

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

# PHYSICAL SETTING CHEMISTRY

**Tuesday, August 13, 2002 — 12:30 to 3:30 p.m., only**

You are to answer *all* questions in all parts of this examination according to the directions provided in the examination booklet.

Your answer sheet for Part A and Part B–1 is the last page of this examination booklet. Turn to the last page and fold it along the perforations. Then, slowly and carefully, tear off your answer sheet and fill in the heading.

Your answer booklet for Part B–2 and Part C is stapled in the center of this examination booklet. Open the examination booklet, carefully remove your answer booklet, and close the examination booklet. Then fill in the heading of your answer booklet.

Record the number of your choice for each Part A and Part B–1 multiple-choice question on your separate answer sheet. Write your answers to the Part B–2 and Part C questions in your answer booklet. All work 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 answer sheet and answer booklet.

When you have completed the examination, you must sign the statement printed at the end of 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 *Reference Tables for Physical Setting/Chemistry* must be available for your 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, write 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 *Reference Tables for Physical Setting/Chemistry*.

1 Subatomic particles can usually pass undeflected through an atom because the volume of an atom is composed of

- (1) an uncharged nucleus
- (2) largely empty space
- (3) neutrons
- (4) protons

2 What is the total number of electrons in the valence shell of an atom of aluminum in the ground state?

- (1) 8
- (2) 2
- (3) 3
- (4) 10

3 Which of these elements has physical and chemical properties most similar to silicon (Si)?

- (1) germanium (Ge)
- (2) lead (Pb)
- (3) phosphorus (P)
- (4) chlorine (Cl)

4 What is the total number of protons in the nucleus of an atom of potassium-42?

- (1) 15
- (2) 19
- (3) 39
- (4) 42

5 Given the equation:  $\text{H}_2\text{O}(s) \rightleftharpoons \text{H}_2\text{O}(\ell)$

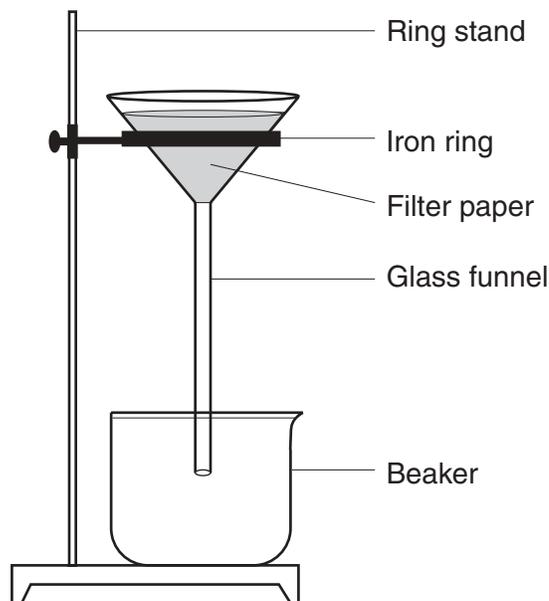
At which temperature will equilibrium exist when the atmospheric pressure is 1 atm?

- (1) 0 K
- (2) 100 K
- (3) 273 K
- (4) 373 K

6 Which species represents a chemical compound?

- (1)  $\text{N}_2$
- (2)  $\text{NH}_4^+$
- (3) Na
- (4)  $\text{NaHCO}_3$

7 Which mixture can be separated by using the equipment shown below?



- (1)  $\text{NaCl}(\text{aq})$  and  $\text{SiO}_2(\text{s})$
- (2)  $\text{NaCl}(\text{aq})$  and  $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq})$
- (3)  $\text{CO}_2(\text{aq})$  and  $\text{NaCl}(\text{aq})$
- (4)  $\text{CO}_2(\text{aq})$  and  $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq})$

8 Which reaction represents natural nuclear decay?

- (1)  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- (2)  $\text{KClO}_3 \rightarrow \text{K}^+ + \text{ClO}_3^-$
- (3)  ${}_{92}^{235}\text{U} \rightarrow {}_2^4\text{He} + {}_{90}^{231}\text{Th}$
- (4)  ${}_{7}^{14}\text{N} + {}_2^4\text{He} \rightarrow {}_8^{17}\text{O} + {}_1^1\text{H}$

