Released Items
Science 30

Released Diploma Examination Items

2019

Alberta

This document was written primarily for:

Students	✓	
Teachers	✓	of Science 30
Administrators	✓	
Parents		
General Audience		
Others		

Alberta Education, Government of Alberta

2019–2020

Science 30 Released Items

Distribution: This document is posted on the Alberta Education website.

Contents

Introduction

The questions presented in this booklet are selected from the *April 2018 Science 30 Diploma Examination*. 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 classroom teachers for an examination, a quiz, or a review for students.

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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://education.alberta.ca/my-content/my-applications

- Detailed statistical information is provided on provincial, group, and individual student performance on January and June diploma examinations.

- *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 Released Materials
available at education.alberta.ca
A selection of items from the January 2008, June 2008, January 2009, and August 2014 diploma examinations are released and are available in PDF format. The entire August 2015, August 2016, and April 2017 diploma examinations are also released and are available in PDF format. The August 2015 diploma examination is also posted on Quest A+ for student practice. https://questaplus.alberta.ca

Science 30 Diploma Examination
April 2018—Blueprint Summary

Key: MC—Multiple Choice; NR—Numerical Response

Question	Diff.*	Key	K	STS	Skill
MC1	0.689	D		A1.1sts	A1.2s
MC2	0.632	D		A1.1sts	A1.2s
MC3	0.689	B	A1.4k		
MC4	0.737	B	A2.4k		
MC5	0.627	B	A1.1k		
MC6	0.789	A	A2.2k		
MC7	0.772	B	A2.3k		
MC8	0.640	D	A3.1k		
MC9	0.719	A	A3.3k, A3.1k		
MC10	0.759	C	A3.2k		A3.3s
MC11	0.649	C	A3.4k		
MC12	0.899	B	A3.6k		
MC13	0.702	C			B1.2s
MC14	0.715	B	B1.3k		B1.3s
MC15	0.820	C	B1.6k		
MC16	0.553	A			B1.3s
MC17	0.798	B	B2.1k		
MC18	0.684	D	B2.5k	B2.1sts	
MC19	0.548	A	B2.6k		
MC20	0.662	A	B3.2k		B3.3s

*Difficulty—proportion of students answering the question correctly

Key: MC—Multiple Choice; NR—Numerical Response

Question	Diff.*	Key	K	STS	Skill
MC21	0.750	C	C1.4k		C1.3s
MC22	0.241	A	C1.6k		
MC23	0.820	D	C1.6k		C1.3s
MC24	0.825	B	C1.7k		C1.3s
MC25	0.803	D	C1.7k		C1.3s
MC26	0.868	A	C2.2k		
MC27	0.759	A	C2.2k	C2.2sts	
MC28	0.754	C	C2.9k		C2.3s
MC29	0.658	B	C2.10k	C2.2sts	
MC30	0.785	D	D1.1k		D1.3s
MC31	0.548	A	D1.2k		
MC32	0.478	C	D1.3k	D1.1sts	
MC33	0.570	C	D2.1k		D2.3s
MC34	0.829	C	D2.13k, D2.12k	D2.1sts	
MC35	0.846	D	D2.4k		D2.3s
MC36	0.583	B	D2.8k		
MC37	0.798	A	D2.12k		
NR1	0.509	2467 (any order)	A1.3k		A1.3s
NR2	0.355	405			A3.2s
NR3	0.746	2143	A3.9k	A3.2sts	
NR4	0.851	2413	B1.2k	B1.2sts	

*Difficulty—proportion of students answering the question correctly

Key: MC—Multiple Choice; NR—Numerical Response

Question	Diff.*	Key	K	STS	Skill
NR5	0.693	149, 268, 357	B1.2k		
NR6	0.623	3412	B1.7k		B1.2s
NR7	0.741	168, 249, 357	B2.2k, B2.1k		
NR8	0.825	169, 247, 368	C1.3k, C1.2k		
NR9	0.825	1342			C1.2s
NR10	0.719	4800	C1.9k		C1.3s
NR11	0.807	231	C2.3k		
NR12	0.605	231	C2.11k		
NR13	0.627	1324, 1342			D2.2s
NR14	0.478	7134			D2.3s
NR15	0.873	158, 159, 248, 249, 367	D2.4k		
NR16	0.851	168, 249, 357	D2.6k		

*Difficulty—proportion of students answering the question correctly

Use the following information to answer question 1.

A group of students wants to test the hypothesis that regular cardiovascular training, such as swimming, will improve the heart's ability to pump blood. During an experiment, the students recorded their average heart rate before, during, and after swimming, as shown in the graph of their results below.

Average Heart Rate of a Group of Students Before and After Cardiovascular Training
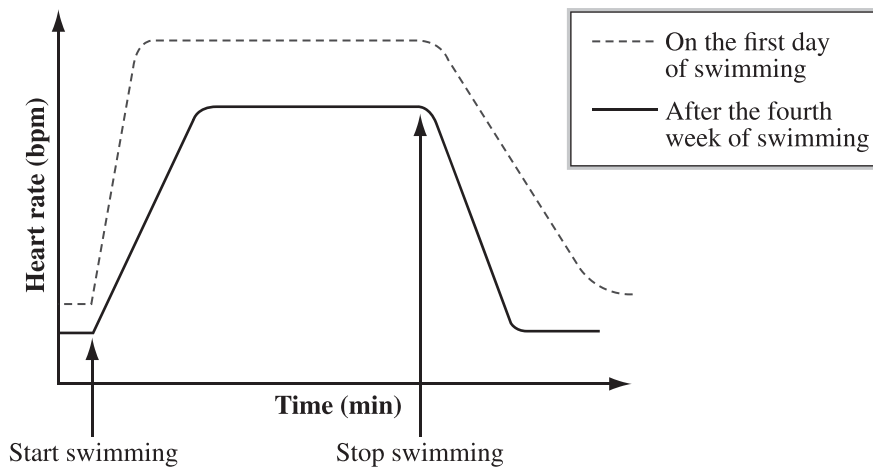
1. An inference supported by the data collected is that cardiovascular training

   A. decreases the risk of cancer
   B. increases the risk of cardiac disease
   C. increases the diameter of blood vessels in the body
   D. decreases the time needed for heart rate to return to normal after exercise

Use the following information to answer question 2.

Angiotensin-converting enzyme (ACE) inhibitors are sometimes prescribed to people to help relax blood vessels and prevent the narrowing of their blood vessels. The chart below shows some results from the physical examination of four adult males.

