Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING

CHEMISTRY

Tuesday, January 20, 2026 — 1:15 to 4:15 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 START THIS EXAMINATION 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 resulted directly from the gold foil experiment?

(1) Atoms are hard, indivisible spheres.
(2) Electrons in an atom are negatively charged.
(3) Atoms contain a small, dense nucleus.
(4) Electrons in an atom are in shells that have different energies.

2 What is the number of electrons in an atom with 37 protons and 49 neutrons?

(1) 12
(2) 37
(3) 49
(4) 86

3 Which statement describes the mass of an electron?

(1) An electron has the same mass as a proton.
(2) An electron has the same mass as a neutron.
(3) An electron has much less mass than a proton.
(4) An electron has much more mass than a neutron.

4 In the wave-mechanical model of the atom, electrons are located in regions called

(1) spectra
(2) orbitals
(3) quanta
(4) nuclei

5 At STP, a sample of potassium can be differentiated from a sample of rubidium based on

(1) density
(2) phase
(3) temperature
(4) pressure

6 Which statement describes a chemical property of chlorine?

(1) Chlorine has an atomic radius of 100. pm.
(2) Chlorine reacts with sodium to form a salt.
(3) Chlorine has a melting point of 172 K.
(4) Chlorine is a green-yellow gas at STP.

7 Oxygen gas, $O_2(g)$, and ozone gas, $O_3(g)$, are two forms of the element oxygen. These two forms of oxygen have

(1) the same molecular structures and the same properties
(2) the same molecular structures and different properties
(3) different molecular structures and the same properties
(4) different molecular structures and different properties

8 Which phrase describes two or more elements chemically combined?

(1) a mixture with a fixed proportion of elements
(2) a mixture with variable proportions of elements
(3) a compound with a fixed proportion of elements
(4) a compound with variable proportions of elements

9 Which formula is an empirical formula?

(1) N_2O_4
(2) N_2O_5
(3) N_2F_2
(4) N_2H_4

10 Which terms represent two different categories of compounds?

(1) covalent and molecular
(2) covalent and electrical
(3) ionic and molecular
(4) ionic and electrical

11 Which element has molecules that each contain a multiple covalent bond?

(1) bromine
(2) hydrogen
(3) iodine
(4) oxygen

12 Which formula represents an asymmetrical molecule?

(1) HCl
(2) CO_2
(3) Cl_2
(4) CH_4

13 Which changes in charge and radius occur when an atom gains one electron?

(1) A negative ion forms with a radius smaller than the atom.
(2) A negative ion forms with a radius larger than the atom.
(3) A positive ion forms with a radius smaller than the atom.
(4) A positive ion forms with a radius larger than the atom.

14 Given the equation representing a reaction:

$$N + N \rightarrow N_2$$

What occurs during this reaction?

(1) Energy is absorbed as bonds are broken.
(2) Energy is absorbed as bonds are formed.
(3) Energy is released as bonds are broken.
(4) Energy is released as bonds are formed.

15 Which compound has both ionic and covalent bonds?

(1) $CaCl_2$
(2) $KClO_2$
(3) Li_2S
(4) MnO_2

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

(1) Fe
(2) Fe_2O_3
(3) $FeSO_4$
(4) $Fe_2(SO_4)_3$

17 According to the kinetic molecular theory, the particles of an ideal gas have

(1) collisions that do not transfer energy
(2) strong attractive forces between them
(3) random, constant, straight-line motion
(4) large volumes compared to the distances between them

18 In order for a chemical reaction to occur, colliding particles must have proper orientation and proper

(1) radii
(2) energy
(3) molar masses
(4) oxidation states

19 At STP, which sample of gas has the same number of atoms as 4.0 liters of Ne gas?

(1) 8.0 L of Ar(g)
(2) 2.0 L of He(g)
(3) 3.0 L of Kr(g)
(4) 4.0 L of Xe(g)