9 If an equation is balanced properly, both sides of the equation must have the same number of

- (1) atoms
- (2) coefficients
- (3) molecules
- (4) moles of molecules

- 10 Which of the following elements has the highest electronegativity?  
(1) H (2) K (3) Al (4) Ca
- 11 Which formula represents an ionic compound?  
(1) NaCl (2) N<sub>2</sub>O (3) HCl (4) H<sub>2</sub>O
- 12 Which species does *not* have a noble gas electron configuration?  
(1) Na<sup>+</sup> (2) Mg<sup>2+</sup> (3) Ar (4) S
- 13 Which statement correctly describes a chemical reaction at equilibrium?  
(1) The concentrations of the products and reactants are equal.  
(2) The concentrations of the products and reactants are constant.  
(3) The rate of the forward reaction is less than the rate of the reverse reaction.  
(4) The rate of the forward reaction is greater than the rate of the reverse reaction.
- 14 Given the reaction:  
$$\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g})$$
  
What is the overall result when CH<sub>4</sub>(g) burns according to this reaction?  
(1) Energy is absorbed and  $\Delta H$  is negative.  
(2) Energy is absorbed and  $\Delta H$  is positive.  
(3) Energy is released and  $\Delta H$  is negative.  
(4) Energy is released and  $\Delta H$  is positive.
- 15 A hydrated salt is a solid that includes water molecules within its crystal structure. A student heated a 9.10-gram sample of a hydrated salt to a constant mass of 5.41 grams. What percent by mass of water did the salt contain?  
(1) 3.69% (2) 16.8% (3) 40.5% (4) 59.5%
- 16 Which statement correctly describes a sample of gas confined in a sealed container?  
(1) It always has a definite volume, and it takes the shape of the container.  
(2) It takes the shape and the volume of any container in which it is confined.  
(3) It has a crystalline structure.  
(4) It consists of particles arranged in a regular geometric pattern.
- 17 Which molecule contains a triple covalent bond?  
(1) H<sub>2</sub> (2) N<sub>2</sub> (3) O<sub>2</sub> (4) Cl<sub>2</sub>
- 18 The solid and liquid phases of water can exist in a state of equilibrium at 1 atmosphere of pressure and a temperature of  
(1) 0°C (2) 100°C (3) 273°C (4) 373°C
- 19 Which compound is an alcohol?  
(1) propanal (2) ethyne (3) butane (4) methanol
- 20 In which reaction is soap a product?  
(1) addition (2) substitution (3) saponification (4) polymerization
- 21 The spontaneous decay of an atom is called  
(1) ionization (2) crystallization (3) combustion (4) transmutation
- 22 In any redox reaction, the substance that undergoes reduction will  
(1) lose electrons and have a decrease in oxidation number  
(2) lose electrons and have an increase in oxidation number  
(3) gain electrons and have a decrease in oxidation number  
(4) gain electrons and have an increase in oxidation number

23 Which electron configuration is correct for a sodium ion?

- (1) 2-7  
(2) 2-8  
(3) 2-8-1  
(4) 2-8-2

24 In which equation does the term "heat" represent heat of fusion?

- (1)  $\text{NaCl}(s) + \text{heat} \rightarrow \text{NaCl}(\ell)$   
(2)  $\text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(\ell) + \text{heat}$   
(3)  $\text{H}_2\text{O}(\ell) + \text{heat} \rightarrow \text{H}_2\text{O}(g)$   
(4)  $\text{H}_2\text{O}(\ell) + \text{HCl}(g) \rightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq) + \text{heat}$

25 Which substance is an Arrhenius acid?

- (1)  $\text{LiF}(aq)$   
(2)  $\text{HBr}(aq)$   
(3)  $\text{Mg}(\text{OH})_2(aq)$   
(4)  $\text{CH}_3\text{CHO}$

26 Which type of emission has the highest penetrating power?

- (1) alpha  
(2) beta  
(3) positron  
(4) gamma

**Note that questions 27 through 30 have only three choices.**

27 As the elements in Group 17 are considered in order of increasing atomic number, the chemical reactivity of each successive element

- (1) decreases  
(2) increases  
(3) remains the same

28 As the pressure on the surface of a liquid *decreases*, the temperature at which the liquid will boil

- (1) decreases  
(2) increases  
(3) remains the same

29 As a Ca atom undergoes oxidation to  $\text{Ca}^{2+}$ , the number of neutrons in its nucleus

- (1) decreases  
(2) increases  
(3) remains the same

30 As the temperature of a liquid increases, its vapor pressure

- (1) decreases  
(2) increases  
(3) remains the same

Part B-1

Answer all questions in this part.