	Patient W	Patient Z	Patient Y	Patient Z
Mass (kg)	74	73	71	72
Resting systolic blood pressure (mmHg)	122	118	115	134
Resting diastolic blood pressure (mmHg)	83	80	74	95
Resting heart rate (bpm)	71	81	52	92

2. The person who would **most likely** benefit from taking an ACE inhibitor is

    A. Person W
    B. Person X
    C. Person Y
    D. Person Z

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

Descriptions of Blood in Different Blood Vessels

1	Moving toward the heart
2	Moving away from the heart
3	Relatively low blood pressure
4	Relatively high blood pressure
5	Relatively low oxygen content
6	Relatively high oxygen content
7	Relatively low carbon dioxide content
8	Relatively high carbon dioxide content

Numerical Response

1. Four descriptions above that characterize blood in an artery in a person's arm are numbered _____, _____, _____, 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 questions 3 to 5.

Hemolytic anemia is a condition in which red blood cells are destroyed faster than they can be produced, resulting in a deficiency of red blood cells.

3. Which of the following symptoms would a person with hemolytic anemia be expected to experience?

    A. Dehydration
    B. Shortness of breath
    C. Inability to clot blood
   **D.** Difficulty fighting off infections

4. Which of the following causes of hemolytic anemia is an autoimmune response?

    A. A gene mutation causes red blood cells to have defective cell membranes.
    B. A person produces antibodies that attach to his or her own red blood cells.
    C. A bacterial infection causes the production of proteins that disrupt red blood cell function.
    D. Blood cells are damaged when they circulate past surgically implanted artificial heart valves.

*Use the following additional information to answer question 5.*

> The destruction of red blood cells releases hemoglobin into the bloodstream, which is an issue for people with hemolytic anemia. Hemoglobin reacts with another compound in blood that normally dilates blood vessels. People with hemolytic anemia have narrowed pulmonary arteries, and the resulting high blood pressure could lead to failure of the right ventricle.

5. In which of the following diagrams do the arrows indicate the structures of the heart **most directly** affected in people with hemolytic anemia?
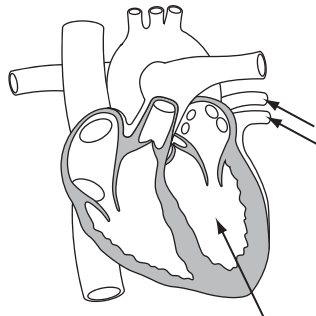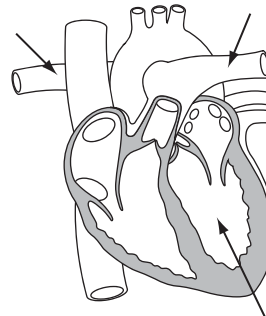
A.
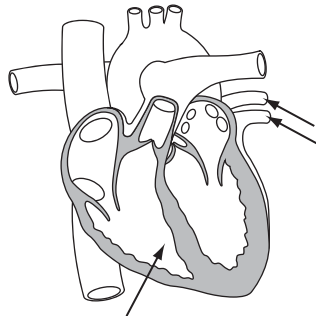
B.
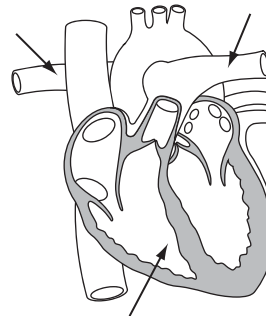
C.

D.

6. Two mechanisms that are part of the body's first line of defence against pathogen infection are

   A.   mucus in the nose and acid in the stomach
   B.   mucus in the nose and plasma in the blood
   C.   antibodies in the blood and acid in the stomach
   D.   antibodies in the blood and plasma in the blood

7. Which of the following rows identifies the immune system cells that identify foreign proteins and the immune system cells that produce antibodies?

Row	Cells That Identify Foreign Proteins	Cells That Produce Antibodies
A.	Helper T cells	Killer T cells
B.	Helper T cells	B cells
C.	Suppressor T cells	Killer T cells
D.	Suppressor T cells	B cells

Use the following information to answer question 8.

Some Cellular Events

I	Gametes (sex cells) produced
II	Somatic (body) cells produced
III	Chromosome number halved
IV	Chromosome number maintained
V	Two cells produced from one cell
VI	Four cells produced from one cell

8. The three events listed above that occur as a result of mitosis are numbered

A. I, III, and VI
B. I, IV, and V
C. II, III, and VI
D. II, IV, and V

A man carries a gene for a particular trait on his Y chromosome.

9. The trait will **most likely** be passed on to

    A. all of the man's sons
    B. all of the man's daughters
    C. half of the man's sons
    D. half of the man's daughters

Some members of a population of rats have an autosomal recessive condition called albinism. Rats with albinism lack pigment in their hair, skin, and eyes. The pedigree chart below is from a sample rat population with an incidence of albinism.

An Unlabelled Pedigree Chart of Albinism in a Rat Population
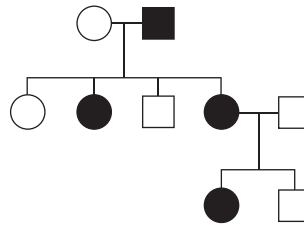
Numerical Response

2. Identify the number of rats represented in the pedigree chart above that would have each of the genotypes given below.

Homozygous recessive   _____ (Record in the **first** column)

Homozygous dominant   _____ (Record in the **second** column)

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

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

In *Drosophila melanogaster* flies, the gene for eye colour is carried on the X chromosome. The allele for red eyes is dominant over the allele for white eyes.

A student was asked to determine the probability that a red-eyed male crossed with a white-eyed female would produce offspring with white eyes. The student did **not** determine the correct probability for this cross because the Punnett square that they drew was incorrect. The Punnett square that the student constructed for this cross is shown below.
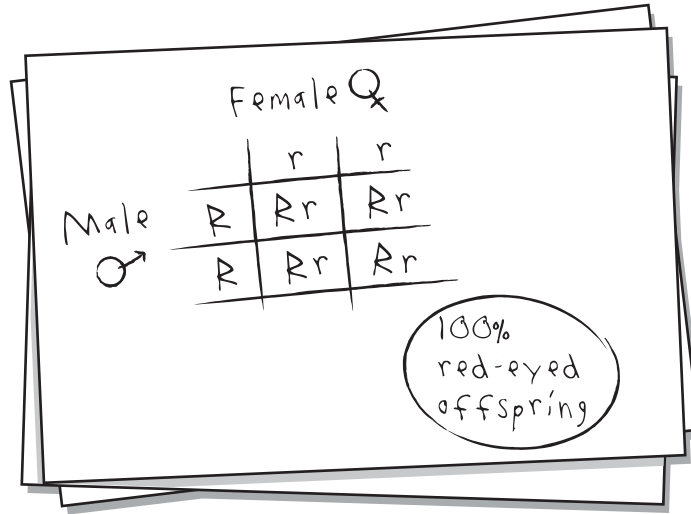
10. The Punnett square that the student should have drawn to represent the cross is

A.