20 Based on Table *I*, the dissolving of which compound is an exothermic process at 298 K and 101.3 kPa?

(1) $KNO_3(s)$
(2) NaOH(s)
(3) $NH_4Cl(s)$
(4) $NH_4NO_3(s)$

21 Which expression represents the heat of reaction for a chemical change in terms of potential energy, *PE*?

(1) *PE* of products $\times$ *PE* of reactants
(2) *PE* of products $\div$ *PE* of reactants
(3) *PE* of products $+$ *PE* of reactants
(4) *PE* of products $-$ *PE* of reactants

22 Which phrase describes how a catalyst increases the rate of a chemical reaction?

(1) provides an alternate reaction pathway
(2) provides an alternate energy source
(3) increases the potential energy of the reactants
(4) increases the activation energy of the reaction

23 At standard pressure, which 5.0-gram sample of xenon has the greatest entropy?

(1) Xe(s) at 161 K
(2) Xe(ℓ) at 161 K
(3) Xe(ℓ) at 165 K
(4) Xe(g) at 165 K

24 Systems in nature tend to undergo changes that result in

(1) lower energy and less disorder
(2) higher energy and less disorder
(3) lower energy and greater disorder
(4) higher energy and greater disorder

25 Which compound is a member of the homologous series represented by the general formula C_nH_{2n}?

(1) C_2H_2
(2) C_3H_6
(3) C_4H_{10}
(4) C_5H_8

26 Which term identifies a reaction that produces an alcohol?

(1) combustion
(2) deposition
(3) fermentation
(4) sublimation

27 Which statement describes a substance that is an electrolyte?

(1) The substance conducts an electric current and cannot dissolve in water.
(2) The substance cannot conduct an electric current and cannot dissolve in water.
(3) When the substance dissolves in water, the solution can conduct an electric current.
(4) When the substance dissolves in water, the solution cannot conduct an electric current.

28 Which substance is an Arrhenius acid?

(1) NH_3
(2) HNO_3
(3) NaCl
(4) NaOH

29 A heavy nucleus splits into two lighter nuclei during which process?

(1) decomposition
(2) deposition
(3) fission
(4) fusion

30 The energy released by nuclear fusion in the Sun results from the conversion of

(1) energy to matter
(2) matter to energy
(3) atoms to molecules
(4) molecules to atoms

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 Which electron configuration represents a lithium atom in an excited state?

(1) 2-1
(2) 2-2
(3) 1-2-1
(4) 1-1-1

32 Which Lewis electron-dot diagram represents an atom of selenium in the ground state?

(1) Se

(3) Se

(2) Se

(4) Se

33 Which element could be represented by the X in the oxide formula, X_2O?

(1) Cd
(2) Cr
(3) Ca
(4) Cs

34 What is a chemical name for the compound PdO?

(1) palladium (II) oxide
(2) palladium (IV) oxide
(3) palladium peroxide
(4) palladium hydroxide

35 Given the balanced equation representing a reaction:

$$CH_4(g) + 2O_2(g) \rightarrow 2H_2O(\ell) + CO_2(g) + 890.4\ kJ$$

When 12 grams of $CH_4(g)$ react completely with 48 grams of $O_2(g)$ to produce 33 grams of $CO_2(g)$, how many grams of $H_2O(\ell)$ are produced?