Directions (31–50): For each statement or question, write 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 *Reference Tables for Physical Setting/Chemistry*.

31 Compared to the nonmetals in Period 2, the metals in Period 2 generally have larger

- (1) ionization energies
- (2) electronegativities
- (3) atomic radii
- (4) atomic numbers

32 Which of the following Group 2 elements has the *lowest* first ionization energy?

- (1) Be
- (2) Mg
- (3) Ca
- (4) Ba

33 The table below shows the normal boiling point of four compounds.

Compound	Normal Boiling Point (°C)
HF( $\ell$ )	19.4
CH <sub>3</sub> Cl( $\ell$ )	-24.2
CH <sub>3</sub> F( $\ell$ )	-78.6
HCl( $\ell$ )	-83.7

Which compound has the strongest intermolecular forces?

- (1) HF( $\ell$ )
- (2) CH<sub>3</sub>Cl( $\ell$ )
- (3) CH<sub>3</sub>F( $\ell$ )
- (4) HCl( $\ell$ )

34 According to Table I, which salt releases energy as it dissolves?

- (1) KNO<sub>3</sub>
- (2) LiBr
- (3) NH<sub>4</sub>NO<sub>3</sub>
- (4) NaCl

35 During a laboratory activity, a student combined two solutions. In the laboratory report, the student wrote “A yellow color appeared.” The statement represents the student’s recorded

- (1) conclusion
- (2) observation
- (3) hypothesis
- (4) inference

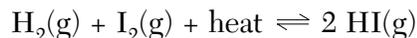
36 How many moles of solute are contained in 200 milliliters of a 1 M solution?

- (1) 1
- (2) 0.2
- (3) 0.8
- (4) 200

37 Increasing the temperature increases the rate of a reaction by

- (1) lowering the activation energy
- (2) increasing the activation energy
- (3) lowering the frequency of effective collisions between reacting molecules
- (4) increasing the frequency of effective collisions between reacting molecules

38 Given the equilibrium reaction in a closed system:



What will be the result of an increase in temperature?

- (1) The equilibrium will shift to the left and [H<sub>2</sub>] will increase.
- (2) The equilibrium will shift to the left and [H<sub>2</sub>] will decrease.
- (3) The equilibrium will shift to the right and [HI] will increase.
- (4) The equilibrium will shift to the right and [HI] will decrease.

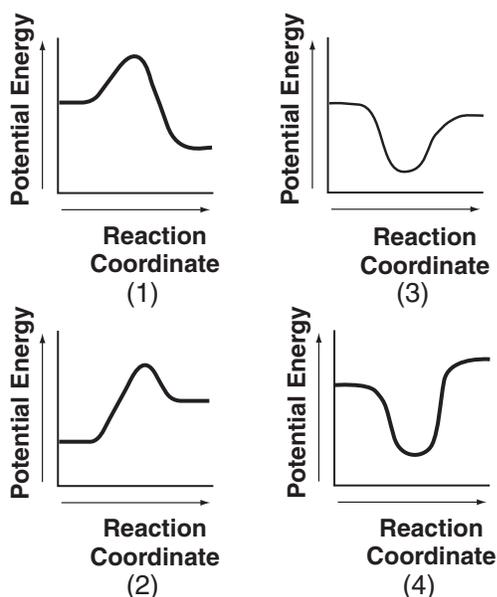
39 Which sample has the *lowest* entropy?

- (1) 1 mole of KNO<sub>3</sub>( $\ell$ )
- (2) 1 mole of KNO<sub>3</sub>(s)
- (3) 1 mole of H<sub>2</sub>O( $\ell$ )
- (4) 1 mole of H<sub>2</sub>O(g)

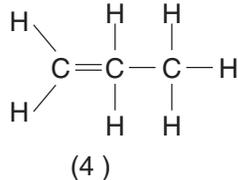
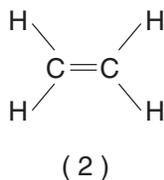
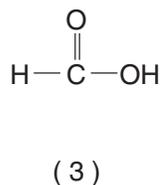
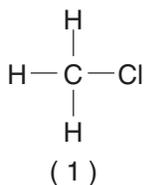
40 Which of the following compounds is *least* soluble in water?

