

Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, write in your answer booklet 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*.

- An orbital is a region of space where there is a high probability of finding
 - a proton
 - a positron
 - a neutron
 - an electron
- Which statement matches a subatomic particle with its charge?
 - A neutron has a negative charge.
 - A proton has a negative charge.
 - A neutron has no charge.
 - A proton has no charge.
- An atom of any element must contain
 - an equal number of protons and neutrons
 - an equal number of protons and electrons
 - more electrons than neutrons
 - more electrons than protons
- Which statement compares the masses of two subatomic particles?
 - The mass of an electron is greater than the mass of a proton.
 - The mass of an electron is greater than the mass of a neutron.
 - The mass of a proton is greater than the mass of an electron.
 - The mass of a proton is greater than the mass of a neutron.
- The bright-line spectrum of sodium is produced when energy is
 - absorbed as electrons move from higher to lower electron shells
 - absorbed as electrons move from lower to higher electron shells
 - released as electrons move from higher to lower electron shells
 - released as electrons move from lower to higher electron shells
- The valence electrons of a germanium atom in the ground state are located in the
 - first shell
 - second shell
 - third shell
 - fourth shell
- The elements on the Periodic Table are arranged in order of increasing
 - atomic mass
 - atomic number
 - first ionization energy
 - selected oxidation state
- Which list of elements contains a metal, a metalloid, a nonmetal, and a noble gas?
 - Be, Si, Cl, Kr
 - C, N, Ne, Ar
 - K, Fe, B, F
 - Na, Zn, As, Sb
- The two forms of oxygen, $O_2(g)$ and $O_3(g)$, have
 - different molecular structures and identical properties
 - different molecular structures and different properties
 - identical molecular structures and identical properties
 - identical molecular structures and different properties
- The sum of the atomic masses of the atoms in one molecule of $C_3H_6Br_2$ is called the
 - formula mass
 - isotopic mass
 - percent abundance
 - percent composition
- What is the total number of electron pairs shared between the two atoms in an O_2 molecule?
 - 1
 - 2
 - 3
 - 4

- 12 When an atom of lithium loses an electron, the atom becomes a
- (1) negative ion with a radius smaller than the radius of the atom
 - (2) negative ion with a radius larger than the radius of the atom
 - (3) positive ion with a radius smaller than the radius of the atom
 - (4) positive ion with a radius larger than the radius of the atom
- 13 Given the balanced equation representing a reaction:
- $$2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2$$
- To break the bonds in NaCl, the reactant must
- (1) absorb energy
 - (2) create energy
 - (3) destroy energy
 - (4) release energy
- 14 A molecular compound is formed when a chemical reaction occurs between atoms of
- (1) chlorine and sodium
 - (2) chlorine and yttrium
 - (3) oxygen and hydrogen
 - (4) oxygen and magnesium
- 15 Which substance can *not* be broken down by chemical means?
- (1) ammonia
 - (2) antimony
 - (3) methane
 - (4) water
- 16 Which two physical properties allow a mixture to be separated by chromatography?
- (1) hardness and boiling point
 - (2) density and specific heat capacity
 - (3) malleability and thermal conductivity
 - (4) solubility and molecular polarity
- 17 The solubility of KCl(s) in water depends on the
- (1) pressure on the solution
 - (2) rate of stirring
 - (3) size of the KCl sample
 - (4) temperature of the water
- 18 Which sample of water contains particles having the highest average kinetic energy?
- (1) 25 mL of water at 95°C
 - (2) 45 mL of water at 75°C
 - (3) 75 mL of water at 75°C
 - (4) 95 mL of water at 25°C
- 19 Under which conditions of temperature and pressure does carbon dioxide gas behave most like an ideal gas?
- (1) low temperature and low pressure
 - (2) low temperature and high pressure
 - (3) high temperature and low pressure
 - (4) high temperature and high pressure
- 20 Which process results in a chemical change?
- (1) tearing tin foil
 - (2) melting an iron bar
 - (3) crushing an aluminum can
 - (4) burning magnesium ribbon
- 21 For a chemical reaction, the heat of reaction is equal to the
- (1) potential energy of the reactants, only
 - (2) potential energy of the products, only
 - (3) potential energy of the products plus the potential energy of the reactants
 - (4) potential energy of the products minus the potential energy of the reactants
- 22 Given the equation representing a system at equilibrium:
- $$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$$
- At equilibrium, the concentration of
- (1) SO₂(g) must equal the concentration of SO₃(g)
 - (2) SO₂(g) must be constant
 - (3) O₂(g) must equal the concentration of SO₂(g)
 - (4) O₂(g) must be decreasing

- 23 The two isomers of butane have different
(1) formula masses (3) molecular formulas
(2) empirical formulas (4) structural formulas
- 24 An oxidation-reduction reaction involves the
(1) sharing of electrons
(2) sharing of protons
(3) transfer of electrons
(4) transfer of protons
- 25 Which energy change occurs in an operating voltaic cell?
(1) chemical to electrical
(2) electrical to chemical
(3) chemical to nuclear
(4) nuclear to chemical
- 26 Which compound is an electrolyte?
(1) butene (3) dimethyl ether
(2) propane (4) methanoic acid
- 27 According to the Arrhenius theory, a base reacts with an acid to produce
(1) ammonia and methane
(2) ammonia and a salt
(3) water and methane
(4) water and a salt
- 28 What is one benefit associated with a nuclear fission reaction?
(1) The products are not radioactive.
(2) Stable isotopes are used as reactants.
(3) There is no chance of biological exposure.
(4) A large amount of energy is produced.
- 29 Which balanced equation represents a fusion reaction?
(1) ${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{36}^{93}\text{Kr} + {}_{56}^{140}\text{Ba} + 3{}_0^1\text{n}$
(2) ${}_1^2\text{H} + {}_1^3\text{H} \rightarrow {}_2^4\text{He} + {}_0^1\text{n}$
(3) ${}_{7}^{14}\text{N} + {}_2^4\text{He} \rightarrow {}_8^{17}\text{O} + {}_1^1\text{H}$
(4) ${}_{88}^{226}\text{Ra} \rightarrow {}_{86}^{222}\text{Rn} + {}_2^4\text{He}$
- 30 Which radioisotope emits alpha particles?
(1) Fe-53 (3) Au-198
(2) Sr-90 (4) Pu-239

