

- Which two particles each have a mass approximately equal to one atomic mass unit?
 - electron and neutron
 - electron and positron
 - proton and electron
 - proton and neutron**
- Which subatomic particles are located in the nucleus of a neon atom?
 - electrons and positrons
 - electrons and neutrons
 - protons and neutrons**
 - protons and electrons
- Which statement best describes the nucleus of an aluminum atom?
 - It has a charge of +13 and is surrounded by a total of 10 electrons.
 - It has a charge of + 13 and is surrounded by a total of 13 electrons.**
 - It has a charge of -13 and is surrounded by a total of 10 electrons.
 - It has a charge of -13 and is surrounded by a total of 13 electrons.
- The mass of an electron is approximately equal to $\frac{1}{1836}$ of the mass of
 - a positron
 - a proton**
 - an alpha particle
 - a beta particle
- Compared to the entire atom, the nucleus of the atom is
 - smaller and contains most of the atom's mass**
 - smaller and contains little of the atom's mass
 - larger and contains most of the atom's mass
 - larger and contains little of the atom's mass
- Experiments with gold foil indicated that atoms
 - usually have a uniform distribution of positive charges
 - usually have a uniform distribution of negative charges
 - contain a positively charged, dense center**
 - contain a negatively charged, dense center
- An atom is electrically neutral because the
 - number of protons equals the number of electrons**
 - number of protons equals the number of neutrons
 - ratio of the number of neutrons to the number of electrons is 1:1
 - ratio of the number of neutrons to the number of protons is 2:1
- As the number of neutrons in the nucleus of a given atom of an element increases, the atomic number of that element
 - decreases
 - increases
 - remains the same**
- An atom of ${}^{40}_{18}\text{Ar}$ has a nucleus that contains a total of
 - 18 electrons
 - 18 protons**
 - 18 neutrons
 - 18 nucleons
- The atomic number of an atom is always equal to the total number of
 - neutrons in the nucleus
 - protons in the nucleus**
 - neutrons plus protons in the atom
 - protons plus electrons in the atom
- What is the mass number of an atom that consists of 20 protons, 20 neutrons, and 18 electrons?
 - 18
 - 20
 - 38
 - 40**
- The atomic mass of an atom is measured in atomic mass units. This unit is based on
 - ${}^1\text{H}$
 - ${}^{14}\text{N}$
 - ${}^{16}\text{O}$
 - ${}^{12}\text{C}$**
- What is the mass number of an atom that contains 19 protons, 19 electrons, and 20 neutrons?
 - 19
 - 20
 - 39**
 - 58
- Atoms of different isotopes of the same element differ in their total number of
 - electrons
 - neutrons**
 - protons
 - valence electrons
- Atoms of ${}^{16}\text{O}$, ${}^{17}\text{O}$, and ${}^{18}\text{O}$ have the same number of
 - neutrons, but a different number of protons
 - protons, but a different number of neutrons**
 - protons, but a different number of electrons
 - electrons, but a different number of protons
- What is the total number of neutrons in an atom of ${}^{57}_{26}\text{Fe}$?
 - 26
 - 31**
 - 57
 - 83
- Which two notations represent atoms that are isotopes of the same element?
 - ${}^{121}_{50}\text{Sn}$ and ${}^{119}_{50}\text{Sn}$
 - ${}^{121}_{50}\text{Sn}$ and ${}^{121}_{50}\text{Sn}$
 - ${}^{19}_8\text{O}$ and ${}^{19}_9\text{F}$
 - ${}^{39}_{17}\text{Cl}$ and ${}^{39}_{19}\text{K}$
- In which two atoms do both nuclides contain the same number of neutrons?
 - ${}^{20}_{10}\text{Ne}$ and ${}^{40}_{18}\text{Ar}$
 - ${}^{65}_{29}\text{Cu}$ and ${}^{65}_{30}\text{Zn}$
 - ${}^{24}_{12}\text{Mg}$ and ${}^{26}_{12}\text{Mg}$
 - ${}^{14}_6\text{C}$ and ${}^{16}_8\text{O}$**