- (1) copper (II) chloride
- (2) aluminum acetate
- (3) iron (III) hydroxide
- (4) potassium sulfate

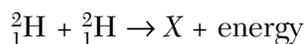
- 41 According to Table I, which potential energy diagram best represents the reaction that forms  $\text{H}_2\text{O}(\ell)$  from its elements?



- 42 Which structural formula is *incorrect*?



- 43 Given the fusion reaction:



Which particle is represented by X?

- (1)  ${}^1_1\text{H}$                       (3)  ${}^3_2\text{He}$   
 (2)  ${}^3_1\text{H}$                       (4)  ${}^4_2\text{He}$
- 44 The vapor pressure of a liquid is 0.92 atm at  $60^\circ\text{C}$ . The normal boiling point of the liquid could be
- (1)  $35^\circ\text{C}$                       (3)  $55^\circ\text{C}$   
 (2)  $45^\circ\text{C}$                       (4)  $65^\circ\text{C}$

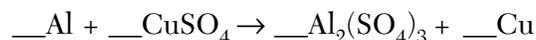
- 45 When 50. milliliters of an  $\text{HNO}_3$  solution is exactly neutralized by 150 milliliters of a 0.50 M solution of KOH, what is the concentration of  $\text{HNO}_3$ ?

- (1) 1.0 M                      (3) 3.0 M  
 (2) 1.5 M                      (4) 0.5 M

- 46 In Period 3, from left to right in order, each successive element will

- (1) decrease in electronegativity  
 (2) decrease in atomic mass  
 (3) increase in number of protons  
 (4) increase in metallic character

- 47 Given the unbalanced equation:



When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?

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

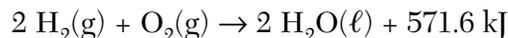
- 48 One hundred grams of water is saturated with  $\text{NH}_4\text{Cl}$  at  $50^\circ\text{C}$ . According to Table G, if the temperature is lowered to  $10^\circ\text{C}$ , what is the total amount of  $\text{NH}_4\text{Cl}$  that will precipitate?

- (1) 5.0 g                      (3) 30. g  
 (2) 17 g                      (4) 50. g

- 49 What is the total number of grams of NaI(s) needed to make 1.0 liter of a 0.010 M solution?

- (1) 0.015                      (3) 1.5  
 (2) 0.15                      (4) 15

- 50 Given the reaction:



What is the approximate  $\Delta H$  for the formation of 1 mole of  $\text{H}_2\text{O}(\ell)$ ?

- (1)  $-285.8 \text{ kJ}$                       (3)  $-571.6 \text{ kJ}$   
 (2)  $+285.8 \text{ kJ}$                       (4)  $+571.6 \text{ kJ}$

## Part B-2

### Answer all questions in this part.

*Directions (51–57):* Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

- 51 On a field trip, Student X and Student Y collected two rock samples. Analysis revealed that both rocks contained lead and sulfur. One rock contained a certain percentage of lead and sulfur by mass, and the other rock contained a different percentage of lead and sulfur by mass. Student X stated that the rocks contained two different mixtures of lead and sulfur. Student Y stated that the rocks contained two different compounds of lead and sulfur. Their teacher stated that both students could be correct.

Draw particle diagrams in *each* of the rock diagrams provided in *your answer booklet* to show how Student X's and Student Y's explanations could both be correct. Use the symbols in the key provided in *your answer booklet* to sketch lead and sulfur atoms. [2]

- 52 One electron is removed from both an Na atom and a K atom, producing two ions. Using principles of atomic structure, explain why the Na ion is much smaller than the K ion. Discuss both ions in your answer. [2]

- 53 In the space provided in *your answer booklet*, draw an electron-dot diagram for *each* of the following substances:

- a* calcium oxide (an ionic compound) [1]  
*b* hydrogen bromide [1]  
*c* carbon dioxide [1]

- 54 A sample of water is heated from a liquid at 40°C to a gas at 110°C. The graph of the heating curve is shown in your answer booklet.

