CHEMISTRY

QUESTION CATALOGUE

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Chemistry

Table Of Contents

I. ATOMIC STRUCTURE

II. PERIODIC TABLE

III. STOICHIOMETRY

IV. CHEMICAL BONDING

V. PHYSICAL BEHAVIOR OF MATTER

VII. ORGANIC CHEMISTRY

VIII. OXIDATION-REDUCTION

IX. ACIDS, BASES AND SALTS

X. NUCLEAR CHEMISTRY

XI. LABS AND MEASUREMENTS

6854 The mass of a proton is approximately equal to the mass of
(1) an alpha particle **(3) a neutron**
(2) an electron (4) a positron

6678 Which particle has the *least* mass?
(1) $^{4}_{2}He$ (3) $^{1}_{0}n$
(2) $^{1}_{1}H$ **(4) $^{0}_{-1}e$**

6597 What is the mass number of a carbon atom that contains six protons, eight neutrons, and six electrons?
(1) 6 **(3) 14**
(2) 8 (4) 20

6515 Which particle has a mass that is approximately the same as the mass of a proton?
(1) an alpha particle **(3) a neutron**
(2) a beta particle (4) a positron

6274 The mass of 12 protons is approximately equal to
(1) 1 atomic mass unit (3) the mass of 1 electron
(2) 12 atomic mass units (4) the mass of 12 electrons

6217 Which two particles make up most of the mass of a hydrogen-2 atom?
(1) electron and neutron **(3) proton and neutron**
(2) electron and proton (4) proton and positron

5993 The total mass of the protons in an atom of gold-198 is approximately
(1) 79 atomic mass units (3) 198 atomic mass units
(2) 119 atomic mass units (4) 277 atomic mass units

5937 What is the mass number of an atom that has six protons, six electrons, and eight neutrons?
(1) 6 **(3) 14**
(2) 12 (4) 20

5513 What is the total number of neutrons in the nucleus of a neutral atom that has 19 electrons and a mass number of 39?
(1) 19 (3) 39
(2) 20 (4) 58

5004 In which list are the elements arranged in order of increasing atomic mass?
(1) Cl, K, Ar (3) Te, I, Xe
(2) Fe, Co, Ni (4) Ne, F, Na

4891 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

4805 What is the total number of neutrons in an atom of $^{7}_{3}Li$?
(1) 7 (3) 3
(2) 10 **(4) 4**

4656 An atom of helium-4 differs from an atom of lithium-7 in that the atom of helium-4 has
(1) one more proton (3) two less protons
(2) one more neutron **(4) two less neutrons**

4653 What is the mass number of $^{19}_{9}F$?
(1) 9 **(3) 19**
(2) 10 (4) 28

4252 An atom of fluorine has a mass of 19 atomic mass units. The total number of protons and neutrons in its nucleus is
(1) 9 **(3) 19**
(2) 10 (4) 28

4191 The mass of a proton is approximately equal to the total mass of 1,836
(1) electrons (3) helium nuclei
(2) neutrons (4) alpha particles

4136 The atomic mass unit is defined as exactly 1/12 the mass of an atom of
(1) $^{12}_{6}C$ (3) $^{24}_{12}Mg$
(2) $^{14}_{6}C$ (4) $^{26}_{12}Mg$

3905 What is the total number of protons and neutrons in an atom of $^{86}_{37}Rb$?
(1) 37 **(3) 86**
(2) 49 (4) 123

3726 The mass of a calcium atom is due primarily to the mass of its
(1) protons, only **(3) protons and neutrons**
(2) neutrons, only (4) protons and electrons

2521 Which atom has a mass of approximately two atomic mass units?
(1) $^{1}_{1}H$ (3) $^{3}_{2}H$
(2) $^{2}_{1}H$ (4) $^{4}_{2}He$

1648 What is the mass number of an atom that consists of 20 protons, 20 neutrons, and 18 electrons?
(1) 18 (3) 38
(2) 20 **(4) 40**

1536 The atomic mass of an atom is measured in atomic mass units. This unit is based on
(1) ^{1}H (3) ^{16}O
(2) ^{14}N **(4) ^{12}C**

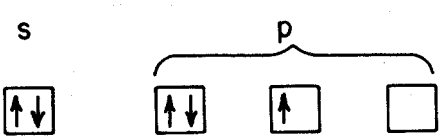
1431 What is the mass number of a $^{3}_{1}H$ atom?
(1) 1 **(3) 3**
(2) 2 (4) 4

1267 An atomic mass unit is defined as exactly
(1) $\frac{1}{12}$ the mass of a ^{12}C (3) $\frac{1}{16}$ the mass of a ^{16}O atom
atom
(2) $\frac{1}{14}$ the mass of a ^{14}N atom (4) $\frac{1}{19}$ the mass of a ^{19}F atom

1206 What is a possible mass number of a sodium atom, Na?
(1) 1 (3) 12
(2) 11 **(4) 23**

1093 A particle has a mass of 1.0 atomic mass unit. What is the approximate mass of this particle in grams?
(1) 1.0 g **(3) 1.7×10^{-24} g**
(2) 2.0 g (4) 6.0×10^{-23} g

3064 Which electron notation represents the valence electrons of a phosphorus atom in the ground state?

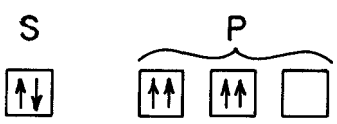
(1) 

(2) 

(3) 

(4) 

2960 Which orbital notation correctly represents the outermost principal energy level of oxygen in the ground state?

(1) 

(2) 

(3) 

(4) 

1949 What is the total number of partially occupied 2*p* orbitals in a nitrogen atom in the ground state?

(1) 1 **(3) 3**
(2) 2 (4) 5

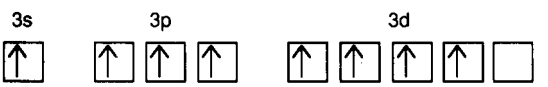
1597 What is the total number of orbitals in a *p* sublevel

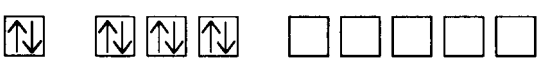
(1) 1 **(3) 3**
(2) 2 (4) 4

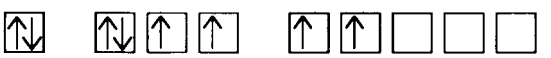
1476 In an atom of lithium in the ground state, what is the total number of orbitals that contain only 1 electron?

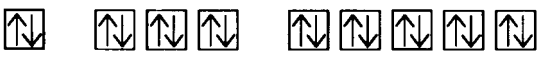
(1) 1 (3) 3
(2) 2 (4) 4

2180 Which is the orbital notation for the electrons in the third principal energy level of an argon atom in the ground state?

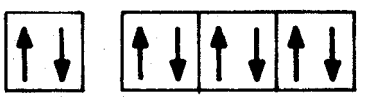
(1) 

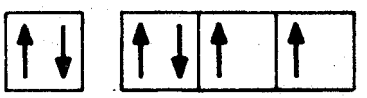
(2) 

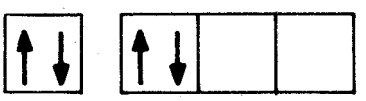
(3) 

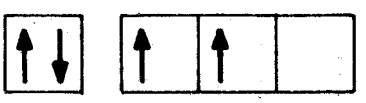
(4) 

1724 Which orbital notation represents the second principal energy level of a silicon atom in the ground state?

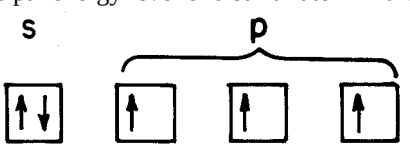
(1) 

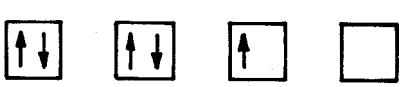
(2) 

(3) 

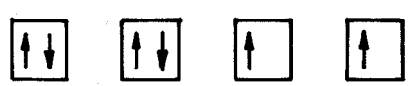
(4) 

1432 Which orbital notation correctly represents the outermost principal energy level of a sulfur atom in the ground state?

(1) 

(2) 

(3) 

(4) 

6959 Which substance can *not* be broken down by a chemical change?
(1) methane
(2) propanal
(3) tungsten
(4) water

6856 Which Group 14 element is classified as a metal?
(1) carbon
(2) germanium
(3) silicon
(4) tin

6763 An element that has a low first ionization energy and good conductivity of heat and electricity is classified as a
(1) metal
(2) metalloid
(3) nonmetal
(4) noble gas

6709 A sample of an element is malleable and can conduct electricity. This element could be
(1) H
(2) He
(3) S
(4) Sn

6600 An element that is malleable and a good conductor of heat and electricity could have an atomic number of
(1) 16
(2) 18
(3) 29
(4) 35

6108 Which two characteristics are associated with metals?
(1) low first ionization energy and low electronegativity
(2) low first ionization energy and high electronegativity
(3) high first ionization energy and low electronegativity
(4) high first ionization energy and high electronegativity

5822 Which element is malleable and can conduct electricity in the solid phase?
(1) iodine
(2) phosphorus
(3) sulfur
(4) tin

5747 Which substance can *not* be decomposed by ordinary chemical means?
(1) methane
(2) mercury
(3) ethanol
(4) ammonia

5655 The elements located in the lower left corner of the Periodic Table are classified as
(1) metals
(2) nonmetals
(3) metalloids
(4) noble gases

5573 Which element is malleable and conducts electricity?
(1) iron
(2) iodine
(3) sulfur
(4) phosphorus

5316 Which statement describes a chemical property of iron?
(1) Iron can be flattened into sheets.
(2) Iron conducts electricity and heat.
(3) Iron combines with oxygen to form rust.
(4) Iron can be drawn into a wire.

5251 Which of these elements is the best conductor of electricity?
(1) S
(2) N
(3) Br
(4) Ni

5191 The element in Period 4 and Group 1 of the Periodic Table would be classified as a
(1) metal
(2) metalloid
(3) nonmetal
(4) noble gas

5234 What is a property of most metals?
(1) They tend to gain electrons easily when bonding.
(2) They tend to lose electrons easily when bonding.
(3) They are poor conductors of heat.
(4) They are poor conductors of electricity.