19. Which pair must represent atoms of the same element?
 A) 1_6X and ${}^{14}_7X$ **B) ${}^{12}_6X$ and ${}^{13}_6X$**
 C) 2_1X and 4_2X D) ${}^{13}_6X$ and ${}^{14}_7X$
20. Compared to an atom of ${}^{12}_6C$, an atom of ${}^{14}_6C$ has
 A) more protons B) fewer protons
C) more neutrons D) fewer neutrons
21. The atomic mass of element *A* is 63.6 atomic mass units. The only naturally occurring isotopes of element *A* are *A*-63 and *A*-65. The percent abundances in a naturally occurring sample of element *A* are closest to
 A) 31% *A*-63 and 69% *A*-65
 B) 50% *A*-63 and 50% *A*-65
C) 69% *A*-63 and 31% *A*-65
 D) 100% *A*-63 and 0% *A*-65
22. A sample of element *X* contains 90. percent ${}^{35}X$ atoms, 8.0 percent ${}^{37}X$ atoms, and 2.0 percent ${}^{38}X$ atoms. The average isotopic mass is closest to
 A) 32 **B) 35** C) 37 D) 38
23. Which electron configuration represents an atom of an element having a completed third principal energy level?
 A) 2-8-2 B) 2-8-6-2
 C) 2-8-10-2 **D) 2-8-18-2**
24. What is the total number of electrons in the second energy shell of a calcium atom in the ground state?
 A) 6 B) 2 **C) 8** D) 18
25. In the ground state, all of the atoms of Period 3 elements have the same
 A) atomic mass
 B) atomic number
C) number of occupied energy shells
 D) number of oxidation states
26. What is the maximum number of electrons in the third shell of an atom?
 A) 6 B) 9 C) 3 **D) 18**
27. Which principal energy level of an atom contains an electron with the lowest energy?
A) $n = 1$ B) $n = 2$ C) $n = 3$ D) $n = 4$
28. Which electron configuration represents the electrons in an atom of chlorine in an excited state?
 A) 2-7-7 **B) 2-7-8** C) 2-8-7 D) 2-8-8
29. Which list of elements contains a metal, a metalloid, and a nonmetal?
 A) Zn, Ga, Ge B) Si, Ge, Sn
C) Cd, Sb, I D) F, Cl, Br
30. Electron *X* can change to a higher energy level or a lower energy level. Which statement is true of electron *X*?
 A) Electron *X* emits energy when it changes to a higher energy level.
B) Electron *X* absorbs energy when it changes to a higher energy level.
 C) Electron *X* absorbs energy when it changes to a lower energy level.
 D) Electron *X* neither emits nor absorbs energy when it changes energy level.
31. As an electron in a hydrogen atom moves from the second principal energy level to the first principal energy level, the energy of the atom
A) decreases B) increases
 C) remains the same
32. An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is
 A) emitted by the nucleus
B) emitted by the electron
 C) absorbed by the nucleus
 D) absorbed by the electron
33. As an electron in an atom moves from the ground state to the excited state, the electron
A) gains energy as it moves to a higher energy level
 B) gains energy as it moves to a lower energy level
 C) loses energy as it moves to a higher energy level
 D) loses energy as it moves to a lower energy level
34. The characteristic bright-line spectrum of an element occurs when electrons
 A) move from lower to higher energy levels
B) move from higher to lower energy levels
 C) are lost by a neutral atom
 D) are gained by a neutral atom
35. Which statement explains why sulfur is classified as a Group 16 element?
A) A sulfur atom has 6 valence electrons.
 B) A sulfur atom has 16 neutrons.
 C) Sulfur is a yellow solid at STP.
 D) Sulfur reacts with most metals.
36. Which elements have the most similar chemical properties?
A) K and Na B) K and Cl
 C) K and Ca D) K and S