- a* On the heating curve diagram provided in *your answer booklet*, label *each* of the following regions: [1]

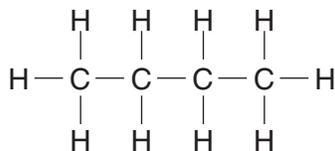
Liquid, only

Gas, only

Phase change

- b* For section *QR* of the graph, state what is happening to the water molecules as heat is added. [1]  
*c* For section *RS* of the graph, state what is happening to the water molecules as heat is added. [1]

55 Given the structural formula for butane:



In the space provided *in your answer booklet*, draw the structural formula of an isomer of butane. [1]

56 Given the ester: ethyl butanoate

*a* In the space provided *in your answer booklet*, draw the structural formula for this ester. [1]

*b* Determine the gram formula mass of this ester. [1]

57 Given the reaction:  $4 \text{Al}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{Al}_2\text{O}_3(s)$

*a* Write the balanced oxidation half-reaction for this oxidation-reduction reaction. [1]

*b* What is the oxidation number of oxygen in  $\text{Al}_2\text{O}_3$ ? [1]

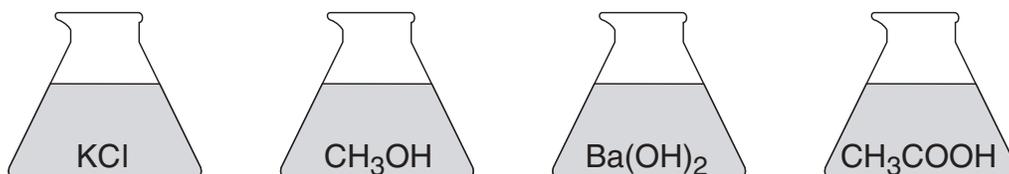
---

## Part C

### Answer all questions in this part.

*Directions (58–62):* Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

- 58 *a* State one possible advantage of using nuclear power instead of burning fossil fuels. [1]  
*b* State one possible risk of using nuclear power. [1]  
*c* If animals feed on plants that have taken up Sr-90, the Sr-90 can find its way into their bone structure. Explain one danger to the animals. [1]
- 59 Four flasks each contain 100 milliliters of aqueous solutions of equal concentrations at 25°C and 1 atm.



- a* Which solutions contain electrolytes? [1]  
*b* Which solution has the *lowest* pH? [1]  
*c* What causes some aqueous solutions to have a low pH? [1]  
*d* Which solution is most likely to react with an Arrhenius acid to form a salt and water? [1]  
*e* Which solution has the *lowest* freezing point? Explain your answer. [2]
- 60 The equation for the saturated solution equilibrium of potassium nitrate (KNO<sub>3</sub>) is shown below.
- $$\text{KNO}_3(\text{s}) + \text{energy} \xrightleftharpoons{\text{H}_2\text{O}} \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$$
- a* In the space provided in *your answer booklet*, diagram the products. Use the key provided in *your answer booklet*. Indicate the exact arrangement of the particles you diagram. [2]  
*b* Compare the rate of dissolving KNO<sub>3</sub> with the rate of recrystallization of KNO<sub>3</sub> for the saturated solution. [1]

- 61 Electron affinity is defined as the energy released when an atom and an electron react to form a negative ion. The data for Group 1 elements are presented below.

Element	Atomic Number	Electron Affinity in kJ/mole
Cs	55	45.5
H	1	72.8
K	19	46.4
Li	3	59.8
Na	11	52.9
Rb	37	?

On the grid provided *in your answer booklet*, draw a graph to show the relationship between *each* member of Group 1 and its electron affinity by following the directions below.

