The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
CHEMISTRY

Friday, January 27, 2023 — 9:15 a.m. to 12:15 p.m., only

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

This is a test of your knowledge of chemistry. Use that knowledge to answer all questions in this examination. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in this examination booklet.

A separate answer sheet for Part A and Part B–1 has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet. Record your answers to the Part A and Part B–1 multiple-choice questions on this separate answer sheet. Record your answers for the questions in Part B–2 and Part C in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

All answers in your answer booklet should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on your separate answer sheet or in your answer booklet as directed.

When you have completed the examination, you must sign the statement printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice. . .
A four-function or scientific calculator and a copy of the *2011 Edition Reference Tables for Physical Setting/Chemistry* must be available for you to use while taking this examination.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

1 Which conclusion was developed as a result of the gold foil experiment?

(1) Atoms are mostly empty space.
(2) All atoms are hard, indivisible spheres.
(3) Atoms have different volumes.
(4) All atoms have the same volume.

2 Which two particles each have a mass approximately equal to one atomic mass unit?

(1) positron and proton
(2) positron and electron
(3) neutron and electron
(4) neutron and proton

3 An excited potassium atom emits a specific amount of energy when one of its electrons moves from

(1) the first shell to the fourth shell
(2) the second shell to the fourth shell
(3) the fourth shell to the fifth shell
(4) the fourth shell to the second shell

4 Which list of elements includes a metal, a metalloid, and a noble gas?

(1) Rb, Cl, Ne
(2) Sr, Si, Rn
(3) Rn, Cl, Ne
(4) Si, Rb, Sr

5 Which element has the *lowest* density at 298 K and 101.3 kPa?

(1) argon
(2) fluorine
(3) nitrogen
(4) oxygen

6 Which phrase describes the crystal structure and properties of two different forms of solid carbon called diamond and graphite?

(1) same crystal structure and same properties
(2) same crystal structure and different properties
(3) different crystal structures and different properties
(4) different crystal structures and same properties

7 Which element has chemical properties most similar to sodium?

(1) magnesium
(2) oxygen
(3) phosphorus
(4) rubidium

8 Which substance contains elements chemically combined in a fixed proportion?

(1) manganese
(2) methane
(3) silicon
(4) strontium

9 Which property can be used to differentiate between a 50.-gram sample of solid potassium nitrate at STP and a 50.-gram sample of solid silver chloride at STP?

(1) mass
(2) temperature
(3) phase
(4) solubility

10 Which type of bond forms when electrons are equally shared between two atoms?

(1) a polar covalent bond
(2) a nonpolar covalent bond
(3) a hydrogen bond
(4) an ionic bond

11 Which statement describes the changes in bonding and energy that occur when a molecule of iodine, I_2, forms two separate atoms of iodine?

(1) A bond is formed as energy is absorbed.
(2) A bond is formed as energy is released.
(3) A bond is broken as energy is absorbed.
(4) A bond is broken as energy is released.

12 The degree of polarity in the bond between a hydrogen atom and an oxygen atom in a molecule of water can be assessed using the difference in

(1) densities
(2) electronegativities
(3) melting points
(4) intermolecular forces

13 Which substance can *not* be broken down by a chemical change?

(1) ammonia
(2) ethanol
(3) krypton
(4) water

14 Which sample of matter is a mixture?

(1) $CO_2(g)$
(2) $CCl_4(\ell)$
(3) $MgCl_2(aq)$
(4) $Sn(s)$

15 Which term is used to express the concentration of an aqueous solution?

(1) parts per million
(2) heat of fusion
(3) pressure at 0°C
(4) volume at 0°C

16 The particles in which sample have the *lowest* average kinetic energy?

(1) 50. g of sulfur at 273 K
(2) 40. g of aluminum at 298 K
(3) 30. g of sulfur at 303 K
(4) 20. g of aluminum at 323 K

17 Which process represents a chemical change?

(1) Iodine sublimes.
(2) Water evaporates.
(3) An ice cube melts.
(4) A candle burns in air.

18 Which equation represents a physical equilibrium?

(1) $NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$
(2) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
(3) $3O_2(g) \rightarrow 2O_3(g)$
(4) $N_2(\ell) \rightleftharpoons N_2(g)$

19 Systems in nature tend to undergo changes toward

(1) higher energy and higher entropy
(2) higher energy and lower entropy
(3) lower energy and higher entropy
(4) lower energy and lower entropy

20 Which formula represents a hydrocarbon?

(1) C_2H_6
(2) C_2H_5OH
(3) C_2H_5Cl
(4) C_2H_6O

21 Which statement describes the bonding in an alkyne molecule?

(1) There is at least one carbon-to-carbon double bond.
(2) There is at least one carbon-to-carbon triple bond.
(3) There is at least one carbon-to-oxygen single bond.
(4) There is at least one carbon-to-oxygen double bond.

22 Which compound has a functional group that contains two oxygen atoms?

(1) 1-propanamine
(2) 2-chloropropane
(3) methyl propanoate
(4) methyl ethyl ether

23 Which term identifies a type of organic reaction?

(1) deposition
(2) distillation
(3) polymerization
(4) vaporization

24 In an electrochemical cell, oxidation occurs at the

(1) anode
(2) cathode
(3) salt bridge
(4) switch

25 Which energy conversion occurs in an operating electrolytic cell?

(1) chemical energy to electrical energy
(2) electrical energy to chemical energy
(3) nuclear energy to electrical energy
(4) electrical energy to nuclear energy

26 One acid-base theory states that a base is an

(1) H^- donor
(2) H^- acceptor
(3) H^+ donor
(4) H^+ acceptor

27 The acidity or alkalinity of a solution can be measured by its

(1) pH value
(2) electronegativity value
(3) boiling point
(4) freezing point

28 When the nucleus of an atom of neon-19 decays, which particle is emitted?

(1) ${}^{4}_{2}\mathrm{He}$
(2) ${}^{0}_{-1}\mathrm{e}$
(3) ${}^{1}_{0}\mathrm{n}$
(4) ${}^{0}_{+1}\mathrm{e}$

29 Which nuclear emission has the greatest mass?

(1) positron
(2) gamma ray
(3) beta particle
(4) alpha particle

30 Which statement describes the net change that occurs during nuclear fission?

(1) Electrons are converted to protons.
(2) Protons are converted to electrons.
(3) Mass is converted to energy.
(4) Energy is converted to mass.