(1) 12 g
(2) 27 g
(3) 60. g
(4) 69 g

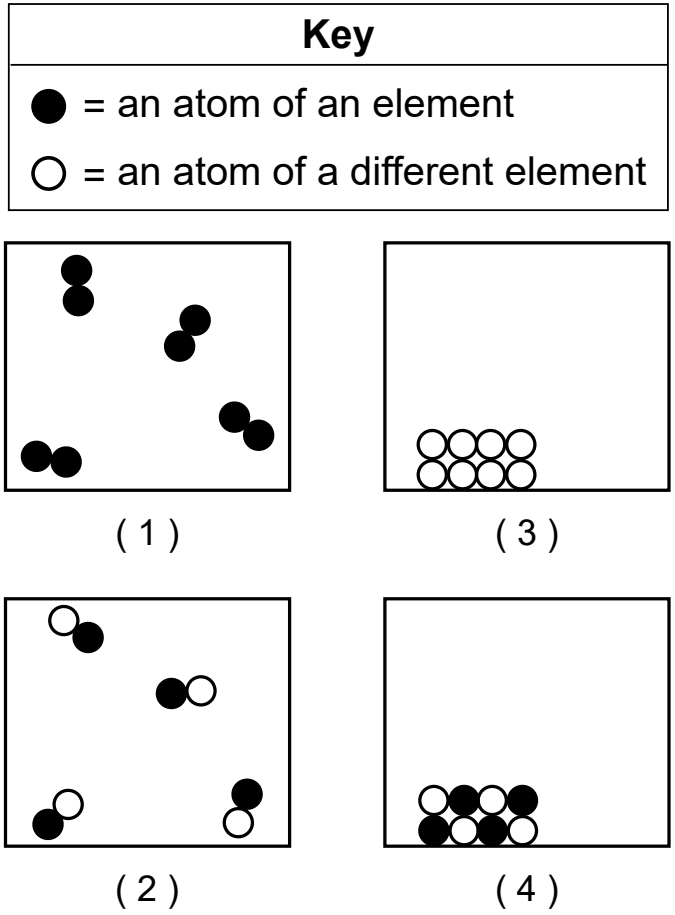
36 What is the gram-formula mass of P_2O_5?

(1) 47 g/mol
(2) 111 g/mol
(3) 142 g/mol
(4) 187 g/mol

37 In the ground state, ions of which two elements each have the same electron configuration as an atom of neon in the ground state?

(1) lithium and fluorine
(2) sodium and chlorine
(3) magnesium and oxygen
(4) calcium and sulfur

38 Which particle model diagram represents a sample of fluorine at STP?



39 Based on Table *F*, which compound is most soluble in water?

(1) Ag_2CrO_4
(2) $AgNO_3$
(3) $CuCO_3$
(4) $Cu_3(PO_4)_2$

40 Which solution has the *lowest* freezing point?

(1) 1.0 M NaCl(aq)
(2) 1.0 M $C_6H_{12}O_6$(aq)
(3) 2.0 M NaCl(aq)
(4) 2.0 M $C_6H_{12}O_6$(aq)

41 What is the amount of heat energy required to completely vaporize a 12.5-gram sample of $H_2O(\ell)$ at 373 K and 1.0 atmosphere?

(1) 4180 J
(2) 5230 J
(3) 19 500 J
(4) 28 300 J

42 A 2.0-gram sample of solid iron, Fe(s), reacts with 25 mL of 0.10 M HCl(aq). Which conditions will produce the fastest reaction rate?

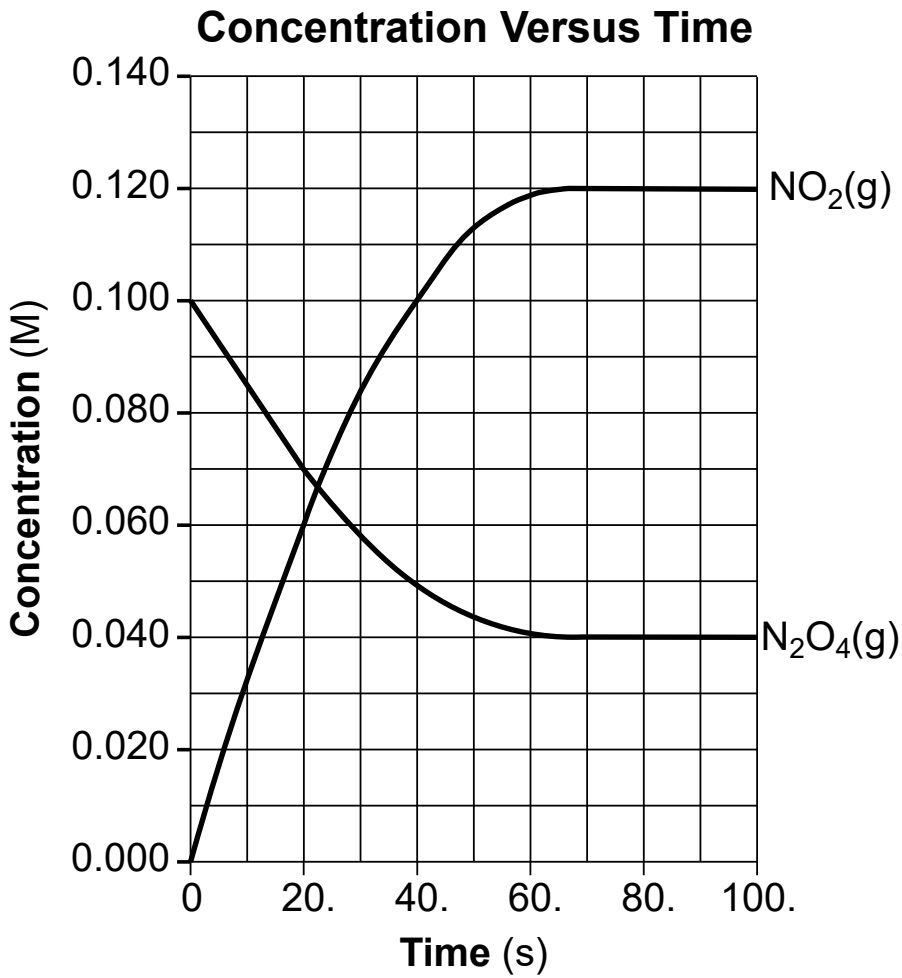
(1) powdered iron at 273 K
(2) powdered iron at 303 K
(3) strip of iron at 273 K
(4) strip of iron at 303 K