- Label the  $y$ -axis "Electron Affinity" and choose an appropriate scale. Label the  $x$ -axis "Atomic Number" and choose an appropriate scale. [1]
- Plot the data from the data table and connect the points with straight lines. [1]
- Using your graph, estimate the electron affinity of Rb, in kilojoules/mole. [1]

- 62 A student used a balance and a graduated cylinder to collect the following data:

Sample mass	10.23 g
Volume of water	20.0 mL
Volume of water and sample	21.5 mL

- Calculate the density of the element. Show your work. Include the appropriate number of significant figures and proper units. [3]
  - If the accepted value is 6.93 grams per milliliter, calculate the percent error. [1]
  - What error is introduced if the volume of the sample is determined first? [1]
-

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING  
CHEMISTRY

Tuesday, August 13, 2002 — 12:30 to 3:30 p.m., only

ANSWER SHEET

Student ..... Sex:  Male  Female Grade .....

Teacher ..... School .....

Record your answers to Part A and Part B-1 on this answer sheet.

Part A

- |          |          |          |
|----------|----------|----------|
| 1 .....  | 11 ..... | 21 ..... |
| 2 .....  | 12 ..... | 22 ..... |
| 3 .....  | 13 ..... | 23 ..... |
| 4 .....  | 14 ..... | 24 ..... |
| 5 .....  | 15 ..... | 25 ..... |
| 6 .....  | 16 ..... | 26 ..... |
| 7 .....  | 17 ..... | 27 ..... |
| 8 .....  | 18 ..... | 28 ..... |
| 9 .....  | 19 ..... | 29 ..... |
| 10 ..... | 20 ..... | 30 ..... |

Part A Score

Part B-1

- |          |          |
|----------|----------|
| 31 ..... | 41 ..... |
| 32 ..... | 42 ..... |
| 33 ..... | 43 ..... |
| 34 ..... | 44 ..... |
| 35 ..... | 45 ..... |
| 36 ..... | 46 ..... |
| 37 ..... | 47 ..... |
| 38 ..... | 48 ..... |
| 39 ..... | 49 ..... |
| 40 ..... | 50 ..... |

Part B-1 Score

Write your answers to Part B-2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

Tear Here

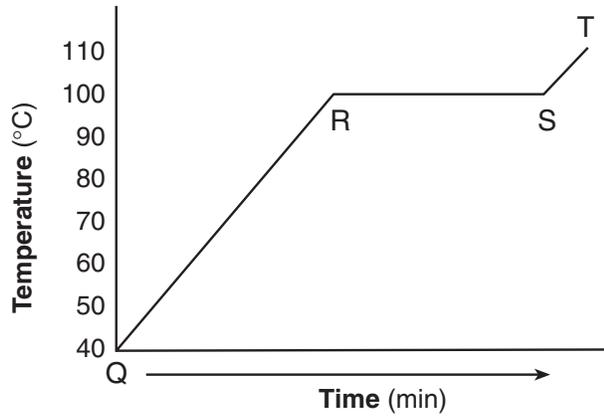
Tear Here

Tear Here



For Raters Only

54 a



54a

b \_\_\_\_\_

b

\_\_\_\_\_

c \_\_\_\_\_

c

\_\_\_\_\_

55

55

56 a

56a

b \_\_\_\_\_

b

57 a \_\_\_\_\_

57 a

b \_\_\_\_\_

b

[b]