Part B–1

Answer all questions in this part.

Directions (31–50): For *each* statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

31 What is the net charge of a monatomic ion that has 15 protons, 16 neutrons, and 18 electrons?

(1) 2+ (3) 3+
(2) 2− (4) 3−

32 The table below shows the atomic masses and natural abundances of the two naturally occurring isotopes of rhenium.

Naturally Occurring Isotopes of Rhenium

Isotope	Atomic Mass (u)	Natural Abundance (%)
Re-185	184.95	37.40
Re-187	186.96	62.60

Which numerical setup can be used to calculate the atomic mass of rhenium?

(1) (184.95 u)(37.40) + (186.96 u)(62.60)

(2) (184.95 u)(0.3740) + (186.96 u)(0.6260)

(3) $\frac{(184.95\text{ u})(37.40) + (186.96\text{ u})(62.60)}{2}$

(4) $\frac{(184.95\text{ u})(0.3740) + (186.96\text{ u})(0.6260)}{2}$

33 Which general trend is observed as the elements in Period 2 are considered from left to right?

(1) Atomic mass decreases.
(2) Melting point increases.
(3) Electronegativity increases.
(4) First ionization energy decreases.

34 Which formula represents chromium(III) oxide?

(1) CrO_3 (3) Cr_2O_3
(2) Cr_3O (4) Cr_3O_2

35 Given the balanced equation representing a reaction:

$$2KClO_3 + \text{energy} \rightarrow 2KCl + 3O_2$$

What is the mass of KCl produced when 24.51 grams of $KClO_3$ reacts completely to produce 9.60 grams of O_2?

(1) 5.31 g (3) 34.11 g
(2) 14.91 g (4) 43.71 g

36 Which equation represents conservation of atoms?

(1) $TiO_2 + 2Al \rightarrow 2Al_2O_3 + Ti$
(2) $TiO_2 + 4Al \rightarrow 2Al_2O_3 + Ti$
(3) $3TiO_2 + 2Al \rightarrow 2Al_2O_3 + 3Ti$
(4) $3TiO_2 + 4Al \rightarrow 2Al_2O_3 + 3Ti$

37 One mole of bromine gas, Br_2, has a mass of

(1) 35.0 g (3) 79.9 g
(2) 70.0 g (4) 159.8 g

38 Given the equation representing a reaction:

$$2NaCl \rightarrow 2Na + Cl_2$$

Which type of reaction does this equation represent?

(1) double replacement
(2) decomposition
(3) synthesis
(4) single replacement

39 Which statement describes the charge and the radius of the magnesium ion formed when a magnesium atom loses two electrons?

(1) The Mg ion is positive and has a radius larger than the Mg atom.
(2) The Mg ion is negative and has a radius larger than the Mg atom.
(3) The Mg ion is positive and has a radius smaller than the Mg atom.
(4) The Mg ion is negative and has a radius smaller than the Mg atom.

40 An oxide ion, O^{2-}, has the same electron configuration as an atom of which noble gas?

(1) helium
(2) neon
(3) argon
(4) krypton

41 What is the vapor pressure of propanone at 45°C?

(1) 21 kPa
(2) 60. kPa
(3) 70. kPa
(4) 79 kPa

42 Based on Table *G*, what is the mass of KCl that must be dissolved in 200. grams of H_2O at 10.°C to make a saturated solution?

(1) 15 g
(2) 30. g
(3) 60. g
(4) 120. g

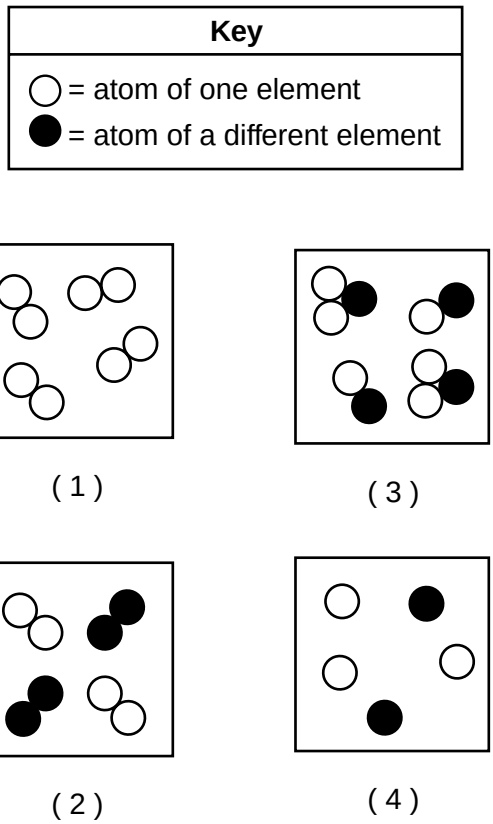
43 Based on Table *I*, which chemical equation represents a reaction with a heat of reaction that indicates a net release of energy?