4890 Which of the following Group 15 elements has the greatest metallic character?
(1) nitrogen
(2) phosphorus
(3) antimony
(4) bismuth

3547 Which element has properties of electrical conductivity and luster and exists as a liquid at STP?
(1) Hg
(2) Br
(3) C
(4) I

3418 Which element is malleable and ductile?
(1) S
(2) Si
(3) Ge
(4) Au

3131 At STP, which of the following substances is the best conductor of electricity?
(1) hydrogen
(2) mercury
(3) oxygen
(4) helium

2919 Metallic substances will conduct electricity in
(1) the solid phase, only
(2) the liquid phase, only
(3) both the solid and the liquid phase
(4) neither the solid nor the liquid phase

2692 Which substance is the best conductor of electricity?
(1) nitrogen
(2) neon
(3) sulfur
(4) silver

1546 In which section of the Periodic Table are the most active metals located?
(1) upper right corner
(2) lower right corner
(3) upper left corner
(4) lower left corner

1543 Which property is generally characteristic of metallic elements?
(1) low electrical conductivity
(2) high heat conductivity
(3) existence as brittle solids
(4) existence as molecular solids

873 The *least* active metal of those represented below has an electron configuration abbreviated as
(1) 2-8-2
(2) 2-8-8-2
(3) 2-8-18-8-2
(4) 2-8-18-18-2

370 Which of the following elements has the most pronounced metallic properties?
(1) C
(2) Al
(3) Co
(4) Rb

22 Which element is considered malleable?
(1) gold
(2) hydrogen
(3) sulfur
(4) radon

74 Atoms of metallic elements tend to
(1) gain electrons and form negative ions
(2) gain electrons and form positive ions
(3) lose electrons and form negative ions
(4) lose electrons and form positive ions

2688 An atom of which of the following elements has the greatest ability to attract electrons?
(1) silicon
(3) nitrogen
(2) sulfur
(4) bromine

2670 As atoms of elements in Group 16 are considered in order from top to bottom, the electronegativity of each successive element
(1) decreases
(3) remains the same
(2) increases

2305 Which element is most likely to gain electrons in a chemical reaction?
(1) Kr
(3) Ca
(2) Br
(4) Ba

2249 Of all the elements, the one with the highest electronegativity is found in Period
(1) 1
(3) 3
(2) 2
(4) 4

2190 Atoms of which of the following elements have the strongest attraction for electrons?
(1) aluminum
(3) silicon
(2) chlorine
(4) sodium

2016 An element with an electronegativity of 3.2 is most likely classified as a
(1) metal
(3) semimetal (metalloid)
(2) nonmetal
(4) noble gas

1966 Atoms of which of the following elements have the greatest tendency to gain electrons?
(1) O
(3) I
(2) Cs
(4) Sn

1900 The greatest difference in electronegativity between an element in Group 2 and an element in Group 16 occurs in Period
(1) 5
(3) 3
(2) 2
(4) 4

1899 Which element in Period 2 has the greatest tendency to form a negative ion?
(1) lithium
(3) neon
(2) carbon
(4) fluorine

1721 Which of the following atoms has the greatest tendency to gain electrons?
(1) Al
(3) I
(2) Rb
(4) F

1482 What is the electronegativity value for an element whose atoms in the ground state have an electron configuration of 2-8-8-1?
(1) 0.8
(3) 100
(2) 0.9
(4) 419

1444 Which element in Period 2 has the greatest tendency to gain electrons?
(1) Li
(3) F
(2) C
(4) Ne

1054 As the elements in Period 3 are considered from left to right, they tend to
(1) lose electrons more readily and increase in metallic character
(2) lose electrons more readily and increase in nonmetallic character
(3) gain electrons more readily and increase in metallic character
(4) gain electrons more readily and increase in nonmetallic character

986 As the elements Li to F in Period 2 of the Periodic Table are considered in succession, how do the relative electronegativity and the covalent radius of each successive element compare?
(1) The relative electronegativity decreases, and the atomic radius decreases.
(2) The relative electronegativity decreases, and the atomic radius increases.
(3) The relative electronegativity increases, and the atomic radius decreases.
(4) The relative electronegativity increases, and the atomic radius increases.

599 Within Period 4 of the Periodic Table, which of the following groups contains the element with the highest electronegativity?
(1) 1
(3) 15
(2) 2
(4) 17

487 In which group of elements do the atoms gain electrons most readily?
(1) 1
(3) 16
(2) 2
(4) 18

424 Which element in Period 3 has the greatest tendency to gain electrons?
(1) Na
(3) Cl
(2) Si
(4) Ar

390 Elements that readily gain electrons tend to have
(1) high ionization energy and high electronegativity
(2) high ionization energy and low electronegativity
(3) low ionization energy and low electronegativity
(4) low ionization energy and high electronegativity

371 The Group 17 element with the highest electronegativity is
(1) fluorine
(3) bromine
(2) chlorine
(4) iodine

129 Which atom has the strongest attraction for electrons?
(1) Cl
(3) Br
(2) F
(4) I

24 Element *M* has an electronegativity of less than 1.2 and reacts with bromine to form the compound MBr_2. Element *M* could be
(1) Al
(3) Ca
(2) Na
(4) K

4438 A sample of an unknown gas at STP has a density of 1.25 grams per liter. What is the gram molecular mass of this gas?
(1) 28.0 g (3) 64.0 g
(2) 44.0 g (4) 80.0 g

4091 What is the gram molecular mass of a gas that has a density of 5.00 grams per liter at STP?
(1) 27.4 g **(3) 112 g**
(2) 56.0 g (4) 223 g

3975 The density of a gas is 1.43 grams per liter at STP. The mass of 1 mole of this gas is equal to
(1) 1.43 g (3) 22.4 g
(2) 15.7 g **(4) 32.0 g**

3741 What is the mass of 1 mole of a gas that has a density of 2.00 grams per liter at STP?
(1) 11.2 g (3) 33.6 g
(2) 22.4 g **(4) 44.8 g**

3474 If 11 grams of a gas occupies 5.6 liters at STP, what is its gram molecular mass?
(1) 11 g/mol **(3) 44 g/mol**
(2) 22 g/mol (4) 88 g/mol

3358 Which gas has a density of 1.70 grams per liter at
(1) F_2(g) (3) N_2(g)
(2) He(g) (4) SO_2(g)

3244 The density of a gas is 0.77 gram per liter at STP. What is the formula mass of the gas?
(1) 8.5 g (3) 29 g
(2) 17 g (4) 34 g

3135 Which of the following gases has the greatest density at STP?
(1) SO_2 **(3) Cl_2**
(2) CO_2 (4) N_2

3038 What is the molecular mass of a gas whose density is 1.25 grams per liter at STP?
(1) 14.0 (3) 20.0
(2) 17.9 **(4) 28.0**

2932 An 80 gram sample of a gas has a volume of 44.8 liters at STP. Its molecular mass is
(1) 80 (3) 30
(2) 20 **(4) 40**

2929 Air consists of approximately 79% nitrogen and 19% oxygen. Which gas is more dense than air at STP?
(1) ammonia (3) carbon monoxide
(2) methane **(4) carbon dioxide**

2812 Which gas has approximately the same density as C_2H_6 at STP?
(1) NO (3) H_2S
(2) NH_3 (4) SO_2

2597 The gram-molecular mass of a gas is 56 grams. Its density at STP in grams per liter is
(1) 1.0 **(3) 2.5**
(2) 5.6 (4) 0.40

2490 Eleven grams of a gas occupies 5.6 liters at STP. What is the molecular mass of this gas?
(1) 11 **(3) 44**
(2) 22 (4) 88

2435 Air consists of approximately 79% nitrogen and 19% oxygen. Which gas is *less* dense than air at STP?
(1) CO_2 **(3) NH_3**
(2) H_2S (4) SO_2

1971 If 28.0 grams of a gas occupies 22.4 liters at STP, the gas could be
(1) CO (3) C_2H_2
(2) CO_2 (4) C_2H_6

1908 At STP, 25.0 liters of a gas has a mass of 50.0 grams. What is the gram molecular mass of the gas?
(1) 75.0 g (3) 25.0 g
(2) 44.8 g (4) 11.2 g

1667 What is the gram-molecular mass of a gas that has a density of 1.78 grams per liter at STP?
(1) 17.8 g **(3) 39.9 g**
(2) 22.4 g (4) 79.6 g

1394 What is the density, in grams per liter, of N_2 gas at STP?
(1) 28.0 **(3) 1.25**
(2) 14.0 (4) 0.800

1345 What is the molecular mass of a gas whose density is 1.4 grams per liter at STP?
(1) 16 **(3) 31**
(2) 22 (4) 38

1288 What is the mass of 1.00 mole of a gas if 28.0 grams of this gas occupies 22.4 liters at STP?
(1) 1.00 g (3) 22.4 g
(2) 1.25 g **(4) 28.0 g**

1109 A sample of an unknown gas at STP has a density of 0.630 gram per liter. What is the gram molecular mass of this gas?
(1) 2.81 g (3) 22.4 g
(2) 14.1 g (4) 63.0 g

723 If the density of gas *X* at STP is 1.00 gram per liter, the mass of a mole of this gas is
(1) 1.00 g (3) 11.2 g
(2) 2.00 g **(4) 22.4 g**

660 At STP, what is the density of a gas that has a gram molecular mass of 32 grams?
(1) 0.70 g/L (3) 3.2 g/L
(2) 2.0 g/L **(4) 1.4 g/L**

543 Which gas has a density of 1.52 grams per liter at STP?
(1) H_2S (3) NO
(2) CH_4 (4) CO

79 If the density of a gas at STP is 2.50 grams per liter, what is the gram molecular mass of the gas?
(1) 2.50 **(3) 56.0**
(2) 22.4 (4) 89.6

2010 Given the unbalanced equation:

$$Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$$

What is the coefficient in front of the H_2O when the equation is completely balanced using the smallest whole number coefficients?

(1) 6 (3) 3
(2) 2 (4) 4

1844 Given the unbalanced equation:

$$\_\_C_3H_8(g) + \_\_O_2(g) \rightarrow \_\_H_2O(g) + \_\_CO_2(g)$$

When the equation is completely balanced using smallest whole numbers, the coefficient of O_2 is

(1) 5 (3) 3
(2) 2 (4) 10

1657 When the equation

$$\_\_H_2O_2 \rightarrow \_\_H_2O + \_\_O_2$$

is completely balanced, the sum of all the coefficients will be

(1) 5 (3) 3
(2) 8 (4) 4

1606 Given the unbalanced equation:

$$\_\_Al_2(SO_4)_3 + \_\_Ca(OH)_2 \rightarrow \_\_Al(OH)_3 + \_\_CaSO_4$$

What is the coefficient in front of the $CaSO_4$ when the equation is completely balanced with the smallest whole-number coefficients?