Total Score for Part B-2

**Part C**

**For Raters Only**

**58 a** \_\_\_\_\_  
\_\_\_\_\_

**58a**

**b** \_\_\_\_\_  
\_\_\_\_\_

**b**

**c** \_\_\_\_\_  
\_\_\_\_\_

**c**

**59 a** \_\_\_\_\_  
**b** \_\_\_\_\_

**59a**

**c** \_\_\_\_\_  
\_\_\_\_\_

**b**

**d** \_\_\_\_\_  
**e** \_\_\_\_\_

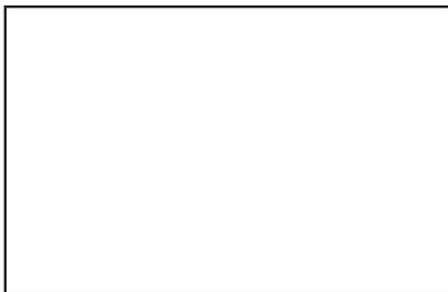
**c**

**d**

\_\_\_\_\_  
\_\_\_\_\_

**e**

**60 a**



**Key**

---

Water molecule   
K<sup>+</sup>   
NO<sub>3</sub><sup>-</sup> 

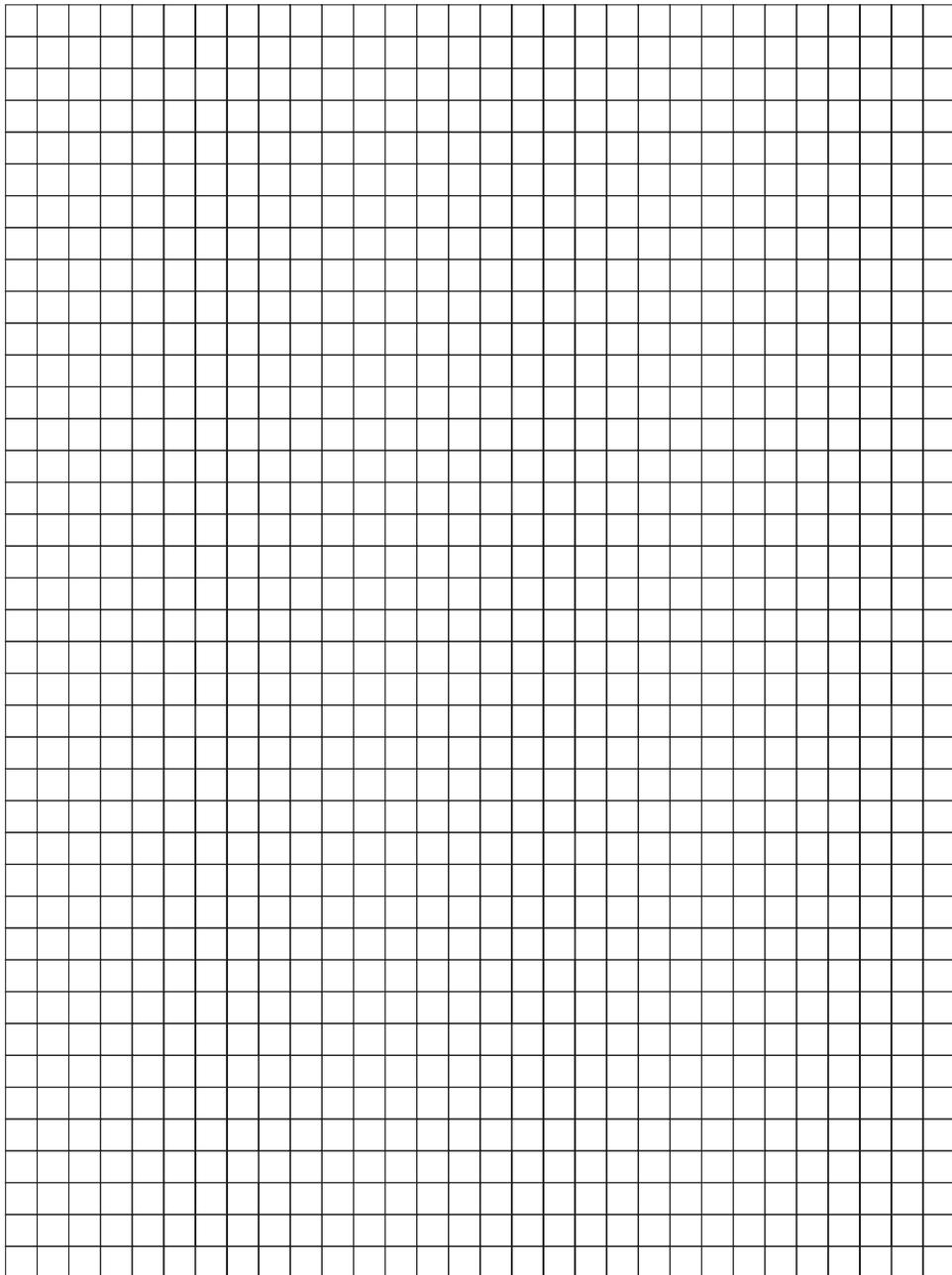
**60a**

**b** \_\_\_\_\_

**b**

**For Raters  
Only**

**61 *a* and *b***



**61*a***

***b***

***c*** \_\_\_\_\_

***c***

**62 *a***

**62*a***

***b*** \_\_\_\_\_

***b***

***c*** \_\_\_\_\_

***c***

[d]

**Total Score for Part C**