43 Which term describes a system with a sealed 100.-mL flask that contains 50. grams of water at 25°C?

(1) physical equilibrium, only
(2) chemical equilibrium, only
(3) condensation, only
(4) evaporation, only

44 Given the equation and graph representing a reaction:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$



At which time is the system at equilibrium?

(1) 12 s
(2) 22 s
(3) 50. s
(4) 70. s

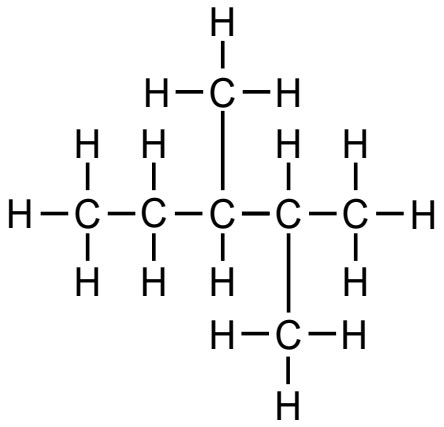
45 Given the equation representing a chemical system at equilibrium in a sealed, rigid container:

$$H_2(g) + I_2(g) + \text{energy} \rightleftharpoons 2HI(g)$$

When the temperature of the system in the container is increased, the equilibrium shifts to the

(1) right and the concentration of HI(g) decreases
(2) right and the concentration of HI(g) increases
(3) left and the concentration of HI(g) decreases
(4) left and the concentration of HI(g) increases

46 Given the formula of a compound:



What is a chemical name for this compound?

(1) 4-methylhexane
(2) 3-methylhexane
(3) 3,4-dimethylpentane
(4) 2,3-dimethylpentane

