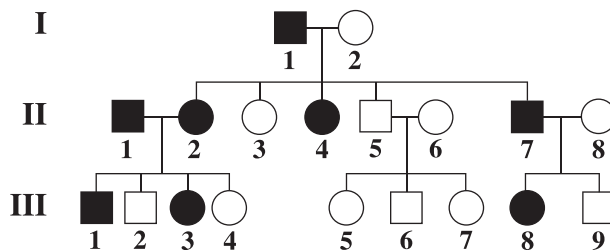
Use the following information to answer question 8.

In some varieties of pea plants, the trait for drought tolerance is controlled by a single dominant allele represented by *D*.

8. If a pea plant having the genotype *Dd* is crossed with a pea plant having the genotype *dd*, what percentage of the offspring would be expected to be drought tolerant?
- A. 100%
 - B. 50%
 - C. 25%
 - D. 0%

Use the following information to answer question 9.

Marfan syndrome is an autosomal genetic disorder that affects connective tissue in the body. The pedigree chart of a particular family with Marfan syndrome is shown below.



9. Which of the following rows identifies the **most likely** type of inheritance for Marfan syndrome, the genotype of individual **III-2**, and the phenotype of individual **II-8**?

| Row | Type of Inheritance | Genotype of III-2 | Phenotype of II-8 |
|-----|---------------------|-------------------|-------------------|
| A. | Recessive | <i>Mm</i> | Affected |
| B. | Recessive | Affected | <i>Mm</i> |
| C. | Dominant | <i>mm</i> | Unaffected |
| D. | Dominant | Unaffected | <i>mm</i> |

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

Some Biological Molecules

- 1** Proteins
- 2** Enzymes
- 3** Hormones
- 4** Amino acids
- 5** Nitrogen bases
- 6** Deoxyribose sugars
- 7** Phosphate molecules

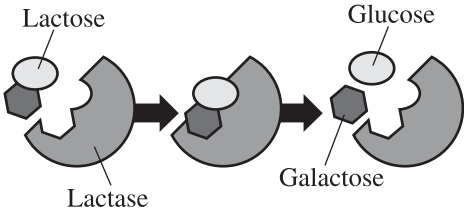
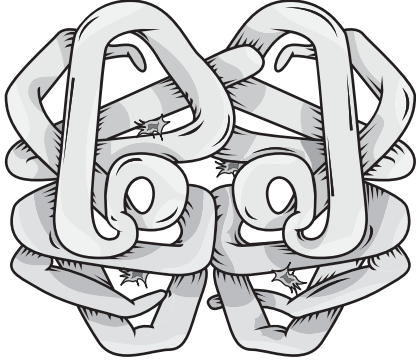
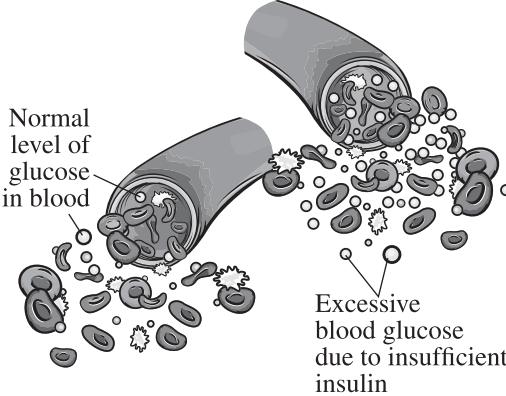
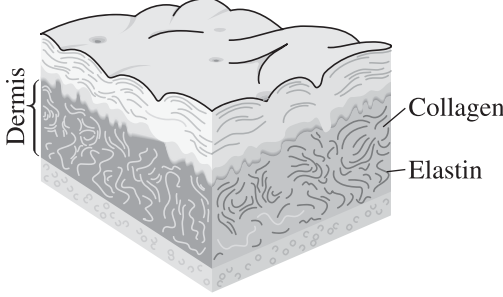
Numerical Response

- 2.** The three molecules in the list above that make up a DNA strand are numbered _____, _____, and _____.

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

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

Some Important Proteins in the Human Body

| | |
|--|---|
|  <p>1 Lactase speeds up the rate at which lactose is broken down.</p> |  <p>2 Hemoglobin carries gases in the body.</p> |
|  <p>3 Insulin helps to regulate blood glucose level and maintain homeostasis.</p> |  <p>4 Collagen provides a framework for skin.</p> |

Numerical Response

- 3.** Match the descriptions of each protein numbered above with its classification below. (Use each number only once.)

Structural protein _____ (Record in the **first** column)

Transport protein _____ (Record in the **second** column)

Hormone _____ (Record in the **third** column)

Enzyme _____ (Record in the **fourth** column)

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

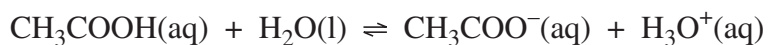
Use the following information to answer question 10.

Some scientists are researching the possibility of using viruses to treat genetic disorders caused by a mutated gene. This treatment uses modified viruses to deliver DNA containing the non-mutated gene to the affected person's cells.

10. The type of treatment described above is called
- A. gene therapy
 - B. plasmid transfer
 - C. genetic screening
 - D. genome sequencing
-

Use the following information to answer question 11.

Ionization of Ethanoic Acid

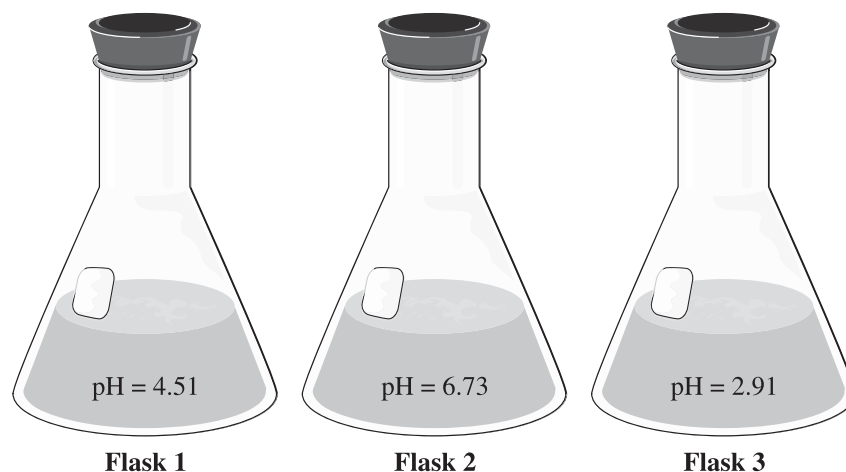


11. The proton donors in the equilibrium equation above are
- A. $\text{H}_2\text{O}(\text{l})$ and $\text{CH}_3\text{COO}^-(\text{aq})$
 - B. $\text{H}_2\text{O}(\text{l})$ and $\text{H}_3\text{O}^+(\text{aq})$
 - C. $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{H}_3\text{O}^+(\text{aq})$
 - D. $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{CH}_3\text{COO}^-(\text{aq})$

12. Which of the following statements accurately compares solutions of $\text{HCl}(\text{aq})$ and $\text{CH}_3\text{COOH}(\text{aq})$ with the same concentration?
- A. The $\text{HCl}(\text{aq})$ has a lower hydronium ion concentration, $[\text{H}_3\text{O}^+(\text{aq})]$, and a lower pH than the $\text{CH}_3\text{COOH}(\text{aq})$.
 - B. The $\text{HCl}(\text{aq})$ has a lower hydronium ion concentration, $[\text{H}_3\text{O}^+(\text{aq})]$, and a higher pH than the $\text{CH}_3\text{COOH}(\text{aq})$.
 - C. The $\text{HCl}(\text{aq})$ has a higher hydronium ion concentration, $[\text{H}_3\text{O}^+(\text{aq})]$, and a lower pH than the $\text{CH}_3\text{COOH}(\text{aq})$.
 - D. The $\text{HCl}(\text{aq})$ has a higher hydronium ion concentration, $[\text{H}_3\text{O}^+(\text{aq})]$, and a higher pH than the $\text{CH}_3\text{COOH}(\text{aq})$.
13. If a sample of hydrochloric acid, $\text{HCl}(\text{aq})$, has a hydronium ion concentration, $[\text{H}_3\text{O}^+(\text{aq})]$, of $5.3 \times 10^{-4} \text{ mol/L}$, then the pH of the sample is
- A. 1.00
 - B. 2.88
 - C. 3.28
 - D. 4.72

Use the following information to answer question 14.

Three Erlenmeyer flasks were set up for an experiment to compare the properties of three different acids of equal concentration. A few drops of bromocresol green were added to each flask prior to experimentation.



14. Which of the following rows identifies the colour of the acid solution within each flask?

| Row | Flask 1 | Flask 2 | Flask 3 |
|-----|---------|---------|---------|
| A. | Green | Yellow | Blue |
| B. | Yellow | Green | Yellow |
| C. | Blue | Blue | Green |
| D. | Green | Blue | Yellow |

Use the following information to answer question 15.

A student plans to perform a titration on lake water near her house where acid rain has been reported. She collects a 10.0 mL sample of lake water and writes out the steps of the titration.

Steps of the Titration

- 1 Rinse the burette with distilled water and then with standardized sodium hydroxide.
- 2 Fill the burette with the standardized sodium hydroxide solution.
- 3 Record the initial burette reading.
- 4 Pipette a 10.0 mL sample of lake water into an Erlenmeyer flask.
- 5 Add a few drops of bromothymol blue to the Erlenmeyer flask.
- 6 Titrate until a dark blue colour persists for at least 30 seconds.
- 7 Record the final burette reading.
- 8 Repeat steps 3 to 7 for two more trials.

15. Which of the following rows identifies an **incorrect** step in the student's procedure above and specifies the reason why it is incorrect?

| Row | Incorrect Step | Reason |
|-----|----------------|--|
| A. | 2 | She should have filled the burette with a solution of unknown concentration. |
| B. | 2 | She should have added a buffer to the burette. |
| C. | 5 | She should have added an indicator to the burette. |
| D. | 6 | She should have stopped when the solution turned green. |

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

A student wants to compare the buffering capacity of soil samples collected from four different locations. She records the initial pH of the soil, adds 10 mL of a strong acid solution to each sample, and after 24 hours records the pH of each soil sample.