(1) 1 **(3) 3**
(2) 2 (4) 4

1384 When the equation

$$\_\_H_2 + \_\_N_2 \rightarrow \_\_NH_3$$

is completely balanced using smallest whole numbers, the sum of all the coefficients will be

(1) 6 (3) 3
(2) 7 (4) 12

1276 When the equation

$$\_\_C_2H_6 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$$

is correctly balanced, the coefficient in front of O_2 will be

(1) 7 (3) 3
(2) 10 (4) 4

866 When the equation

$$\_Fe_2O_3(s) + \_CO(g) \rightarrow \_Fe(l) + \_CO_2(g)$$

is correctly balanced using the smallest whole numbers, the coefficient of Fe(*l*) is

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

708 When the equation

$$\_\_Ca(ClO_3)_2 \rightarrow \_\_CaCl_2 + \_\_O_2$$

is correctly balanced, the coefficient in front of the O_2 will be

(1) 1 **(3) 3**
(2) 2 (4) 4

530 Given the unbalanced equation:

$$\_\_Li + \_\_N_2 \rightarrow \_\_Li_3N$$

When the equation is correctly balanced using smallest whole numbers, the coefficient of the lithium is

(1) 1 (3) 3
(2) 2 **(4) 6**

415 When the equation

$$\_\_Al(s) + \_\_O_2(g) \rightarrow \_\_Al_2O_3(s)$$

is correctly balanced using smallest whole numbers, the sum of the coefficients will be

(1) 9 (3) 3
(2) 7 (4) 12

244 When the equation

$$\_\_Al(s) + \_\_O_2(g) \rightarrow \_\_Al_2O_3(s)$$

is correctly balanced using the smallest whole numbers, the coefficient of Al(s) is

(1) 1 (3) 3
(2) 2 **(4) 4**

159 When the equation

$$\_\_NH_3 + \_\_O_2 \rightarrow \_\_N_2 + \_\_H_2O$$

is completely balanced using the smallest whole numbers, the coefficient of the O_2 will be

(1) 1 **(3) 3**
(2) 2 (4) 4

6984 Which element forms an ionic compound when it reacts with lithium?
(1) K (3) Kr
(2) Fe **(4) Br**

6775 An ionic compound is formed when there is a reaction between the elements
(1) strontium and chlorine (3) nitrogen and oxygen
(2) hydrogen and chlorine (4) sulfur and oxygen

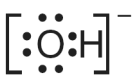
6526 The bonds in BaO are best described as
(1) covalent, because valence electrons are shared
(2) covalent, because valence electrons are transferred
(3) ionic, because valence electrons are shared
(4) ionic, because valence electrons are transferred

6391 Which compound contains both ionic and covalent bonds?
(1) ammonia **(3) sodium nitrate**
(2) methane (4) potassium chloride

6305 When sodium and fluorine combine to produce the compound NaF, the ions formed have the same electron configuration as atoms of
(1) argon, only (3) both argon and neon
(2) neon, only (4) neither argon nor neon

6198 Which formula represents an ionic compound?
(1) H_2 (3) CH_3OH
(2) CH_4 **(4) NHCl**

6028 Which Lewis electron-dot diagram correctly represents a hydroxide ion?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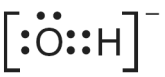
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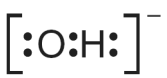

(2)


(4)

5914 Which substance contains bonds that involved the transfer of electrons from one atom to another?
(1) CO_2 **(3) KBr**
(2) NH_3 (4) Cl_2

5828 Which type of bond results when one or more valence electrons are transferred from one atom to another?
(1) a hydrogen bond
(2) an ionic bond
(3) a nonpolar covalent bond
(4) a polar covalent bond

5746 Which type of bond is found in sodium bromide?
(1) covalent **(3) ionic**
(2) hydrogen (4) metallic

5745 Compared to a calcium atom, the calcium ion Ca^{2+} has
(1) more protons (3) more electrons
(2) fewer protons **(4) fewer electrons**

5664 What occurs when an atom loses an electron?
(1) The atom's radius decreases and the atom becomes a negative ion.
(2) The atom's radius decreases and the atom becomes a positive ion.
(3) The atom's radius increases and the atom becomes a negative ion.
(4) The atom's radius increases and the atom becomes a positive ion.

5577 As a chlorine atom becomes a negative ion, the atom
(1) gains an electron and its radius increases
(2) gains an electron and its radius decreases
(3) loses an electron and its radius increases
(4) loses an electron and its radius decreases

5493 Which compound contains both ionic and covalent bonds?
(1) $CaCO_3$ (3) MgF_2
(2) PCl_3 (4) CH_2O

5328 Which sample contains particles in a rigid, fixed, geometric pattern?
(1) $CO_2(aq)$ (3) $H_2O(\ell)$
(2) HCl(g) **(4) KCl(s)**

5165 Which type of bond is formed when electrons are transferred from one atom to another?
(1) covalent (3) hydrogen
(2) ionic (4) metallic

4944 Which formula represents an ionic compound?
(1) NaCl (3) HCl
(2) N_2O (4) H_2O

4861 Which compound contains ionic bonds?
(1) NO **(3) CaO**
(2) NO_2 (4) CO_2

4761 Which statement best describes the substance that results when electrons are transferred from a metal to a nonmetal?
(1) It contains ionic bonds and has a low melting point.
(2) It contains ionic bonds and has a high melting point.
(3) It contains covalent bonds and has a low melting point.
(4) It contains covalent bonds and has a high melting point.

4558 A neutral atom with the electron configuration 2-6 would most likely form a bond with an atom having the configuration
(1) 2 (3) 2-8
(2) 2-2 (4) 2-8-8

4481 Which kind of compound generally results when nonmetal atoms chemically combine with metal atoms?
(1) hydrogen (3) covalent
(2) ionic (4) metallic

4430 Which elements combine by forming an ionic bond?
(1) sodium and potassium (3) carbon and oxygen
(2) sodium and oxygen (4) carbon and sulfur

6447 Solid $ZnCl_2$ and liquid $ZnCl_2$ have different
(1) empirical formulas (3) ion ratios
(2) formula masses **(4) physical properties**

6367 Which equation represents a physical change?
(1) $H_2O(s) + 6.01\ kJ \rightarrow H_2O(\ell)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 483.6\ kJ$
(3) $H_2(g) + I_2(g) + 53.0\ kJ \rightarrow 2HI(g)$
(4) $N_2(g) + 2O_2(g) + 66.4\ kJ \rightarrow 2NO_2(g)$

6276 Which statement describes a chemical property of hydrogen gas?
(1) Hydrogen gas burns in air.
(2) Hydrogen gas is colorless.
(3) Hydrogen gas has a density of 0.000 09g/cm^3 at STP.
(4) Hydrogen gas has a boiling point of 20. K at standard pressure.

6193 Which statement describes a chemical property of the element magnesium?
(1) Magnesium is malleable.
(2) Magnesium conducts electricity.
(3) Magnesium reacts with an acid.
(4) Magnesium has a high boiling point.

5918 Which statement best describes the shape and volume of an aluminum cylinder at STP?
(1) It has a definite shape and a definite volume.
(2) It has a definite shape and no definite volume.
(3) It has no definite shape and a definite volume.
(4) It has no definite shape and no definite volume.

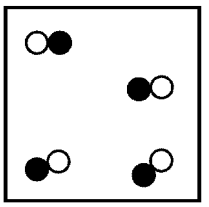
5913 Which process is a chemical change?
(1) melting of ice (3) subliming of ice
(2) boiling of water **(4) decomposing of water**

5739 Which statement describes a chemical property of oxygen?
(1) Oxygen has a melting point of 55 K.
(2) Oxygen can combine with a metal to produce a compound.
(3) Oxygen gas is slightly soluble in water.
(4) Oxygen gas can be compressed.

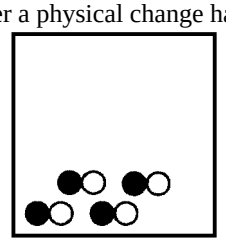
5694 Which set of procedures and observations indicates a chemical change?
(1) Ethanol is added to an empty beaker and the ethanol eventually disappears.
(2) A solid is gently heated in a crucible and the solid slowly turns to liquid.
(3) Large crystals are crushed with a mortar and pestle and become powder.
(4) A cool, shiny metal is added to water in a beaker and rapid bubbling occurs.

5498 Which form of energy is converted to thermal energy when propane burns in air?
(1) electromagnetic (3) electrical
(2) nuclear **(4) chemical**

5766 Given the particle diagram representing four molecules of a substance:



Which particle diagram best represents this same substance after a physical change has taken place?



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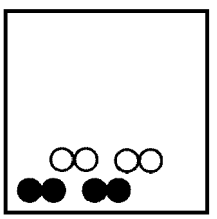

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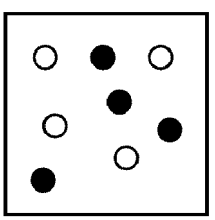

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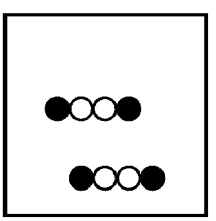


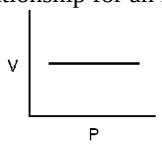
(4)

5572 An example of a physical property of an element is the element's ability to
(1) react with an acid
(2) react with oxygen
(3) form a compound with chlorine
(4) form an aqueous solution

5500 Which transfer of energy occurs when ice cubes are placed in water that has a temperature of 45°C?
(1) Chemical energy is transferred from the iceto the water.
(2) Chemical energy is transferred from the water to the ice.
(3) Thermal energy is transferred from the ice to the water.
(4) Thermal energy is transferred from the water to the ice.

