

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

PHYSICAL SETTING CHEMISTRY

Friday, June 21, 2002 — 1:15 to 4:15 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.

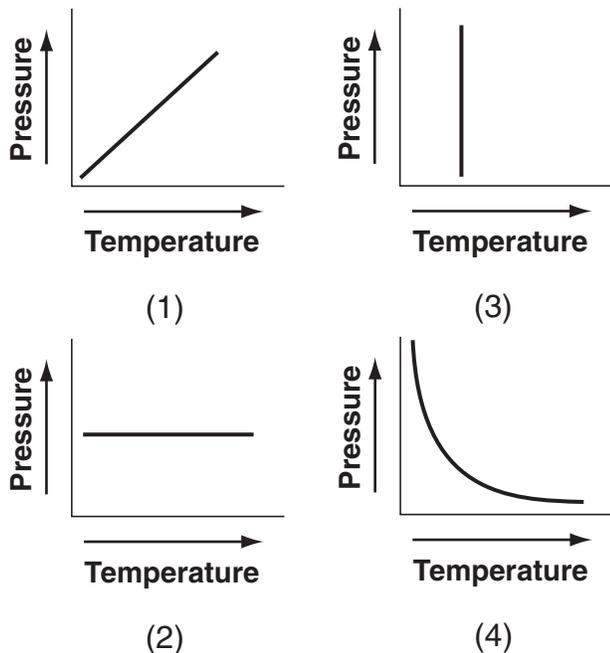
Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, write on the 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*.

- What is the electron configuration of a sulfur atom in the ground state?
 - 2–4
 - 2–6
 - 2–8–4
 - 2–8–6
- The modern model of the atom shows that electrons are
 - orbiting the nucleus in fixed paths
 - found in regions called orbitals
 - combined with neutrons in the nucleus
 - located in a solid sphere covering the nucleus
- Which compound contains ionic bonds?
 - NO
 - NO₂
 - CaO
 - CO₂
- All the isotopes of a given atom have
 - the same mass number and the same atomic number
 - the same mass number but different atomic numbers
 - different mass numbers but the same atomic number
 - different mass numbers and different atomic numbers
- What are two properties of most nonmetals?
 - high ionization energy and poor electrical conductivity
 - high ionization energy and good electrical conductivity
 - low ionization energy and poor electrical conductivity
 - low ionization energy and good electrical conductivity
- Which element is classified as a noble gas at STP?
 - hydrogen
 - oxygen
 - neon
 - nitrogen
- The percent by mass of hydrogen in NH₃ is equal to
 - $\frac{17}{1} \times 100$
 - $\frac{17}{3} \times 100$
 - $\frac{1}{17} \times 100$
 - $\frac{3}{17} \times 100$
- Metallic bonding occurs between atoms of
 - sulfur
 - copper
 - fluorine
 - carbon
- Atoms of the same element that have different numbers of neutrons are classified as
 - charged atoms
 - charged nuclei
 - isomers
 - isotopes
- Compared to the radius of a chlorine atom, the radius of a chloride ion is
 - larger because chlorine loses an electron
 - larger because chlorine gains an electron
 - smaller because chlorine loses an electron
 - smaller because chlorine gains an electron
- Which of the following atoms has the greatest tendency to attract electrons?
 - barium
 - beryllium
 - boron
 - bromine
- Which 5.0-milliliter sample of NH₃ will take the shape of and completely fill a closed 100.0-milliliter container?
 - NH₃(s)
 - NH₃(ℓ)
 - NH₃(g)
 - NH₃(aq)
- The strongest forces of attraction occur between molecules of
 - HCl
 - HF
 - HBr
 - HI

14 Which graph shows the pressure-temperature relationship expected for an ideal gas?



15 At the same temperature and pressure, which sample contains the same number of moles of particles as 1 liter of $O_2(g)$?

- (1) 1 L $Ne(g)$ (2) 2 L $N_2(g)$ (3) 0.5 L $SO_2(g)$ (4) 1 L $H_2O(l)$

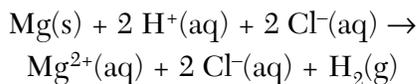
16 Which change in the temperature of a 1-gram sample of water would cause the greatest increase in the average kinetic energy of its molecules?

