

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*.

- Compared to the charge of a proton, the charge of an electron has
 - a greater magnitude and the same sign
 - a greater magnitude and the opposite sign
 - the same magnitude and the same sign
 - the same magnitude and the opposite sign
- Which atom has the largest atomic radius?
 - potassium
 - rubidium
 - francium
 - cesium
- In the wave-mechanical model of the atom, an orbital is defined as
 - a region of the most probable proton location
 - a region of the most probable electron location
 - a circular path traveled by a proton around the nucleus
 - a circular path traveled by an electron around the nucleus
- When an excited electron in an atom moves to the ground state, the electron
 - absorbs energy as it moves to a higher energy state
 - absorbs energy as it moves to a lower energy state
 - emits energy as it moves to a higher energy state
 - emits energy as it moves to a lower energy state
- Which polyatomic ion is found in the compound represented by the formula NaHCO_3 ?
 - acetate
 - hydrogen carbonate
 - hydrogen sulfate
 - oxalate
- The atomic mass of magnesium is the weighted average of the atomic masses of
 - all of the artificially produced isotopes of Mg
 - all of the naturally occurring isotopes of Mg
 - the two most abundant artificially produced isotopes of Mg
 - the two most abundant naturally occurring isotopes of Mg
- Which element has atoms that can form halide ions?
 - iodine
 - silver
 - strontium
 - xenon
- Two forms of solid carbon, diamond and graphite, differ in their physical properties due to the differences in their
 - atomic numbers
 - crystal structures
 - isotopic abundances
 - percent compositions
- Which quantity can be calculated for a solid compound, given only the formula of the compound and the Periodic Table of the Elements?
 - the density of the compound
 - the heat of fusion of the compound
 - the melting point of each element in the compound
 - the percent composition by mass of each element in the compound
- Which terms identify types of chemical reactions?
 - decomposition and sublimation
 - decomposition and synthesis
 - deposition and sublimation
 - deposition and synthesis

- 11 The greatest amount of energy released per gram of reactants occurs during a
- (1) redox reaction
 - (2) fission reaction
 - (3) substitution reaction
 - (4) neutralization reaction
- 12 Which element has atoms with the strongest attraction for electrons in a chemical bond?
- (1) chlorine
 - (2) nitrogen
 - (3) fluorine
 - (4) oxygen
- 13 Compared to the physical and chemical properties of the compound NO_2 , the compound N_2O has
- (1) different physical properties and different chemical properties
 - (2) different physical properties and the same chemical properties
 - (3) the same physical properties and different chemical properties
 - (4) the same physical properties and the same chemical properties
- 14 Which phrase describes a molecule of CH_4 , in terms of molecular polarity and distribution of charge?
- (1) polar with an asymmetrical distribution of charge
 - (2) polar with a symmetrical distribution of charge
 - (3) nonpolar with an asymmetrical distribution of charge
 - (4) nonpolar with a symmetrical distribution of charge
- 15 Which sample of copper has atoms with the *lowest* average kinetic energy?
- (1) 10. g at 45°C
 - (2) 20. g at 35°C
 - (3) 30. g at 25°C
 - (4) 40. g at 15°C
- 16 Which change results in the formation of different substances?
- (1) burning of propane
 - (2) melting of $\text{NaCl}(s)$
 - (3) deposition of $\text{CO}_2(g)$
 - (4) solidification of water
- 17 Which substance can *not* be broken down by a chemical change?
- (1) ammonia
 - (2) ethanol
 - (3) propanal
 - (4) zirconium
- 18 According to Table I, which equation represents a change resulting in the greatest quantity of energy released?
- (1) $2\text{C}(s) + 3\text{H}_2(g) \rightarrow \text{C}_2\text{H}_6(g)$
 - (2) $2\text{C}(s) + 2\text{H}_2(g) \rightarrow \text{C}_2\text{H}_4(g)$
 - (3) $\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$
 - (4) $\text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{NO}(g)$
- 19 Which element is a liquid at STP?
- (1) bromine
 - (2) cesium
 - (3) francium
 - (4) iodine
- 20 Which statement describes a reversible reaction at equilibrium?
- (1) The activation energy of the forward reaction must equal the activation energy of the reverse reaction.
 - (2) The rate of the forward reaction must equal the rate of the reverse reaction.
 - (3) The concentration of the reactants must equal the concentration of the products.
 - (4) The potential energy of the reactants must equal the potential energy of the products.
- 21 Given the balanced equation representing a reaction:
- $$\text{O}_2 \rightarrow \text{O} + \text{O}$$
- 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.
- 22 In terms of entropy and energy, systems in nature tend to undergo changes toward
- (1) lower entropy and lower energy
 - (2) lower entropy and higher energy
 - (3) higher entropy and lower energy
 - (4) higher entropy and higher energy

23 Which term is defined as the difference between the potential energy of the products and the potential energy of the reactants in a chemical reaction?