Comparison of Soil pH Before and After Addition of 10 mL of a Strong Acid

| Soil Sample | Source of Soil Sample | Initial Soil pH | Soil pH After Addition of Acid |
|-------------|-----------------------|-----------------|--------------------------------|
| 1 | Nova Scotia beach | 7.0 | 3.5 |
| 2 | Alberta mountain | 7.8 | 7.5 |
| 3 | Ontario forest | 6.5 | 3.8 |
| 4 | Saskatchewan farm | 6.0 | 5.5 |

Numerical Response

4. When the soil samples listed above are placed in order from **greatest** buffering capacity to **least**, the order is

_____ **Greatest**

_____ **Least**

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

16. Which of the following pairs of substances could regulate changes in pH by acting as a buffer?
- A. $\text{H}_2\text{CO}_3(\text{aq})/\text{HCO}_3^-(\text{aq})$
 - B. $\text{SO}_3^{2-}(\text{aq})/\text{SO}_4^{2-}(\text{aq})$
 - C. $\text{NaOH}(\text{aq})/\text{OH}^-(\text{aq})$
 - D. $\text{NaCl}(\text{aq})/\text{Cl}^-(\text{aq})$

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

A 10.0 mL sample of nitric acid, $\text{HNO}_3(\text{aq})$, was placed in a flask and titrated with a 1.50×10^{-1} mol/L solution of sodium hydroxide, $\text{NaOH}(\text{aq})$. The indicator changed colour when 25.0 mL of $\text{NaOH}(\text{aq})$ was added to the flask.

Numerical Response

5. The concentration of the nitric acid in the flask was _____ $\times 10^{-1}$ mol/L.

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

Use the following information to answer question 17.

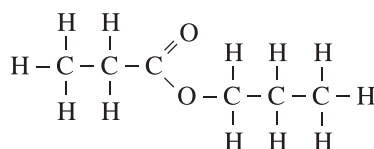
Next to a river is an old rail yard. Much of this site is contaminated with creosote that was used to preserve wood in railway ties. Creosote is a substance with a high concentration of polychlorinated biphenyls (PCBs).

17. One concern regarding the release of creosote into the river ecosystem could be the resulting
- A. increase in pH
 - B. decrease in dissolved oxygen levels
 - C. biomagnification in aquatic food chains
 - D. heavy metal leaching from aquatic soils

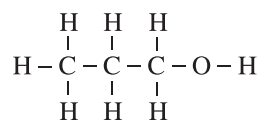
Use the following information to answer numerical-response question 6.

Structural Formulas Representing Some Propane Derivatives

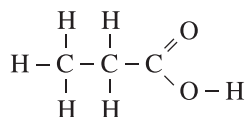
1



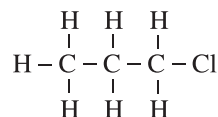
2



3



4



Numerical Response

6. Match the structural formula numbered above with its compound name listed below.

Structural
formula:

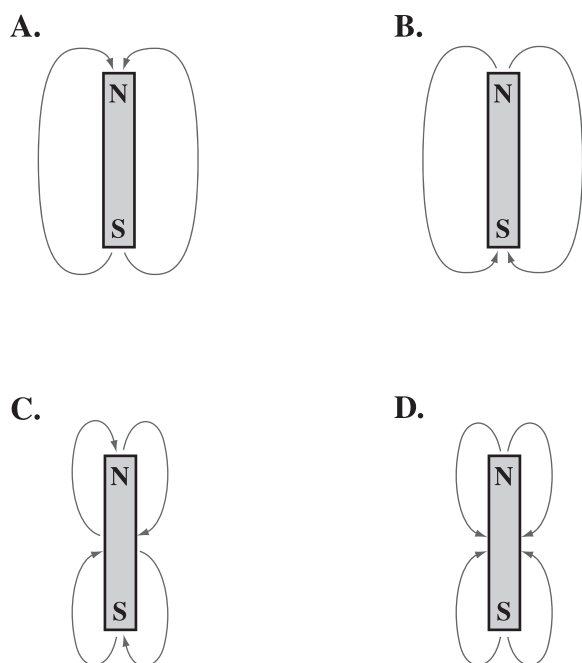
Compound name: _____ _____ _____ _____
1-Chloropropane Propan-1-ol Propanoic acid Propyl propanoate

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

18. Which of the following types of atmospheric pollutant is harmful in the lower atmosphere but beneficial in the upper atmosphere because it blocks harmful ultraviolet rays?

- A. Hydrocarbons
- B. $\text{SO}_x(\text{g})$
- C. CFCs
- D. $\text{O}_3(\text{g})$

19. Which of the following diagrams **best** represents the shape and direction of the magnetic field close to a strong permanent bar magnet?

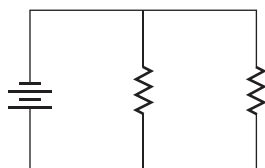


20. The strength of an electric field 1.50 m from a point charge of 2.10×10^{-9} C is

- A. 12.6 N/C
- B. 8.39 N/C
- C. 3.15×10^{-9} N/C
- D. 6.22×10^{-20} N/C

Use the following information to answer questions 21 and 22.

Two identical resistors are connected in parallel, as shown in the circuit diagram below.

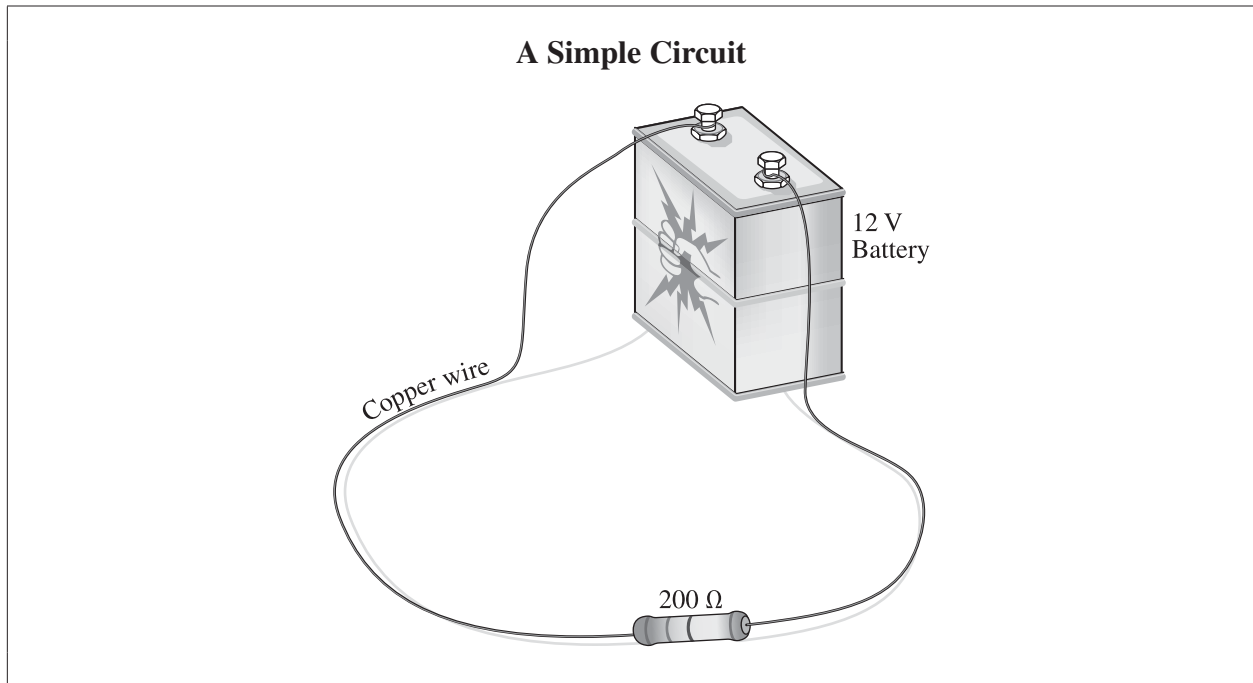


21. If the total resistance of the circuit represented by the diagram shown above is 1.0Ω , then the resistance of each resistor is
- A. 0.10Ω
 - B. 0.50Ω
 - C. 1.0Ω
 - D. 2.0Ω
22. The instrument used to directly measure the current flowing through the circuit represented above is *i* , which should be connected in *ii* with the battery in the circuit.

The statement above is completed by the information in row

| Row | <i>i</i> | <i>ii</i> |
|-----|-------------|-----------|
| A. | an ammeter | series |
| B. | an ammeter | parallel |
| C. | a voltmeter | series |
| D. | a voltmeter | parallel |

Use the following information to answer question 23.



23. The current flowing in the circuit above is

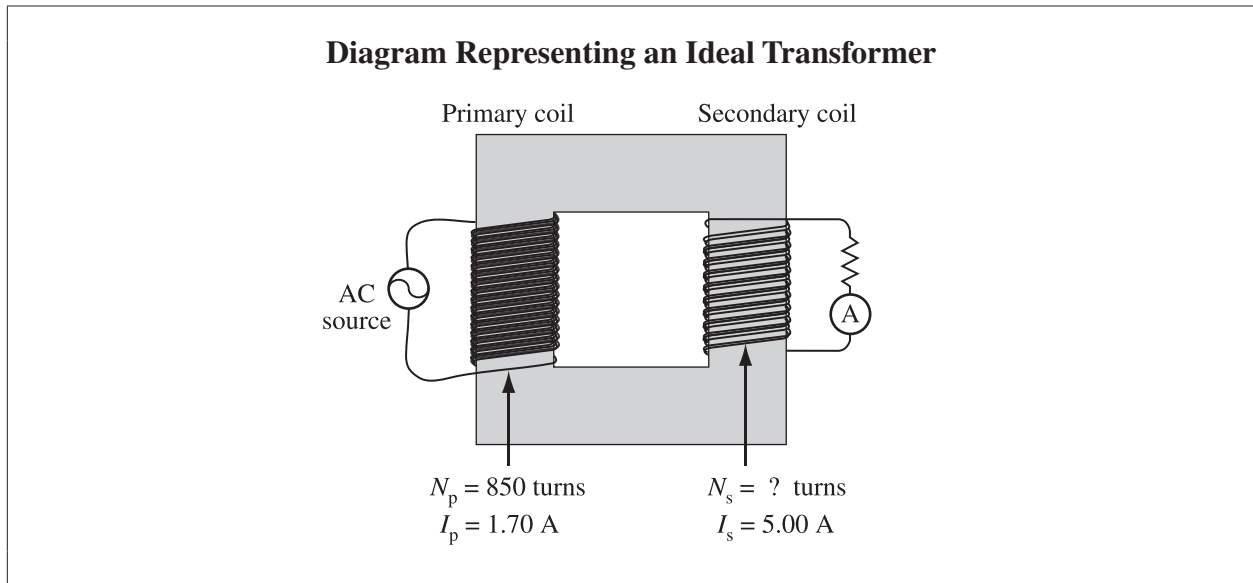
- A. 0.060 A
- B. 17 A
- C. 2.4×10^3 A
- D. 2.9×10^4 A

Use the following information to answer question 24.