37. The elements in Period 5 on the Periodic Table are arranged from left to right in order of
- A) decreasing atomic mass
 B) decreasing atomic number
 C) increasing atomic mass
D) increasing atomic number
38. Which three groups of the Periodic Table contain the most elements classified as metalloids (semimetals)?
- A) 1, 2, and 13 B) 2, 13, and 14
C) 14, 15, and 16 D) 16, 17, and 18
39. Which element is a member of the halogen family?
- A) K B) B **C) I** D) S
40. Which element exists as a diatomic molecule at STP?
- A) bromine** B) argon
 C) sulfur D) rubidium
41. The element in Period 2 with the largest atomic radius is
- A) a halogen
 B) a noble gas
C) an alkali metal
 D) an alkaline earth metal
42. Which element is malleable and can conduct electricity in the solid phase?
- A) iodine B) phosphorus
 C) sulfur **D) tin**
43. Which of the following elements has the most pronounced metallic properties?
- A) C B) Al C) Co **D) Rb**
44. Which is a property of most nonmetallic solids?
- A) high thermal conductivity
 B) high electrical conductivity
C) brittleness
 D) malleability
45. Which element is a liquid at STP and has low electrical conductivity?
- A) silver B) mercury
 C) barium **D) bromine**
46. Which substance at STP exists in the form of a monatomic gas?
- A) neon** B) oxygen
 C) chlorine D) nitrogen
47. Which gaseous element has the greatest density at STP?
- A) N₂ B) O₂ **C) Cl₂** D) F₂
48. The chemical formula for nickel (II) bromide is
- A) Ni₂Br **B) NiBr₂** C) N₂Br D) NBr₂
49. Which Lewis electron-dot diagram represents a boron atom in the ground state?
- A) $\cdot\text{B}$ **B) $\cdot\ddot{\text{B}}\cdot$** C) $:\ddot{\text{B}}\cdot$ D) $:\ddot{\text{B}}:$
50. What is the correct Lewis electron-dot structure for the compound magnesium fluoride?
- A) $\text{Mg}:\ddot{\text{F}}:$ B) $\text{Mg}^+[\ddot{\text{F}}:]^-$
 C) $[\ddot{\text{F}}:]^- \text{Mg}^{2+}[\ddot{\text{F}}:]^-$ D) $:\ddot{\text{F}}:\text{Mg}:\ddot{\text{F}}:$
51. Which is the electron-dot symbol for a chlorine atom in the ground state?
- A) $:\ddot{\text{Cl}}:$ B) $\text{Cl}:$ **C) $:\ddot{\text{Cl}}\cdot$** D) $\cdot\ddot{\text{Cl}}:$
52. The atoms of the elements in Group 2 have the same
- A) mass number
 B) atomic number
 C) number of protons
D) number of valence electrons
53. What is the total number of valence electrons in an atom of phosphorus in the ground state?
- A) 5** B) 2 C) 3 D) 7
54. Which set of properties is most characteristic of transition elements?
- A) colorless ions in solution, multiple positive oxidation states
 B) colorless ions in solution, multiple negative oxidation states
C) colored ions in solution, multiple positive oxidation states
 D) colored ions in solution, multiple negative oxidation states
55. Which compound is colorless in a water solution?
- A) Al₂(SO₄)₃** B) Cr₂(SO₄)₃
 C) Fe₂(SO₄)₃ D) Co₂(SO₄)₃
56. Which changes occur as a cadmium atom, Cd, becomes a cadmium ion, Cd²⁺?
- A) The Cd atom gains two electrons and its radius decreases.
 B) The Cd atom gains two electrons and its radius increases.
C) The Cd atom loses two electrons and its radius decreases.
 D) The Cd atom loses two electrons and its radius increases.
57. Which element has atoms with the largest atomic radius?
- A) Rb **B) Cs** C) Sr D) Ba