5492 Which statement describes a chemical property that can be used to distinguish between compound A and compound B?
(1) A is a blue solid, and B is a white solid.
(2) A has a high melting point, and B has a low melting point.
(3) A dissolves in water, and B does not dissolve in water.
(4) A does not burn in air, and B does burn in air

5271 Which graph best represents the pressure-volume relationship for an ideal gas at constant temperature?



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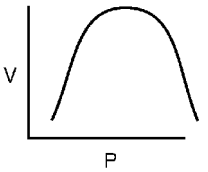

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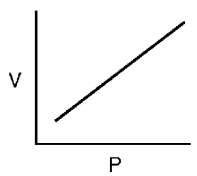

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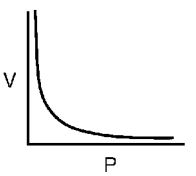


(4)

5046 A gas occupies a volume of 40.0 milliliters at 20°C. If the volume is increased to 80.0 milliliters at constant pressure, the resulting temperature will be equal to

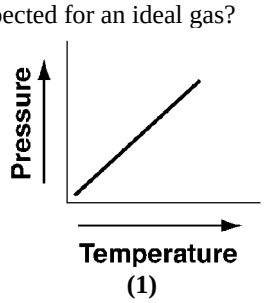
$20°C \times \frac{80.0mL}{40.0mL}$
(1)

$293K \times \frac{80.0mL}{40.0mL}$
(3)

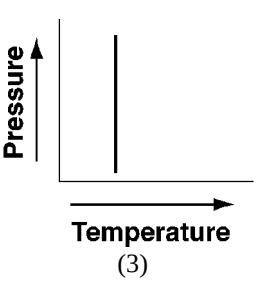
$20°C \times \frac{40.0mL}{80.0mL}$
(2)

$293K \times \frac{40.0mL}{80.0mL}$
(4)

4872 Which graph shows the pressure-temperature relationship expected for an ideal gas?



(1)



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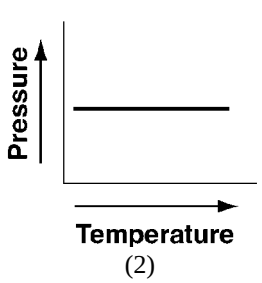

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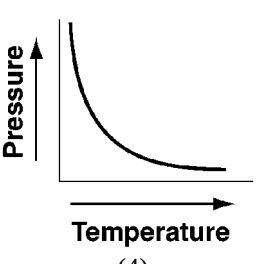


(4)

4820 A 3.00-liter sample of gas is at 288 K and 1.00 atm. If the pressure of the gas is increased to 2.00 atm and its volume is decreased to 1.50 liters, the Kelvin temperature of the sample will be

(1) 144 K
(2) 288 K
(3) 432 K
(4) 576 K

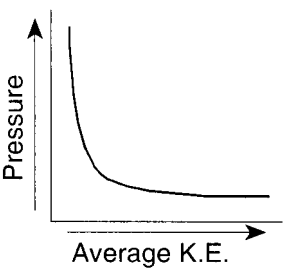
4803 Which temperature change would cause the volume of a sample of an ideal gas to double when the pressure of the sample remains the same?

(1) from 200ºC to 400ºC
(2) from 400ºC to 200ºC
(3) from 200 K to 400 K
(4) from 400 K to 200 K

4798 As the temperature of a gas increases at constant pressure, the volume of the gas

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

4688 Which graph best shows the relationship between the pressure of a gas and its average kinetic energy at constant volume?

(1)


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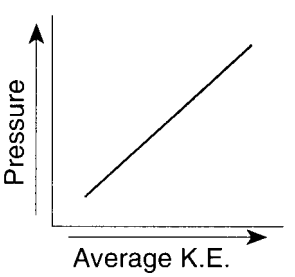

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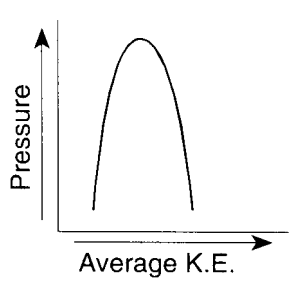

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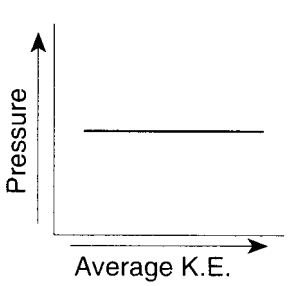


4415 As the temperature of a given sample of a gas decreases at constant pressure, the volume of the gas

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

6801 Which solution has the highest boiling point at standard pressure?

(1) 0.10 M KCl(aq)
(3) 0.10 M K_3PO_4(aq)
(2) 0.10 M K_2SO_4(aq)
(4) 0.10 M KNO_3(aq)

6696 How do the boiling point and freezing point of a solution of water and calcium chloride at standard pressure compare to the boiling point and freezing point of water at standard pressure?

(1) Both the freezing point and boiling point of the solution are higher.
(2) Both the freezing point and boiling point of the solution are lower.
(3) The freezing point of the solution is higher and the boiling point of the solution is lower.
(4) The freezing point of the solution is lower and the boiling point of the solution is higher.

6614 Compared to the freezing point and boiling point of water at 1 atmosphere, a solution of a salt and water at 1 atmosphere has a

(1) lower freezing point and a lower boiling point
(2) lower freezing point and a higher boiling point
(3) higher freezing point and a lower boiling point
(4) higher freezing point and a higher boiling point

6473 Which aqueous solution of KI freezes at the lowest temperature?

(1) 1 mol of KI in 500. g of water
(2) 2 mol of KI in 500. g of water
(3) 1 mol of KI in 1000. g of water
(4) 2 mol of KI in 1000. g of water

6398 Which solution has the lowest freezing point?

(1) 10. g of KI dissolved in 100. g of water
(2) 20. g of KI dissolved in 200. g of water
(3) 30. g of KI dissolved in 100. g of water
(4) 40. g of KI dissolved in 200. g of water

6010 Compared to a 2.0 M aqueous solution of NaCl at 1 atmosphere, a 3.0 M aqueous solution of NaCl at 1 atmosphere has a

(1) lower boiling point and a higher freezing point
(2) lower boiling point and a lower freezing point
(3) higher boiling point and a higher freezing point
(4) higher boiling point and a lower freezing point

5764 Compared to the freezing point of 1.0 M KCl(aq) at standard pressure, the freezing point of 1.0 M $CaCl_2$(aq) at standard pressure is

(1) lower
(3) the same
(2) higher

877 Which concentration of a solution of CH_3OH in water has the *lowest* freezing point?

(1) 0.1 M
(3) 0.001 M
(2) 0.01 M
(4) 0.0001 M

5581 Compared to a 0.1 M aqueous solution of NaCl, a 0.8 M aqueous solution of NaCl has a

(1) higher boiling point and a higher freezing point
(2) higher boiling point and a lower freezing point
(3) lower boiling point and a higher freezing point
(4) lower boiling point and a lower freezing point

5242 Compared to pure water, an aqueous solution of calcium chloride has a

(1) higher boiling point and higher freezing point
(2) higher boiling point and lower freezing point
(3) lower boiling point and higher freezing point
(4) lower boiling point and lower freezing point

5098 At standard pressure when NaCl is added to water, the solution will have a

(1) higher freezing point and a lower boiling point than water
(2) higher freezing point and a higher boiling point than water
(3) lower freezing point and a higher boiling point than water
(4) lower freezing point and a lower boiling point than water

5020 What occurs when NaCl(s) is added to water?

(1) The boiling point of the solution increases, and the freezing point of the solution decreases.
(2) The boiling point of the solution increases, and the freezing point of the solution increases.
(3) The boiling point of the solution decreases, and the freezing point of the solution decreases.
(4) The boiling point of the solution decreases, and the freezing point of the solution increases.

4207 As a solute is added to a solvent, what happens to the freezing point and the boiling point of the solution?

(1) The freezing point decreases and the boiling point decreases.
(2) The freezing point decreases and the boiling point increases.
(3) The freezing point increases and the boiling point decreases.
(4) The freezing point increases and the boiling point increases.

2810 When ethylene glycol (an antifreeze) is added to water, the boiling point of the water

(1) decreases, and the freezing point decreases
(2) decreases, and the freezing point increases
(3) increases, and the freezing point decreases
(4) increases, and the freezing point increases

5412 At STP, which 4.0-gram zinc sample will react fastest with dilute hydrochloric acid?
(1) lump **(3) powdered**
(2) bar (4) sheet metal

5329 Given the reaction at 25°C:
$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
The rate of this reaction can be increased by using 5.0 grams of powdered zinc instead of a 5.0-gram strip of zinc because the powdered zinc has
(1) lower kinetic energy **(3) more surface area**
(2) lower concentration (4) more zinc atoms

4279 Given the reaction:
$Fe(s) + 2\ HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$
In this reaction, 5 grams of powdered iron will react faster than a 1-gram piece of solid iron because the powdered iron
(1) has less surface area (3) is less dense
(2) has more surface area (4) is more dense

4158 A 1.0-gram sample of powdered Zn reacts faster with HCl than a single 1.0-gram piece of Zn because the atoms in powdered Zn have
(1) higher average kinetic energy
(2) lower average kinetic energy
(3) more contact with the H^+ ions in the acid
(4) less contact with the H^+ ions in the acid

3928 An increase in the surface area of reactants in a heterogeneous reaction will result in
(1) a decrease in the rate of the reaction
(2) an increase in the rate of the reaction
(3) a decrease in the heat of reaction
(4) an increase in the heat of reaction

3697 Beaker *A* contains a 1 gram piece of zinc and beaker *B* contains 1 gram of powdered zinc. If 100 milliliters of 0.1 M HCl is added to each of the beakers, how does the rate of reaction in beaker *A* compare to the rate of reaction in beaker *B*?
(1) The rate in *A* is greater due to the smaller surface area of the zinc.
(2) The rate in *A* is greater due to the larger surface area of the zinc.
(3) The rate in *B* is greater due to the smaller surface area of the zinc.
(4) The rate in *B* is greater due to the larger surface area of the zinc.

497 Four aluminum samples are each reacted with separate 1 M copper sulfate solutions under the same conditions of temperature and pressure. Which aluminum sample would react most rapidly?
(1) 1 gram bar of Al (3) 1 gram of Al pellets
(2) 1 gram of Al ribbon **(4) 1 gram of Al powder**

610 When a single 1-gram piece of zinc is added to 3 M hydrochloric acid at 25ºC, the reaction is slow. Which procedure would most likely increase the rate of reaction if the reaction were repeated?
(1) using 1 gram of powdered zinc
(2) using 1 M hydrochloric acid
(3) decreasing the temperature to 20.ºC
(4) decreasing the concentration of the zinc

3111 As the surface area of the Zn(s) used in the reaction
$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
is increased, the rate of the reaction will
(1) decrease (3) remain the same
(2) increase

2730 Base your answer to the following question on the table below, which represents the production of 50 milliliters of CO_2 in the reaction of HCl with $NaHCO_3$. Five trials were performed under different conditions as shown. (The same mass of $NaHCO_3$ was used in each trial.)