Scientists hypothesize that a conductive copper wire suspended from a satellite orbiting Earth would produce enough energy to power the satellite's electrical components.

24. The power in this situation would result from the
- A. wire acting as a step-up transformer
 - B. conductive wire moving through Earth's magnetic field
 - C. resistance within the wire due to the extreme cold of space
 - D. friction of Earth's atmosphere acting on the conductive wire
-
25. If the power output of one type of laser pointer is 5.0×10^{-3} W and the laser pointer is left on for 30 min, how many joules of energy does it use?
- A. 1.6×10^{-4} J
 - B. 0.15 J
 - C. 9.0 J
 - D. 6.0×10^3 J

Use the following information to answer numerical-response question 7.



Numerical Response

7. The number of turns on the secondary coil of the ideal transformer shown above is _____ turns.

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

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

Technologies That Emit Electromagnetic Radiation (EMR)

| Row | Technology | Typical Wavelength (m) |
|-----|------------------|------------------------|
| 1 | Tanning bed | 10^{-9} |
| 2 | Radar detector | 10^{-2} |
| 3 | Microwave oven | 10^{-1} |
| 4 | Cancer treatment | 10^{-13} |

Numerical Response

8. When the technologies that emit EMR numbered above are listed in order from the one with the **lowest** energy per photon to the one with the **highest** energy per photon, the order is

_____ **Lowest**

_____ **Highest**

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

Use the following information to answer question 26.

Security threads have been added to Canadian bills to help detect counterfeit money. These threads glow when the bills are held under counterfeit-detection lamps that emit EMR with wavelengths between 390 nm and 565 nm.

26. Which types of EMR do the counterfeit detection lamps emit?
- A. Visible and ultraviolet
 - B. Visible and infrared
 - C. Radio and ultraviolet
 - D. Radio and infrared

Use the following information to answer numerical-response question 9.

Some Technologies Used to Study Celestial Bodies

- 1** Reflecting telescope
- 2** Refracting telescope
- 3** Radio telescope
- 4** Spectroscope

Numerical Response

- 9.** Match each technology numbered above with a key component used by that technology. (Use each number only once.)

Lens _____ (Record in the **first** column)

Mirror _____ (Record in the **second** column)

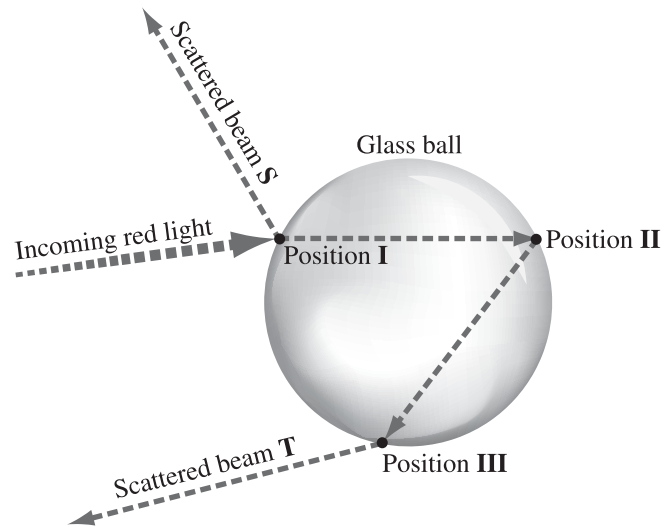
Satellite dish _____ (Record in the **third** column)

Diffraction grating _____ (Record in the **fourth** column)

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

Use the following information to answer question 27.

A beam of incoming red light strikes a glass ball at an angle, as shown below, and two scattered beams of red light (beams **S** and **T**) are observed.



27. In the diagram above, the phenomenon of refraction is shown at
- A. Position I only
 - B. Position II only
 - C. Position I and Position II
 - D. Position I and Position III

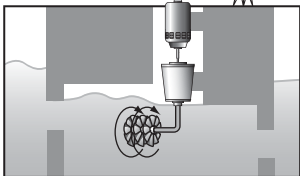
28. Which of the following rows describes the appearance of light from an object that is moving away from Earth and provides the name of this phenomenon?

| Row | Appearance of Light from an Object Moving Away from Earth | Name of this Phenomenon |
|------------|--|--------------------------------|
| A. | Higher frequency and longer wavelength | Red shift |
| B. | Higher frequency and shorter wavelength | Blue shift |
| C. | Lower frequency and longer wavelength | Red shift |
| D. | Lower frequency and shorter wavelength | Blue shift |

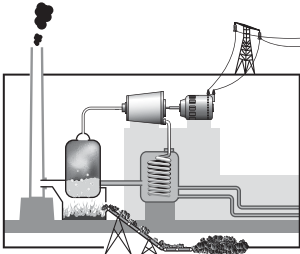
Use the following information to answer numerical-response question 10.

Power Station Diagram

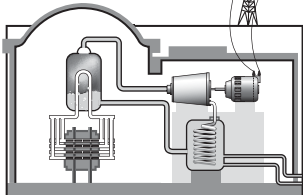
1



2



3



| Energy Conversions | | Type of Energy Used | |
|--------------------|--|---------------------|---------------|
| 4 | $E_{\text{gravitational}} \rightarrow E_{\text{kinetic}} \rightarrow E_{\text{electrical}}$ | 7 | Renewable |
| 5 | $E_{\text{chemical potential}} \rightarrow E_{\text{kinetic}} \rightarrow E_{\text{electrical}}$ | 8 | Non-renewable |
| 6 | $E_{\text{nuclear potential}} \rightarrow E_{\text{kinetic}} \rightarrow E_{\text{electrical}}$ | | |

Numerical Response

- 10.** Using the numbers above, choose **one power station diagram** and match it with the energy conversions that occur in that power station to produce electricity and the type of energy used by that power station. (There is more than one correct answer.)

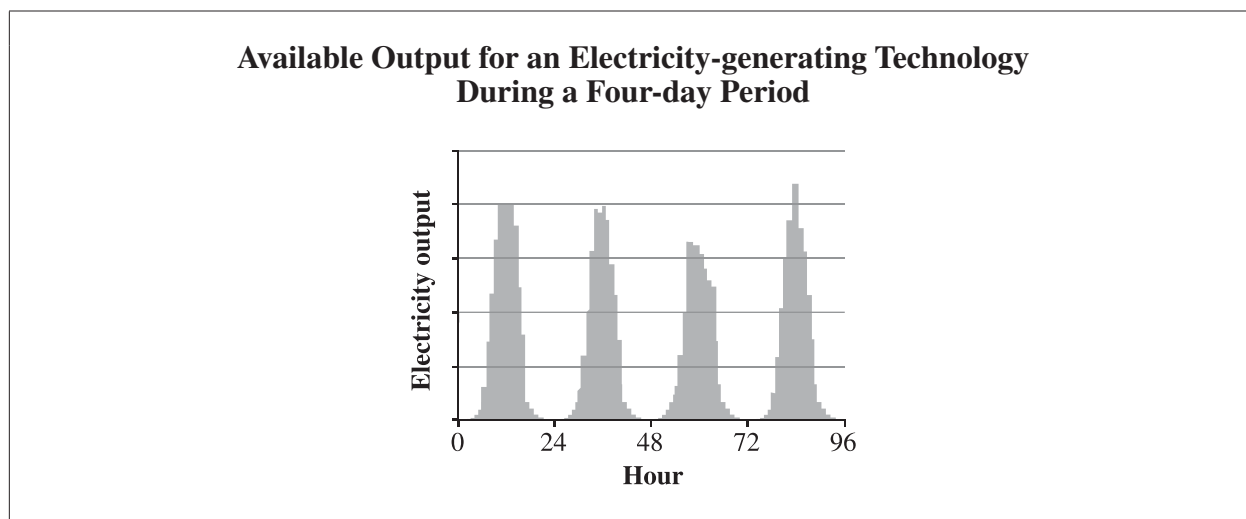
Power station diagram _____ (Record in the **first** column)

Energy conversions _____ (Record in the **second** column)

Type of energy _____ (Record in the **third** column)

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

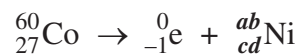
Use the following information to answer question 29.



29. Which of the following electricity-generating technologies **most likely** produced the graph shown above?
- A. Photovoltaic panel
 - B. Hydroelectric dam
 - C. Nuclear power plant
 - D. Natural-gas power plant

Use the following information to answer numerical-response question 11.

Radiation therapy works by damaging cell nuclei so that cancer cells can be destroyed and stop reproducing. Cobalt-60 isotopes are used for cancer treatment. Cobalt-60 undergoes nuclear decay as shown below.



Numerical Response

11. In the nuclear decay shown above, the values of a , b , and c , d are

$\frac{\quad}{a}$ $\frac{\quad}{b}$ and $\frac{\quad}{c}$ $\frac{\quad}{d}$.

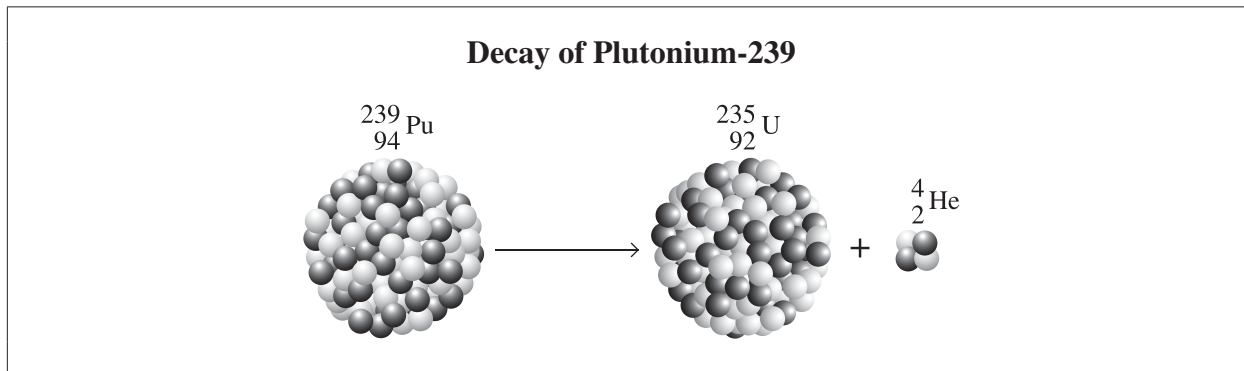
(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)

Numerical Response

12. If 1.17×10^{-6} kg of mass is converted to energy in a nuclear decay reaction, then the energy produced is _____ $\times 10^{11}$ J.