58. Which of the following atoms has the greatest tendency to attract electrons?

- A) barium B) beryllium
C) boron D) **bromine**

59. The amount of energy required to remove the outermost electron from a gaseous atom in the ground state is known as

- A) **first ionization energy**
B) activation energy
C) conductivity
D) electronegativity

60. In Period 2 of the Periodic Table, which Group contains the element with the highest first ionization energy?

- A) alkali metals
B) alkaline earth metals
C) halogens
D) **noble gases**

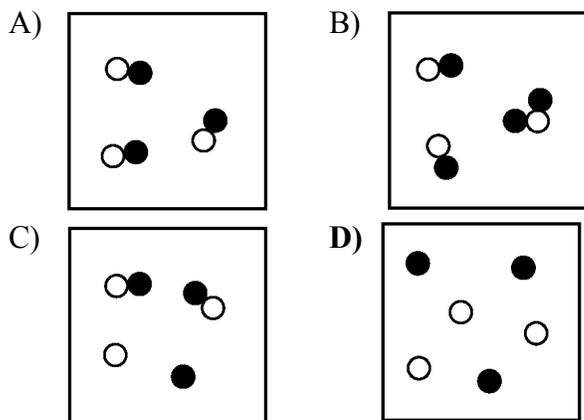
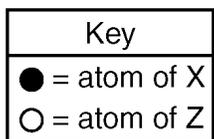
61. Which statement is true about the properties of the elements in any one period of the Periodic Table?

- A) They are determined by the number of neutrons.
B) They are determined by the number of electrons in the first shell.
C) **They change in a generally systematic manner.**
D) They change in a random, unpredictable manner.

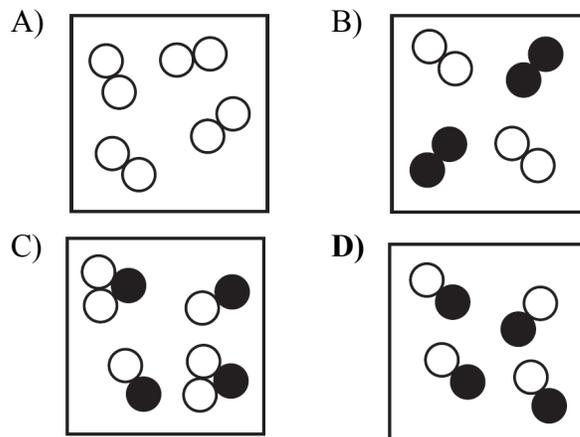
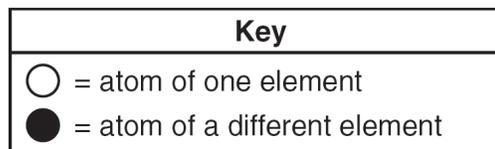
62. As elements in Group 15 of the Periodic Table are considered in order from top to bottom, the metallic character of each successive element generally

- A) decreases B) **increases**
C) remains the same

63. Which particle diagram represents a mixture of element X and element Z, only?



64. Which particle diagram represents a sample of one compound, only?



65. Which two substances can *not* be broken down by chemical change?

- A) C and CuO B) **C and Cu**
C) CO₂ and CuO D) CO₂ and Cu

66. Which substance represents a compound?

- A) C(s) B) Co(s)
C) **CO(g)** D) O₂(g)

67. Which type of change must occur to form a compound?

- A) **chemical** B) physical
C) nuclear D) phase

68. The list below shows four samples: A, B, C, and D.

- (A) HCl(aq)
(B) NaCl(aq)
(C) HCl(g)
(D) NaCl(s)

Which samples are mixtures?