Female ♀

	R	r
r	Rr	rr
r	Rr	rr

Male ♂

B.

Female ♀

	R	r
R	RR	Rr
r	Rr	rr

Male ♂

C.

Female ♀

	X^r	X^r
X^R	X^RX^r	X^RX^r
Y	X^rY	X^rY

Male ♂

D.

Female ♀

	X^r	X^r
X^R	X^RX^r	X^RX^r
Y^R	X^rY^R	X^rY^R

Male ♂

The double-helix structure of the DNA molecule is often compared to a ladder that has been twisted.
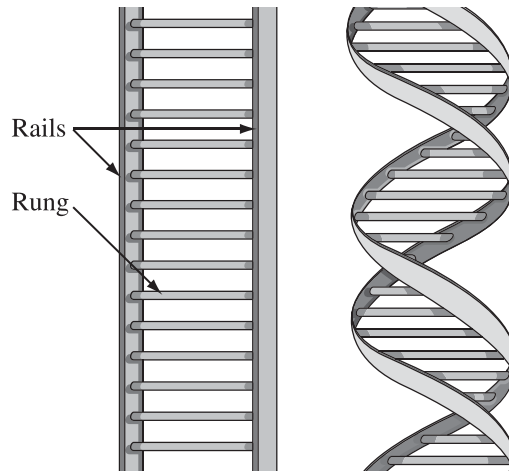
Rails

Rung

11. *In this comparison, the rails of the ladder represent* ____*i*____ *, and each rung of the ladder represents a pair of* ____*ii*____ *.*

The statement above is completed by the information in row

Row	*i*	*ii*
A.	proteins and enzymes	nitrogen bases
B.	proteins and enzymes	amino acids
C.	deoxyribose sugars and phosphate groups	nitrogen bases
D.	deoxyribose sugars and phosphate groups	amino acids

Certain amino acids cannot be produced by the body and, therefore, must come from the foods we eat. Humans are unable to produce eight particular amino acids. These amino acids are called essential amino acids because it is essential that they are included in our diet in order for us to synthesize particular proteins.

The Eight Essential Human Amino Acids

Lysine	Valine	Leucine	Threonine
Isoleucine	Tryptophan	Methionine	Phenylalanine

12. Which of the following gene segments codes for an essential amino acid?

    A. GCG

    B. TTT

    C. AGA

    D. CCA

One biotechnology company has produced a genetically modified (GM) Atlantic salmon that matures in 16 to 18 months instead of the typical three years. DNA from two other types of fish were inserted into the DNA of this species of Atlantic salmon so that it continuously produces growth hormone. The company plans to sell the GM salmon eggs to fish farms, where they would be fertilized and raised. Government food and health agencies are considering whether or not to approve this GM salmon for human consumption.

Some Arguments Against Approving GM Salmon

1   If the GM salmon are released from their farms into the wild, they might out-compete the non-GM salmon.

2   The biotechnology company owns the patent on the GM salmon, so they can sell the GM salmon eggs to fish farmers for whatever price they want.

3   Approving the GM salmon would negatively affect the livelihoods of fishermen who fish in traditional ways.

4   Genetically engineering and patenting animals treats them like manufactured products instead of living beings.

Numerical Response

3.   Match each of the arguments numbered above with its perspective below. (Use each number only once.)

    Argument: _____   _____   _____   _____
    Perspective: **Economic**   **Ecological**   **Ethical**   **Societal**

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

Some 0.10 mol/L Acids Associated with Industrial Processes

1	Nitrous acid, $HNO_2(aq)$
2	Sulfuric acid, $H_2SO_4(aq)$
3	Carbonic acid, $H_2CO_3(aq)$
4	Sulfurous acid, $H_2SO_3(aq)$

Numerical Response

4. When the acids numbered above are listed in order from the **strongest** acid to the **weakest** acid, the order is

_____ , _____ , _____ , and _____ .
Strongest   **Weakest**

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

A student recorded the following observations when indicators were added to samples of two colourless solutions.

Indicators Added	Colour of Solution X	Colour of Solution Y
Bromocresol green	Blue	Green
Chlorophenol red	Red	Yellow
Methyl red	*i*	Not tested
Thymol blue	Not tested	*ii*

13. *When methyl red is added to a new sample of Solution X, the solution will turn*
   ____*i*____ , *and when thymol blue is added to a new sample of Solution Y, the solution
   will turn* ____*ii*____ .

The statement above is completed by the information in row

Row	*i*	*ii*
A.	red	yellow
B.	red	blue
C.	yellow	yellow
D.	yellow	blue

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

	Type of Solution		Solution Property		Examples of Solution Type
1	Acidic	**4**	Reacts with many metals to produce $H_2(g)$	**7**	$C_6H_{12}O_6(aq)$ and $CH_3OH(aq)$
2	Basic	**5**	Does not conduct electricity	**8**	$KOH(aq)$ and $NaOH(aq)$
3	Neutral molecular	**6**	Turns phenolphthalein indicator pink	**9**	$H_2SO_4(aq)$ and $HCl(aq)$

Numerical Response

5. Using the numbers above, choose **one type of solution** and match it with a property of that solution and with some identifying examples of that solution. (There is more than one correct answer.)

Type of solution _____ (Record in the **first** column)

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

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

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

In one species of hydrangea shrub, the flowers can be different colours depending on the pH of the soil in which the hydrangea is grown.

Relationship Between Hydrangea Flower Colour and Soil pH

Flower Colour	Soil pH
Blue	Less than 5.4
Purple	5.5 to 5.9
Pink	6.0 to 6.4
Red	Greater than 6.5

14. If the results of a titration showed that the hydronium ion concentration, $[H_3O^+(aq)]$, of a soil sample was 2.02×10^{-6} mol/L, then the colour of a hydrangea flower grown in this soil would be

   A. blue
   B. purple
   C. pink
   D. red

15. The relationship between soil pH and hydrangea flower colour is similar to the relationship between pH and the properties of