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

Use the following information to answer question 31.



30. The type of nuclear change shown above is
- A. alpha decay, which is a type of nuclear fission
 - B. alpha decay, which is a type of nuclear fusion
 - C. beta decay, which is a type of nuclear fission
 - D. beta decay, which is a type of nuclear fusion

Use the following information to answer numerical-response question 13.

A particular water-injection pump produces kinetic energy at a rate of 3.10×10^4 W and requires input electrical energy at a rate of 3.68×10^4 W to run the pump.

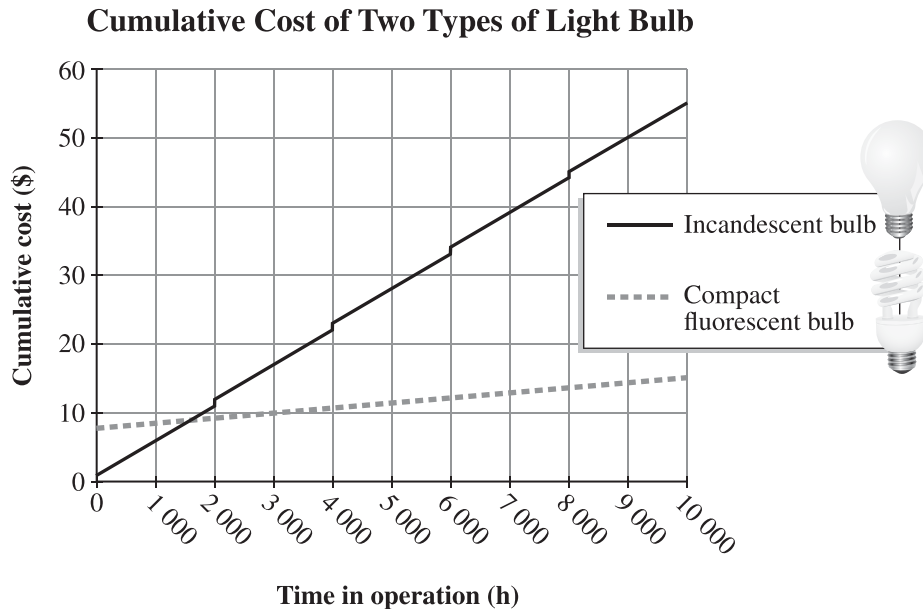
Numerical Response

13. The percent efficiency of this pump is _____ %.

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

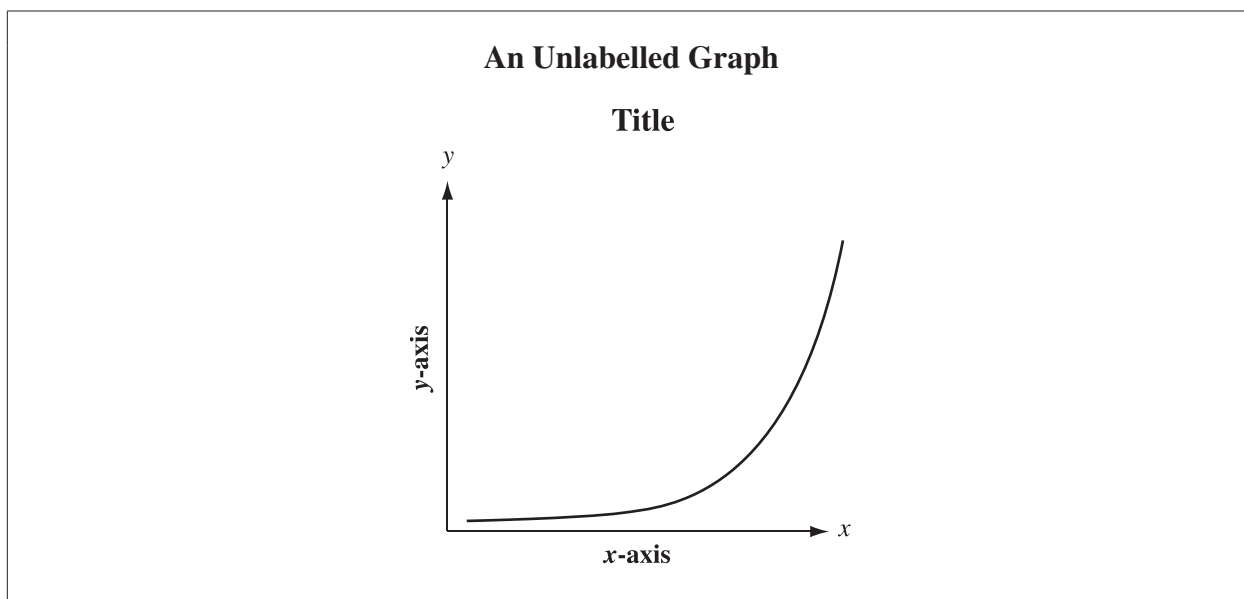
Use the following information to answer question 31.

The graph below shows the cumulative cost of purchasing and operating one compact fluorescent light (CFL) bulb over 10 000 hours, and the cost of purchasing and operating incandescent bulbs over the same period. Over 10 000 hours, the incandescent bulb would have to be replaced four times, while the CFL bulb would not need to be replaced.



31. Which of the following statements accurately compares CFL bulbs and incandescent bulbs?
- A. CFL bulbs are less expensive to purchase and are less energy efficient than incandescent bulbs.
 - B. CFL bulbs are less expensive to purchase and are more energy efficient than incandescent bulbs.
 - C. CFL bulbs are more expensive to purchase and are less energy efficient than incandescent bulbs.
 - D. CFL bulbs are more expensive to purchase and are more energy efficient than incandescent bulbs.

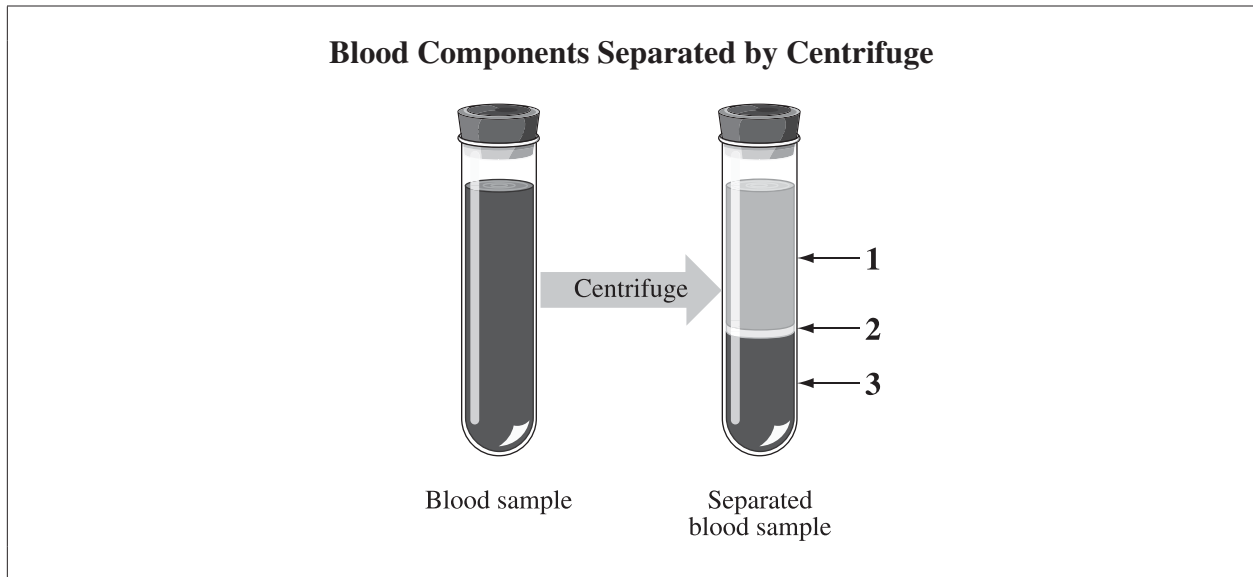
Use the following information to answer question 32.



32. Which of the following titles **best** corresponds with the trend in the graph above?
- A. “Titration of a Strong Base with a Weak Acid”
 - B. “Global Energy Consumption over the Last Century”
 - C. “The Effect of Increasing Distance on the Field Strength of a Test Object”
 - D. “The Effect of Increasing Resistance on the Current Flowing Through a Circuit”

Science 30 Diploma Examination April 2017— Released Items

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



Numerical Response

- 1.** Match each section of the separated blood sample numbered above with its corresponding blood component below.

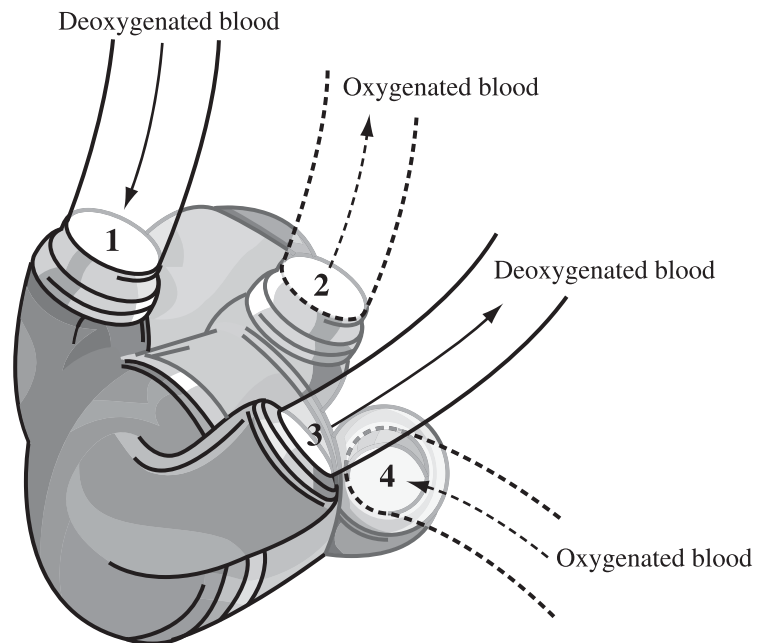
| | | | |
|-------------------|---------------|------------------------|--|
| Number: | _____ | _____ | _____ |
| Component: | Plasma | Red blood cells | Platelets and white blood cells |

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

Use the following information to answer question 1 and numerical-response question 2.

