Honors Chemistry / SAT II

Table of Contents

I. STRUCTURE OF MATTER

II. STATES OF MATTER

VII. NUCLEAR CHEMISTRY

VIII. DESCRIPTIVE CHEMISTRY

UNIT I

STRUCTURE OF MATTER

2159. What is the shell configuration of electrons for neutral atoms of nickel, ${}_{28}Ni$, in the ground state?
(A) 2–8–16–2
(B) 2–8–10–8
(C) 2–8–8–10
(D) 2–18–8–0
(E) 2–8–16–28

2161. What is the electron shell configuration for ions of selenium, ${}_{34}Se^{2-}$?
(A) 2–8–18–6
(B) 2–8–18–8–2
(C) 2–8–18–4
(D) 2–8–18–8
(E) 2–8–14–12

2162. What is the electron shell configuration for calcium ions, Ca^{2+}?
(A) 2–8–8–2
(B) 2–8–8
(C) 2–8–8–4
(D) 2–8–6
(E) 2–8–6-2

2477. In the orbital notation $1s^2$ the *coefficient* 1 indicates that
(A) helium has 1 electron
(B) helium has an atomic number of 1
(C) helium has an atomic mass of 1
(D) helium has an energy level of 1
(E) helium has 1 neutron

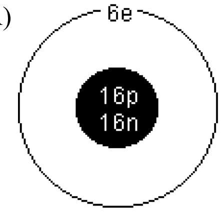
2478. The maximum number of electrons in the second energy level, n = 2, of any atom, is
(A) 8
(B) 2
(C) 16
(D) 4
(E) 6

2479. The maximum number of electrons that may be accommodated in the 4th energy level of any atom is
(A) 4
(B) 8
(C) 12
(D) 16
(E) 32

2480. The maximum number of electrons which can occupy the 3rd energy level of any atom is
(A) 2
(B) 8
(C) 9
(D) 12
(E) 18

2481. The maximum number of electrons which can occupy the 1st principal energy level of any atom is
(A) 8
(B) 2
(C) 10
(D) 18
(E) 4

2482. The Bohr energy shell representation for a neutral atom of sulfur, ${}^{32}_{16}S$, is

(A)


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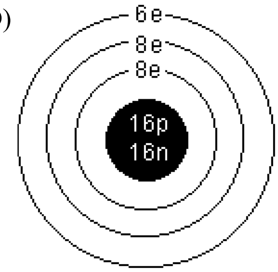

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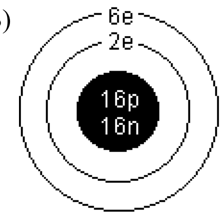

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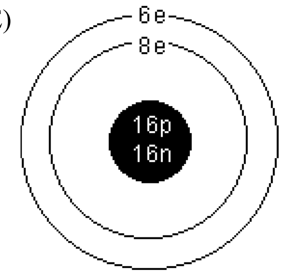

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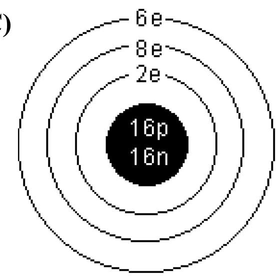


2483. "The atom consists of a nucleus containing subatomic particles and electrons arranged in concentric shells around the nucleus." This description most clearly fits the atomic theory proposed by
(A) Bohr
(B) Rutherford
(C) Dalton
(D) Thomson
(E) Avogadro

2487. The maximum number of electrons possible in the second energy level of an atom is
(A) 8
(B) 2
(C) 10
(D) 18
(E) 6

2488. The maximum numbers of electrons in the K, L, M, and N shells of any element are respectively
(A) 1, 2, 8, 16
(B) 1, 4, 9, 16
(C) 2, 8, 16, 24
(D) 2, 8, 18, 32
(E) 2, 6, 10, 14