   A. strong bases
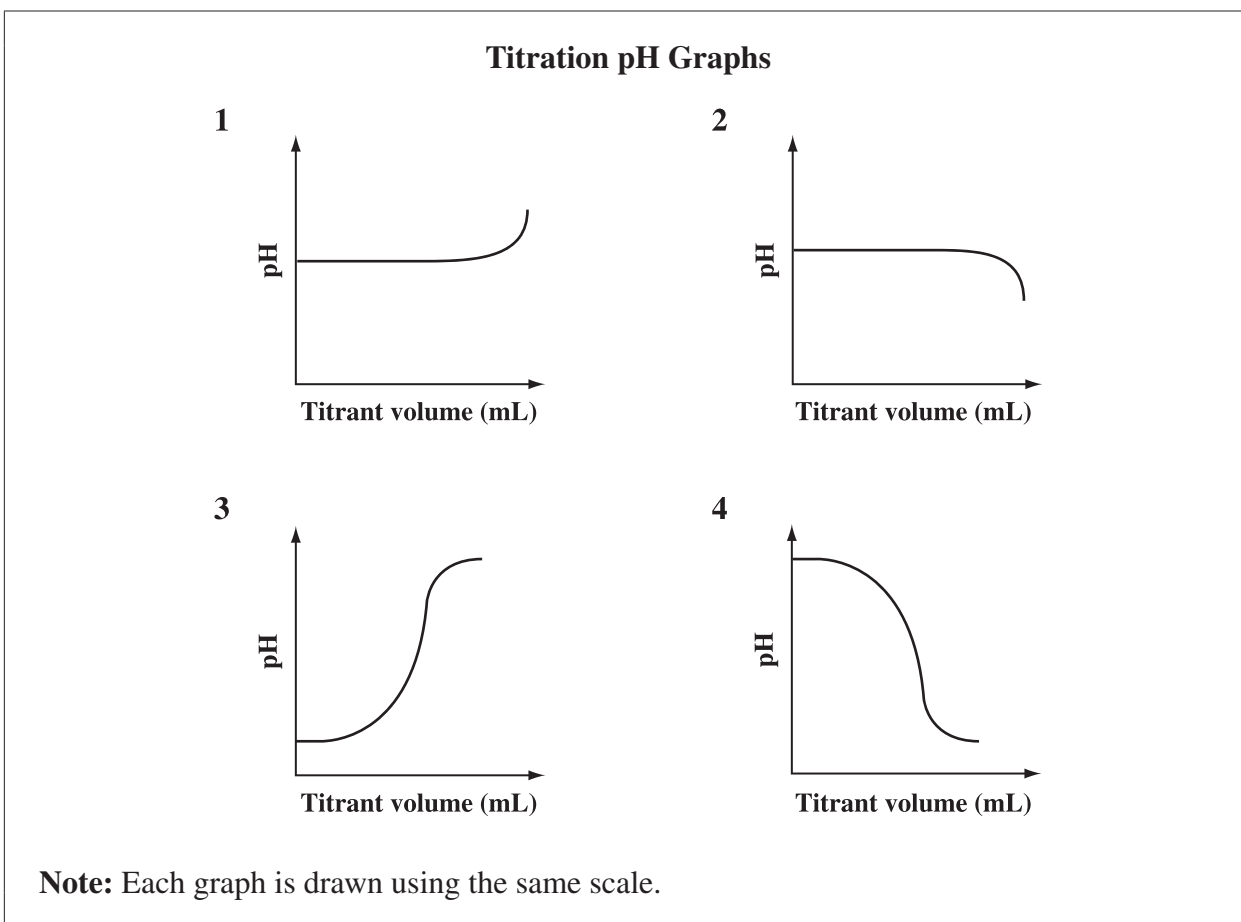   **B.** strong acids
   C. indicators
   D. buffers

**Titration of 15.00 mL of Hydrochloric Acid, HCl(aq), with
0.100 mol/L Sodium Hydroxide, NaOH(aq)**

	Trial			
	I	**II**	**III**	**IV**
Final volume of NaOH(aq) (mL)	10.45	20.55	30.50	40.55
Initial volume of NaOH(aq) (mL)	0.00	10.45	20.55	30.50
Total volume of NaOH(aq) added (mL)				
Colour of phenolphthalein indicator at endpoint	Dark pink	Light pink	Light pink	Light pink

16. What is the average volume of the **three** trials of NaOH(aq) that should be used to determine the concentration of the hydrochloric acid?

A. 10.03 mL

B. 10.14 mL

C. 15.38 mL

D. 25.51 mL

Titration pH Graphs

1

2

3

4

Note: Each graph is drawn using the same scale.

Numerical Response

6. Match each of the titration pH graphs numbered above with the type of titration given below that would produce that graph.

Titration of a strong acid with a strong base _____ (Record in the **first** column)

Titration of a strong base with a strong acid _____ (Record in the **second** column)

Titration of a buffer with a strong base _____ (Record in the **third** column)

Titration of a buffer with a strong acid _____ (Record in the **fourth** column)

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

17. Which of the following statements describes the structure for the functional group of an alcohol?

    A.   The functional group consists of two oxygen atoms bonded to a single carbon atom.

    B.   The functional group consists of an oxygen atom bonded to a single hydrogen atom.

    C.   The functional group consists of an oxygen atom bonded to two different carbon atoms.

    D.   The functional group consists of an oxygen atom double-bonded to a single carbon atom.

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

Compound	Chemical Structure	Common Use
1 Methanol	**4** Cl | Cl – C – Cl | F	**7** Used as an artificial flavouring with a pineapple-like scent

2 Trichlorofluoromethane	**5**
	 H H O
	 | | //
	H – C – C – C H H
	 | | \\ | |
	 H H O – C – C – H
	           | |
	           H H
		8 Used as an additive in windshield washer fluid to lower the freezing point

3 Ethyl propanoate	**6** H | H – C – O | \\ H H	**9** Previously used as a refrigerant but depleted the ozone layer

Numerical Response

7. Using the numbers above, choose **one compound** and match it with the chemical structure representing that compound and with the common use for that compound. (There is more than one correct answer.)

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

Chemical structure   _____ (Record in the **second** column)

Common use   _____ (Record in the **third** column)

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

Some Gases Present in the Atmosphere

I	CFCs
II	$CO_2(g)$
III	$CH_4(g)$
IV	$O_2(g)$
V	$O_3(g)$
VI	$SO_2(g)$
VII	$SO_3(g)$

18. The three gases listed above that are emitted as a direct result of burning coal in a coal-fired power plant are numbered

    A.   I, III, and VI

    B.   I, IV, and V

    C.   II, III, and IV

    D.   II, VI, and VII

Use the following information to answer question 19.

Pharmaceutical drugs are generally developed using stable molecules that have a relatively long shelf life.

19. One concern related to the presence of such stable molecules in the environment is the possibility that they

    A.   biomagnify as they move through the food chain

    B.   initiate cell division by meiosis

    C.   develop resistance to disease

    D.   break down over time

Use the following information to answer question 20.