(1) $N_2(g) + O_2(g) \rightarrow 2NO(g)$
(2) $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$
(3) $2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$
(4) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$

44 The greatest increase in entropy occurs when a 1.00-gram sample of water changes from

(1) solid to liquid
(2) solid to gas
(3) gas to liquid
(4) liquid to solid

45 Which particle diagram represents one substance, only?



46 Based on Table *J*, atoms of which metal will lose electrons to Ca^{2+} ions?

(1) aluminum
(2) lead
(3) nickel
(4) potassium

47 Which aqueous solution is the best conductor of an electrical current?

(1) 0.1 M $NaNO_3$
(2) 0.2 M $NaNO_3$
(3) 0.01 M $NaNO_3$
(4) 0.02 M $NaNO_3$

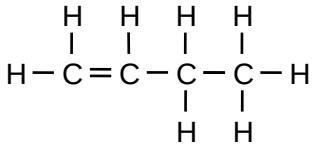
48 Given the equation representing a reaction:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$$

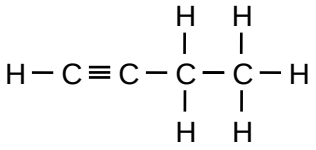
This equation represents

(1) sublimation
(2) condensation
(3) fission
(4) fusion

49 Which formula represents 2-butene?



(1)



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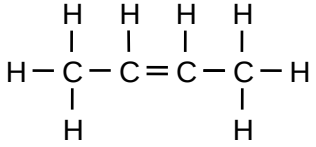

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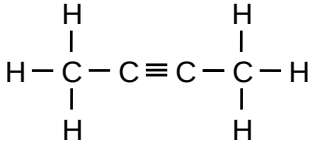
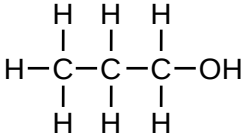
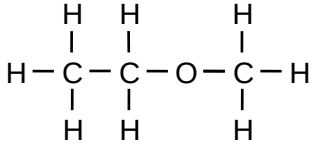


(4)

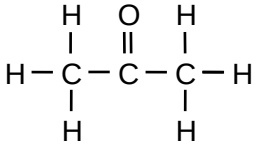
50 Given a formula representing a compound:



Which formula represents an isomer of the compound?



(1)



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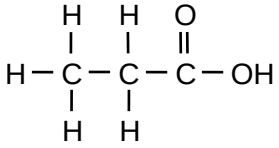

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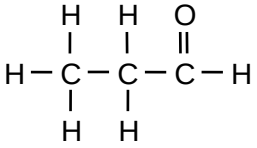


(4)

Part B–2

Answer all questions in this part.

Directions (51-65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

51 Explain, in terms of neutrons and protons, why P-32 and P-31 are different isotopes of phosphorus. [1]

52 Determine the oxidation state of chromium in K_2CrO_4. [1]

Base your answers to questions 53 and 54 on the information below and on your knowledge of chemistry.

The first four elements in Group 14 are carbon, silicon, germanium, and tin. These elements form compounds with chlorine that have similar formulas. Two examples of these formulas are silicon tetrachloride, $SiCl_4$, and germanium tetrachloride, $GeCl_4$.

53 State the general trend in atomic radius as these four elements are considered in order of increasing atomic number. [1]

54 State, in terms of electron configuration, why silicon and germanium both form tetrachloride compounds. [1]

Base your answers to questions 55 through 57 on the information below and on your knowledge of chemistry.

The equation below represents the reaction between ammonia and hydrogen chloride.

$$\underset{\text{compound 1}}{NH_3(g)} + \underset{\text{compound 2}}{HCl(g)} \rightarrow NH_4Cl(s)$$

55 Explain, in terms of distribution of charge, why a molecule of compound 1 is polar. [1]

56 Draw a Lewis electron-dot diagram for a molecule of compound 2. [1]

57 Identify the *two* types of chemical bonds in the product of this reaction. [1]

Base your answers to questions 58 through 60 on the information below and on your knowledge of chemistry.

A sample of helium gas, He(g), is placed in a rigid cylinder sealed with a movable piston. The temperature of the helium is 25.0°C. The volume of the helium is 300. milliliters and the pressure is 0.500 atmosphere.

58 State, in terms of the average distance between the helium atoms, why the density of the gas increases when the piston is pushed farther into the rigid cylinder. [1]

59 Determine the volume of the helium gas when the pressure is increased to 1.50 atm and the temperature remains at 25.0°C. [1]

60 Compare the number of helium atoms in the cylinder at a pressure of 0.500 atm to the number of helium atoms in the cylinder when the pressure is increased to 1.50 atm by pushing the piston in. [1]

Base your answers to questions 61 and 62 on the information below and on your knowledge of chemistry.

During a laboratory activity, a student places 21.0 mL of hydrochloric acid solution, HCl(aq), of unknown concentration into a flask. The solution is titrated with 0.125 M NaOH(aq) until the acid is exactly neutralized. The volume of NaOH(aq) added is 18.5 milliliters. During this laboratory activity, appropriate safety equipment is used and safety procedures are followed.

61 Explain, in terms of ions, why the hydrochloric acid solution can conduct an electric current. [1]

62 Determine the concentration of the HCl(aq) solution, using the titration data. [1]

Base your answers to questions 63 through 65 on the information below and on your knowledge of chemistry.

The table below lists the hydronium ion concentration and pH values of four different solutions and distilled water. The pH value is missing for sample 2.

Hydronium Concentration and pH Value for Five Samples

Sample Number	Sample Description	Hydronium Ion Concentration (M)	pH Value
1	0.1 M HCl(aq)	1×10^{-1}	1.0
2	0.01 M HCl(aq)	1×10^{-2}	?
3	distilled $H_2O(\ell)$	1×10^{-7}	7.0
4	0.01 M NaOH(aq)	1×10^{-12}	12.0
5	0.1 M NaOH(aq)	1×10^{-13}	13.0

63 Determine the pH value of sample 2. [1]

64 Identify the ion released by the compound dissolved in sample 4 that allows the compound to be classified as an Arrhenius base. [1]

65 State how many times greater the hydronium ion concentration is in sample 4 than it is in sample 5. [1]

Part C

Answer all questions in this part.

Directions (66-85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

Base your answers to questions 66 through 68 on the information below and on your knowledge of chemistry.