One type of artificial heart contains rotating components that help push a constant stream of blood through two separate compartments. As a result, a patient with this type of artificial heart will not have a pulse or heartbeat.

Diagram of Blood Flow Through a Two-compartment Artificial Heart



1. Which of the following structures prevent the backflow of blood within the normal human heart but are missing from the two-compartment artificial heart?
 - A. Coronary arteries
 - B. Ventricles
 - C. Valves
 - D. Atria

Numerical Response

2. Match each structure numbered in the diagram of the artificial heart on the previous page with a description below. (Use each number only once.)

| | | | | |
|---------------------|--------------------------------------|-------------------------------------|-------------------------------------|--|
| Structure: | _____ | _____ | _____ | _____ |
| Description: | Attached to the vena cava | Sends blood to the lungs | Sends blood to the brain | Attached to the pulmonary veins |

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

2. A pathogen is **more likely** to infect a person who has
- A. badly damaged skin
 - B. high red blood cell levels
 - C. excessive sweat secretions
 - D. stomach acid with a low pH

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

| Type of White Blood Cell | | One Function | Another Function |
|--------------------------|----------------|--|---------------------------------------|
| 1 | Helper T cells | 4 Recognize antigens and send chemical message | 7 Expose foreign antigens |
| 2 | Macrophages | 5 Produce proteins which bind to specific antigens of the invaders | 8 Become memory cells |
| 3 | B cells | 6 Surround invading pathogens | 9 Signal production of killer T cells |

Numerical Response

3. Using the numbers above, choose **one type of white blood cell** and match it with two functions of that type of white blood cell. (There is more than one correct answer.)

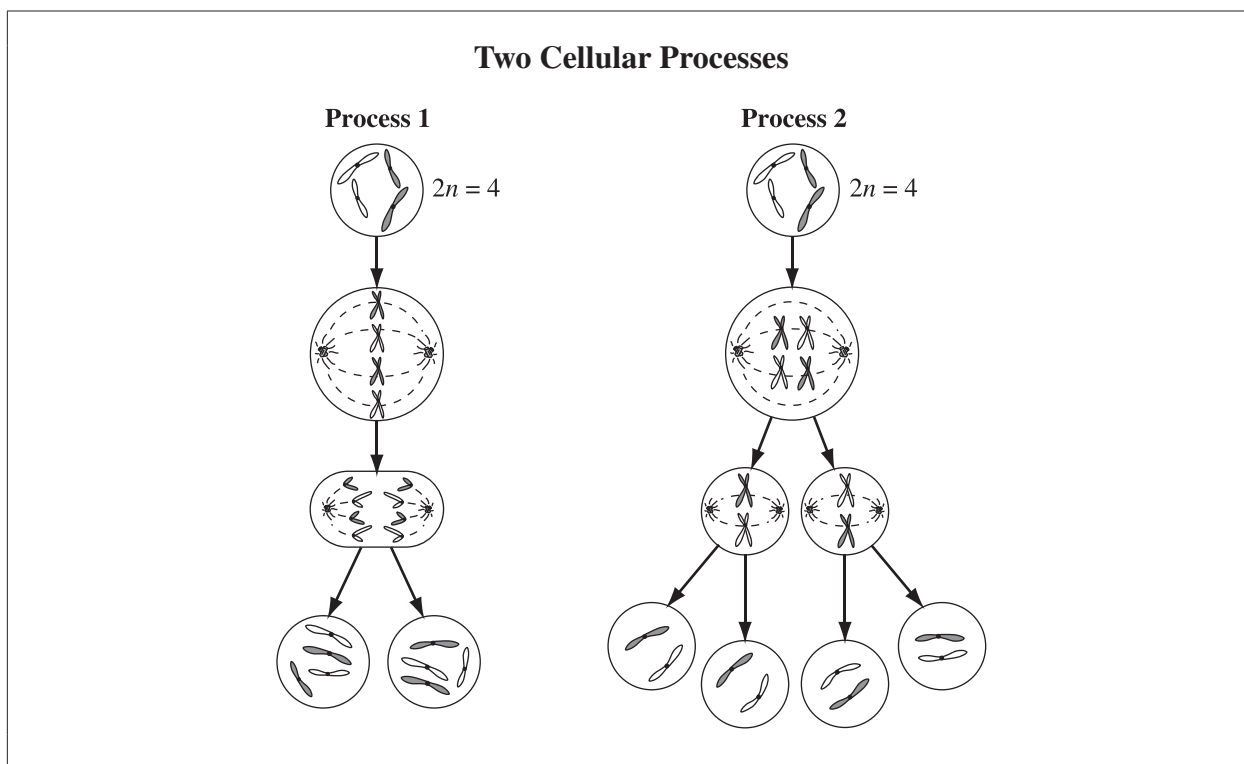
Type of white blood cell _____ (Record in the **first** column)

One function _____ (Record in the **second** column)

Another function _____ (Record in the **third** column)

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

Use the following information to answer question 3.



3. Which of the following rows identifies the **final** chromosome content in each of the cells produced by the two processes illustrated above?

| Row | Cells Produced by Process 1 | Cells Produced by Process 2 |
|-----|-----------------------------|-----------------------------|
| A. | $2n = 4$ | $2n = 4$ |
| B. | $2n = 4$ | $1n = 2$ |
| C. | $1n = 2$ | $1n = 4$ |
| D. | $1n = 2$ | $2n = 2$ |

Use the following information to answer question 4.

Erwin Chargaff was a scientist whose work led to the discovery of which nitrogen bases in a DNA molecule pair together. He determined the relative portions of each of the four nitrogen bases in a particular DNA molecule.

Some Results from Chargaff's Experiment

| Nitrogen Base | Relative Portion of a Particular DNA Molecule |
|----------------------|--|
| Adenine | 30% |
| Guanine | 20% |

4. Based on the results of Chargaff's experiment, which of the following rows identifies the relative portion of cytosine in the DNA molecule and the relative portion of thymine in the DNA molecule?

| Row | Relative Portion of Cytosine in the DNA Molecule | Relative Portion of Thymine in the DNA Molecule |
|------------|---|--|
| A. | 20% | 30% |
| B. | 30% | 20% |
| C. | 70% | 80% |
| D. | 80% | 70% |

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

People with hemophilia A, a recessive sex-linked disorder, lack a blood protein known as clotting factor VIII. A woman with hemophilia (X^hX^h) and a man without hemophilia (X^HY) have a child.

Numerical Response

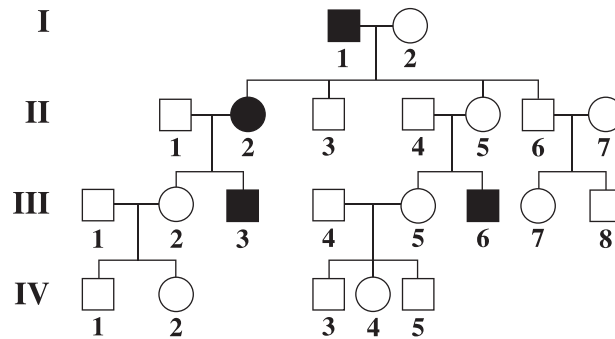
4. The percent probability the child described above will have hemophilia is _____%.

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

Use the following information to answer questions 5 to 7.

Changes to the *Gla* gene cause Fabry disease, an X-linked recessive disorder that results in a buildup of fat in many body cells. As the disease progresses, fat builds up in the large blood vessels that move blood away from the heart, increasing the risk of kidney damage, heart attack, and stroke.

Pedigree Chart Representing a Family with Fabry Disease



5. The blood vessels expected to be **most affected** by Fabry disease are
- capillaries
 - venules
 - arteries
 - veins
6. Which of the following rows represents the genotype and phenotype of individual **II-4** shown in the pedigree chart above?

| Row | Genotype of II-4 | Phenotype of II-4 |
|-----|------------------|-------------------|
| A. | Affected male | $X^F Y$ |
| B. | Unaffected male | $X^F X^f$ |
| C. | $X^F Y$ | Unaffected male |
| D. | $X^F X^f$ | Affected male |

7. Which of the following processes could cause Fabry disease?
- A base pair mutation
 - Meiosis in fat cells
 - Mitosis in fat cells
 - A viral infection

Use the following information to answer question 8.

Adenosine deaminase (ADA) deficiency is a genetic disorder that prevents DNA replication in the stem cells that produce T cells and B cells. Some people with ADA deficiency have DNA from their T cells removed. This DNA is modified with a functioning ADA gene and then inserted into a virus. The virus is then delivered back into the person with ADA deficiency, who is then able to produce normal levels of T cells and B cells.

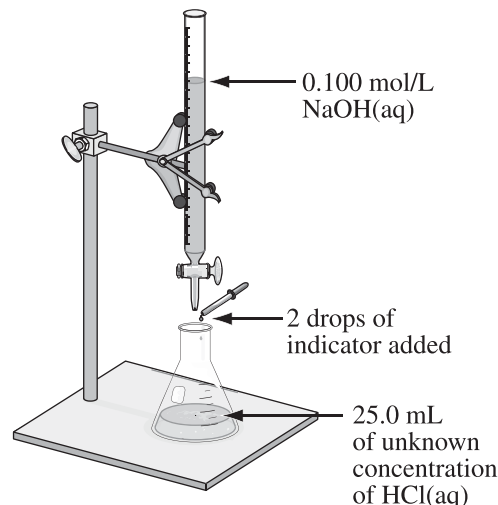
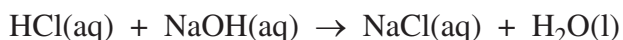
8. The treatment described above is an example of
- A. DNA fingerprinting
 - B. genetic screening
 - C. transformation
 - D. gene therapy

Use the following information to answer questions 9 and 10 and numerical-response question 5.

Illustration of Titration Setup

The titration setup illustrated to the right was used to determine the concentration of an aqueous solution of hydrochloric acid, $\text{HCl}(\text{aq})$, using phenolphthalein as the indicator.

A 0.100 mol/L aqueous solution of sodium hydroxide, $\text{NaOH}(\text{aq})$, was slowly added to 25.0 mL samples of $\text{HCl}(\text{aq})$. The chemical reaction that occurred is represented by the equation below.