47 What is the oxidation state of chlorine in the compound $KClO_3$?

(1) +1
(2) −1
(3) +5
(4) +7

48 Given the equation representing a reversible reaction:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

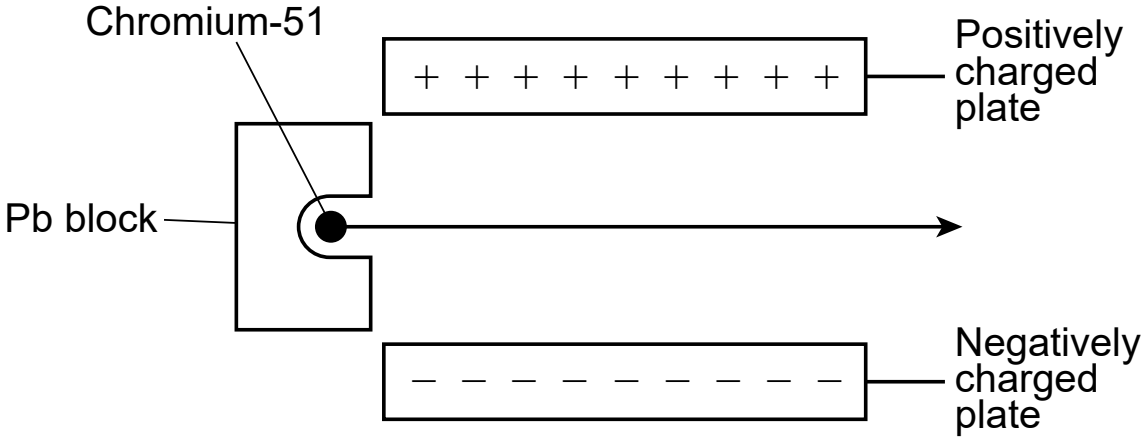
According to one acid-base theory, the reactant in the reverse reaction that donates an H^+ ion is

(1) $NH_3(g)$
(2) $H_2O(\ell)$
(3) $NH_4^+(aq)$
(4) $OH^-(aq)$

49 When the pH value of a solution is changed from 4.0 to 7.0, what is the change in the concentration of hydronium ions?

(1) decreased by a factor of 1000
(2) decreased by a factor of 3
(3) increased by a factor of 1000
(4) increased by a factor of 3

50 The diagram below represents a radioactive emission from a sample of chromium-51 passing through an electric field between two oppositely charged metal plates.



Which type of radioactive emission is represented in the diagram?

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

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 Determine the percent composition by mass of Cu in $CuSO_4$ (gram-formula mass = 160. g/mol). [1]

Base your answers to questions 52 through 54 on the information below and on your knowledge of chemistry.

The three naturally occurring isotopes of potassium are K-39, K-40, and K-41. The atomic mass and percent natural abundance of each of these isotopes are shown in the table below.

Naturally Occurring Isotopes of Potassium

Isotope	**Atomic Mass** (u)	**Natural Abundance** (%)
K-39	38.964	93.26
K-40	39.964	0.01
K-41	40.962	6.73

52 State, in terms of *both* protons and neutrons, why an atom of K-39 is an isotope of an atom of K-40. [1]

53 Compare the energy of an electron in the first shell of a potassium atom to the energy of an electron in the fourth shell of the same atom. [1]

54 Show a numerical setup for calculating the atomic mass of potassium. [1]

GO RIGHT ON TO THE NEXT PAGE ⇨

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

Ammonia, NH_3, is used in the production of some fertilizers, textiles, and plastics. Nitrogen gas and hydrogen gas react to produce ammonia as represented by the balanced equation below.

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

55 State, in terms of the number of each type of atom, why the equation is balanced. [1]

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

57 Determine the number of moles of hydrogen gas required to react completely with nitrogen gas to produce 10.0 moles of ammonia gas in this reaction. [1]

Base your answers to questions 58 through 61 on the information below and on your knowledge of chemistry.

A 320.-milliliter sample of nitrogen gas, $N_2(g)$, is placed in a sealed, rigid cylinder with a movable piston at 300. K and 100. kilopascals.

58 State the number of significant figures used to express the original temperature of the sample of nitrogen gas. [1]

59 Compare the force of collisions of the gas particles at 300. K to the force of collisions at 450. K. [1]

60 State a change in temperature and a change in pressure of the nitrogen gas that will cause the gas in the cylinder to behave more like an ideal gas. [1]

61 Determine the volume of the N_2 gas if the temperature is changed to 450. K and the pressure is changed to 60.0 kPa. [1]

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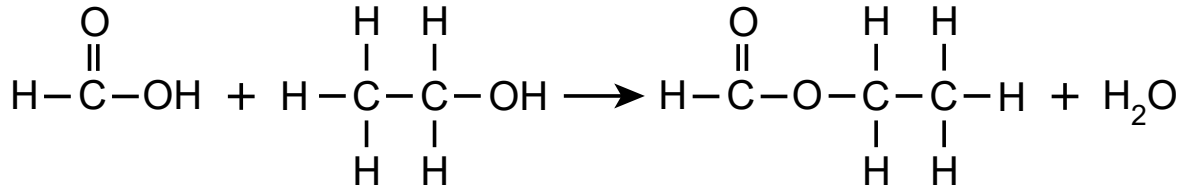
Base your answers to questions 62 through 65 on the information below and on your knowledge of chemistry.