Trial	Particle Size of $NaHCO_3$	Concentration of HCl	Temperature (°C) of HCl
A	small	1 M	20
B	large	1 M	20
C	large	1 M	40
D	small	2 M	40
E	large	2 M	40

Which trial would produce the fastest reaction?
(1) trial *A* (3) trial *C*
(2) trial *B* **(4) trial *D***

1743 Charcoal reacts with oxygen according to the equation
$C(s) + O_2(g) \rightarrow CO_2(g)$.
Which of the following changes would cause the greatest increase in the rate of reaction?
(1) decreasing the concentration of $O_2(g)$
(2) decreasing the pressure of $O_2(g)$
(3) using charcoal in powdered form
(4) using charcoal in lump form

1229 Given the reaction:
$CuSO_4(s) \leftrightarrow Cu^{2+}(aq) + SO^{2-}(aq)$
The $CuSO_4(s)$ dissolves more rapidly when it is powdered because the increased surface area due to powdering permits
(1) increased solvent contact
(2) increased solute solubility
(3) the equilibrium to shift to the left
(4) the equilibrium to shift to the right

1061 Which statement explains why the speed of some chemical reactions is increased when the surface area of the reactant is increased?
(1) This change increases the density of the reactant particles.
(2) This change increases the concentration of the reactant.
(3) This change exposes more reactant particles to a possible collision.
(4) This change alters the electrical conductivity of the reactant particles.

4443 The change in the free energy of a reaction (ΔG) is equal to
(1) $T\Delta H - \Delta S$
(3) $\Delta H - T\Delta S$
(2) $T\Delta H + \Delta S$
(4) $\Delta H + T\Delta S$

4329 Which compound forms spontaneously from its elements at 1 atm and 298 K?
(1) $C_2H_2(g)$
(3) HF(g)
(2) $C_2H_4(g)$
(4) HI(g)

3981 According to Reference Table U, which reaction spontaneously forms a compound from its elements?
(1) $H_2(g) + I_2(g) \rightarrow 2\ HI(g)$
(2) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$
(3) $N_2(g) + O_2(g) \rightarrow 2\ NO(g)$
(4) $N_2(g) + 2\ O_2(g) \rightarrow 2\ NO_2(g)$

3746 According to Reference Table U, which compound is spontaneously formed even though the reaction is endothermic?
(1) ICl(g)
(3) $H_2O(\ell)$
(2) $CO_2(g)$
(4) $Al_2O_3(s)$

3481 Given the equation:

$$\Delta G = \Delta H - T\Delta S$$

The ΔS represents a change in
(1) entropy
(3) enthalpy
(2) free energy
(4) temperature

3427 Based on Reference Table U, which compound forms spontaneously under standard conditions?
(1) NaCl
(3) C_2H_4
(2) HI
(4) NO_2

3361 According to Reference Table U, which compound will form spontaneously from its elements?
(1) ethene
(3) nitrogen (II) oxide
(2) hydrogen iodide
(4) magnesium oxide

3246 According to Reference Table U, which compound will form spontaneously from its elements?
(1) nitrogen (IV) oxide
(3) hydrogen iodide
(2) ethene
(4) potassium chloride

3140 According to Reference Table U, which substance will form spontaneously from its elements in their standard states at 1 atmosphere and 298 K?
(1) ethene
(3) hydrogen iodide
(2) ethyne
(4) hydrogen fluoride

3028 According to Reference Table U, which of the following compounds is the most stable?
(1) CO(g)
(3) NO(g)
(2) $CO_2(g)$
(4) $NO_2(g)$

2990 For a given chemical reaction, ΔG will always be negative if ΔH is
(1) negative and $T\Delta S$ is negative
(2) negative and $T\Delta S$ is positive
(3) positive and $T\Delta S$ is negative
(4) positive and $T\Delta S$ is positive

2934 Based on Reference Table U, the compound which could form spontaneously under standard conditions from its elements is
(1) HF
(3) NO
(2) HI
(4) NO_2

2816 Based on Reference Table U, which compound will form spontaneously from its elements?
(1) carbon dioxide (g)
(3) ethene (g)
(2) nitrogen (II) oxide (g)
(4) ethyne (g)

2702 Which reaction will occur spontaneously? [Refer to Reference Table U.]
(1) $\frac{1}{2}\ N_2(g) + \frac{1}{2}\ O_2(g) \rightarrow NO(g)$
(2) $\frac{1}{2}\ N_2(g) + O_2(g) \rightarrow NO_2(g)$
(3) $2\ C(s) + 3\ H_2(g) \rightarrow C_2H_6(g)$
(4) $2\ C(s) + 2\ H_2(g) \rightarrow C_2H_4(g)$

2548 According to Reference Table U, which compound will form spontaneously from its elements at 1 atmosphere and 298 K?
(1) NO
(3) C_2H_4
(2) NO_2
(4) ICl

2497 A chemical reaction is most likely to occur spontaneously if the
(1) free energy change (ΔG) is negative
(2) entropy change (ΔS) is negative
(3) activation energy (E) is positive
(4) heat of reaction (ΔH) is positive

2141 What is the free energy change for a system at equilibrium?
(1) one
(3) zero
(2) greater than one
(4) less than zero

2026 The change in free energy, ΔG, of a chemical reaction is equal to
(1) $\Delta T + \Delta S$
(3) $\Delta H \times T\Delta S$
(2) $\Delta H - T\Delta S$
(4) $\Delta H \div T\Delta S$

1796 Which pair of changes would indicate that a reaction is endothermic but occurs spontaneously?
(1) a positive ΔH and a positive ΔG
(2) a positive ΔH and a negative ΔG
(3) a negative ΔH and a positive ΔG
(4) a negative ΔH and a negative ΔG

1793 According to Reference Table U, which compound forms spontaneously from its elements?
(1) C_2H_4
(3) NO_2
(2) C_2H_2
(4) CO_2

1226 In the free energy equation

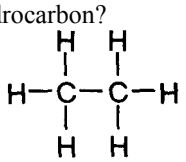
$$\Delta G = \Delta H - T\Delta S,$$

the symbol T refers to
(1) time in seconds
(3) Celsius temperature
(2) time in hours
(4) Kelvin temperature

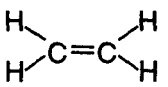
4295 The formula for a saturated hydrocarbon is
(1) C_6H_6 (3) C_6H_{12}
(2) C_6H_{10} **(4) C_6H_{14}**

4294 In which group could the hydrocarbons all belong to the same alkene series?
(1) C_2H_2, C_2H_4, C_2H_6 (3) C_2H_4, C_2H_6, C_3H_6
(2) C_2H_2, C_2H_4, C_4H_8 **(4) C_2H_4, C_3H_6, C_4H_8**

4178 Which structural formula represents a saturated hydrocarbon?



(1)



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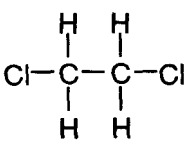

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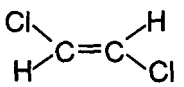
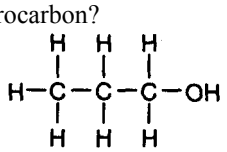


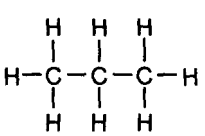
(4)

4115 Natural gas is mostly comprised of
(1) butane **(3) methane**
(2) ethane (4) propane

3947 Which structural formula represents a saturated hydrocarbon?



(1)



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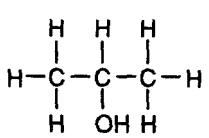

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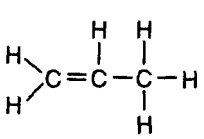


(4)

3879 Which pair of names refers to the same compound?
(1) ethyne and acetylene (3) ethane and acetylene
(2) ethyne and ethene (4) ethane and ethene

3644 Ethane, ethene, and ethyne are all similar in that they are
(1) hydrocarbons (3) saturated
(2) unsaturated compounds (4) cyclic compounds

3643 Which compound is a hydrocarbon?
(1) CH_3I (3) CH_3COOH
(2) CH_3OCH_3 **(4) CH_3CH_3**

3641 What is the geometric shape of a methane molecule?
(1) triangular (3) octahedral
(2) rectangular **(4) tetrahedral**

3610 Molecules of 2-methyl-propane and *n*-butane differ in their
(1) structural formulas
(2) molecular formulas
(3) number of carbon atoms
(4) number of covalent bonds

3608 As the number of carbon atoms in each successive member of a homologous hydrocarbon series increases, the number of possible isomers
(1) decreases (3) remains the same
(2) increases

3448 A hydrocarbon molecule is considered to be saturated if the molecule contains
(1) single covalent bonds, only
(2) a double covalent bond, only
(3) a triple covalent bond
(4) single and double covalent bonds

3447 Which formula represents butane?
(1) CH_3CH_3 **(3) $CH_3CH_2CH_2CH_3$**
(2) $CH_3CH_2CH_3$ (4) $CH_3CH_2CH_2CH_2CH_3$

3107 Which of the following compounds has the greatest possible number of isomers?
(1) butane **(3) pentane**
(2) ethane (4) propane

3007 Which compound is a member of the alkane series?
(1) C_2H_6 (3) C_4H_6
(2) C_3H_6 (4) C_6H_6

3006 What is the total number of carbon atoms contained in an ethyl group?
(1) 1 (3) 3
(2) 2 (4) 4

2952 Which molecule contains ten hydrogen atoms?
(1) butane (3) propane
(2) butene (4) propene

2714 The compound C_4H_{10} belongs to the series of hydrocarbons with the general formula
(1) C_nH_{2n} (3) C_nH_{2n-2}
(2) C_nH_{2n+2} (4) C_nH_{2n-6}

2669 Which compound is a saturated hydrocarbon?
(1) methane (3) ethyne
(2) ethene (4) ethanol

2616 The total number of covalent bonds in a molecule of C_3H_8 is
(1) 11 (3) 3
(2) 10 (4) 8

2567 All carbon-carbon bonds in a saturated hydrocarbon molecule are
(1) single covalent (3) triple covalent
(2) double covalent (4) coordinate covalent

2340 Which alkane has isomers?
(1) methane (3) propane
(2) ethane **(4) butane**

3651 The class of organic compounds to which $C_3H_5(OH)_3$ belongs is called
(1) bases **(3) alcohols**
(2) acids (4) hydrocarbons

3629 The compound 2-propanol is classified as a
(1) primary alcohol (3) tertiary alcohol
(2) secondary alcohol (4) dihydroxy alcohol

3628 What is the formula for pentanol?
(1) C_5H_{12} (3) C_4H_{10}
(2) $C_5H_{11}OH$ (4) C_4H_9OH

3627 Which two compounds are monohydroxy alcohols?
(1) ethylene glycol and ethanol
(2) ethylene glycol and glycerol
(3) methanol and ethanol
(4) methanol and glycerol