2138. When an electron moves from the level where n=4 to the level where n=2, the change in energy is

Bohr Equation

$$E = \frac{-1312\ kJ \cdot mol^{-1}}{n^2}$$

(A) $+246.kJ\bullet mol^{-1}$
(B) $-246.kJ\bullet mol^{-1}$
(C) $+307.kJ\bullet mol^{-1}$
(D) $-307.kJ\bullet mol^{-1}$
(E) $-656.kJ\bullet mol^{-1}$

2139. When an electron moves from the level where n=3 to the level where n=1, the change in energy is

Bohr Equation

$$E = \frac{-1312\ kJ \cdot mol^{-1}}{n^2}$$

(A) $-874.kJ\bullet mol^{-1}$
(B) $+874.kJ\bullet mol^{-1}$
(C) $-1166.kJ\bullet mol^{-1}$
(D) $+1166.kJ\bullet mol^{-1}$
(E) $+ 656.kJ\bullet mol^{-1}$

2140. Movement of an electron from the 5^{th} to the 1^{st} energy level in an atom is:
(A) exothermic and absorbs energy.
(B) exothermic and evolves energy.
(C) endothermic and absorbs energy.
(D) endothermic and evolves energy.
(E) neither exothermic nor endothermic.

2141. Movement of an electron from the 4^{th} to the 8^{th} energy level in an atom is
(A) exothermic and absorbs energy
(B) exothermic and evolves energy
(C) endothermic and absorbs energy
(D) endothermic and evolves energy
(E) neither endothermic nor exothermic

2142. Sunlight, when viewed through a prism or a diffraction grating, shows all of the colors of visible light. This is an example of a
(A) bright line spectrum
(B) continuous spectrum
(C) infrared spectrum
(D) visible spectrum
(E) ultraviolet spectrum

2143. Neon light, when viewed through a prism or a diffraction grating, shows only certain colors of visible light. This is an example of a
(A) bright line spectrum
(B) continuous spectrum
(C) infrared spectrum
(D) visible spectrum
(E) absorbtion spectrum

2264. A single burst of visible light is released by an atom. Which is an explanation of what happened in the atom? An electron
(A) removed a proton from the nucleus
(B) was changed from a particle to a wave
(C) moved from a higher to a lower energy level
(D) moved from a lower to a higher energy level
(E) was released from the nucleus

2265. What is the mass number of a potassium ion, K^+, consisting of 18 electrons, 19 protons and 20 neutrons?
(A) 36
(B) 37
(C) 38
(D) 39
(E) 57

2485. The light from fluorescent lights, when analyzed in a spectrometer, exhibit the same lines in the yellow, green and blue spectral regions. This is evidence that
(A) fluorescent lights contain fluorine gas
(B) air is present in all fluorescent lights
(C) there are no gases present in fluorescent lights
(D) the same element is present in all the fluorescent lights
(E) different elements are present in each fluorescent light

2486. The colors of the spectral emission lines produced by the gas in a discharge tube are determined by the
(A) applied voltage
(B) pressure of the gas
(C) gas used in the tube
(D) temperature of the gas
(E) applied current

2989. Which of the following statements are *true*?

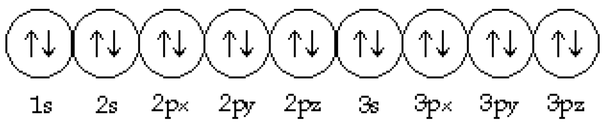
I. The energy of electromagnetic radiation increases as its frequency increases.
II. The energy of an atom is increased as it emits electromagnetic radiation.
III. An excited atom returns to its ground state by absorbing electromagnetic radiation.
IV. The frequency and wavelength of electromagnetic radiation are inversely proportional.
V. An electron in the n = 3 state in the hydrogen atom can go to the n = 1 state by emitting electromagnetic radiation at the appropriate frequency.