9. Which of the following rows identifies the acid in the chemical equation shown above and the role of the acid in the reaction?

| Row | Acid | Role of Acid |
|-----|--------------------------|------------------|
| A. | $\text{NaOH}(\text{aq})$ | Donates a proton |
| B. | $\text{NaOH}(\text{aq})$ | Accepts a proton |
| C. | $\text{HCl}(\text{aq})$ | Donates a proton |
| D. | $\text{HCl}(\text{aq})$ | Accepts a proton |

10. When phenolphthalein is added to the $\text{HCl}(\text{aq})$ solution before the titration, the solution will be
- A. pink
 - B. blue
 - C. yellow
 - D. colourless

Numerical Response

5. If the concentration of the HCl(aq) sample was determined to be 2.26×10^{-2} mol/L, then in order to reach the endpoint, the students must have added _____ mL of NaOH(aq).

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

11. Which of the following 1.0 mol/L carboxylic acids is the strongest acid?
- A. Methanoic acid, HCOOH(aq)
 - B. Benzoic acid, C₆H₅COOH(aq)
 - C. Ethanoic acid, CH₃COOH(aq)
 - D. Oxalic acid, HOCCOOH(aq)
12. If the pH of a solution is 7.20, then its hydronium ion concentration, [H₃O⁺(aq)], is
- A. 0.72 mol/L
 - B. 0.86 mol/L
 - C. 1.0×10^{-7} mol/L
 - D. 6.3×10^{-8} mol/L

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

| Chemical | | Environmental Impact | | Strategy to Reduce the Chemical's Environmental Impact | |
|----------|-----------------|----------------------|-----------------------------------|--|--|
| 1 | DDT | 4 | Contributes to photochemical smog | 7 | Grow genetically engineered crops that are resistant to pests. |
| 2 | SO _x | 5 | Biomagnifies in a food chain | 8 | Use catalytic converters in automobiles. |
| 3 | NO _x | 6 | Creates acid deposition | 9 | Install scrubbers on smokestacks. |

Numerical Response

6. Using the numbers above, choose **one chemical** and match it with its environmental impact and the strategy that may reduce that chemical's environmental impact. (There is more than one correct answer.)

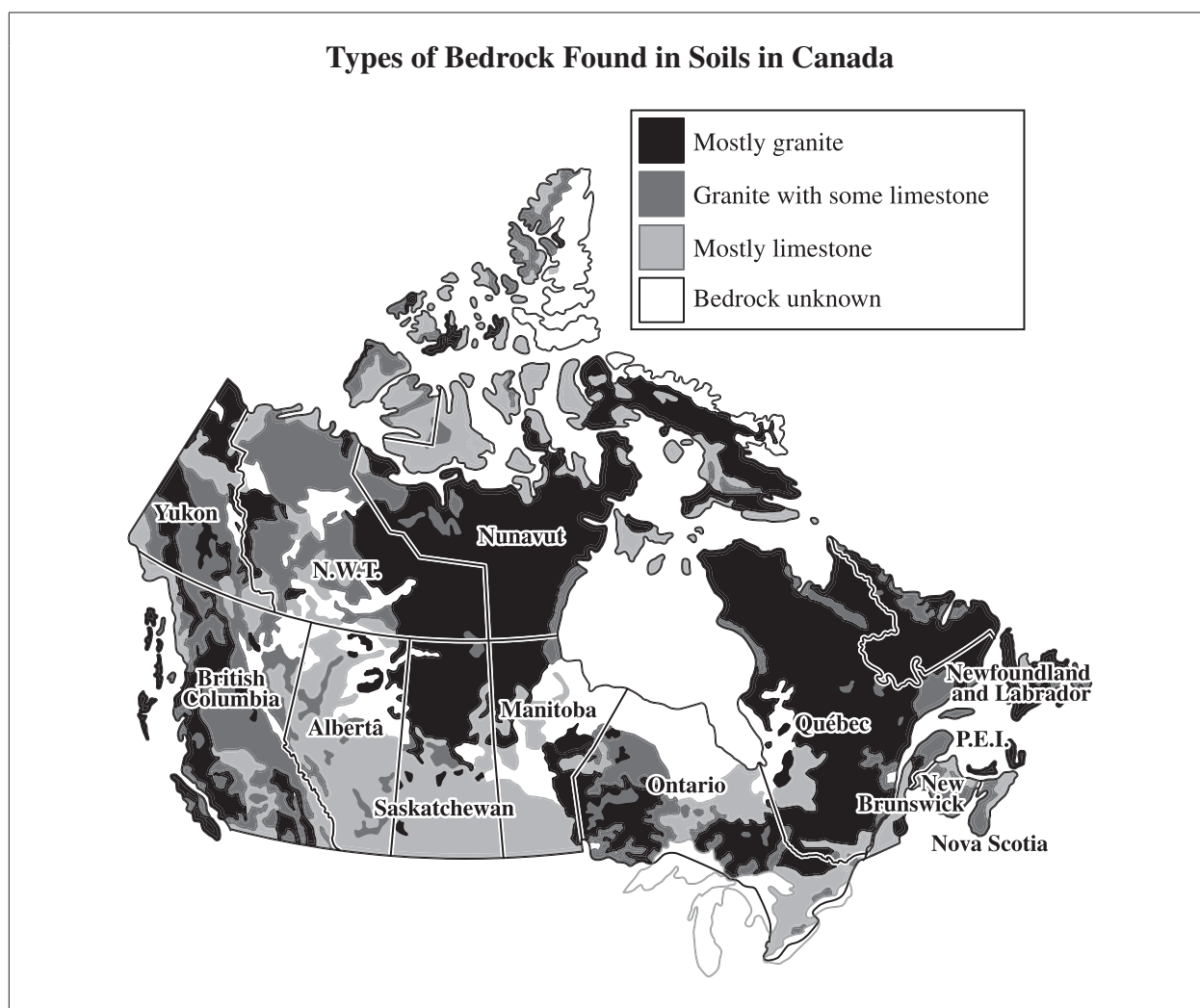
Chemical _____ (Record in the **first** column)

Impact _____ (Record in the **second** column)

Strategy _____ (Record in the **third** column)

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

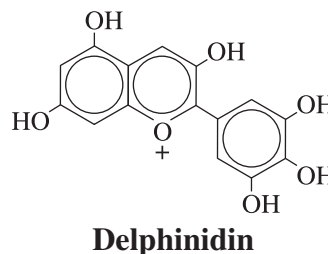
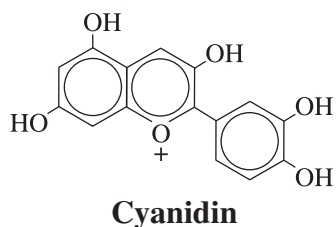
Use the following information to answer question 13.



13. According to the map above, the province with the soil that can **best** resist the effects of acid deposition is
- A. Alberta
 - B. Manitoba
 - C. Ontario
 - D. Québec

Use the following information to answer questions 14 to 17.

Cyanidin and delphinidin are two chemicals commonly found in day lily flowers, where cyanidin produces red colours and delphinidin produces blue colours. Controlled studies, in test tubes without soil, indicate that day lilies with both chemicals are red under acidic conditions and blue under basic conditions.

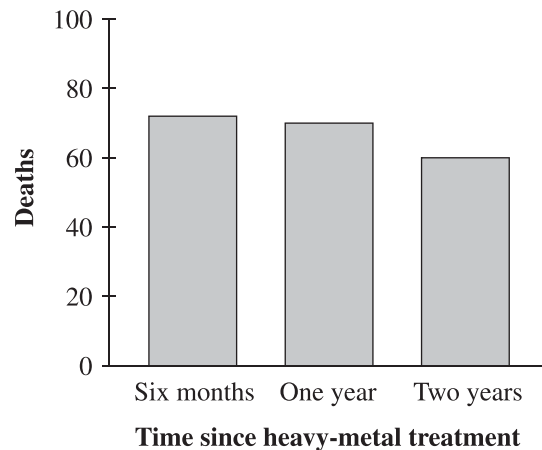


14. In the controlled studies, the colour change of a day lily is similar to the action of
- buffers like limestone
 - buffers like phenol red
 - indicators like limestone
 - indicators like phenol red
15. Two structures present in both the cyanidin and delphinidin molecules above are the same as those in
- benzene and alcohols
 - benzene and halogenated hydrocarbons
 - carboxylic acids and alcohols
 - carboxylic acids and halogenated hydrocarbons
16. Compounds like cyanidin can be used to produce esters in labs. In order to convert such compounds into esters, which chemical below could be added to produce the reaction?
- Ethanol
 - Methanoic acid
 - Ethyl methanoate
 - Sodium hydroxide

17. Day lilies do **not** typically exhibit blue colour when grown in soil. This is an example of how environment can affect
- A. phenotype
 - B. genotype
 - C. mitosis
 - D. meiosis

Use the following information to answer question 18.

A study was performed to test the toxicity of soils contaminated with heavy metals such as lead and mercury. Three soil samples were prepared with identical concentrations of heavy metals. One sample was left for 6 months, a second sample was left for 1 year, and a third sample was left for 2 years. One hundred worms were then transferred to each sample. The worms were left in the soil for 24 hours, and then the number of dead worms was counted. The number of worm deaths was used to indicate the incidence of metal toxicity.



18. For the experiment described above, which of the following possible components would be an appropriate control group?
- A. The number of live worms after a 48-hour period
 - B. The number of other organisms affected by heavy-metal toxicity
 - C. Worms in a soil sample that was not treated with any heavy metals
 - D. Worms in a soil sample treated with heavy metals at a 3-year interval

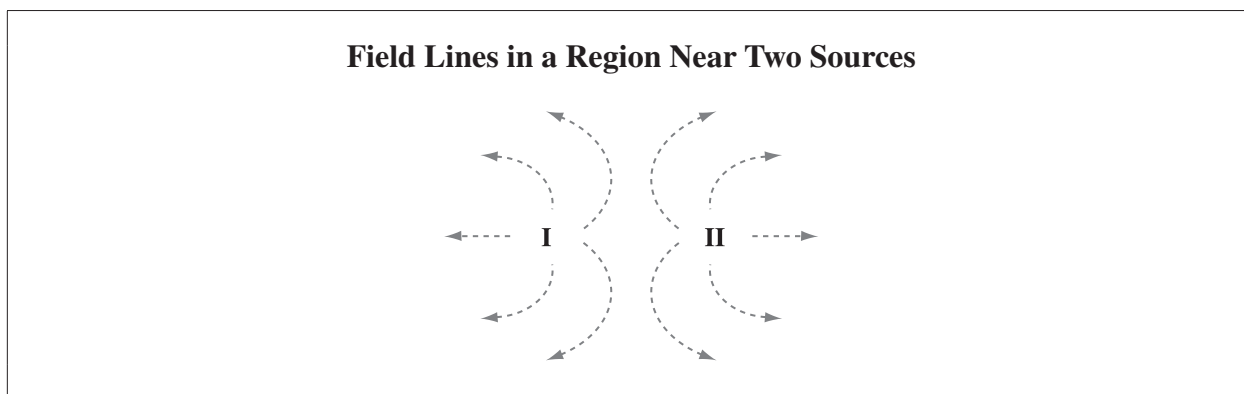
19. One risk associated with using chlorofluorocarbons (CFCs) is that when they are released into the atmosphere, they
- A. lower the pH of lakes, which increases the rate of skin cancer
 - B. lower the pH of lakes, which increases respiratory illnesses
 - C. deplete ozone, which increases the rate of skin cancer
 - D. deplete ozone, which increases respiratory illnesses

Use the following information to answer question 20.