Boric acid, H_3BO_3, is heated to produce tetraboric acid, $H_2B_4O_7$, and water. The equation below represents the reaction to form tetraboric acid.

$$\underset{\text{boric acid}}{4H_3BO_3(s)} \xrightarrow{\text{heat}} \underset{\text{tetraboric acid}}{H_2B_4O_7(s)} + 5H_2O(g)$$

The tetraboric acid is then used to make borax, which is used as a cleaning agent. Borax, $Na_2B_4O_7 \cdot 10H_2O$, is a hydrate with a gram-formula mass of 381 grams per mole. A hydrate is a compound with water within its crystal structure. Borax has ten moles of water for every mole of $Na_2B_4O_7$.

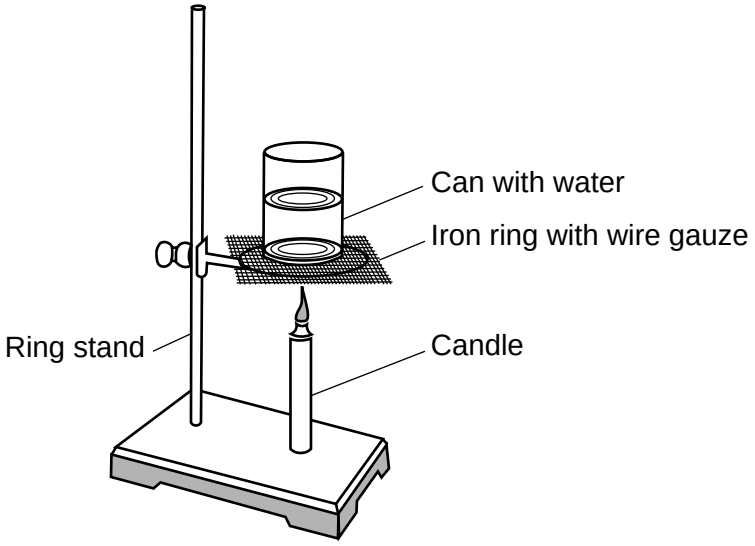
66 Explain why the formula for tetraboric acid is an empirical formula. [1]

67 Determine the number of moles of boric acid that react in the equation to produce 10 moles of water. [1]

68 Show a numerical setup for calculating the mass, in grams, of a 0.200-mole sample of borax. [1]

Base your answers to questions 69 through 71 on the information below and on your knowledge of chemistry.

During a laboratory activity, appropriate safety equipment is used and safety procedures are followed. A student uses the lab equipment shown in the diagram below to determine the heat of combustion of candle wax.



Heat of combustion is defined as the amount of heat released when a known mass of a substance is burned and can be measured in joules per gram. At the start of the activity, the mass of the candle and the mass of the water are measured. The starting temperature of the water is 5.0°C, and the air temperature in the room is 22.0°C. The candle is lit, and the water is stirred with a stirring rod. Several minutes later, the candle is extinguished, and the student measures the temperature of the water in the can. When the candle is cool, the student measures the final mass of the candle. Lab activity results are shown in the table below.

Lab Activity Results

Mass of Candle Wax Burned (g)	**Mass of Water in the Can** (g)	**Calculated Temperature Change of Water** (°C)	**Heat Absorbed by the Water** (J)	**Calculated Heat of Combustion of Candle Wax** (J/g)
0.83	190.	39	?	37 000

69 State the number of significant figures used to express the value for the mass of the water in the can. [1]

70 State the direction of the heat flow between the air and the water in the can before the candle is lit. [1]

71 Determine the amount of heat absorbed by the water. [1]

Base your answers to questions 72 through 76 on the information below and on your knowledge of chemistry.

A process was developed in 1912 to produce ammonia gas from atmospheric nitrogen gas and hydrogen gas. Iron can be used as a catalyst. The equation representing this system at equilibrium is shown below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 91.8\ kJ$$

72 State evidence from the equation that the forward reaction is exothermic. [1]

73 Compare the rate of the forward reaction to the rate of the reverse reaction at equilibrium. [1]

74 On the labeled axes *in your answer booklet*, draw a potential energy diagram for the forward reaction represented in this equation. [1]

75 State, in terms of moles of gases, why the equilibrium shifts to the right due to an increase in pressure on the system at constant temperature. [1]

76 State what happens to the rate of forward reaction when the iron is added to this system. [1]

Base your answers to questions 77 through 79 on the information below and on your knowledge of chemistry.

Before the year 1828, it was thought that organic compounds were produced only by living organisms and that inorganic compounds were made from nonliving substances. Urea is an organic compound. In 1828, a chemist heated ammonium cyanate and produced urea, which is very soluble in water. The equation below represents this reaction.

$$\underset{\text{ammonium cyanate}}{NH_4OCN} \xrightarrow{\text{heat}} \underset{\text{urea}}{H_2NCONH_2}$$

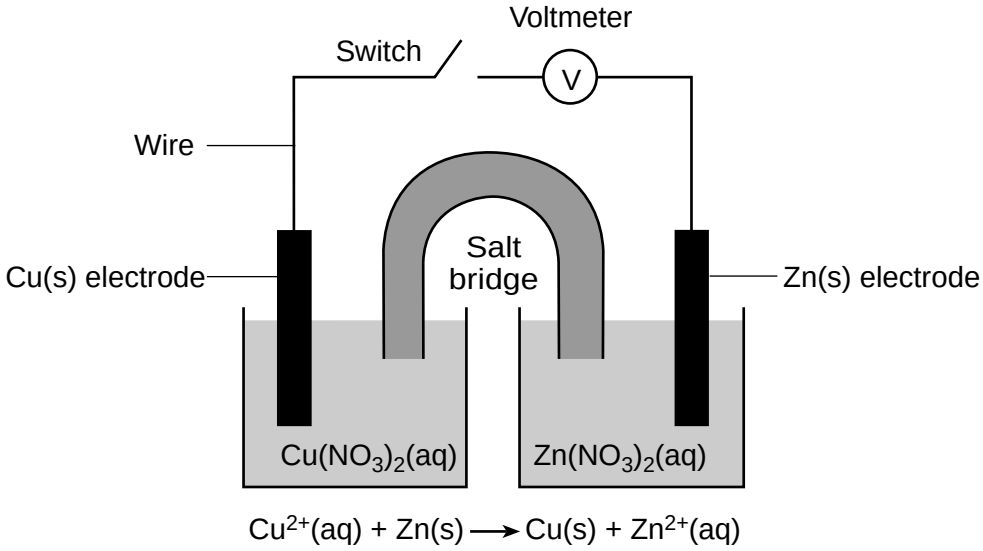
77 Identify the element present in urea that is present in all organic compounds. [1]