(A) II, III, and V only
(B) III and IV only
(C) I, II, and III only
(D) I, IV, and V only
(E) II, III, and V only

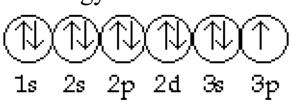
2500. The electronic configuration of the S^{2-} ion is
(A) $1s^22s^22p^63s^23p^2$
(B) $1s^22s^22p^63s^23p^4$
(C) $1s^22s^22p^63s^23p^5$
(D) $1s^22s^22p^63s^23p^6$
(E) $1s^22s^22p^63s^43p^4$

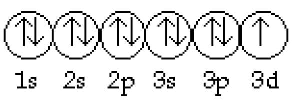
2501. The atomic number of an element whose electronic configuration is $1s^22s^22p^1$ is
(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

2502. Consider the orbital diagram



The species that does *not* have this orbital occupancy pattern is
(A) ${}^{40}_{18}Ar$
(B) ${}^{34}_{16}S$
(C) ${}^{37}_{17}Cl^-$
(D) ${}^{39}_{19}K^+$
(E) ${}^{32}_{16}S^{2-}$

2503. The orbital diagram for an atom of sodium, ${}_{11}Na$, in its lowest energy state is
(A)


(B)


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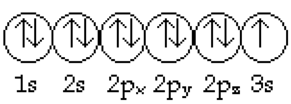
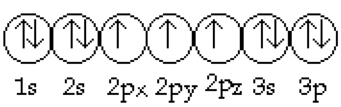
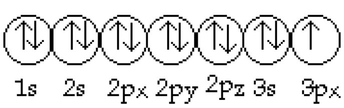


(D)


(E) none of the above.

2504. Consider the orbital diagram.



The species that has this orbital configuration is
(A) ${}^{13}_{7}N$
(B) ${}^{27}_{13}Al$
(C) ${}^{27}_{13}Al^{3+}$
(D) ${}^{31}_{15}P^{3-}$
(E) None of the above

2505. Which species has the same number of electrons as the magnesium ion, Mg^{2+}?
(A) Ca^{2+}
(B) Na^+
(C) F
(D) Ne^+
(E) Ba^{2+}

2506. The species having the same number of electrons as Mg^{2+} is
(A) Na
(B) O^{2-}
(C) N^-
(D) Ar
(E) Ne^{1+}

2507. Which of the species is the most stable?
(A) He(g)
(B) He^+(g)
(C) Ne(g)
(D) Ne^+(g)
(E) Xe(g)

2508. Which shell electron configuration is that of the most reactive nonmetal?
(A) 2, 8, 1
(B) 2, 8, 3
(C) 2, 8, 7
(D) 2, 8, 8
(E) 2, 8, 6

2509. How many electrons are usually left out of the condensed electron dot diagrams of elements with atomic numbers 11 to 18?
(A) 8
(B) 2
(C) 10
(D) 12
(E) 18

2510. The shell electron configuration of a neutral carbon atom is
(A) 1, 5
(B) 2, 4
(C) 2, 6
(D) 2, 2, 4
(E) 2, 2, 2

2511. The ground state electronic configuration for an atom of neon, ${}^{20}_{10}Ne$, is
(A) $1s^2\,2s^2$
(B) $1s^2\,2s^2\,2p^6$
(C) $1s^2\,2s^2\,2p^6\,3s^1$
(D) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$
(E) $1s^2\,2s^4\,2p^4$

3850. Which of the following could not represent the electron configuration of a neutral atom in the ground state?
(A) $1s^2\,2s^2\,2p^6\,3s^23p^4$
(B) $1s^2\,2s^2\,2p^2$
(C) $1s^2\,2s^2\,2p^6\,3s^33p^4$
(D) $1s^2\,2s^2\,2p^6\,3s^2$
(E) $1s^2\,2s^2\,2p^6\,3s^1$

1597. Which term best describes the molecular geometry of ethylene, C_2H_4?
(A) Linear
(B) Planar
(C) Pyramidal
(D) Octahedral
(E) Trigonal

1599. The arrangement of atoms in a water molecule, H_2O, is best described as
(A) ring
(B) trigonal planar
(C) linear
(D) trigonal pyramidal
(E) bent

1619. The shape of a chloroform molecule, $CHCl_3$. is
(A) linear
(B) octahedral
(C) tetrahedral
(D) planar triangular
(E) seesaw