The organic compound ethyl methanoate is a clear liquid with a pleasant odor. A reaction to produce ethyl methanoate is represented by the equation below.



62 Based on Table *R*, write the name of the class of compound to which reactant 1 belongs. [1]

63 Identify the element in reactant 2 that allows it to be classified as an organic compound. [1]

64 State the number of electrons shared between the carbon atoms in reactant 2. [1]

65 State, in terms of molecular formulas and structural formulas, why propanoic acid, CH_3CH_2COOH, is an isomer of ethyl methanoate, $HCOOCH_2CH_3$. [1]

GO RIGHT ON TO THE NEXT PAGE ⇨

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 70 on the information below and on your knowledge of chemistry.

Fluorine, chlorine, bromine, and iodine are called halogens. One use for some halogens is as a gas in halogen lightbulbs. These lightbulbs have a tungsten wire filament that glows brightly when electricity flows through the wire. The contents of the halogen lightbulbs reach an operating temperature of 3200 K.

66 State, in terms of valence electrons, why bromine and iodine have similar chemical properties. [1]

67 State, in terms of the strength of intermolecular forces, why bromine has a higher boiling point at standard pressure than chlorine at standard pressure. [1]

68 Based on Table *S*, state the trend in first ionization energy for these four halogen elements as they are considered in order of increasing atomic number. [1]

69 Based on Table *S*, state why the tungsten filament does *not* melt in the operating halogen lightbulb. [1]

70 State the element classification of the element tungsten. [1]

GO RIGHT ON TO THE NEXT PAGE ⇨

Base your answers to questions 71 through 75 on the information below and on your knowledge of chemistry.

During a laboratory activity appropriate safety equipment was used and safety procedures were followed. In the activity, a student performed a controlled experiment designed to investigate the cooling effect of the evaporation of water. The student used three beakers. A paper towel was held in place over the top of each beaker as shown in the diagram below.

Using a dropper, the student added room temperature water to one of the paper towels, added hot water to another paper towel, and left one paper towel dry. The surface temperature of the dry towel was measured at the start and 8 minutes later. The temperatures of the other two towels were measured when the water was added and 8 minutes later. The data for this activity are shown in the table on the page below.

Temperature Data for the Activity

Towel	Temperature at the Start (°C)	Temperature after 8 minutes (°C)
Dry towel	22.0	22.0
Towel with room temperature water	22.0	19.0
Towel with hot water	67.0	20.0