Part B-1

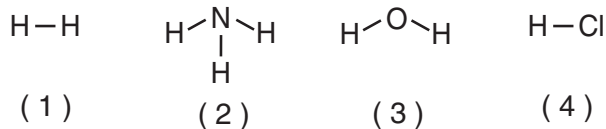
Answer all questions in this part.

Directions (31–50): For each statement or question, write in your answer booklet 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*.

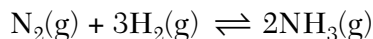
- 31 Which electron configuration represents the electrons of an atom in an excited state?
(1) 2-1 (3) 2-8-7
(2) 2-7-4 (4) 2-4
- 32 What is the total number of neutrons in an atom of O-18?
(1) 18 (3) 10
(2) 16 (4) 8
- 33 What is the net charge of an ion that has 8 protons, 9 neutrons, and 10 electrons?
(1) 1+ (3) 1-
(2) 2+ (4) 2-
- 34 Which element is malleable and a good conductor of electricity at STP?
(1) argon (3) iodine
(2) carbon (4) silver
- 35 Which element has chemical properties that are most similar to the chemical properties of sodium?
(1) beryllium (3) lithium
(2) calcium (4) magnesium
- 36 If an element, X, can form an oxide that has the formula X_2O_3 , then element X would most likely be located on the Periodic Table in the same group as
(1) Ba (3) In
(2) Cd (4) Na
- 37 What is the total mass of KNO_3 that must be dissolved in 50. grams of H_2O at $60.^{\circ}C$ to make a saturated solution?
(1) 32 g (3) 64 g
(2) 53 g (4) 106 g
- 38 Which statement describes the general trends in electronegativity and metallic properties as the elements in Period 2 are considered in order of increasing atomic number?
(1) Both electronegativity and metallic properties decrease.
(2) Both electronegativity and metallic properties increase.
(3) Electronegativity decreases and metallic properties increase.
(4) Electronegativity increases and metallic properties decrease.
- 39 Which balanced equation represents a single-replacement reaction?
(1) $Mg + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2Ag$
(2) $2Mg + O_2 \rightarrow 2MgO$
(3) $MgCO_3 \rightarrow MgO + CO_2$
(4) $MgCl_2 + 2AgNO_3 \rightarrow 2AgCl + Mg(NO_3)_2$
- 40 Given the balanced equation representing a reaction:
$$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$$

This reaction occurs more quickly when powdered iron is used instead of a single piece of iron of the same mass because the powdered iron
(1) acts as a better catalyst than the single piece of iron
(2) absorbs less energy than the single piece of iron
(3) has a greater surface area than the single piece of iron
(4) is more metallic than the single piece of iron
- 41 The temperature of a sample of water changes from $10^{\circ}C$ to $20^{\circ}C$ when the sample absorbs 418 joules of heat. What is the mass of the sample?
(1) 1 g (3) 100 g
(2) 10 g (4) 1000 g

45 Which molecule has a nonpolar covalent bond?



46 Given the equation representing a reaction at equilibrium:



What occurs when the concentration of $\text{H}_2(\text{g})$ is increased?

- (1) The equilibrium shifts to the left, and the concentration of $\text{N}_2(\text{g})$ decreases.
- (2) The equilibrium shifts to the left, and the concentration of $\text{N}_2(\text{g})$ increases.
- (3) The equilibrium shifts to the right, and the concentration of $\text{N}_2(\text{g})$ decreases.
- (4) The equilibrium shifts to the right, and the concentration of $\text{N}_2(\text{g})$ increases.

47 Which ionic equation is balanced?

- (1) $\text{Fe}^{3+} + \text{Al} \rightarrow \text{Fe}^{2+} + \text{Al}^{3+}$
- (2) $\text{Fe}^{3+} + 3\text{Al} \rightarrow \text{Fe}^{2+} + 3\text{Al}^{3+}$
- (3) $3\text{Fe}^{3+} + \text{Al} \rightarrow 3\text{Fe}^{2+} + \text{Al}^{3+}$
- (4) $3\text{Fe}^{3+} + \text{Al} \rightarrow \text{Fe}^{2+} + 3\text{Al}^{3+}$

48 The table below gives information about four aqueous solutions at standard pressure. SKIP

Four Aqueous Solutions

Aqueous Solution	Concentration (M)	Solute
A	2.0	BaCl_2
B	2.0	NaNO_3
C	1.0	$\text{C}_6\text{H}_{12}\text{O}_6$
D	1.0	K_2SO_3

Which list of solutions is arranged in order from highest boiling point to lowest boiling point?

- (1) A, B, D, C
- (2) A, C, B, D
- (3) C, D, B, A
- (4) D, B, C, A

49 What is the total number of years that must pass before only 25.00 grams of an original 100.0-gram sample of C-14 remains unchanged?

- (1) 2865 y
- (2) 5730 y
- (3) 11 460 y
- (4) 17 190 y

50 Which radioisotope is used for diagnosing thyroid disorders? SKIP

- (1) U-238
- (2) Pb-206
- (3) I-131
- (4) Co-60