A new process is being developed to convert plastic waste into a high-quality fuel oil. An environmental benefit of this process is that the oil produced contains no sulfur.

20. The environmental problem that would be **most** reduced by replacing conventional oil with a fuel that contains no sulfur is

A. acid deposition

B. ozone depletion

C. global warming

D. photochemical smog

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

	Type of Field		Nature of Force		Test Body
1	Electric	4	Attraction only	7	A mass
2	Gravitational	5	Repulsion only	8	North end of a compass needle
3	Magnetic	6	Attraction or repulsion	9	A positive point charge

Numerical Response

8. Using the numbers above, choose **one type of field** and match it with the nature of force associated with that field and with the test body associated with that field. (There is more than one correct answer.)

Type of field   _____ (Record in the **first** column)

Nature of force   _____ (Record in the **second** column)

Test body   _____ (Record in the **third** column)

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

Jupiter has a mass of 1.90×10^{27} kg, and two of the moons that orbit the planet are Io and Europa. Io orbits at a radius of 4.22×10^{8} m from the centre of Jupiter, and Europa orbits at a radius of 6.71×10^{8} m from the centre of Jupiter.

Two of the Moons That Orbit Jupiter

Io

4.22×10^{8} m

Jupiter

6.71×10^{8} m

Europa
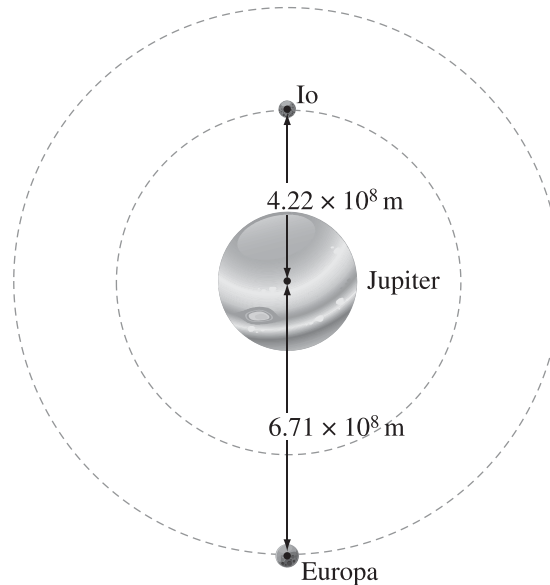
21. Jupiter's gravitational field strength at the position of Io is

    A. 1.05×10^{11} N/kg

    B. 3.00×10^{8} N/kg

    C. 7.12×10^{-1} N/kg

    D. 2.24×10^{-3} N/kg

22. Which of the following statements **best** describes voltage?

    A. Voltage is the difference in potential energy for an electron at two different points in a circuit.

    B. Voltage is the number of electrons flowing through a point in a circuit.

    C. Voltage is the resistance to the flow of electrons in a circuit.

    D. Voltage is the rate that electrons use energy in a circuit.

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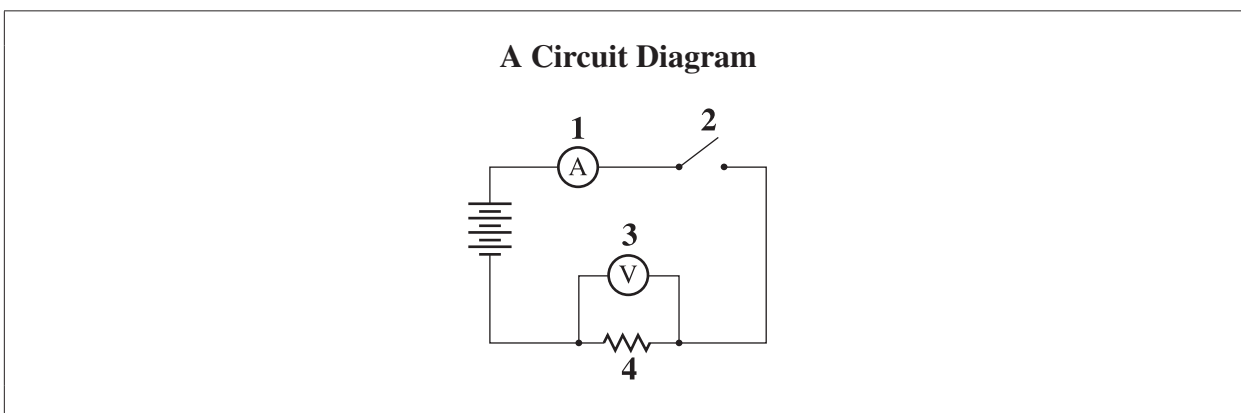
A Circuit Diagram

Numerical Response

9. Match each component numbered in the circuit diagram above with a description below. (Use each number only once.)

Component:	_____	_____	_____	_____
Description:	**Measurement device connected in series**	**Measurement device connected in parallel**	**Resistor**	**Switch**

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

23. If a 3.80 V light-emitting diode (LED) flashlight has a current of 0.0200 A, then the resistance of the circuit is

- **A.** 0.00526 Ω
- **B.** 0.0760 Ω
- **C.** 3.82 Ω
- **D.** 190 Ω

Numerical Response

10. If an adapter for a laptop computer has an input of 120.00 V, an output of 10.00 V, and 400 turns on the secondary coil of the transformer in the adapter, then the number of turns on the primary coil of the transformer is _____.

(Record your answer to the **nearest whole number** in the numerical-response section on the answer sheet.)

Use the following information to answer questions 24 and 25.

A household had a variety of light bulbs turned on for different lengths of time during a particular day.

	Bulb 1	Bulb 2	Bulb 3	Bulb 4
Power (W)	40	60	80	100
Time (h)	9	7	5	4
Energy (J or kW·h)				
Current (A)				

24. The light bulb that used the **most** energy during the day is

    A. Bulb 1
    B. Bulb 2
    C. Bulb 3
    D. Bulb 4

25. If each light bulb was plugged into an identical 120 V circuit, the bulb with the **highest** current would be

    A. Bulb 1
    B. Bulb 2
    C. Bulb 3
    D. Bulb 4

High-energy EMR is called ionizing radiation because it can ionize atoms in living tissue, creating dangerous free radicals that can damage DNA. A student grouped the types of EMR that she had been studying into ionizing radiation and non-ionizing radiation. The table she created is shown below.

Ionizing Radiation	Non-Ionizing Radiation
Gamma	Visible
Ultraviolet	Infrared
X-ray	Microwave
Radio	Television

26. Which of the types of EMR listed in the table above is in the **wrong** column?

  A. Radio
  B. Infrared
  C. Ultraviolet
  D. Microwave

Gliese 581 is a red dwarf star that emits EMR primarily in the wavelength range of 10^{-4} m to 10^{-6} m.