- (1) activation energy (3) heat of fusion
(2) thermal energy (4) heat of reaction

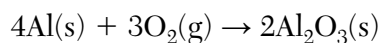
24 What is the atomic number of the element whose atoms bond to each other in chains, rings, and networks?

- (1) 10 (3) 6
(2) 8 (4) 4

25 How many pairs of electrons are shared between two adjacent carbon atoms in a saturated hydrocarbon?

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

26 Given the balanced equation representing a reaction:



As the aluminum loses 12 moles of electrons, the oxygen

- (1) gains 4 moles of electrons
(2) gains 12 moles of electrons
(3) loses 4 moles of electrons
(4) loses 12 moles of electrons

27 Which compound is an electrolyte?

- (1) CH_3CHO (3) CH_3COOH
(2) CH_3OCH_3 (4) $\text{CH}_3\text{CH}_2\text{CH}_3$

28 Which statement describes one acid-base theory?

- (1) An acid is an H^+ acceptor, and a base is an H^+ donor.
(2) An acid is an H^+ donor, and a base is an H^+ acceptor.
(3) An acid is an H^- acceptor, and a base is an H^- donor.
(4) An acid is an H^- donor, and a base is an H^- acceptor.

29 Which compounds are classified as Arrhenius acids?

- (1) HCl and NaOH
(2) HNO_3 and NaCl
(3) NH_3 and H_2CO_3
(4) HBr and H_2SO_4

30 Which statement describes the stability of the nuclei of potassium atoms?

- (1) All potassium atoms have stable nuclei that spontaneously decay.
(2) All potassium atoms have unstable nuclei that do not spontaneously decay.
(3) Some potassium atoms have unstable nuclei that spontaneously decay.
(4) Some potassium atoms have unstable nuclei that do not spontaneously decay.

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 notations represent different isotopes of the element sodium?

- (1) ^{32}S and ^{34}S (3) Na^+ and Na^0
(2) S^{2-} and S^{6+} (4) ^{22}Na and ^{23}Na

32 Which electron configuration represents the electrons in an atom of Ga in an excited state?

- (1) 2-8-17-3 (3) 2-8-18-3
(2) 2-8-17-4 (4) 2-8-18-4

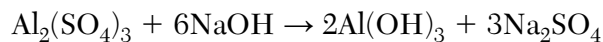
33 Which statement describes the general trends in electronegativity and first ionization energy as the elements in Period 3 are considered in order from Na to Cl?

- (1) Electronegativity increases, and first ionization energy decreases.
(2) Electronegativity decreases, and first ionization energy increases.
(3) Electronegativity and first ionization energy both increase.
(4) Electronegativity and first ionization energy both decrease.

34 What is the gram-formula mass of $\text{Fe}(\text{NO}_3)_3$?

- (1) 146 g/mol (3) 214 g/mol
(2) 194 g/mol (4) 242 g/mol

35 Given the balanced equation representing a reaction:



The mole ratio of NaOH to $\text{Al}(\text{OH})_3$ is

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

36 Which equation represents a single replacement reaction?

- (1) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
(2) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
(3) $\text{H}_2\text{SO}_4 + \text{Mg} \rightarrow \text{H}_2 + \text{MgSO}_4$
(4) $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}$

37 The accepted value for the percent by mass of water in a hydrate is 36.0%. In a laboratory activity, a student determined the percent by mass of water in the hydrate to be 37.8%. What is the percent error for the student's measured value?

- (1) 5.0% (3) 1.8%
(2) 4.8% (4) 0.05%

38 The boiling points, at standard pressure, of four compounds are given in the table below.

Boiling Points of Four Compounds

Compound	Boiling Point ($^{\circ}\text{C}$)
H_2O	100.0
H_2S	-59.6
H_2Se	-41.3
H_2Te	-2.0

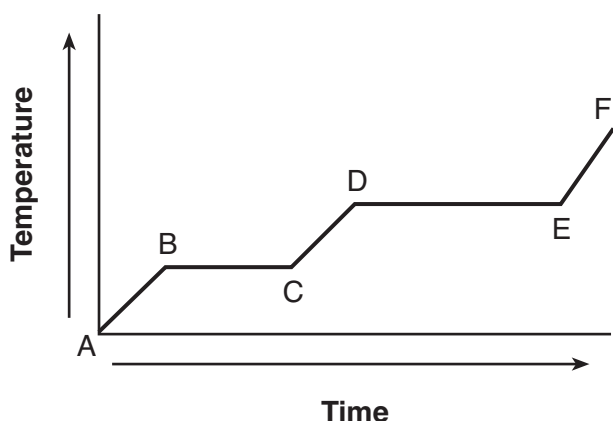
Which type of attraction can be used to explain the unusually high boiling point of H_2O ?