- A) **A and B** B) A and C
C) C and B D) C and D

69. A chemical formula is an expression used to represent

- A) mixtures, only
B) elements, only
C) compounds, only
D) **compounds and elements**

70. What is the total number of different elements present in NH₄NO₃?

- A) 7 B) 9 C) **3** D) 4

71. Which group on the Periodic Table of the Elements contains elements that react with oxygen to form compounds with the general formula X_2O ?

- A) Group 1 B) Group 2
C) Group 14 D) Group 18

72. Element X reacts with iron to form two different compounds with the formulas FeX and Fe_2X_3 . To which group on the Periodic Table does element X belong?

- A) Group 8 B) Group 2
C) Group 13 D) Group 16

73. An example of a binary compound is

- A) potassium chloride B) ammonium chloride
C) potassium chlorate D) ammonium chlorate

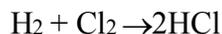
74. What is the chemical formula for nickel (II) hypochlorite?

- A) $NiCl_2$ B) $Ni(ClO)_2$
C) $NiClO_2$ D) $Ni(ClO)_3$

75. Which particles may be gained, lost, or shared by an atom when it forms a chemical bond?

- A) protons B) electrons
C) neutrons D) nucleons

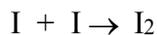
76. Given the reaction:



Which statement best describes the energy change as bonds are formed and broken in this reaction?

- A) The breaking of the Cl–Cl bond releases energy.
B) The breaking of the H–H bond releases energy.
C) The forming of the H–Cl bond absorbs energy.
D) The forming of the H–Cl bond releases energy.

77. Given the equation:



As the atoms of the iodine react to form molecules of iodine, the stability of the iodine

- A) decreases B) increases
C) remains the same

78. Which electron-dot diagram represents H_2 ?

- A) $H \cdot H$ B) $H \cdot \cdot H$
C) $\cdot \cdot \cdot \cdot$
 $\cdot H \cdot H \cdot$
 $\cdot \cdot \cdot \cdot$ D) $\cdot \cdot \cdot \cdot$
 $\cdot H \cdot \cdot H \cdot$
 $\cdot \cdot \cdot \cdot$

79. Which molecule contains a triple covalent bond?

- A) H_2 B) N_2 C) O_2 D) Cl_2

80. Given the electron dot diagram:



The electrons in the bond between hydrogen and fluorine are more strongly attracted to the atom of

- A) hydrogen, which has the higher electronegativity
B) fluorine, which has the higher electronegativity
C) hydrogen, which has the lower electronegativity
D) fluorine, which has the lower electronegativity

81. Which compound has the greatest degree of ionic character?

- A) NaF B) MgF_2 C) AlF_3 D) SiF_4

82. Two atoms with an electronegativity difference of 0.4 form a bond that is

- A) ionic, because electrons are shared
B) ionic, because electrons are transferred
C) covalent, because electrons are shared
D) covalent, because electrons are transferred

83. Which formula represents an ionic compound?

- A) H_2 B) CH_4
C) CH_3OH D) $NH \cdot Cl$

84. Which type of bond is formed when electrons are transferred from one atom to another?

- A) covalent B) ionic
C) hydrogen D) metallic

85. A solid substance was tested in the laboratory. The test results are listed below.

- dissolves in water
- is an electrolyte
- melts at a high temperature

Based on these results, the solid substance could be

- A) Cu B) $CuBr_2$
C) C D) $C_6H_{12}O_6$

86. Covalent bonds are formed when electrons are

- A) transferred from one atom to another
B) captured by the nucleus
C) mobile within a metal
D) shared between two atoms

87. In which material are the particles arranged in a regular geometric pattern?

- A) $CO_2(g)$ B) $NaCl(aq)$
C) $H_2O(l)$ D) $C_{12}H_{22}O_{11}(s)$

88. What is the maximum number of covalent bonds that a carbon atom can form?

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

89. The ability to conduct electricity in the solid state is a characteristic of metallic bonding. This characteristic is best explained by the presence of

- A) high ionization energies
- B) high electronegativities
- C) mobile electrons**
- D) mobile protons