27. The EMR emitted by Gliese 581 is classified as

  A. infrared, which has a lower frequency than visible light
  B. infrared, which has a higher frequency than visible light
  C. ultraviolet, which has a lower frequency than visible light
  D. ultraviolet, which has a higher frequency than visible light

Earth's atmosphere protects life by blocking some forms of EMR emitted by the Sun.

Some Types of EMR Emitted by the Sun

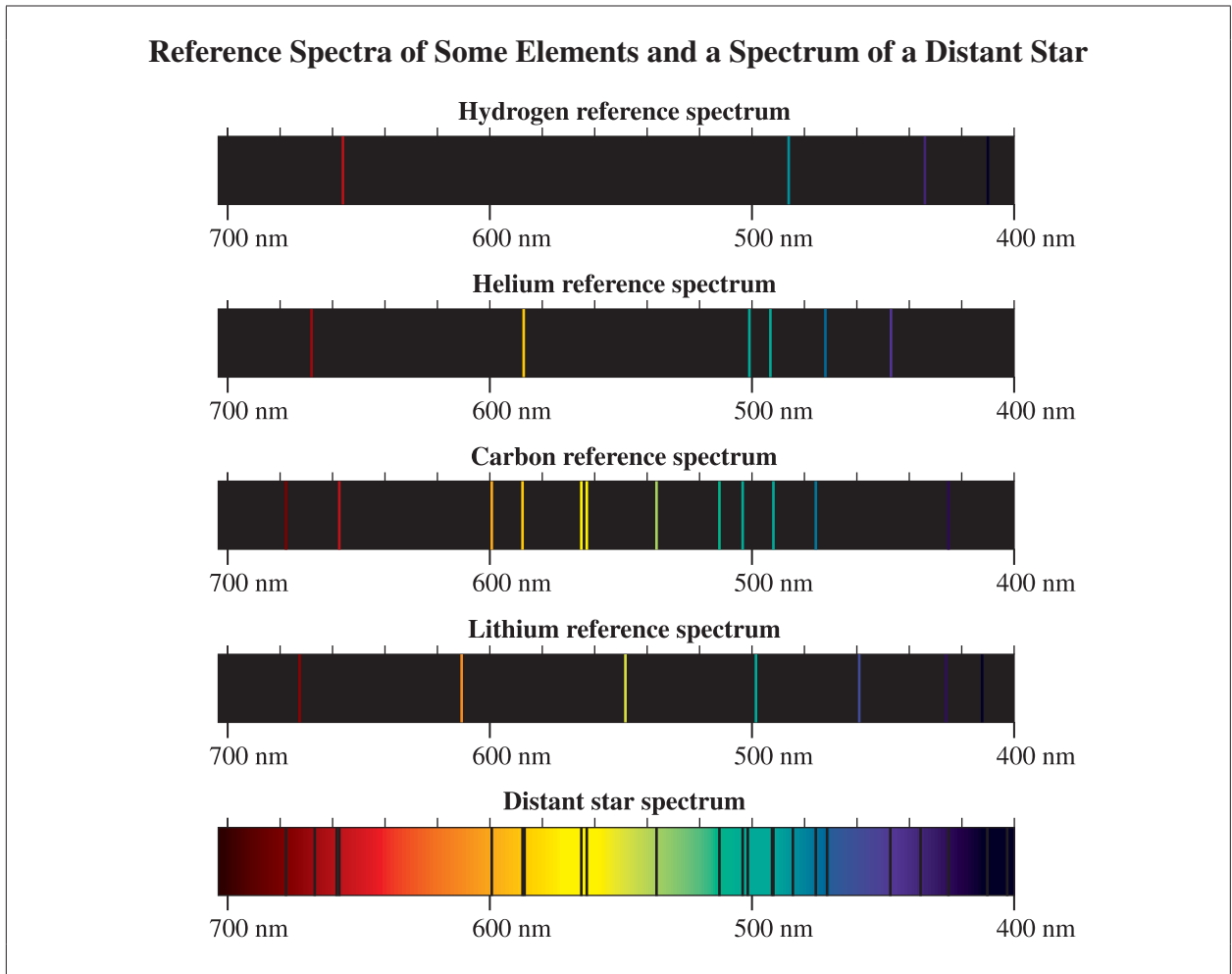|	
1	Visible
2	Gamma
3	Ultraviolet

Numerical Response

11. The types of EMR listed above, arranged in order from **most** blocked by Earth's atmosphere to **least** blocked by Earth's atmosphere, are

_____   _____   _____
Most blocked   **Least blocked**

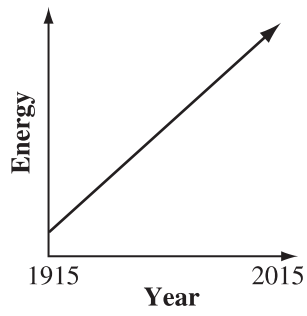(Record all **three digits** of your answer in the numerical-response section on the answer sheet.)

Reference Spectra of Some Elements and a Spectrum of a Distant Star

Hydrogen reference spectrum

700 nm   600 nm   500 nm   400 nm

Helium reference spectrum

700 nm   600 nm   500 nm   400 nm

Carbon reference spectrum

700 nm   600 nm   500 nm   400 nm

Lithium reference spectrum

700 nm   600 nm   500 nm   400 nm

Distant star spectrum

700 nm   600 nm   500 nm   400 nm
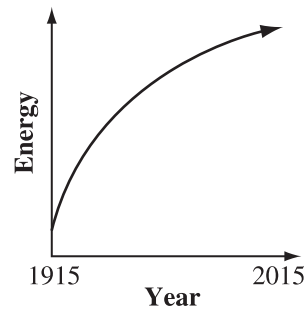
28. The elements present in the atmosphere of the distant star include

    A. helium and lithium only
    B. helium, carbon, and lithium
    C. hydrogen, helium, and carbon
    D. hydrogen, helium, and lithium

29. Which of the following rows identifies the type of Doppler shift typically observed in EMR from distant galaxies and describes an inference about the universe made from that observation?

Row	Type of Doppler Shift Observed	Inference Made from this Observation
A.	Red shift	The universe is shrinking.
B.	Red shift	The universe is expanding.
C.	Blue shift	The universe is shrinking.
D.	Blue shift	The universe is expanding.

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

Eventually, stars run out of the fuel needed to maintain nuclear fusion. When this happens, the star undergoes a transformation to a remnant object. The type of remnant that forms depends on the mass of the original star.