Ground-level ozone is a toxic pollutant that is created when nitrogen dioxide emissions are exposed to sunlight. The production of ground-level ozone is an environmental and health issue in many cities.

20. One action that a city's government could take to reduce ground-level ozone would be to
- A. add a recycling deposit fee to batteries containing heavy metals
 - B. pass a law preventing motorists from letting their cars idle for long periods of time
 - C. impose fines on natural gas companies that release hydrogen sulfide, $\text{H}_2\text{S}(\text{g})$, into the atmosphere
 - D. develop an education program to encourage the public to properly dispose of refrigerators and air conditioners

Use the following information to answer question 21.



21. Which of the following rows shows the possible identifications for Source I and Source II?

| Row | Source I | Source II |
|-----|------------------------|------------------------|
| A. | North pole of a magnet | Positive point charge |
| B. | North pole of a magnet | South pole of a magnet |
| C. | Positive point charge | South pole of a magnet |
| D. | Positive point charge | Positive point charge |

Use the following information to answer numerical-response question 7.

The summit of Mount Chimborazo, an inactive volcano in Ecuador, is the furthest point on Earth's surface from Earth's centre. The distance from Earth's centre to the summit of Mount Chimborazo is 6.38×10^6 m.

Numerical Response

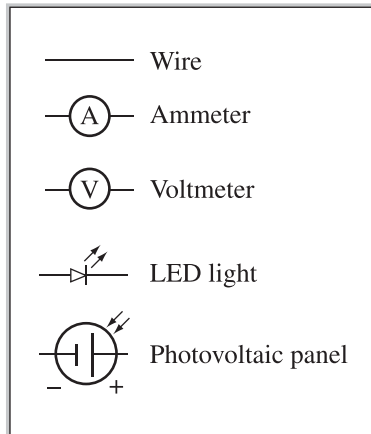
7. The predicted gravitational field strength at the summit of Mount Chimborazo is _____ N/kg.

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

Use the following information to answer question 22.

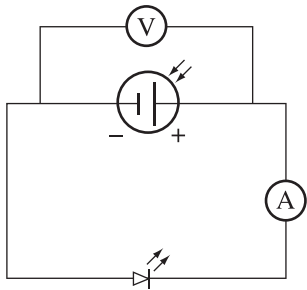
A student constructed a circuit containing an ammeter, a voltmeter, an LED light, and a small panel of photovoltaic cells.

Some Symbols for Components in a Circuit Diagram

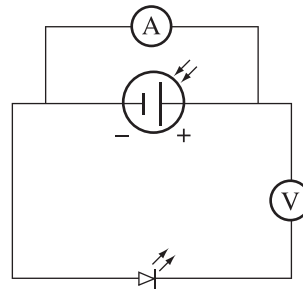


22. Which of the following diagrams shows an ammeter and a voltmeter correctly arranged in the circuit?

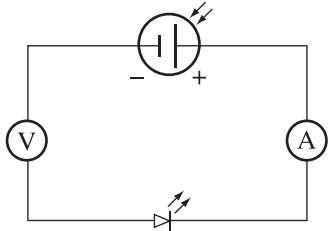
A.



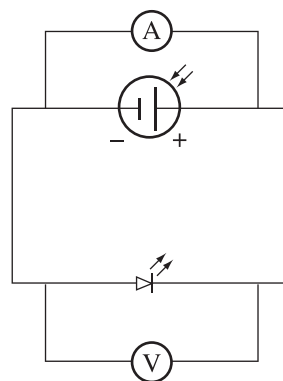
B.



C.



D.



Numerical Response

8. A defibrillator applies a current of 3.50 A to a patient's chest. If the resistance of the patient's chest is $1.60 \times 10^2 \Omega$, then the power applied by this device, expressed in scientific notation, is $a.bc \times 10^d$ W. The values of a , b , c , and d are _____, _____, _____, and _____.

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

23. One characteristic of direct current is that it
- A. flows back and forth
 - B. can be provided by batteries
 - C. does not produce a magnetic field
 - D. is used to step up voltage in a transformer

Use the following information to answer numerical-response question 9.

Characteristics of Some Transformers

- 1 There are more turns on the secondary coil than on the primary coil.
- 2 There are more turns on the primary coil than on the secondary coil.
- 3 The voltage is higher in the secondary coil than in the primary coil.
- 4 The voltage is higher in the primary coil than in the secondary coil.
- 5 The current is higher in the secondary coil than in the primary coil.
- 6 The current is higher in the primary coil than in the secondary coil.

Numerical Response

9. The characteristics of an ideal step-up transformer are numbered _____, _____, and _____.

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

Use the following information to answer numerical-response question 10.

| Device | | Input Energy | | Output Energy | |
|--------|-----------|--------------|------------|---------------|------------|
| 1 | Generator | 3 | Electrical | 5 | Kinetic |
| 2 | Motor | 4 | Kinetic | 6 | Electrical |

Numerical Response

10. Using the numbers above, choose **one device** and match it with the input energy and output energy of that device. (There is more than one correct answer.)

Device _____ (Record in the **first** column)

Input energy _____ (Record in the **second** column)

Output energy _____ (Record in the **third** column)

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

24. Two safety technologies that prevent the flow of excess current in circuits are
- A. fuses and breakers
 - B. fuses and ground wiring
 - C. polarized plugs and breakers
 - D. polarized plugs and ground wiring

Use the following information to answer question 25.

Types of Electromagnetic Radiation (EMR) Used by Some Technologies

- 1 Television remote controls use infrared.
- 2 Radiation therapy uses X-rays to kill cancer cells.
- 3 Medical equipment sterilizers use ultraviolet.
- 4 Magnetic resonance imaging (MRI) machines use long-wave radio.

25. When the types of EMR used by the technologies listed above are placed in order from **least** energy per photon to **greatest** energy per photon, the correct order is
- A. 2, 3, 1, 4
 - B. 2, 1, 3, 4
 - C. 4, 3, 1, 2
 - D. 4, 1, 3, 2
-
26. Which of the following types of EMR does **not** reach Earth's surface because it is completely absorbed by Earth's atmosphere?
- A. Radio
 - B. Gamma
 - C. Infrared
 - D. Microwave

Use the following information to answer question 27.

Sound waves from a particular emergency alarm bell travel through the air at a speed of 344 m/s.

27. If the frequency of the alarm is 1 200 Hz, then the wavelength of the sound waves is
- A. 0.287 m
 - B. 3.49 m
 - C. 2.50×10^5 m
 - D. 4.13×10^5 m

Use the following information to answer numerical-response question 11.

| EMR Type | | Frequency Range | Technological Application | | |
|----------|-------------|-----------------|------------------------------|---|-------------------|
| 1 | Radio | 4 | Greater than 10^{19} Hz | 7 | Telecommunication |
| 2 | Ultraviolet | 5 | 10^3 Hz to 10^{12} Hz | 8 | Cancer therapy |
| 3 | Gamma | 6 | 10^{15} Hz to 10^{18} Hz | 9 | Tanning beds |

Numerical Response

11. Using the numbers above, choose **one EMR type** and match it with its frequency range and its technological application. (There is more than one correct answer.)

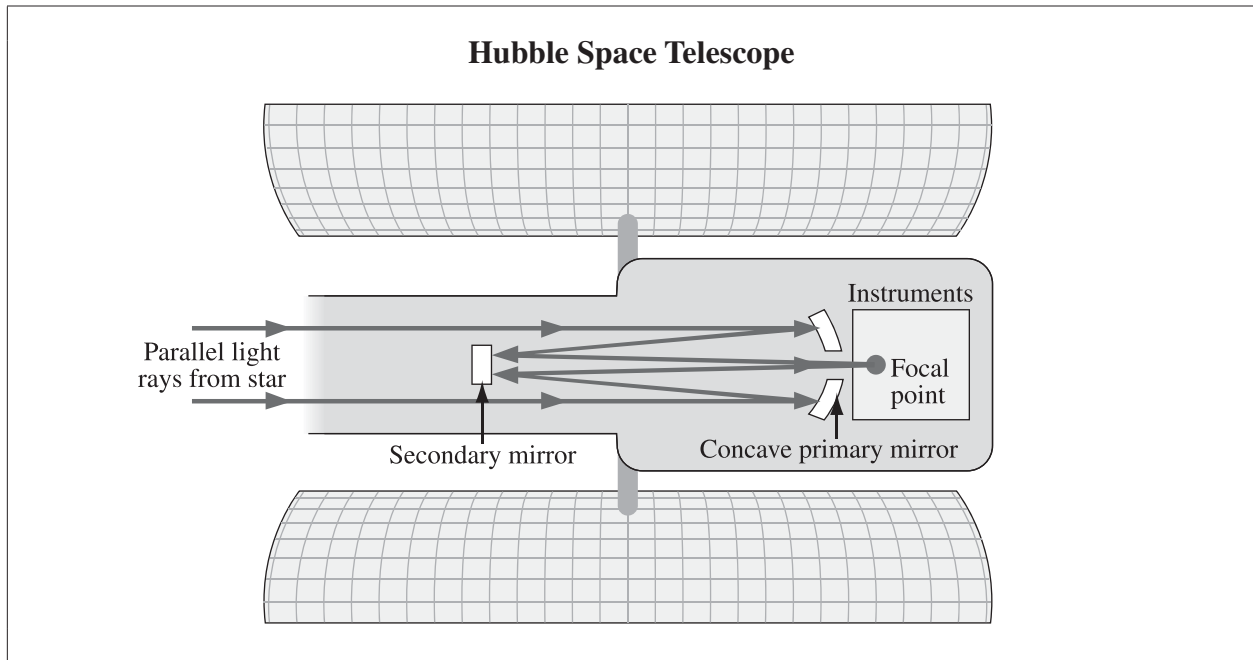
EMR type _____ (Record in the **first** column)

Frequency range _____ (Record in the **second** column)

Technological application _____ (Record in the **third** column)

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

Use the following information to answer question 28.