- (1) $1^\circ C$ to $10^\circ C$ (2) $10^\circ C$ to $1^\circ C$ (3) $50^\circ C$ to $60^\circ C$ (4) $60^\circ C$ to $50^\circ C$

17 Which compound is classified as a hydrocarbon?

- (1) ethane (2) ethanol (3) chloroethane (4) ethanoic acid

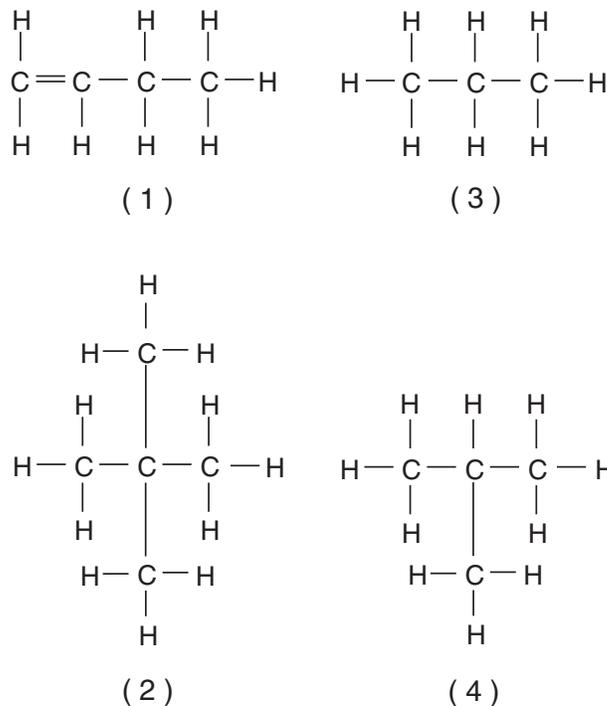
18 Given the reaction:



Which species undergoes oxidation?

- (1) $Mg(s)$ (2) $H^+(aq)$ (3) $Cl^-(aq)$ (4) $H_2(g)$

19 Which formula is an isomer of butane?



20 Which particles are gained and lost during a redox reaction?

- (1) electrons (2) protons (3) neutrons (4) positrons

21 What is the oxidation number of chromium in $K_2Cr_2O_7$?

- (1) +12 (2) +2 (3) +3 (4) +6

22 Which process requires an external power source?

- (1) neutralization (2) synthesis (3) fermentation (4) electrolysis

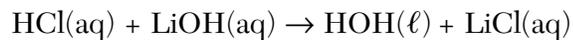
23 A substance that conducts an electrical current when dissolved in water is called

- (1) a catalyst (2) a metalloid (3) a nonelectrolyte (4) an electrolyte

24 Which product of nuclear decay has mass but no charge?

- (1) alpha particles (2) neutrons (3) gamma rays (4) beta positrons

25 Given the reaction:



The reaction is best described as

- (1) neutralization
 - (2) synthesis
 - (3) decomposition
 - (4) oxidation-reduction
- 26 Which ion is produced when an Arrhenius base is dissolved in water?
- (1) H^+ , as the only positive ion in solution
 - (2) H_3O^+ , as the only positive ion in solution
 - (3) OH^- , as the only negative ion in solution
 - (4) H^- , as the only negative ion in solution
- 27 The change that is undergone by an atom of an element made radioactive by bombardment with high-energy protons is called
- (1) natural transmutation
 - (2) artificial transmutation
 - (3) natural decay
 - (4) radioactive decay

Note that questions 28 through 30 have only three choices.

- 28 As ice melts at standard pressure, its temperature remains at 0°C until it has completely melted. Its potential energy
- (1) decreases
 - (2) increases
 - (3) remains the same
- 29 As a sample of the radioactive isotope ^{131}I decays, its half-life
- (1) decreases
 - (2) increases
 - (3) remains the same
- 30 As an atom becomes an ion, its mass number
- (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 the 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 In which shell are the valence electrons of the elements in Period 2 found?
(1) 1 (3) 3
(2) 2 (4) 4
- 32 Which of the following Group 15 elements has the greatest metallic character?
(1) nitrogen (3) antimony
(2) phosphorus (4) bismuth
- 33 The number of neutrons in the nucleus of an atom can be determined by
(1) adding the atomic number to the mass number
(2) subtracting the atomic number from the mass number
(3) adding the mass number to the atomic mass
(4) subtracting the mass number from the atomic number
- 34 A compound has a gram formula mass of 56 grams per mole. What is the molecular formula for this compound?
(1) CH₂ (3) C₃H₆
(2) C₂H₄ (4) C₄H₈
- 35 Given the equilibrium reaction at STP:
$$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$$