Some Stellar Remnants

1   Black hole
2   White dwarf
3   Neutron star

Numerical Response

12. When the stellar remnants numbered above are listed in order of the mass of the stars that created them, the order is

_____ ,   _____ ,   and   _____ .
Smallest   **Largest**
mass   **mass**

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

30. Which of the following graphs **best** represents world energy consumption from 1915–2015?

A.

Energy

1915   2015
Year

B.

Energy

1915   2015
Year

C.

Energy

1915   2015
Year

D.
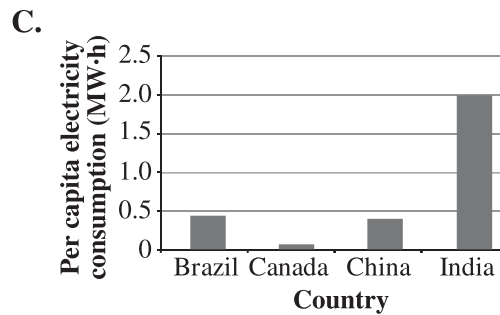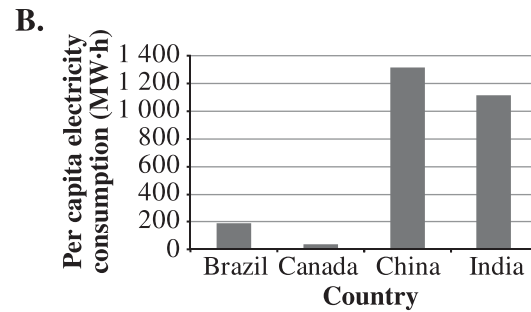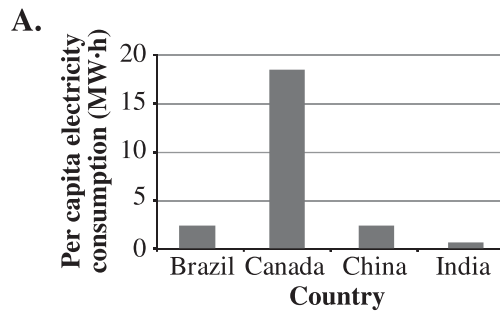
Energy

1915   2015
Year
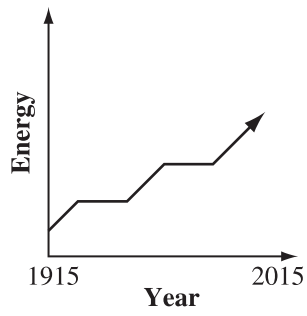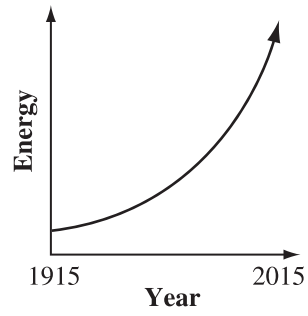
Use the following information to answer question 31.

Electricity Consumption of Four Countries (2006)

Country	Electricity Consumption (TW·h)	Population (Millions)
Brazil	390	189.3
Canada	547	32.6
China	2 716	1 311.8
India	558	1 109.8

—based on International Energy Agency, 2008

31. The bar graph that represents the **per capita** electricity consumption for the countries listed above is

A.

B.

C.

D.
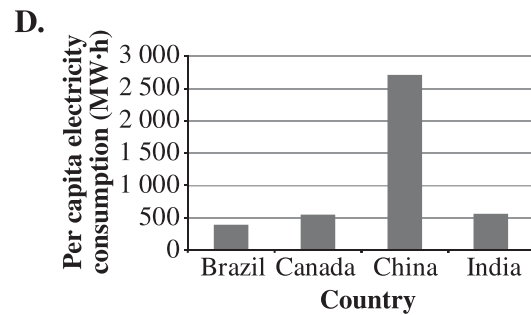
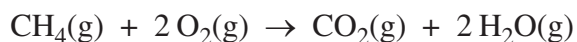*Use the following information to answer question 32.*

According to one energy analyst, the best way to reduce human contributions to global climate change is to develop devices that use conventional energy resources more effectively. He has said that it makes more economic sense to pursue this strategy until it becomes more expensive than developing alternative energy sources.

—based on Lovins, 1977

32. Which of the following strategies is **most consistent** with this energy analyst's point of view?

    A.   Increasing our use of biofuels

    B.   Developing solar-powered cars

    C.   Increasing the efficiency of home-heating systems

    D.   Developing new exploration tools to find oil and gas

Reaction for the Combustion of Methane

$$CH_4(g) \ + \ 2\,O_2(g) \ \rightarrow \ CO_2(g) \ + \ 2\,H_2O(g)$$

33. The energy released during the combustion of one mole of methane is

- **A.** 74.6 kJ
- **B.** 560.7 kJ
- **C.** 802.5 kJ
- **D.** 877.1 kJ

Photovoltaic (PV) cells convert radiant solar energy into electrical energy. An experiment is set up to measure the efficiency of electricity production of different PV cells.

Some Components of the Experiment

1 Type of PV cell
2 Intensity of sunlight
3 Electrical energy produced
4 Angle of light striking the PV cell

Numerical Response

13. Match each component in the experiment numbered above to a type of variable below. Use each number only once. (There is more than one correct answer.)

Manipulated variable _____ (Record in the **first** column)

Responding variable _____ (Record in the **second** column)

Controlled variable _____ (Record in the **third** column)

Controlled variable _____ (Record in the **fourth** column)

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

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

One type of PV cell that is designed to use both visible and infrared radiation to produce electricity has a maximum efficiency of 46.0%.

Numerical Response

14. If the radiant energy input of the PV cell described above is 1.55×10^5 J, then the maximum electrical output, expressed in scientific notation, would be $\boldsymbol{a.bc} \times 10^{\boldsymbol{d}}$ J. The values of $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$, and $\boldsymbol{d}$ are _____, _____, _____, and _____.
$\qquad\quad a \quad\quad b \quad\quad c \quad\qquad d$

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

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34. *The type of energy used by both tidal generating stations and hydroelectric power stations to produce electricity is ____i____ . A disadvantage of both of these electricity-producing technologies is that ____ii____ .*

The statements above are completed by the information in row

Row	i	ii
A.	radiant solar energy	there are a limited number of suitable locations
B.	radiant solar energy	they produce emissions that contribute to acid deposition
C.	gravitational potential energy	there are a limited number of suitable locations
D.	gravitational potential energy	they produce emissions that contribute to acid deposition

Use the following information to answer question 35.