78 Compare the formula mass of the two compounds in the equation. [1]

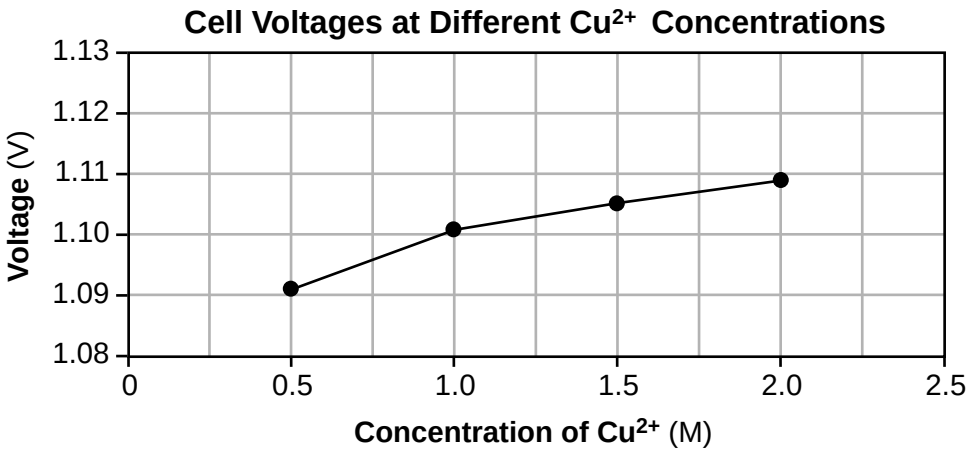
79 State, in terms of molecular polarity, why urea is very soluble in water. [1]

Base your answers to questions 80 and 81 on the information below and on your knowledge of chemistry.

When a voltmeter is connected in the circuit of a voltaic cell, an electrical measurement called voltage can be read on the meter. The voltage of the cell is affected if the concentration of the solute in the half-cells is changed. The diagram, the ionic equation, and the graph below represent a copper-zinc cell. When the switch is closed, electricity flows through the circuit as the cell operates at constant temperature.



$Cu^{2+}(aq) + Zn(s) \longrightarrow Cu(s) + Zn^{2+}(aq)$



80 Based on the graph, determine the voltage of the cell if the $Cu(NO_3)_2(aq)$ concentration is 1.5 M. [1]

81 Write a balanced half-reaction equation for the oxidation of zinc that occurs in this operating cell. [1]

Base your answers to questions 82 through 85 on the information below and on your knowledge of chemistry.

Synthetic radioisotopes may be made by bombarding other nuclides with neutrons. The equations below represent a sequence of reactions converting stable iron–58 to cobalt–60, which is used in medical treatments.

Equation 1: $^{58}_{26}\text{Fe} + {}^{1}_{0}\text{n} \rightarrow {}^{59}_{26}\text{Fe}$

Equation 2: $^{59}_{26}\text{Fe} \rightarrow {}^{59}_{27}\text{Co} + {}^{0}_{-1}\text{e}$

Equation 3: $^{59}_{27}\text{Co} + X \rightarrow {}^{60}_{27}\text{Co}$

82 State the neutron to proton ratio for an atom of the ^{58}Fe in equation 1. [1]

83 State, in terms of elements, why equation 2 represents a transmutation reaction. [1]

84 Identify the particle represented by *X* in equation 3. [1]

85 Determine the fraction of an original sample of Co-60 that remains unchanged after 15.813 years. [1]

P.S./CHEMISTRY

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
CHEMISTRY

Friday, January 27, 2023 — 9:15 a.m. to 12:15 p.m., only

ANSWER BOOKLET

Student . . . . . .

Teacher . . . . . .

School . . . . . Grade . . . . . .

Record your answers for Part B–2 and Part C in this booklet.

Part B–2

51 _____

_____

_____

52 _____

53 _____

_____

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54 _____

_____

_____

55 _____

_____

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56

57 _____ **and** _____

58 _____

_____

_____

59 _____ **mL**

60 _____

_____

_____

61 _____

_____

_____

62 _____ **M**

63 _____

64 _____

65 _____

Part C

66 _____

_____

_____

67 _____ **mol**

68

69 _____

70 From _____ to _____

71 _____ **J**

72 _____

_____

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73 _____

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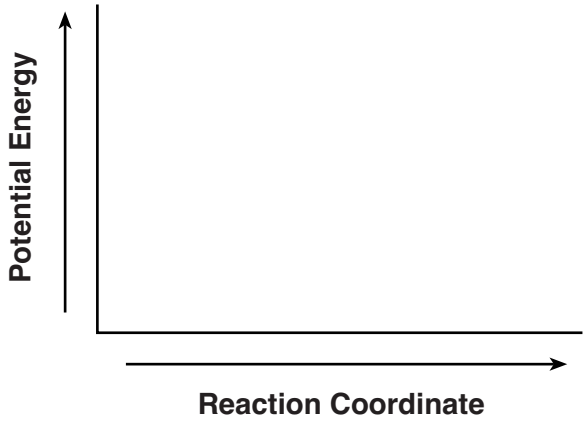
_____

74



75 _____

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76 _____

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77 _____

78 _____

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79 _____

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_____

80 _____ **V**

81 _____

82 _____

83 _____

_____

_____

84 _____

85 _____

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P.S./CHEMISTRY

The State Education Department / The University of the State of New York

Regents Examination in Physical Setting/Chemistry – January 2023

Scoring Key: Parts A and B-1 (Multiple-Choice Questions)