Which statement correctly describes this system?
(1) The forward and reverse reaction rates are equal.
(2) The forward and reverse reaction rates are both increasing.
(3) The concentrations of N₂O₄ and NO₂ are equal.
(4) The concentrations of N₂O₄ and NO₂ are both increasing.
- 36 What is the total number of oxygen atoms in the formula MgSO₄•7 H₂O? [The • represents seven units of H₂O attached to one unit of MgSO₄.]
(1) 11 (3) 5
(2) 7 (4) 4
- 37 Given the reaction:
$$6 \text{CO}_2 + 6 \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$$

What is the total number of moles of water needed to make 2.5 moles of C₆H₁₂O₆?
(1) 2.5 (3) 12
(2) 6.0 (4) 15
- 38 A student calculated the percent by mass of water in a hydrate as 14.2%. A hydrate is a compound that contains water as part of its crystal structure. If the accepted value is 14.7%, the student's percent error was
(1) $\frac{0.5}{14.2} \times 100$ (3) $\frac{0.5}{14.7} \times 100$
(2) $\frac{14.7}{14.2} \times 100$ (4) $\frac{14.2}{14.7} \times 100$
- 39 Which of the following ions has the *smallest* radius?
(1) F⁻ (3) K⁺
(2) Cl⁻ (4) Ca²⁺
- 40 According to Reference Table G, which solution is saturated at 30°C?
(1) 12 grams of KClO₃ in 100 grams of water
(2) 12 grams of KClO₃ in 200 grams of water
(3) 30 grams of NaCl in 100 grams of water
(4) 30 grams of NaCl in 200 grams of water
- 41 The gram formula mass of NH₄Cl is
(1) 22.4 g/mole (3) 53.5 g/mole
(2) 28.0 g/mole (4) 95.5 g/mole

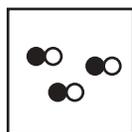
42 What is the molarity of a solution that contains 0.50 mole of NaOH in 0.50 liter of solution?

- (1) 1.0 M (3) 0.25 M
 (2) 2.0 M (4) 0.50 M

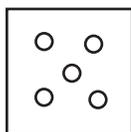
43 Given:

● = particle X
 ○ = particle Y

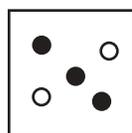
Which diagram represents a mixture?



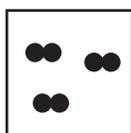
(1)



(3)



(2)



(4)

44 Which process is accompanied by a *decrease* in entropy?

- (1) boiling of water
 (2) condensing of water vapor
 (3) subliming of iodine
 (4) melting of ice

45 If 5.0 milliliters of a 0.20 M HCl solution is required to neutralize exactly 10. milliliters of NaOH, what is the concentration of the base?

- (1) 0.10 M (3) 0.30 M
 (2) 0.20 M (4) 0.40 M

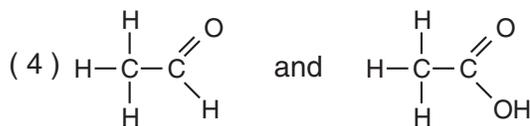
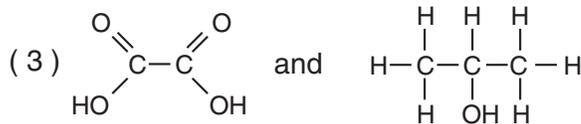
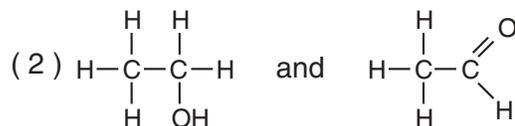
46 Exactly how much time must elapse before 16 grams of potassium-42 decays, leaving 2 grams of the original isotope?

- (1) 8×12.4 hours (3) 3×12.4 hours
 (2) 2×12.4 hours (4) 4×12.4 hours

47 Which mass measurement contains four significant figures?

- (1) 0.086 g (3) 1003 g
 (2) 0.431 g (4) 3870 g

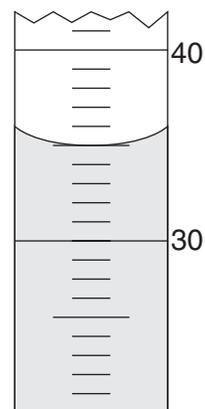
48 Which pair of compounds are alcohols?