90. Which formula represents a nonpolar molecule containing polar covalent bonds?

- A) H₂O
- B) CCl₄**
- C) NH₃
- D) H₂

91. Which formula represents a nonpolar molecule?

- A) CH₄**
- B) HCl
- C) H₂O
- D) NH₃

92. Which type of bond exists between an atom of carbon and an atom of fluorine?

- A) ionic
- B) metallic
- C) polar covalent**
- D) nonpolar covalent

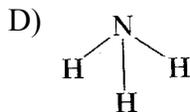
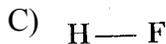
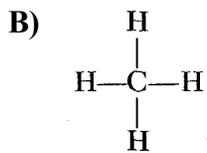
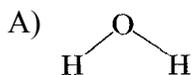
93. Hexane (C₆H₁₄) and water do *not* form a solution. Which statement explains this phenomenon?

- A) Hexane is polar and water is nonpolar.
- B) Hexane is ionic and water is polar.
- C) Hexane is nonpolar and water is polar.**
- D) Hexane is nonpolar and water is ionic.

94. The four single bonds of a carbon atom in CH₄ are directed toward the corners of a

- A) square
- B) tetrahedron**
- C) rectangle
- D) parallelogram

95. Which structural formula represents a nonpolar symmetrical molecule?



96. The molar mass of Ba(OH)₂ is

- A) 154.3 g
- B) 155.3 g
- C) 171.3 g**
- D) 308.6 g

97. The gram-formula mass of (NH₄)₂CO₃ is

- A) 46.0 g
- B) 64.0 g
- C) 78.0 g
- D) 96.0 g**

98. What is the gram formula mass of CuSO₄ • 5H₂O?

- A) 160. g
- B) 178 g
- C) 186 g
- D) 250. g**

99. What is the gram formula mass of (NH₄)₂SO₄?

- A) 66.0 g
- B) 94.0 g
- C) 114 g
- D) 132 g**

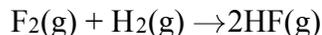
100. What is the total number of moles of oxygen atoms in 1 mole of N₂O₃?

- A) 1
- B) 2
- C) 3**
- D) 5

101. What is the total number of moles of atoms present in 1 gram formula mass of Pb(C₂H₃O₂)₂?

- A) 9
- B) 14
- C) 3
- D) 15**

102. Given the balanced equation representing a reaction:



What is the mole ratio of H₂(g) to HF(g) in this reaction?

- A) 1:1
- B) 1:2**
- C) 2:1
- D) 2:3

103. Given the equation:



How many moles of oxygen are required to react completely with 1.0 mole of C₂H₂?

- A) 2.5**
- B) 2.0
- C) 5.0
- D) 10

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

- A) atoms**
- B) coefficients
- C) molecules
- D) moles of molecules

105. Given the balanced equation:



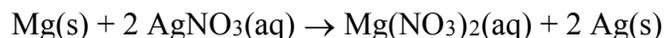
What is the correct formula for the product represented by the letter X?

- A) NaO
- B) Na₂O
- C) NaOH**
- D) Na₂OH

106. Which list includes three types of chemical reactions?

- A) condensation, double replacement, and sublimation
- B) condensation, solidification, and synthesis
- C) decomposition, double replacement, and synthesis**
- D) decomposition, solidification, and sublimation

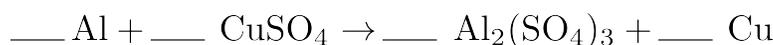
107. Given the reaction:



Which type of reaction is represented?