Examination	Date	Question Number	Scoring Key	Question Type	Credit	Weight
Physical Setting/Chemistry	January '23	**1**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**2**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**3**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**4**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**5**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**6**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**7**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**8**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**9**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**10**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**11**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**12**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**13**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**14**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**15**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**16**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**17**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**18**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**19**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**20**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**21**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**22**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**23**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**24**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**25**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**26**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**27**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**28**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**29**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**30**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**31**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**32**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**33**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**34**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**35**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**36**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**37**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**38**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**39**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**40**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**41**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**42**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**43**	**3**	MC	1	1
Physical Setting/Chemistry	January '23	**44**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**45**	**1**	MC	1	1
Physical Setting/Chemistry	January '23	**46**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**47**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**48**	**4**	MC	1	1
Physical Setting/Chemistry	January '23	**49**	**2**	MC	1	1
Physical Setting/Chemistry	January '23	**50**	**1**	MC	1	1

Regents Examination in Physical Setting/Chemistry – January 2023

Scoring Key: Parts B-2 and C (Constructed-Response Questions)

Examination	Date	Question Number	Scoring Key	Question Type	Credit	Weight
Physical Setting/Chemistry	January '23	**51**	-	CR	1	1
Physical Setting/Chemistry	January '23	**52**	-	CR	1	1
Physical Setting/Chemistry	January '23	**53**	-	CR	1	1
Physical Setting/Chemistry	January '23	**54**	-	CR	1	1
Physical Setting/Chemistry	January '23	**55**	-	CR	1	1
Physical Setting/Chemistry	January '23	**56**	-	CR	1	1
Physical Setting/Chemistry	January '23	**57**	-	CR	1	1
Physical Setting/Chemistry	January '23	**58**	-	CR	1	1
Physical Setting/Chemistry	January '23	**59**	-	CR	1	1
Physical Setting/Chemistry	January '23	**60**	-	CR	1	1
Physical Setting/Chemistry	January '23	**61**	-	CR	1	1
Physical Setting/Chemistry	January '23	**62**	-	CR	1	1
Physical Setting/Chemistry	January '23	**63**	-	CR	1	1
Physical Setting/Chemistry	January '23	**64**	-	CR	1	1
Physical Setting/Chemistry	January '23	**65**	-	CR	1	1
Physical Setting/Chemistry	January '23	**66**	-	CR	1	1
Physical Setting/Chemistry	January '23	**67**	-	CR	1	1
Physical Setting/Chemistry	January '23	**68**	-	CR	1	1
Physical Setting/Chemistry	January '23	**69**	-	CR	1	1
Physical Setting/Chemistry	January '23	**70**	-	CR	1	1
Physical Setting/Chemistry	January '23	**71**	-	CR	1	1
Physical Setting/Chemistry	January '23	**72**	-	CR	1	1
Physical Setting/Chemistry	January '23	**73**	-	CR	1	1
Physical Setting/Chemistry	January '23	**74**	-	CR	1	1
Physical Setting/Chemistry	January '23	**75**	-	CR	1	1
Physical Setting/Chemistry	January '23	**76**	-	CR	1	1
Physical Setting/Chemistry	January '23	**77**	-	CR	1	1
Physical Setting/Chemistry	January '23	**78**	-	CR	1	1
Physical Setting/Chemistry	January '23	**79**	-	CR	1	1
Physical Setting/Chemistry	January '23	**80**	-	CR	1	1
Physical Setting/Chemistry	January '23	**81**	-	CR	1	1
Physical Setting/Chemistry	January '23	**82**	-	CR	1	1
Physical Setting/Chemistry	January '23	**83**	-	CR	1	1
Physical Setting/Chemistry	January '23	**84**	-	CR	1	1
Physical Setting/Chemistry	January '23	**85**	-	CR	1	1

Key
MC = Multiple-choice question
CR = Constructed-response question

The chart for determining students' final examination scores for the **January 2023 Regents Examination in Physical Setting/Chemistry** will be posted on the Department's web site at https://www.nysedregents.org/Chemistry/ on the day of the examination. Conversion charts provided for the previous administrations of the Physical Setting/Chemistry examination must NOT be used to determine students' final scores for this administration.

FOR TEACHERS ONLY

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING/CHEMISTRY

Friday, January 27, 2023 — 9:15 a.m. to 12:15 p.m., only

RATING GUIDE

Directions to the Teacher:

Refer to the directions on page 2 before rating student papers.

Updated information regarding the rating of this examination may be posted on the New York State Education Department's web site during the rating period. Check this web site at: http://www.nysed.gov/state-assessment/high-school-regents-examinations and select the link "Scoring Information" for any recently posted information regarding this examination. This site should be checked before the rating process for this examination begins and several times throughout the Regents Examination period.

Directions to the Teacher

Follow the procedures below for scoring student answer papers for the Regents Examination in Physical Setting/Chemistry. Additional information about scoring is provided in the publication *Information Booklet for Scoring Regents Examinations in the Sciences.*

At least two science teachers must participate in the scoring of the Part B–2 and Part C open-ended questions on a student's paper. Each of these teachers should be responsible for scoring a selected number of the open-ended questions on each answer paper. No one teacher is to score more than approximately one-half of the open-ended questions on a student's answer paper. Teachers may not score their own students' answer papers.

Students' responses must be scored strictly according to the Rating Guide. For open-ended questions, credit may be allowed for responses other than those given in the rating guide if the response is a scientifically accurate answer to the question and demonstrates adequate knowledge, as indicated by the examples in the rating guide. Do not attempt to correct the student's work by making insertions or changes of any kind. On the student's separate answer sheet, for each question, record the number of credits earned and the teacher's assigned rater/scorer letter.

Fractional credit is *not* allowed. Only whole-number credit may be given for a response. If the student gives more than one answer to a question, only the first answer should be rated. Units need not be given when the wording of the questions allows such omissions.