49 The process of joining many small molecules into larger molecules is called

- (1) neutralization (3) saponification
 (2) polymerization (4) substitution

50 The diagram below represents a portion of a 100-milliliter graduated cylinder.



What is the reading of the meniscus?

- (1) 35.0 mL (3) 44.0 mL
 (2) 36.0 mL (4) 45.0 mL

Part B-2

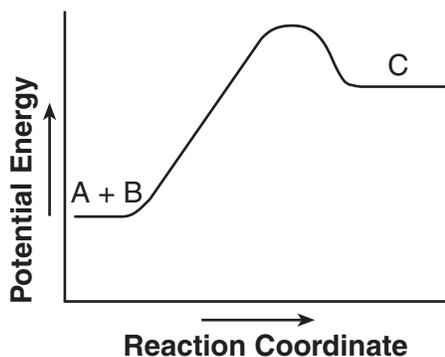
Answer all questions in this part.

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 In the box provided in *your answer booklet*, draw the electron-dot (Lewis) structure of an atom of calcium. [1]
- 52 In the box provided in *your answer booklet*, draw the electron-dot (Lewis) structure of an atom of chlorine. [1]
- 53 In the box provided in *your answer booklet*, draw the electron-dot (Lewis) structure of calcium chloride. [2]
- 54 A student is given two beakers, each containing an equal amount of clear, odorless liquid. One solution is acidic and the other is basic.
- a* State *two* safe methods of distinguishing the acid solution from the base solution. [2]
- b* For *each* method, state the results of both the testing of the acid solution *and* the testing of the base solution. [2]

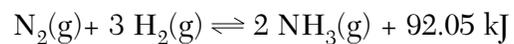
Base your answers to questions 55 and 56 on the information and diagram below, which represent the changes in potential energy that occur during the given reaction.

Given the reaction: $A + B \rightarrow C$



- 55 Does the diagram illustrate an exothermic or an endothermic reaction? State one reason, in terms of energy, to support your answer. [2]
- 56 On the diagram provided in *your answer booklet*, draw a dashed line to indicate a potential energy curve for the reaction if a catalyst is added. [1]
-

57 Given the reaction at equilibrium:



- a* State the effect on the number of moles of $\text{N}_2(\text{g})$ if the temperature of the system is increased. [1]
- b* State the effect on the number of moles of $\text{H}_2(\text{g})$ if the pressure on the system is increased. [1]
- c* State the effect on the number of moles of $\text{NH}_3(\text{g})$ if a catalyst is introduced into the reaction system. Explain why this occurs. [2]
-

Part C

Answer all questions in this part.

Directions (58–75): 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*.

Base your answers to questions 58 through 60 on the information below.

In the modern model of the atom, each atom is composed of three major subatomic (or fundamental) particles.

- 58 Name the subatomic particles contained in the nucleus of the atom. [1]
- 59 State the charge associated with *each* type of subatomic particle contained in the nucleus of the atom. [1]
- 60 What is the net charge of the nucleus? [1]
-

Base your answers to questions 61 through 63 on the information below.

Testing of an unknown solid shows that it has the properties listed below.

- (1) low melting point
- (2) nearly insoluble in water
- (3) nonconductor of electricity
- (4) relatively soft solid

- 61 State the type of bonding that would be expected in the particles of this substance. [1]
- 62 Explain in terms of attractions between particles why the unknown solid has a low melting point. [1]
- 63 Explain why the particles of this substance are nonconductors of electricity. [1]
-

Base your answers to questions 64 through 66 on the information below.

A hot pack contains chemicals that can be activated to produce heat. A cold pack contains chemicals that feel cold when activated.

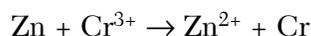
- 64 Based on energy flow, state the type of chemical change that occurs in a hot pack. [1]
- 65 A cold pack is placed on an injured leg. Indicate the direction of the flow of energy between the leg and the cold pack. [1]
- 66 What is the Law of Conservation of Energy? Describe how the Law of Conservation of Energy applies to the chemical reaction that occurs in the hot pack. [2]
-

Base your answers to questions 67 through 69 on the table below, which shows the electronegativity of selected elements of Period 2 of the Periodic Table.