- A) single replacement**
- B) double replacement
- C) synthesis
- D) decomposition

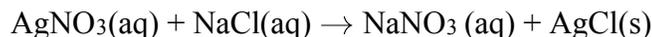
108. Given the unbalanced equation:



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

- A) 1 **B) 2** C) 3 D) 4

109. Given the balanced equation:



This reaction is classified as

- A) synthesis B) decomposition
C) single replacement **D) double replacement**

110. Which pair consists of a molecular formula and its corresponding empirical formula?

- A) C₂H₂ and CH₃CH₃
B) C₆H₆ and C₂H₂
C) P₄O₁₀ and P₂O₅
D) SO₂ and SO₃

111. What is the empirical formula for the compound C₆H₁₂O₆?

- A) CH₂O** B) C₂H₄O₂
C) C₃H₆O₃ D) C₆H₁₂O₆

112. The empirical formula of a compound is CH₂. The molecular formula of this compound could be

- A) CH₄ B) C₂H₂ C) **C₂H₄** D) C₂H₆

113. Two basic properties of the gas phase are

- A) a definite shape and a definite volume
B) a definite shape but no definite volume
C) no definite shape but a definite volume
D) no definite shape and no definite volume

114. The primary forces of attraction between water molecules in H₂O(ℓ) are

- A) ionic bonds
B) hydrogen bonds
C) molecule-ion attractions
D) van der Waals forces

115. Bronze contains 90 to 95 percent copper and 5 to 10 percent tin. Because these percentages can vary, bronze is classified as

- A) a compound B) an element
C) a mixture D) a substance

116. Which of these contains only one substance?

- A) distilled water** B) sugar water
C) saltwater D) rainwater

117. A dilute, aqueous potassium nitrate solution is best classified as a

- A) homogeneous compound
B) homogeneous mixture
C) heterogeneous compound
D) heterogeneous mixture

118. Which statement is an identifying characteristic of a mixture?

- A) A mixture can consist of a single element.
B) A mixture can be separated by physical means.
C) A mixture must have a definite composition by weight.
D) A mixture must be homogeneous.

119. When sample X is passed through a filter paper a white residue, Y, remains on the paper and a clear liquid, Z, passes through. When liquid Z is vaporized, another white residue remains. Sample X is best classified as

- A) an element
B) a compound
C) a heterogeneous mixture
D) a homogeneous mixture

120. When a mixture of water, sand, and salt is filtered, what passes through the filter paper?

- A) water, only
B) water and sand, only
C) water and salt, only
D) water, sand, and salt

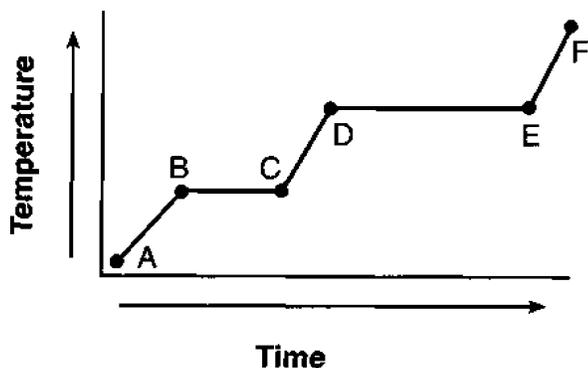
121. Fractional distillation is a technique used to separate complex mixtures of hydrocarbons based on differences in their

- A) heats of fusion
B) heats of vaporization
C) melting points
D) boiling points

122. In which process does a solid change directly into a vapor?

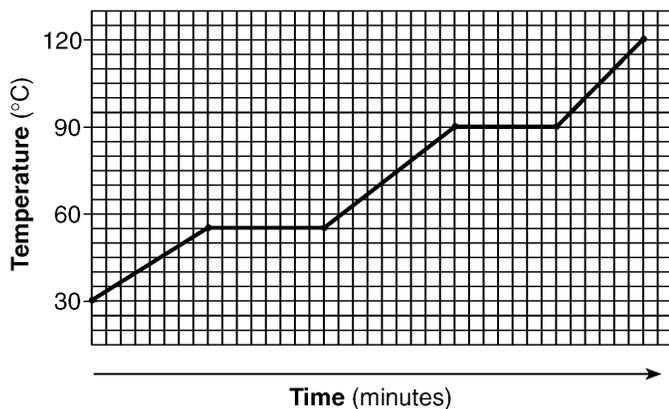
- A) condensation **B) sublimation**
C) deposition D) solidification

123. The graph below represents the uniform heating of a substance, starting below its melting point, when the substance is solid.