For hand scoring, raters should enter the scores earned in the appropriate boxes printed on the separate answer sheet. Next, the rater should add these scores and enter the total in the box labeled "Total Raw Score." Then the student's raw score should be converted to a scale score by using the conversion chart that will be posted on the Department's web site at: http://www.nysed.gov/state-assessment/high-school-regents-examinations on Friday, January 27, 2023. The student's scale score should be entered in the box labeled "Scale Score" on the student's answer sheet. The scale score is the student's final examination score.

Schools are not permitted to rescore any of the open-ended questions on this exam after each question has been rated once, regardless of the final exam score. Schools are required to ensure that the raw scores have been added correctly and that the resulting scale score has been determined accurately.

Because scale scores corresponding to raw scores in the conversion chart may change from one administration to another, it is crucial that, for each administration, the conversion chart provided for that administration be used to determine the student's final score.

Part B–2

Allow a total of 15 credits for this part. The student must answer all questions in this part.

51 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

An atom of P-32 has 15 protons and 17 neutrons. An atom of P-31 also has 15 protons but has 16 neutrons.

These two atoms have the same number of protons but a different number of neutrons.

same number of p, different number of n

52 [1] Allow 1 credit for +6 *or* 6+.

53 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

As atomic number increases, atomic radius increases.

Atomic radius increases.

Radius increases going down the group.

From top to bottom in Group 14, radius increases.

54 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Both germanium and silicon have 4 valence electrons in the ground state.

The Si and Ge atoms have the same number of outermost shell electrons.

55 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

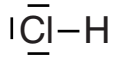
A molecule of NH_3 is polar because the distribution of charge is asymmetrical.

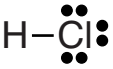
The molecule has an uneven charge distribution.

The center of positive charge and the center of negative charge do not coincide.

56 [1] Allow 1 credit.

Examples of 1-credit responses:





Note: Do *not* allow credit for •—• *or* •—• *or* —• for a bond because each • represents one electron and each — represents two electrons.

57 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

polar covalent bonds and ionic bonds

ionic and covalent

ionic and coordinate covalent

58 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The gas atoms are closer together, so the volume of the gas is smaller. A smaller volume means a greater density because the mass remained the same.

The atoms have a smaller average distance between them.

Average distance decreases.

59 [1] Allow 1 credit for 100. mL *or* 100 mL.

60 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The number of helium atoms at 0.50 atm is equal to the number of helium atoms at 1.50 atm.

The number of atoms is the same.

equal

same

61 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The HCl(aq) has ions in water, which are mobile.

The ions in the solution move freely.

Hydrochloric acid solution contains $H^+(aq)$ and $Cl^-(aq)$ ions.

62 [1] Allow 1 credit for 0.110 M *or* any value from 0.11 M to 0.11012 M, inclusive.

63 [1] Allow 1 credit for 2.0 *or* 2 *or* two.

64 [1] Allow 1 credit for OH^- ion *or* hydroxide.
Note: Do *not* allow credit for OH *or* hydroxyl *or* hydroxyl ion.

65 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

10

ten

tenfold

10 times

Part C

Allow a total of 20 credits for this part. The student must answer all questions in this part.

66 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The formula is the simplest whole number ratio of atoms of the elements in the compound.

The formula $Na_2B_4O_7$ cannot be reduced.

67 [1] Allow 1 credit for 8 mol.

68 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$$0.200 \text{ mol} = \frac{x}{381 \text{ g/mol}}$$

(0.200 mol)(381 g/mol)

(0.2)(381)

$$0.200 \text{ mol} \times \frac{381 \text{ g}}{1 \text{ mol}}$$

Note: Allow credit for a setup using a gram-formula mass for borax ($Na_2B_4O_7 \bullet 10H_2O$) with any value from 381 g/mol to 382 g/mol, inclusive.

69 [1] Allow 1 credit for 3 *or* three.

70 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

from the air to the water

from air to H_2O

71 [1] Allow 1 credit for 31 000 J *or* any value from 30 700 J to 31 122 J, inclusive.

72 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The heat term is on the right side of the equation.

The 91.8 kJ of energy is a product.

The energy term is on the product side.

Note: Do *not* accept "Heat is released." without stating supporting evidence from the equation.

73 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The rate of the forward reaction is equal to the rate of the reverse reaction.

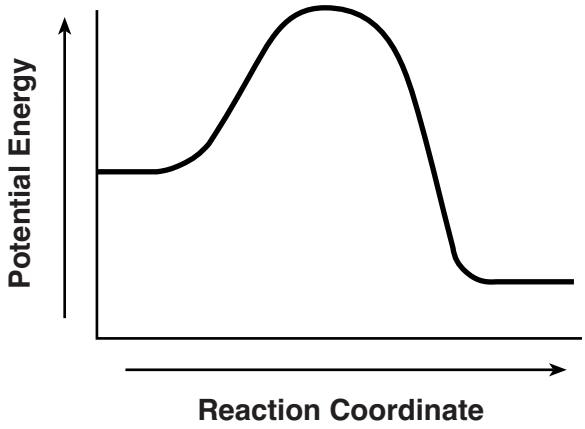
The rates are the same.

equal

same

74 [1] Allow 1 credit for showing that the PE of the products is lower than the PE of the reactants.

Example of a 1-credit response:



75 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

There are 4 moles of gas on the left side and 2 moles of gas on the right side of the equation, so the shift to the right relieves the increased pressure.

There are more moles of gas on the left side of the equation than on the other.

fewer moles, less pressure

76 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Adding the iron will increase the rate of production of the $NH_3(g)$.

The rate of the forward reaction would increase.

Forward rate increases.

The $NH_3(g)$ will be produced faster.

77 [1] Allow 1 credit for C *or* carbon.

78 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

The formula mass of ammonium cyanate is equal to the formula mass of urea.

The formula masses of the two compounds are the same.

Ammonium cyanate and urea both have a formula mass of 60. u.

equal

same

79 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

Urea and water have similar molecular polarities.

Water molecules and urea molecules are both polar.

Urea is polar.