28. The Hubble Space Telescope can **best** be classified as
- A. a refracting optical telescope
 - B. a reflecting optical telescope
 - C. an X-ray telescope
 - D. a radio telescope

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

Celestial Bodies Produced at the End of a Star Life Cycle

- 1 White dwarf
- 2 Neutron star
- 3 Black hole

Numerical Response

12. When the celestial bodies numbered above are ranked by relative mass of the star that they **originated** from, the order from **largest** original star to **smallest** original star is

_____, _____, and _____ .
Largest **Smallest**
original star **original star**

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

Use the following information to answer numerical-response question 13.

Some Government Actions

- 1 Installing low-energy street lights
- 2 Funding improved access to public transportation
- 3 Increasing development of coal-fired power plants
- 4 Reducing business taxes to increase economic growth
- 5 Providing incentives to purchase fuel-efficient automobiles
- 6 Compensating for high fuel prices with rebates to consumers
- 7 Encouraging the upgrading of home insulation with rebates to homeowners

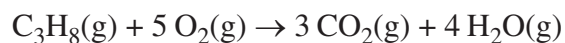
Numerical Response

13. The government actions numbered above that **most directly** promote ecological sustainability are _____, _____, _____, and _____.

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

Use the following information to answer question 29.

A student was given a balanced reaction equation for the combustion of propane and was asked to determine the energy change for the reaction. The student's work is shown below.

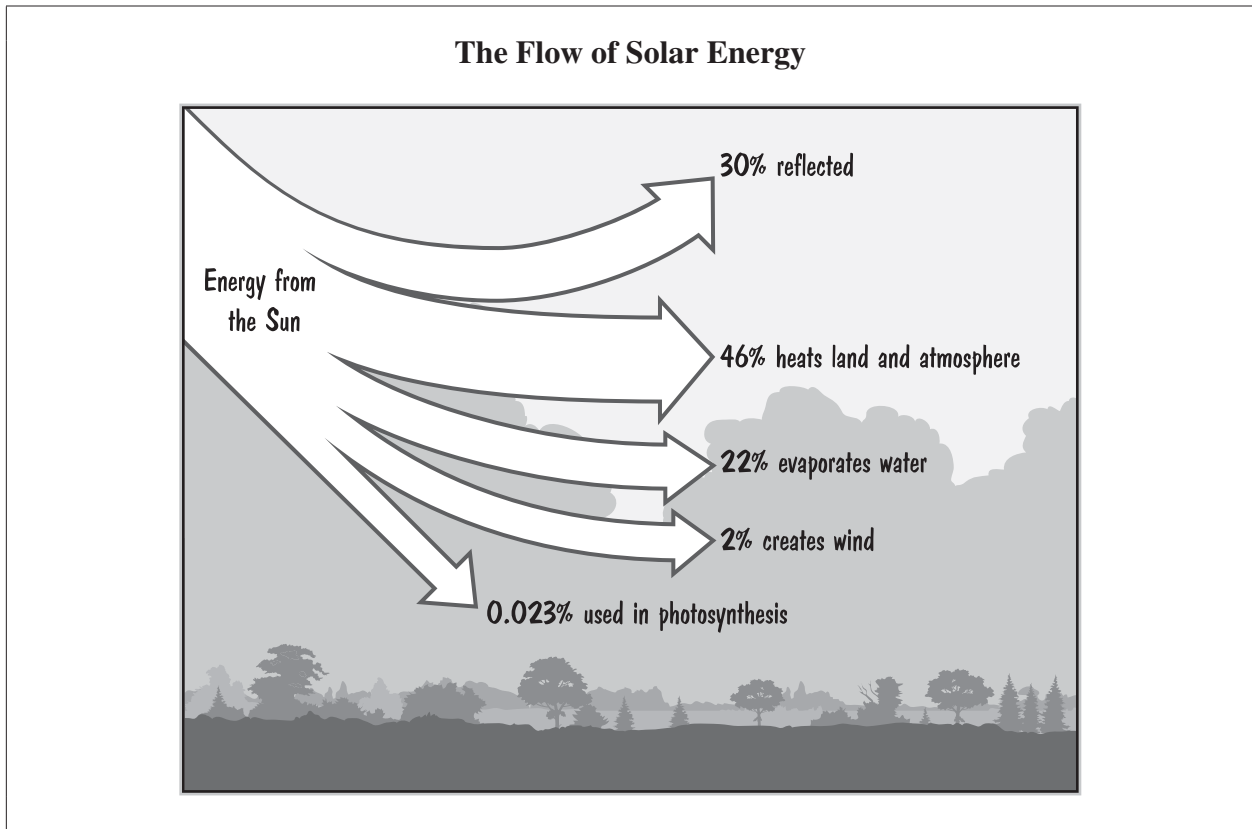


$$\begin{aligned}\Delta_c H^\circ &= \sum n \Delta_f H^\circ \text{ products} - \sum n \Delta_f H^\circ \text{ reactants} \\ &= [(-393.5 \text{ kJ/mol}) + (-241.8 \text{ kJ/mol})] - [(-103.8 \text{ kJ/mol}) + (0 \text{ kJ/mol})] \\ &= (-635.3 \text{ kJ}) - (-103.8 \text{ kJ}) \\ &= -531.5 \text{ kJ}\end{aligned}$$

The energy change is -531.5 kJ .

29. The correct answer is $-2\,043.9 \text{ kJ/mol}$. The student did **not** determine this answer because the student
- A. subtracted the energy of the products from the reactants rather than the energy of the reactants from the products
 - B. used the value for the molar heat of formation for liquid water rather than for water vapour
 - C. did not multiply the molar heat of formation of each compound by the number of moles
 - D. performed the calculations for an endothermic change rather than an exothermic change

Use the following information to answer question 30.



30. Based on the diagram above, the percentage of solar energy that results directly in the production of biomass is *i* , while the percentage of solar energy that is **most directly** related to the production of hydro power is *ii* .

The statement above is completed by the information in row

| Row | <i>i</i> | <i>ii</i> |
|-----|----------|-----------|
| A. | 46% | 30% |
| B. | 46% | 22% |
| C. | 0.023% | 30% |
| D. | 0.023% | 22% |

Use the following information to answer question 31.

A researcher is trying to determine which brand of solar panel has the highest efficiency. The following data were collected.

Comparison of Different Brands of Solar Panels

| Brand of Solar Panel | Surface Area of Solar Panel (m²) | Solar Radiation Input Power (W/m²) | Total Input Power (W) | Total Output Power (W) | Efficiency (%) |
|-----------------------------|--|--|------------------------------|-------------------------------|-----------------------|
| W | 2.15 | 900 | | 464 | |
| X | 2.58 | 900 | | 603 | |
| Y | 3.08 | 900 | | 832 | |
| Z | 3.60 | 900 | | 648 | |

31. If a consumer wanted to purchase the **most efficient** solar panel brand, the **best** choice would be
- A. Brand W
 - B. Brand X
 - C. Brand Y
 - D. Brand Z
-
32. The sequence of energy conversions in the production of electricity from a coal-burning power plant is
- A. chemical → thermal → kinetic → electrical
 - B. thermal → chemical → kinetic → electrical
 - C. chemical → gravitational → kinetic → electrical
 - D. thermal → gravitational → kinetic → electrical

Use the following information to answer numerical-response question 14.

Four Statements by Residents in an Area Where a Dam Will Be Built

- 1 Our country has signed an international agreement to reduce harmful air emissions; building a dam instead of a coal-fired power plant is an effective way to meet our commitment.
- 2 The construction of the dam will be expensive, but it will provide jobs.
- 3 The dam will prevent fish migration, and the reservoir behind the dam will flood sensitive wildlife habitat.
- 4 The creation of the reservoir will displace some people from their communities, but it will create recreation areas for swimming and boating.

Numerical Response

- 14.** Match each statement numbered above to the perspective it represents below. (Use each number only once.)

Statement: _____
Perspective: **Ecological** **Economic** **Societal** **Political**

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

Use the following information to answer numerical-response question 15.

Four energy sources that are used to produce electricity were evaluated and summarized in a table. A check mark (✓) was used to indicate that a statement is **true** for that energy source.

| Results of Using Energy Source to Produce Electricity | Energy Source | | | |
|---|---------------|---|---|---|
| | 1 | 2 | 3 | 4 |
| Depletes a non-renewable resource | x | ✓ | x | ✓ |
| Emits carbon dioxide, CO ₂ (g) | ✓ | ✓ | ✓ | ✓ |
| Produces particulate emissions | ✓ | ✓ | x | x |
| Diverts food crops to fuel production | ✓ | x | x | x |
| Can be used to produce energy in a variety of locations | ✓ | ✓ | x | ✓ |

Numerical Response

15. Match each numbered energy source in the chart above to the name of that energy source given below. (Use each number only once.)

Number: _____
 Name: Coal Natural gas Biomass Geothermal

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

Use the following information to answer question 33.

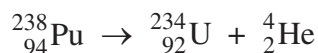
Some wristwatch faces are coated with a layer of phosphor and filled with tritium gas. The spontaneous beta decay of the tritium causes the phosphor coating to glow. These types of watches glow continuously in the dark without previous exposure to a light source.

33. Which of the following equations shows the beta decay reaction that occurs in the wristwatches described above?

- A. ${}^3_1\text{H} \rightarrow {}^3_2\text{He} + {}^0_{-1}\text{e}$
- B. ${}^3_1\text{H} \rightarrow 2{}^1_0\text{n} + {}^0_{+1}\text{e}$
- C. ${}^3_1\text{H} + {}^{17}_9\text{F} \rightarrow {}^{20}_{10}\text{Ne}$
- D. ${}^3_1\text{H} + {}^1_1\text{p} \rightarrow {}^4_2\text{He} + {}^0_0\gamma$

Use the following information to answer numerical-response question 16.

Equation Representing Pu-238 Decay



Masses of Nuclides Involved in Pu-238 Decay

| Nuclide | ${}^{238}_{94}\text{Pu}$ | ${}^{234}_{92}\text{U}$ | ${}^4_2\text{He}$ |
|---------------------------------|--------------------------|-------------------------|-------------------|
| Mass ($\times 10^{-3}$ kg/mol) | 238.049 55 | 234.040 95 | 4.001 51 |

Numerical Response

16. The mass change that occurs when one mole of Pu-238 undergoes the reaction shown above is _____ $\times 10^{-6}$ kg.

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

34. Which of the following diagrams **best** shows the process that occurs in a CANDU nuclear fission reactor?