Power Produced by a Particular Wind Turbine at Various Wind Speeds
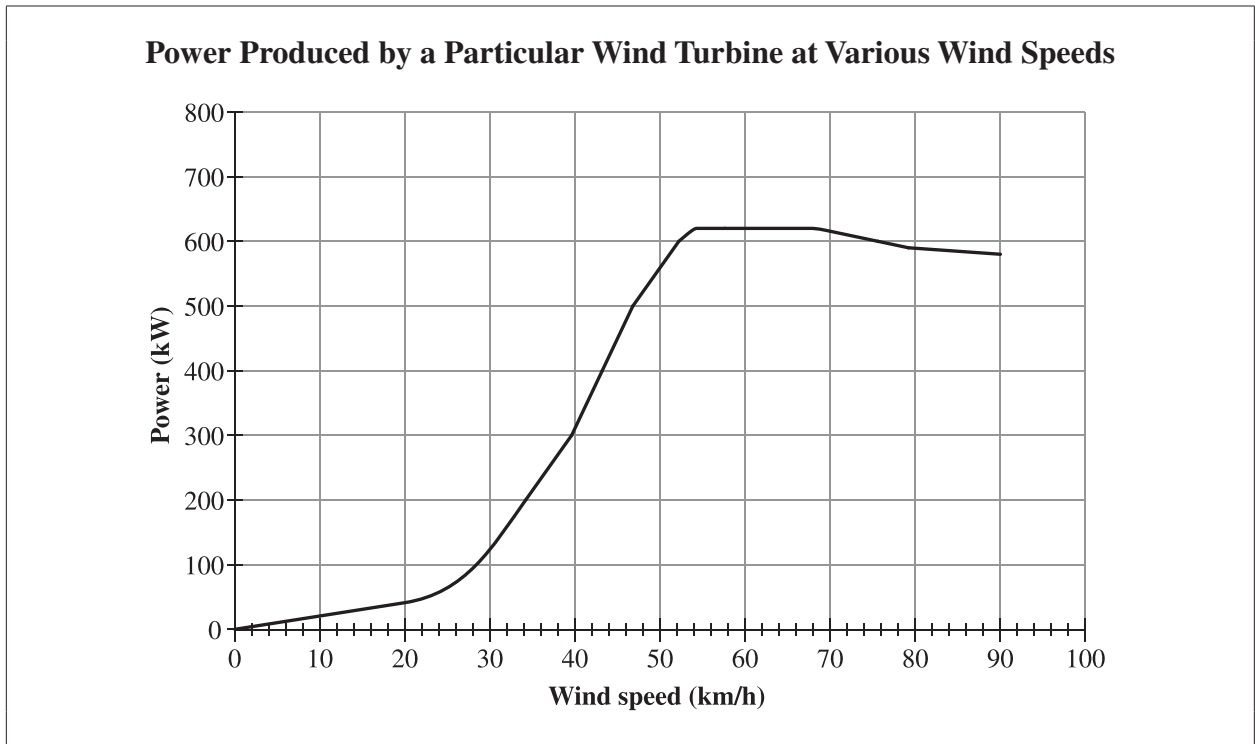
35. Which of the following statements about the wind turbine is supported by the information shown in the graph above?

    A.   Doubling the wind speed doubles the power output of the wind turbine.

    B.   At 100 km/h, the turbine will likely produce more than 700 kW of power.

    C.   The higher the wind speed, the higher the power output of the wind turbine.

    D.   The wind turbine becomes less efficient at wind speeds greater than 60 km/h.

_____

36. *In a nuclear power plant that uses uranium fuel, the fuel is bombarded by* ___*i*___ , *causing the uranium nuclei to undergo* ___*ii*___ .

The statement above is completed by the information in row

Row	*i*	*ii*
A.	neutrons	fusion
B.	neutrons	fission
C.	electrons	fusion
D.	electrons	fission

Energy Source	Disadvantage of Using Energy Source		Advantage of Using Energy Source	
1 Fusion isotopes	**4**	Few suitable locations	**7**	Reliable and relatively inexpensive
2 Wind	**5**	Technology is only in experimental stage	**8**	Renewable
3 Coal	**6**	Non-renewable	**9**	No CO_2(g) emissions

Numerical Response

15. Using the numbers above, choose **one energy source** and match it with a disadvantage of using that energy source and with an advantage of using that energy source. (There is more than one correct answer.)

Energy source   _____ (Record in the **first** column)

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

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

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

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

Type of Radiation	Characteristic of Radiation	Nuclear Reaction Producing Radiation
1 Alpha	**4** Negatively charged particles	**7** $^{234}_{90}\text{Th} \rightarrow {}^{234}_{90}\text{Th} + {}^{0}_{0}\gamma$
2 Beta	**5** Photons with no mass or charge	**8** $^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\text{He}$
3 Gamma	**6** Positively charged particles	**9** $^{131}_{53}\text{I} \rightarrow {}^{131}_{54}\text{Xe} + {}^{0}_{-1}\text{e}$

Numerical Response

16. Using the numbers above, choose **one type of radiation** and match it with the number of the characteristic of that radiation and with the number of the nuclear reaction producing that type of radiation. (There is more than one correct answer.)

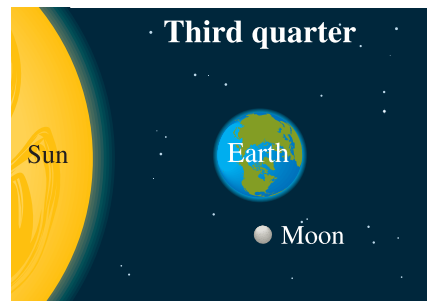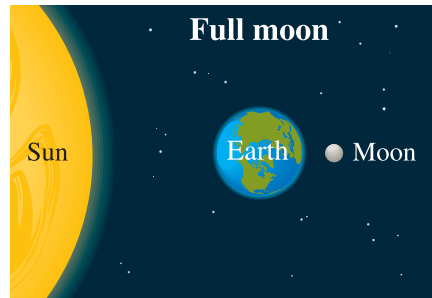Type of radiation _____ (Record in the **first** column)

Characteristic of radiation _____ (Record in the **second** column)

Nuclear reaction producing radiation _____ (Record in the **third** column)

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

The relative position of the Sun, Earth, and the Moon during four different phases of the Moon are shown in the diagrams below.

Full moon
Sun   Earth ● Moon

New moon
Sun   ● Earth
           Moon

First quarter
           ● Moon
Sun   Earth

Third quarter
Sun   Earth
           ● Moon

Note: The diagram is **not** drawn to scale.

37. The phases of the Moon that are associated with the greatest tidal variation are

   A.   full moon and new moon
   B.   new moon and first quarter moon
   C.   full moon and third quarter moon
   D.   first quarter moon and third quarter moon