80 [1] Allow 1 credit for any value from 1.102 V to 1.108 V, inclusive.

81 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

$Zn \rightarrow 2e^- + Zn^{+2}$

Note: Do *not* allow credit for the e without the minus sign (−).

82 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

32:26

$\frac{32}{26}$

16 to 13

83 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

An atom of iron is changed to an atom of cobalt.

The Fe-59 has an atomic number of 26 and becomes Co-59 with an atomic number of 27.

One element changed to a different element.

84 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$^{1}_{0}n$

n

neutron

85 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

$\frac{1}{8}$

0.125

12.5%

Regents Examination in Physical Setting/Chemistry

January 2023

Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

The *Chart for Determining the Final Examination Score for the January 2023 Regents Examination in Physical Setting/Chemistry* will be posted on the Department's web site at: http://www.nysed.gov/state-assessment/high-school-regents-examinations on Friday, January 27, 2023. Conversion charts provided for previous administrations of the Regents Examination in Physical Setting/Chemistry must NOT be used to determine students' final scores for this administration.

Online Submission of Teacher Evaluations of the Test to the Department

Suggestions and feedback from teachers provide an important contribution to the test development process. The Department provides an online evaluation form for State assessments. It contains spaces for teachers to respond to several specific questions and to make suggestions. Instructions for completing the evaluation form are as follows:

1. Go to https://www.surveymonkey.com/r/8LNLLDW.
2. Select the test title.
3. Complete the required demographic fields.
4. Complete each evaluation question and provide comments in the space provided.
5. Click the SUBMIT button at the bottom of the page to submit the completed form.

Map to Core Curriculum

January 2023 Physical Setting/Chemistry			
Question Numbers			
Key Ideas/Performance Indicators	Part A	Part B	Part C
Standard 1			
Math Key Idea 1		32,33	68,69,80
Math Key Idea 2		36,41,47,58	84
Math Key Idea 3		31,34,35,37,51,52, 59,62,65	67,71,81,82,85
Science Inquiry Key Idea 1		38,39,40,44,45,47, 48,49,50,53,54,55, 57,58,60,61,64,65	66,70,72,73,75,76, 77,78,79,82,83,84
Science Inquiry Key Idea 2			
Science Inquiry Key Idea 3		34,35,36,38,39,40, 43,45,47,48,49,50, 51,52,58,64	74,81
Engineering Design Key Idea 1			
Standard 2			
Key Idea 1			
Key Idea 2			
Key Idea 3			
Standard 6			
Key Idea 1			70
Key Idea 2		45, 56	
Key Idea 3		63, 65	
Key Idea 4			
Key Idea 5		42	74
Standard 7			
Key Idea 1			
Key Idea 2			
Standard 4 Process Skills			
Key Idea 3		32,33,35,36,37,38, 42,45,46,51,53,54, 59,62,64	66,67,68,73,75,76, 79,81,82
Key Idea 4		43	71, 72, 74, 84, 85
Key idea 5		40, 56	
Standard 4			
Key Idea 3	1,2,3,4,5,7,8,9,13, 14,15,17,18,19,20, 21,22,23,24,25,26, 27,29	31,32,33,34,35,36, 37,38,42,44,45,46, 47,49,50,51,52,53, 54,58,59,60,61,62, 63,64,65	66,67,68,73,75,76, 77,78,80,81,82
Key Idea 4	16, 28	43,48	69,70,71,72,74,84, 85
Key Idea 5	6, 10, 11, 12, 30	39,40,41,55,56, 57	79, 83
Reference Tables			
2011 Edition	2,4,5,7,8,9,12,13, 15,20,21,22,27,28, 29	31,33,34,37,39,40, 41,42,43,46,49,51, 53,54,56,57,59,62, 64	68,71,72,77,78,82, 83,84,85

Regents Examination in Physical Setting/Chemistry – January 2023

Chart for Converting Total Test Raw Scores to Final Examination Scores (Scale Scores)

Raw Score	Scale Score
85	**100**
84	**98**
83	**96**
82	**95**
81	**93**
80	**92**
79	**90**
78	**89**
77	**87**
76	**86**
75	**85**
74	**84**
73	**83**
72	**82**
71	**81**
70	**80**
69	**79**
68	**78**
67	**77**
66	**76**
65	**75**
64	**75**

Raw Score	Scale Score
63	**74**
62	**73**
61	**72**
60	**72**
59	**71**
58	**70**
57	**69**
56	**69**
55	**68**
54	**67**
53	**67**
52	**66**
51	**66**
50	**65**
49	**64**
48	**63**
47	**63**
46	**62**
45	**61**
44	**61**
43	**60**
42	**59**

Raw Score	Scale Score
41	**59**
40	**58**
39	**57**
38	**57**
37	**56**
36	**55**
35	**54**
34	**54**
33	**53**
32	**52**
31	**51**
30	**50**
29	**49**
28	**48**
27	**47**
26	**46**
25	**45**
24	**44**
23	**43**
22	**42**
21	**41**
20	**40**

Raw Score	Scale Score
19	**38**
18	**37**
17	**36**
16	**34**
15	**33**
14	**31**
13	**30**
12	**28**
11	**26**
10	**24**
9	**22**
8	**20**
7	**18**
6	**16**
5	**14**
4	**11**
3	**9**
2	**6**
1	**3**
0	**0**

To determine the student's final examination score, find the student's total test raw score in the column labeled "Raw Score" and then locate the scale score that corresponds to that raw score. The scale score is the student's final examination score. Enter this score in the space labeled "Scale Score" on the student's answer sheet.

Schools are not permitted to rescore any of the open-ended questions on this exam after each question has been rated once, regardless of the final exam score. Schools are required to ensure that the raw scores have been added correctly and that the resulting scale score has been determined accurately.

Because scale scores corresponding to raw scores in the conversion chart change from one administration to another, it is crucial that for each administration the conversion chart provided for that administration be used to determine the student's final score. The chart above is usable only for this administration of the Regents Examination in Physical Setting/Chemistry.