3626 The formula $C_5H_{11}OH$ represents an
(1) acid (3) ether
(2) ester **(4) alcohol**

3625 How many hydroxy groups (–OH) does a primary alcohol molecule contain?
(1) 1 (3) 3
(2) 2 (4) 4

3624 When the name of an alcohol is derived from the corresponding alkane, the final "–e" of the name of the alkane should be replaced by the suffix
(1) "–al" (3) "–ane"
(2) "–ol" (4) "–ase"

3623 What could be the name of a compound that has the general formula R–OH?
(1) methanol (3) methanoic acid
(2) methane (4) methyl methanoate

3622 Which class of organic compounds can be represented as R–OH?
(1) acids (3) esters
(2) alcohols (4) ethers

3621 Which formula represents an alcohol?
(1) CH_3COOH (3) $Ca(OH)_2$
(2) CH_3CHO **(4) CH_3OH**

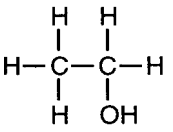
3609 Molecules of 1-propanol and 2-propanol have different
(1) percentage compositions (3) molecular formulas
(2) molecular masses **(4) structural formulas**

3587 Which compound is a dihydroxy alcohol?
(1) $Al(OH)_2$ (3) $C_3H_5(OH)_3$
(2) $Al(OH)_3$ **(4) $C_2H_4(OH)_2$**

3377 Which organic compound is classified as a primary alcohol?
(1) ethylene glycol (3) glycerol
(2) ethanol (4) 2-butanol

3261 Which formula represents 1,2-ethanediol?
(1) $C_2H_4(OH)_2$ (3) $Ca(OH)_2$
(2) $C_3H_5(OH)_3$ (4) $Co(OH)_3$

3492 Which structural formula represents a dihydroxy alcohol?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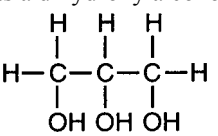
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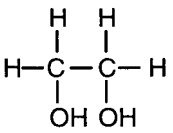
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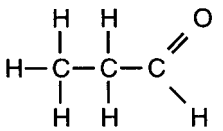
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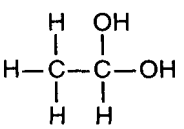
3378 What is the structural formula for 1,2-ethanediol?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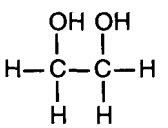
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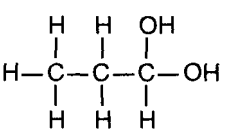
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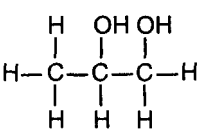
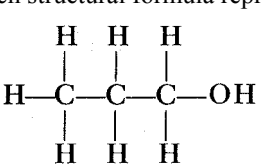

(4)

3157 Which structural formula represents a secondary alcohol?

(1)


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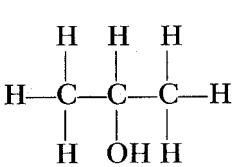

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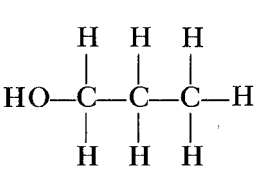

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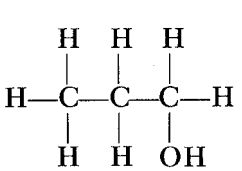
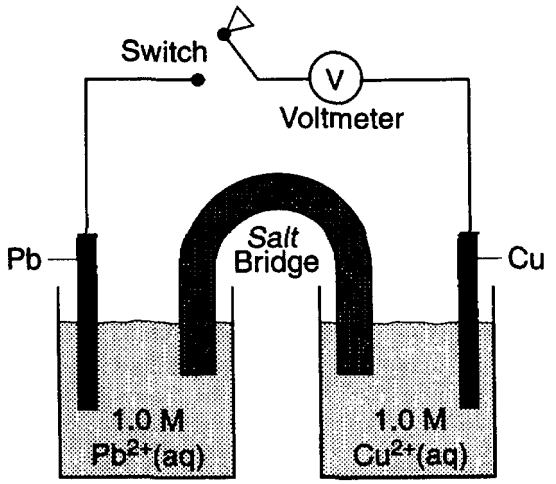


3989 Base your answer to the following question on the diagram of a chemical cell and the equation below. The reaction occurs at 1 atmosphere and 298 K.



$Pb(s) + Cu^{2+}(aq) \longrightarrow Pb^{2+}(aq) + Cu(s)$

Which change occurs when the switch is closed?

(1) Pb is oxidized, and electrons flow to the Cu electrode.
(2) Pb is reduced, and electrons flow to the Cu electrode.
(3) Cu is oxidized, and electrons flow to the Pb electrode.
(4) Cu is reduced, and electrons flow to the Pb electrode.

3951 Given the redox reaction:

$$2\ NaCl(\ell) \rightarrow 2\ Na(\ell) + Cl_2(g)$$

As the Cl^- is oxidized, the oxidation number of chlorine will
(1) decrease (3) remain the same
(2) increase

3942 Given the cell reaction:

$$Ca(s) + Mg^{2+}(aq) \rightarrow Ca^{2+}(aq) + Mg(s)$$

Which substance was oxidized?
(1) Ca(s) (3) $Ca^{2+}(aq)$
(2) $Mg^{2+}(aq)$ (4) Mg(s)

3758 Given the redox reaction:

$$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$$

Which species acts as the oxidizing agent?
(1) Cu(s) (3) Mg(s)
(2) $Cu^{2+}(aq)$ (4) $Mg^{2+}(aq)$

3449 In a chemical reaction, as a species is oxidized, its oxidation number
(1) decreases (3) remains the same
(2) increases

3825 Given the reaction:

$$4\ HCl(aq) + MnO_2(s) \rightarrow MnCl_2(aq) + 2\ H_2O(\ell) + Cl_2(g)$$

The manganese is
(1) reduced and its oxidation number changes from +4 to +2
(2) reduced and its oxidation number changes from +2 to +4
(3) oxidized and its oxidation number changes from +4 to +2
(4) oxidized and its oxidation number changes from +2 to +4

3712 Given the reaction:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Which substance is oxidized?
(1) Zn(s) (3) $Cl^-(aq)$
(2) HCl(aq) (4) $H^+(aq)$

3442 Which half-reaction correctly represents oxidation?
(1) $Sn^{2+} + 2e^- \rightarrow Sn^0$ (3) $Sn^{2+} \rightarrow Sn^0 + 2e^-$
(2) $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ **(4) $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$**

3372 Given the reaction:

$$2\ Li(s) + Cl_2(g) \rightarrow 2\ LiCl(s)$$

As the reaction takes place, the $Cl_2(g)$ will
(1) gain electrons (3) gain protons
(2) lose electrons (4) lose protons

3324 Given the redox reaction:

$$2\ I^-(aq) + Br_2(\ell) \rightarrow 2\ Br^-(aq) + I_2(s)$$

What occurs during this reaction?

(1) The I^- ion is oxidized, and its oxidation number increases.
(2) The I^- ion is oxidized, and its oxidation number decreases.
(3) The I^- ion is reduced, and its oxidation number increases.
(4) The I^- ion is reduced, and its oxidation number decreases.

3215 In the reaction:

$$Cl_2 + H_2O \rightarrow HClO + HCl,$$

the hydrogen is
(1) oxidized, only
(2) reduced, only
(3) both oxidized and reduced
(4) neither oxidized nor reduced

4465 Metals from which groups are obtained by the reduction of their fused salts?
(1) Group 1 and Group 2 (3) Group 2 and Group 11
(2) Group 1 and Group 12 (4) Group 11 and Group 12

4350 Which metal can be produced only by the electrolysis of its fused salt?
(1) Ag (3) Pb
(2) Zn **(4) K**

4118 Which metal is produced by the electrolytic reduction of its fused salt?
(1) Fe **(3) K**
(2) Zn (4) Cr

3999 Which metals are obtained by electrolysis of their fused salts?
(1) Ka and Ca (3) Cu and Zn
(2) Ka and Cr (4) Cu and Hg

3886 Which element is obtained only by the electrolysis of its fused salt?
(1) lithium (3) silver
(2) gold (4) zinc

3352 Which metal is most likely obtained by the electrolysis of its fused salt?
(1) Au **(3) Li**
(2) Ag (4) Zn

3052 Which occurs in an electrolytic cell containing $CuCl_2(aq)$?
(1) Cu^{2+} ions migrate toward the positive electrode.
(2) Cl^- ions migrate toward the negative electrode.
(3) Cu^{2+} ions are reduced.
(4) Cl^- ions are reduced.

2571 Given the chemical cell:

$Zn, Zn^{2+}(1M)$ and $Cu^{2+}(1M), Cu$

As the reaction in this cell takes place, the mass of the copper electrode
(1) decreases (3) remains the same
(2) increases

1931 Which metal is obtained from its fused salt by electrolysis?
(1) Ca (3) Pb
(2) Cr (4) Pt

1813 Which metal is usually produced by the electrolysis of its fused salt?
(1) iron **(3) sodium**
(2) copper (4) lead

1691 A metal that is usually obtained from its fused compound by electrolytic reduction is
(1) copper (3) zinc
(2) iron **(4) sodium**

1358 In the electrolysis of molten $CaCl_2$, the particle reduced is
(1) Cl^- (3) Ca^0
(2) C^0 **(4) Ca^{2+}**

1683 Which occurs at the cathode during the electrolysis of fused KCl?
(1) the oxidation of K^+ ion (3) the oxidation of Cl^- ion
(2) the reduction of K^+ ion (4) the reduction of Cl^- ion

1637 For which chemical reaction must an electrolytic cell be used?
(1) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
(2) $Cu + FeCl_2 \rightarrow CuCl_2 + Fe$
(3) $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$
(4) $2\ Al + 3\ Ni(NO_3)_2 \rightarrow 2\ Al(NO_3)_3 + 3\ Ni$

1464 During the electrolysis of fused NaCl, which half-reaction occurs at the negative electrode?
(1) $Na^+ + 1e^- \rightarrow Na^0$ (3) $2\ Cl^- \rightarrow Cl_2^0 + 2e^-$
(2) $Na^0 \rightarrow Na^+ + 1e^-$ (4) $Cl_2^0 + 2e^- \rightarrow 2\ Cl^-$