71 Convert the temperature of the dry towel after 8 minutes to kelvins. [1]

72 Determine the amount of heat absorbed when 3.60 grams of the water is heated from 22.0°C to 67.0°C. [1]

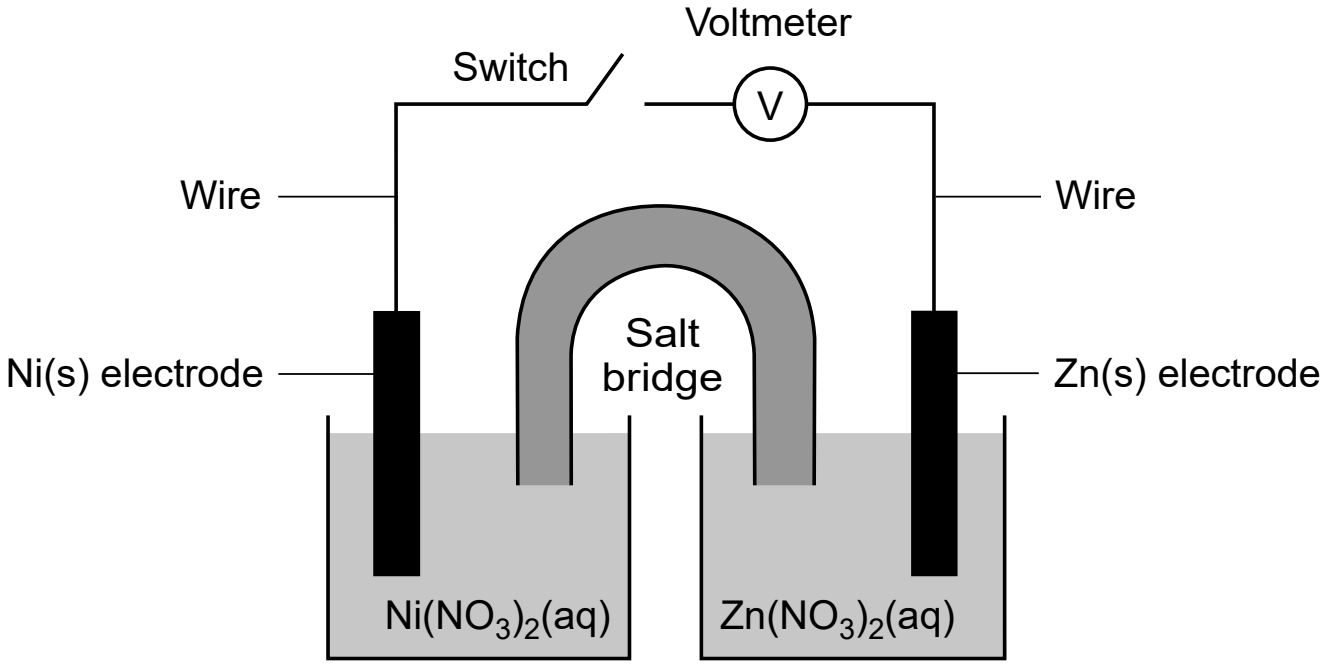
73 State the direction of heat flow between the hot water on the towel and the air at room temperature. [1]

74 State what happens to the potential energy of the molecules of water as the water evaporates from the wet towels. [1]

75 State, in terms of experimental design, why the student left one paper towel dry on a beaker. [1]

Base your answers to questions 76 through 78 on the information below and on your knowledge of chemistry.

A voltaic cell is used during a laboratory investigation. The diagram and ionic equation below represent this cell and the reaction that occurs when the switch is closed. During this laboratory activity appropriate safety equipment is used and safety procedures are followed.



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

76 State the form of energy that is converted to electrical energy in the operating cell. [1]

77 Identify the electrode that is the anode in the operating cell. [1]

78 Write a balanced equation for the half-reaction that occurs in the nickel half-cell when the cell operates. [1]

Base your answers to questions 79 through 82 on the information below and on your knowledge of chemistry.

A 15.0-milliliter sample of HCl(aq) was exactly neutralized by 25.2 milliliters of 0.50 M NaOH(aq). During this laboratory activity appropriate safety equipment was used and safety procedures were followed.

79 Identify the negative ion present in the NaOH(aq) solution. [1]

80 Complete the equation *in your answer booklet* for the reaction of HCl(aq) with NaOH(aq) by writing the formula of the missing product. [1]

81 State the color of methyl orange indicator if it was added to a sample of the NaOH(aq). [1]

82 Determine the concentration of the HCl(aq) sample using the titration data. [1]

Base your answers to questions 83 through 85 on the information below and on your knowledge of chemistry.

Nuclear fusion reactions are being researched as a source of energy to produce electricity. One fusion reaction researched is the reaction of deuterium, H-2, and tritium, H-3. Deuterium can be recovered from seawater. Tritium can be produced by neutron bombardment of lithium as represented by the equation below.

$$^{6}_{3}\text{Li} + {}^{1}_{0}\text{n} \rightarrow {}^{3}_{1}\text{H} + {}^{4}_{2}\text{He}$$

83 Based on Table *N*, state the decay mode of tritium, H-3. [1]

84 Complete the equation *in your answer booklet* for the nuclear fusion of deuterium and tritium by writing a notation for the missing product. [1]

85 Based on Table *N*, determine the fraction of an original sample of tritium that remains unchanged after 36.93 years. [1]

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