Which line segments represent an increase in average kinetic energy?

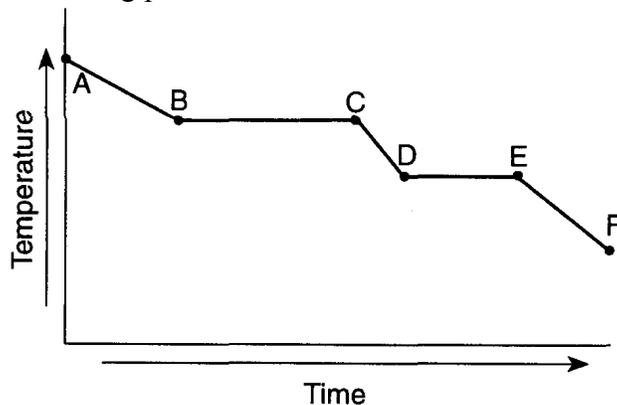
- A) \overline{AB} and \overline{BC} B) \overline{AB} and \overline{CD}
 C) \overline{BC} and \overline{DE} D) \overline{DE} and \overline{EF}
124. Which physical changes are endothermic?
- A) melting and freezing
B) melting and evaporating
 C) condensation and sublimation
 D) condensation and deposition
125. The graph below represents the heating curve of a substance that starts as a solid below its freezing point.



What is the melting point of this substance?

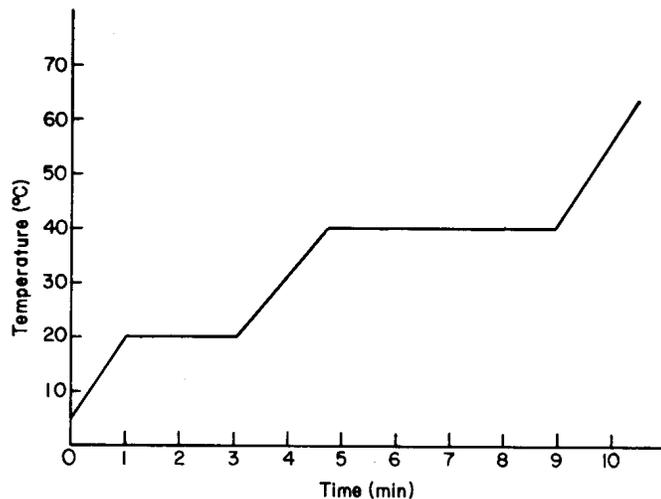
- A) 30°C B) 55°C
 C) 90°C D) 120°C
126. The temperature 30. K expressed in degrees Celsius is
- A) 243°C B) -243°C
 C) 303°C D) -303°C
127. Which measurement contains a total of three significant figures?
- A) 0.12 B) 012 C) 120 D) 120.

128. The graph below represents the uniform cooling of a substance, starting with the substance as a gas above its boiling point.



During which interval is the substance completely in the liquid phase?

- A) AB B) BC C) CD D) DE
129. The graph below represents changes of state for an unknown substance.



What is the boiling temperature of the substance?

- A) 0°C B) 20°C C) 70°C D) 40°C
130. A student calculated the percent by mass of water in a sample of $\text{BaCl}_2 \cdot 2 \text{H}_2\text{O}$ to be 16.4%, but the accepted value is 14.8%. What was the student's percent error?
- A) $\frac{14.8}{16.4} \times 100\%$ B) $\frac{16.4}{14.8} \times 100\%$
 C) $\frac{1.6}{14.8} \times 100\%$ D) $\frac{14.8}{1.6} \times 100\%$