1248 Which metals are produced commercially only by electrolysis of their fused salts?
(1) Sr and Cr (3) Li and Ni
(2) Be and Fe **(4) Na and Ca**

1019 Group 1 and Group 2 metals are obtained commercially from their fused compounds by
(1) reduction with CO (3) reduction with Al
(2) reduction by heat **(4) electrolytic reduction**

558 Which equation represents the half-cell reaction that occurs at the negative electrode during the electrolysis of fused calcium chloride?
(1) $Ca^{2+} \rightarrow Ca(s) + 2e^-$ (3) $2\ Cl^- + 2e^- \rightarrow Cl_2(g)$
(2) $Ca^{2+} + 2e^- \rightarrow Ca(s)$ (4) $2\ Cl^- \rightarrow Cl_2(g) + 2e^-$

453 The metals in Group 1 (I*A*) are obtained commercially from their fused salts by
(1) electrolysis with electricity
(2) decomposing with heat
(3) reduction with carbon
(4) reduction with aluminum

336 Which group of metals is normally obtained by the electrolysis of their fused salts?
(1) Group 17 (VII*A*) (3) Group 7 (VII*B*)
(2) Group 2 (II*A*) (4) Group 4 (IVB)

94 Which half-reaction occurs at the cathode in an electrolytic cell in which an object is being plated with copper?
(1) $Cu(s) \rightarrow Cu^{2+} + 2e^-$ (3) $Cu^{2+} \rightarrow Cu(s) + 2e^-$
(2) $Cu(s) + 2e^- \rightarrow Cu^{2+}$ **(4) $Cu^{2+} + 2e^- \rightarrow Cu(s)$**

4830 An example of a nonelectrolyte is
(1) $C_6H_{12}O_6(aq)$
(2) $K_2SO_4(aq)$
(3) NaCl(aq)
(4) HCl(aq)

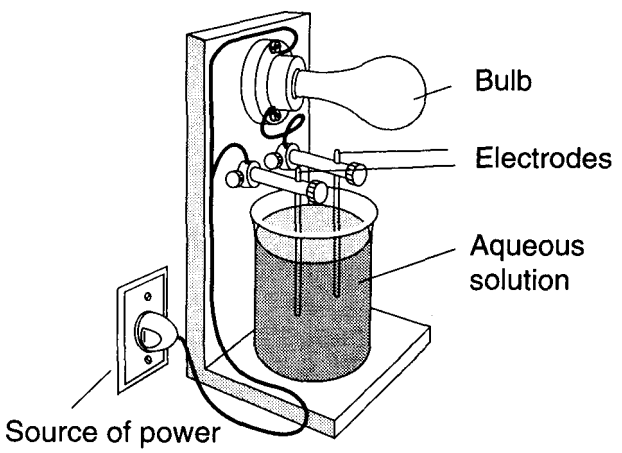
4780 Based on Reference Table *F*, which salt is the strongest electrolyte?
(1) $CaCO_3$
(2) Na_2SO_4
(3) AgCl
(4) $Zn_3(PO_4)_2$

4452 Which compound is a nonelectrolyte?
(1) HNO_3
(2) H_2SO_4
(3) NaOH
(4) CH_3OH

4220 Which compound is classified as an electrolyte?
(1) $C_6H_{12}O_6$
(2) $C_{12}H_{22}O_{11}$
(3) CH_3OH
(4) $Ca(OH)_2$

3867 Which formula represents a compound that is a strong electrolyte?
(1) $C_6H_{12}O_6$
(2) $C_{12}H_{22}O_{11}$
(3) HNO_2
(4) HNO_3

3751 The diagram below shows an apparatus used to test the conductivity of various materials.



Which aqueous solution will cause the bulb to light?
(1) $C_6H_{12}O_6(aq)$
(2) $C_{12}H_{22}O_{11}(aq)$
(3) $CH_3OH(aq)$
(4) LiOH(aq)

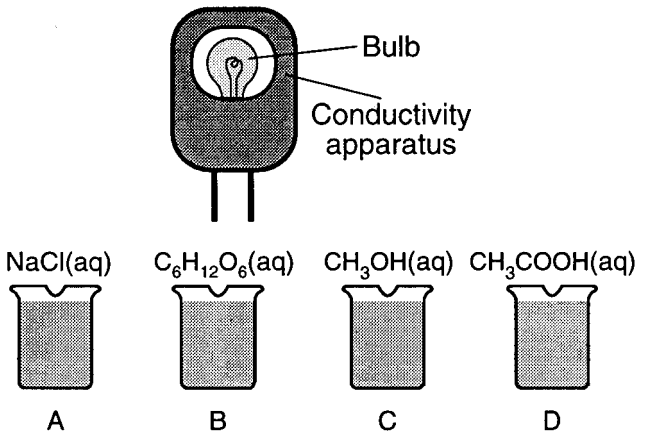
3435 Which compound will conduct an electric current when dissolved in water?
(1) NaOH
(2) C_2H_5OH
(3) $C_6H_{12}O_6$
(4) $C_{12}H_{22}O_{11}$

3098 Water containing dissolved electrolyte conducts electricity because the solution contains mobile
(1) electrons
(2) molecules
(3) atoms
(4) ions

2424 Which sample of HCl most readily conducts electricity?
(1) HCl(s)
(2) HCl(ℓ)
(3) HCl(g)
(4) HCl(aq)

1983 Which compound is a nonelectrolyte?
(1) KOH
(2) HNO_3
(3) $CaCl_2$
(4) $C_{12}H_{22}O_{11}$

3508 Beakers *A*, *B*, *C*, and *D* shown below each contain a different solution.



The bulb will glow when the conductivity apparatus is placed into which beakers?
(1) *A* and *B*
(2) *B* and *C*
(3) *A* and *D*
(4) *C* and *D*

2245 Which of the following liquids is the best conductor of electricity?
(1) $CCl_4(\ell)$
(2) $H_2O(\ell)$
(3) $CH_3OH(\ell)$
(4) NaOH(aq)

2212 Which of the following 0.1 M solutions is the best conductor of electricity?
(1) $H_2S(aq)$
(2) HCl(aq)
(3) $C_6H_{12}O_6(aq)$
(4) $C_{12}H_{22}O_{11}(aq)$

1507 Based on Reference Table V, which 0.1 M aqueous solution is the best conductor of electricity?
(1) HI
(2) HNO_2
(3) H_2S
(4) H_3PO_4

1334 Which compound, in the liquid phase, conducts electricity best?
(1) H_2O
(2) H_2S
(3) NH_3
(4) NaOH

1302 Which compound is a nonelectrolyte?
(1) NH_3
(2) CH_3OH
(3) KBr
(4) HCl

1234 Which is a characteristic of an aqueous solution of HNO_3?
(1) It conducts electricity.
(2) It forms OH^- ions.
(3) It turns litmus blue.
(4) It turns phenolphthalein pink.

503 Which compounds are both classified as electrolytes?
(1) NH_4Cl and KCl
(2) $C_6H_{12}O_6$ and CH_3OH
(3) NH_4Cl and $C_6H_{12}O_6$
(4) KCl and CH_3OH

269 Which of the following is the best conductor of electricity?
(1) NaCl(s)
(2) NaCl(aq)
(3) $C_6H_{12}O_6(s)$
(4) $C_6H_{12}O_6(aq)$

6908 Which compound is produced when HCl(aq) is neutralized by $Ca(OH)_2(aq)$?
(1) $CaCl_2$ (3) HClO
(2) CaH_2 (4) $HClO_2$

6620 Which word equation represents a neutralization reaction?
(1) base + acid → salt + water
(2) base + salt → water + acid
(3) salt + acid → base + water
(4) salt + water → acid + base

6314 What are the products of a reaction between KOH(aq) and HCl(aq)?
(1) H_2 and KClO (3) KH and HClO
(2) H_2O and KCl (4) KOH and HCl

6037 Given the balanced equation representing a reaction:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$$

Which type of reaction is represented by this equation?
(1) decomposition (3) single replacement
(2) neutralization (4) synthesis

5933 Which equation represents a neutralization reaction?
(1) $4Fe(s) + 3O_2(g) \rightarrow Fe_2O_3(s)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$
(3) $HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(\ell)$
(4) $AgNO_3(aq) + KCl(aq) \rightarrow KNO_3(aq) + AgCl(s)$

5867 Which reactants form the salt $CaSO_4(s)$ in a neutralization reaction?
(1) $H_2S(g)$ and $Ca(ClO_4)_2(s)$
(2) $H_2SO_3(aq)$ and $Ca(NO_3)_2(aq)$
(3) $H_2SO_4(aq)$ and $Ca(OH)_2(aq)$
(4) $SO_2(g)$ and CaO(s)

5614 Sulfuric acid, $H_2SO_4(aq)$, can be used to neutralize barium hydroxide, $Ba(OH)_2(aq)$. What is the formula for the salt produced by this neutralization?
(1) BaS (3) $BaSO_3$
(2) $BaSO_2$ **(4) $BaSO_4$**

5528 Given the reaction:

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2\,H_2O(\ell) + \text{energy}$$

As the barium hydroxide solution is added to the solution of sulfuric acid, the electrical conductivity of the acid solution decreases because the
(1) volume of the reaction mixture increases
(2) temperature of the reaction mixture decreases
(3) concentration of ions increases
(4) concentration of ions decreases

5340 Which compound could serve as a reactant in a neutralization reaction?
(1) NaCl (3) CH_3OH
(2) KOH (4) CH_3CHO

5184 Which reaction occurs when hydrogen ions react with hydroxide ions to form water?
(1) substitution (3) ionization
(2) saponification **(4) neutralization**

5105 Which equation represents a neutralization reaction?
(1) $Na_2CO_3 + CaCl_2 \rightarrow 2\,NaCl + CaCO_3$
(2) $Ni(NO_3)_2 + H_2S \rightarrow NiS + 2\,HNO_3$
(3) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
(4) $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2\,H_2O$

4883 Given the reaction:

$$HCl(aq) + LiOH(aq) \rightarrow HOH(\ell) + LiCl(aq)$$

The reaction is best described as
(1) neutralization (3) decomposition
(2) synthesis (4) oxidation-reduction

4832 Which type of reaction will produce water and a salt?
(1) saponification (3) esterification
(2) fermentation **(4) neutralization**

4783 Which reaction represents the process of neutralization?
(1) $Mg(s) + 2\,HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
(2) $HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(\ell)$
(3) $Pb(NO_3)_2(aq) + CaCl(aq) \rightarrow Ca(NO_3)_2(aq) + PbCl_2(s)$
(4) $2\,KClO_3(s) \rightarrow KCl(s) + 3\,O_2(g)$