- (1) ionic bonding
(2) hydrogen bonding
(3) polar covalent bonding
(4) nonpolar covalent bonding

39 Which formula represents a molecule with the most polar bond?

- (1) CO (3) HI
(2) NO (4) HCl

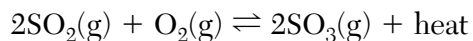
- 40 The graph below represents the uniform heating of a substance from the solid to the gas phase.



Which line segment of the graph represents boiling?

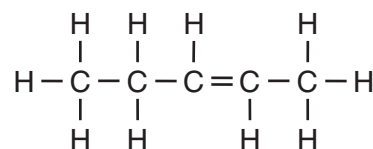
- (1) \overline{AB} (2) \overline{BC} (3) \overline{CD} (4) \overline{DE}
- 41 A 1-gram sample of a compound is added to 100 grams of $\text{H}_2\text{O}(\ell)$ and the resulting mixture is then thoroughly stirred. Some of the compound is then separated from the mixture by filtration. Based on Table *F*, the compound could be
- (1) AgCl (2) CaCl_2 (3) NaCl (4) NiCl_2
- 42 At standard pressure, the total amount of heat required to completely vaporize a 100.-gram sample of water at its boiling point is
- (1) $2.26 \times 10 \text{ J}$ (2) $2.26 \times 10^2 \text{ J}$ (3) $2.26 \times 10^3 \text{ J}$ (4) $2.26 \times 10^5 \text{ J}$
- 43 A sample of helium gas is in a sealed, rigid container. What occurs as the temperature of the sample is increased?
- (1) The mass of the sample decreases.
 (2) The number of moles of gas increases.
 (3) The volume of each atom decreases.
 (4) The frequency of collisions between atoms increases.

- 44 Given the equation representing a reaction at equilibrium:



Which change causes the equilibrium to shift to the right?

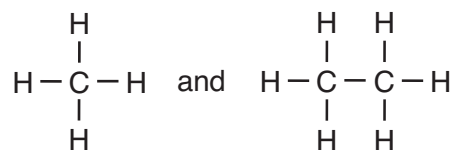
- (1) adding a catalyst
 (2) adding more $\text{O}_2(\text{g})$
 (3) decreasing the pressure
 (4) increasing the temperature
- 45 Given the formula representing a compound:



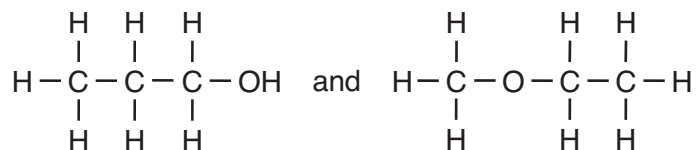
What is a chemical name of this compound?

- (1) 2-pentene (2) 2-pentyne (3) 3-pentene (4) 3-pentyne
- 46 What is the oxidation number of manganese in KMnO_4 ?
- (1) +7 (2) +2 (3) +3 (4) +4
- 47 When the pH of an aqueous solution is changed from 1 to 2, the concentration of hydronium ions in the solution is
- (1) decreased by a factor of 2
 (2) decreased by a factor of 10
 (3) increased by a factor of 2
 (4) increased by a factor of 10
- 48 What is the color of the indicator thymol blue in a solution that has a pH of 11?
- (1) red (2) blue (3) pink (4) yellow

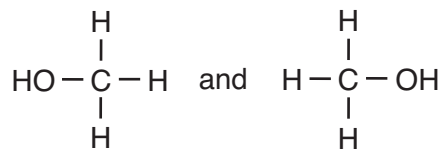
49 Which formulas represent compounds that are isomers of each other?



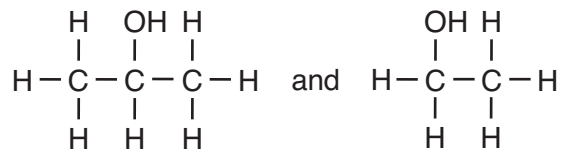
(1)



(3)



(2)



(4)

50 One beneficial use of radioisotopes is

- (1) detection of disease
 - (2) neutralization of an acid spill
 - (3) decreasing the dissolved $\text{O}_2(\text{g})$ level in seawater
 - (4) increasing the concentration of $\text{CO}_2(\text{g})$ in the atmosphere
-