Element	Atomic Number	Electronegativity (g/mL)
Beryllium	4	1.6
Boron	5	2.0
Carbon	6	2.6
Fluorine	9	4.0
Lithium	3	1.0
Oxygen	8	3.4

- 67 On the grid provided *in your answer booklet*, set up a scale for electronegativity on the *y*-axis. Plot the data by drawing a best-fit line. [2]
- 68 Using the graph, predict the electronegativity of nitrogen. [1]
- 69 For these elements, state the trend in electronegativity in terms of atomic number. [1]
-

Base your answers to questions 70 through 75 on the following redox reaction, which occurs spontaneously in an electrochemical cell.



- 70 Write the half-reaction for the reduction that occurs. [1]
- 71 Write the half-reaction for the oxidation that occurs. [1]
- 72 *In your answer booklet*, balance the equation using the *smallest* whole-number coefficients. [1]
- 73 Which species loses electrons and which species gains electrons? [1]
- 74 Which half-reaction occurs at the cathode? [1]
- 75 State what happens to the number of protons in a Zn atom when it changes to Zn^{2+} as the redox reaction occurs. [1]
-

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The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Friday, June 21, 2002 — 1:15 to 4:15 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

[Box for 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

[Box for 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

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PHYSICAL SETTING CHEMISTRY

Friday, June 21, 2002 — 1:15 to 4:15 p.m., only

ANSWER BOOKLET

Male

Student Sex: Female

Teacher

School Grade

Answer all questions in Part B-2 and Part C. Record your answers
in this booklet.

Part	Maximum Score	Student's Score
A	30	
B-1	20	
B-2	15	
C	20	
Total Written Test Score (Maximum Raw Score: 85)		<input type="text"/>
Final Score (from conversion chart)		<input type="text"/>
Raters' Initials: Rater 1 Rater 2		

Part B-2		For Raters Only
51	<input type="text"/>	51 <input type="text"/>
52	<input type="text"/>	52 <input type="text"/>
53	<input type="text"/>	53 <input type="text"/>

For Raters
Only

54 *a* Method one: _____

Method two: _____

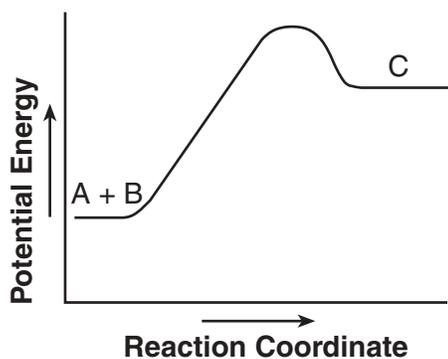
b Results of method one: _____

Results of method two: _____

55 _____

Reason: _____

56



56

57 *a* _____

b _____

c _____

57 *a*

b

c

Total Score for Part B-2

Part C

58 _____

59 _____

60 _____

61 _____

62 _____

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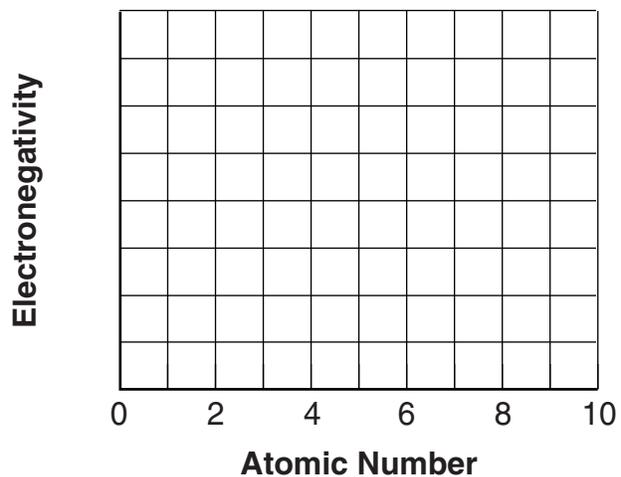
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68 _____

68

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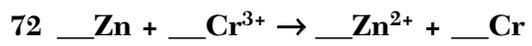
69

70 _____

70

71 _____

71



72

73 _____ loses electrons.

73

_____ gains electrons.

74 _____

74

75 _____

75

Total Score for Part C