4778 Equal volumes of 0.1 M NaOH and 0.1 M HCl are thoroughly mixed. The resulting solution has a pH closest to
(1) 5 (3) 3
(2) 7 (4) 9

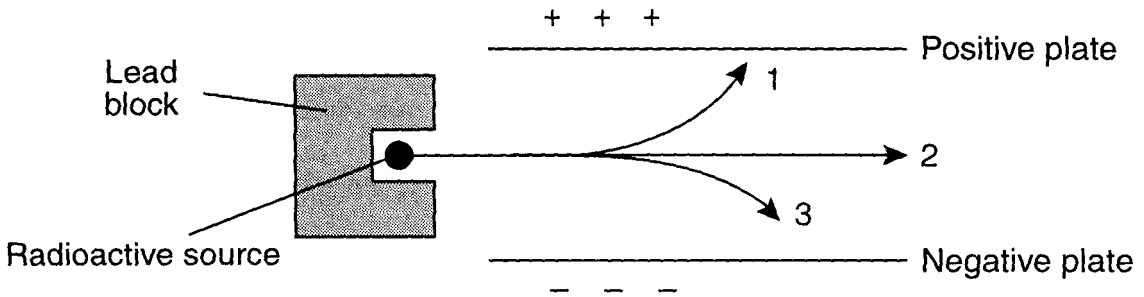
4404 Which reaction occurs when equivalent quantities of H^+ (or H_3O^+) and OH^- are mixed?
(1) oxidation (3) hydrolysis
(2) reduction **(4) neutralization**

4282 What is the pH of a solution that results from the complete neutralization of an HCl solution with a KOH solution?
(1) 1 (3) 10
(2) 7 (4) 4

4181 As an acid solution is added to neutralize a base solution, the OH^- concentration of the base solution
(1) decreases (3) remains the same
(2) increases

3433 Which compound is a salt?
(1) $NaNO_3$ (3) CH_3COOH
(2) H_3PO_4 (4) $Ca(OH)_2$

4804 The diagram below represents radioactive emanations passing through an electric field.



Which type of emanation is represented by the arrow labeled 1?
(1) alpha particle **(2) beta particle** (3) positron (4) gamma ray

6788 Which radioisotope has an atom that emits a particle with a mass number of 0 and a charge of +1?
(1) ^{3}H **(3) ^{19}Ne**
(2) ^{16}N (4) ^{239}Pu

6707 Which particle is emitted from a hydrogen-3 nucleus when it undergoes radioactive decay?
(1) α (3) β^{+}
(2) β^{-} (4) γ

6624 A beta particle may be spontaneously emitted from
(1) a ground-state electron (3) an excited electron
(2) a stable nucleus **(4) an unstable nucleus**

6383 Which particle is emitted when an atom of ^{85}Kr spontaneously decays?
(1) an alpha particle (3) a neutron
(2) a beta particle (4) a proton

6297 Which two radioisotopes have the same decay mode?
(1) ^{37}Ca and ^{53}Fe (3) ^{37}K and ^{42}K
(2) ^{220}Fr and ^{60}Co (4) ^{99}Tc and ^{19}Ne

6213 What is the decay mode of ^{37}K?
(1) β^{-} (3)
(2) β^{+} (4) a

5934 Which notation of a radioisotope is correctly paired with the notation of its emission particle?
(1) ^{37}Ca and $^{4}_{2}He$ (3) ^{16}N and $^{1}_{1}p$
(2) ^{235}U and $^{0}_{+1}e$ **(4) ^{3}H and $^{0}_{-1}e$**

5758 Positrons are spontaneously emitted from the nuclei of
(1) potassium-37 (3) nitrogen-16
(2) radium-226 (4) thorium-232

5597 Which equation represents positron decay?
(1) $^{87}_{37}Rb \rightarrow {}^{0}_{-1}e + {}^{87}_{38}Sr$ (3) $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$
(2) $^{277}_{92}U \rightarrow {}^{223}_{90}Th + {}^{4}_{2}He$ **(4) $^{11}_{6}C \rightarrow {}^{0}_{+1}e + {}^{11}_{5}B$**

5257 Which equation represents a spontaneous nuclear decay?
(1) $C + O_2 \rightarrow CO_2$ (3) $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$
(2) $H_2CO_3 \rightarrow CO_2 + H_2O$ **(4) $^{90}_{38}Sr \rightarrow {}^{0}_{-1}e + {}^{90}_{39}Y$**

5532 Given the nuclear equation:

$$^{19}_{10}Ne \rightarrow X + {}^{19}_{9}F$$

What particle is represented by *X*?
(1) alpha (3) neutron
(2) beta **(4) positron**

5187 Given the nuclear reaction:

$$^{60}_{27}Co \rightarrow {}^{0}_{-1}e + {}^{60}_{28}Ni$$

This reaction is an example of
(1) fission (3) artificial transmutation
(2) fusion **(4) natural transmutation**

5186 Alpha particles and beta particles differ in
(1) mass, only **(3) both mass and charge**
(2) charge, only (4) neither mass nor charge

5124 In the reaction $^{239}_{93}Np \rightarrow {}^{239}_{94}Pu + X$, what does *X* represent?
(1) a neutron (3) an alpha particle
(2) a proton **(4) a beta particle**

5021 Which radioisotope is a beta emitter?
(1) ^{90}Sr (3) ^{37}K
(2) ^{220}Fr (4) ^{238}U

4850 When cobalt-60 undergoes nuclear decay, it emits
(1) a positron **(3) a beta particle**
(2) a neutron (4) an alpha particle

4301 As ^{14}C decays to ^{14}N, the number of protons in the nucleus
(1) decreases (3) remains the same
(2) increases

4192 A carbon-14 atom spontaneously decayed to form a nitrogen-14 atom. This change took place because
(1) a transmutation occurred without particle emission
(2) a transmutation occurred with particle emission
(3) nitrogen-14 has an unstable nucleus
(4) carbon-14 has a stable nucleus

6891 A sample of an element has a mass of 34.261 grams and a volume of 3.8 cubic centimeters. To which number of significant figures should the calculated density of the sample be expressed?
(1) 5 (3) 3
(2) 2 (4) 4

6720 Which quantity of heat is equal to 200. joules?
(1) 20.0 kJ **(3) 0.200 kJ**
(2) 2.00 kJ (4) 0.0200 kJ

6470 A temperature of 37°C is equivalent to a temperature of
(1) 98.6 K **(3) 310. K**
(2) 236 K (4) 371 K

6225 Which kelvin temperature is equal to 56°C?
(1) –329 K (3) 217 K
(2) –217 K **(4) 329 K**

5861 Which kelvin temperature is equivalent to –24ºC?
(1) 226 K (3) 273 K
(2) 249 K (4) 297 K

5444 A student calculates the density of an unknown solid. The mass is 10.04 grams, and the volume is 8.21 cubic centimeters. How many significant figures should appear in the final answer?
(1) 1 **(3) 3**
(2) 2 (4) 4

4905 Which mass measurement contains four significant figures?
(1) 0.086 g **(3) 1003 g**
(2) 0.431 g (4) 3870 g

4856 Expressed to the correct number of significant figures, the sum of two masses is 445.2 grams. Which two masses produce this answer?
(1) 210.10 g + 235.100 g **(3) 210.1 g + 235.1 g**
(2) 210.100 g + 235.10 g (4) 210.10 g + 235.10 g

4694 During a laboratory experiment, a sample of aluminum is found to have a mass of 12.50 grams and a volume of 4.6 milliliters.

What is the density of this sample, expressed to the correct number of significant figures?
(1) 2.717 g/mL (3) 3 g/mL
(2) 2.72 g/mL **(4) 2.7 g/mL**

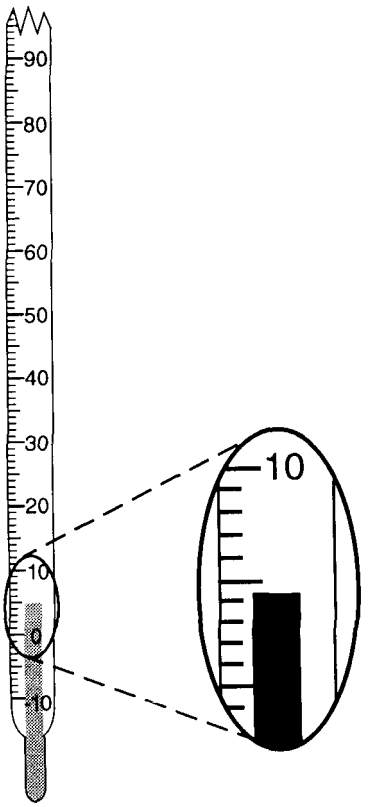
4514 Which quantity is equivalent to 50 kiloJoules?
(1) 5000 J (3) 5×10^3 J
(2) 0.05 J **(4) 5×10^4 J**

4509 One kiloJoule is the same as
(1) 0.001 Joule (3) 100 Joules
(2) 0.01 Joule **(4) 1,000 Joules**

4502 How many kiloJoules are equivalent to 10 Joules?
(1) 0.001 kJ (3) 1000 kJ
(2) 0.01 kJ (4) 10,000 kJ

3391 Which measurement contains three significant figures?
(1) 0.08 cm (3) 800 cm
(2) 0.080 cm **(4) 8.08 cm**

4855 The diagram below represents a Celsius thermometer recording a certian temperature.



What is the correct reading of the thermometer?
(1) 5ºC (3) 0.3ºC
(2) 4.3ºC (4) 4ºC

4474 The measurement 0.41006 gram, rounded to three significant figures, is expressed as
(1) 0.41 g (3) 0.4100 g
(2) 0.410 g (4) 0.4101 g

4361 A solution contains 12.55 grams of a solid dissolved in 50.0 milliliters of water. What is the number of grams of solid dissolved per milliliter of water, rounded to the correct number of significant figures?
(1) 0.25 g/mL (3) 0.3 g/mL
(2) 0.251 g/mL (4) 0.2510 g/mL

4243 Which measurement contains a total of three significant figures?
(1) 0.12 (3) 120
(2) 012 **(4) 120.**

4010 What is the product of (2.324 cm × 1.11 cm) expressed to the correct number of significant figures?
(1) 2.58 cm^2 (3) 2.5796 cm^2
(2) 2.5780 cm^2 (4) 2.57964 cm^2

348 Which measurement contains three significant figures?
(1) 0.05 g (3) 0.056 g
(2) 0.050 g **(4) 0.0563 g**