1632. Which is the shape of the ammonium ion, NH_4^+?
(A) Linear
(B) Tetrahedral
(C) Trigonal planar
(D) Trigonal pyramidal
(E) Bent

1671. What is the geometry of the $CHCl_3$ molecule?
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1672. What is the geometry of the BF_3 molecule?
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1673. What is the geometry of the NH_3 molecule?
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1674. What is the geometry of the HBr molecule?
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1675. What is the geometry of the SF_2 molecule?
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1676. Predict the geometry of the CO_2 molecule.
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1677. Predict the geometry of the CH_4 molecule.
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1678. Predict the geometry of the HI molecule.
(A) Bent
(B) Linear
(C) Tetrahedral
(D) Trigonal pyramidal
(E) Planar triangular

1679. Predict the geometry and polar nature of the PH_3 molecule.
(A) linear dipole
(B) linear nondipole
(C) pyramidal dipole
(D) pyramidal nondipole
(E) tetrahedral nondipole

1680. Predict the geometry and polar nature of the BeF_2 molecule.
(A) bent dipole
(B) linear dipole
(C) linear nondipole
(D) pyramidal dipole
(E) tetrahedral nondipole

1681. Predict the geometry and polar nature of the FCl molecule.
(A) linear dipole
(B) linear nondipole
(C) pyramidal dipole
(D) pyramidal nondipole
(E) tetrahedral nondipole

1682. Predict the geometry and polar nature of the NH_3 molecule.
(A) bent dipole
(B) linear dipole
(C) pyramidal dipole
(D) pyramidal nondipole
(E) tetrahedral nondipole

1683. Predict the geometry and polar nature of the CCl_4 molecule.
(A) linear dipole
(B) linear nondipole
(C) pyramidal dipole
(D) pyramidal nondipole
(E) tetrahedral nondipole

1684. Predict the geometry and polar nature of the H_2O molecule.
(A) bent dipole
(B) linear dipole
(C) linear nondipole
(D) pyramidal dipole
(E) tetrahedral nondipole

1685. Predict the geometry and polar nature of the BeFCl molecule.
(A) bent dipole
(B) linear dipole
(C) linear nondipole
(D) pyramidal dipole
(E) tetrahedral nondipole

1686. Predict the geometry and polar nature of the $CHCl_3$ molecule.
(A) bent dipole
(B) linear dipole
(C) linear nondipole
(D) tetrahedral dipole
(E) tetrahedral nondipole

1687. Predict the geometry and polar nature of the CO_2 molecule.
(A) bent dipole
(B) linear dipole
(C) linear nondipole
(D) tetrahedral dipole
(E) tetrahedral nondipole

1781. The shape of the sulfate ion, SO_4^{2-}, is most similar to the shape of
(A) N_2H_4
(B) CO_3^{2-}
(C) C_2H_4
(D) SiH_4
(E) SO_3^{2-}

1796. The molecular geometry of the sulfite ion, SO_3^{2-}, is most similar to that of
(A) water, H_2O
(B) the sulfate ion, SO_4^{2-}
(C) the ammonium ion, NH_4^+
(D) the hydronium ion, H_3O^+
(E) boron chloride, BCl_3

1890. The shape of the carbonate ion, CO_3^{2-} is
(A) linear
(B) pyramidal
(C) octahedral
(D) tetrahedral
(E) trigonal planar

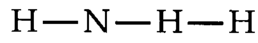
1891. The shape of a BF_3 molecule is
(A) octahedral
(B) planar triangular
(C) square pyramidal
(D) tetrahedral
(E) trigonal pyramidal

1893. Which consists of tetrahedral molecules?
(A) CsCl
(B) CO_2
(C) CCl_4
(D) H_2O
(E) NH_3

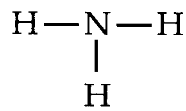
1894. The F-B-F angle in a BF_3 molecule is
(A) 90°
(B) 102°
(C) 109.5°
(D) 120°
(E) 180°

1895. The shape of an NF_3 molecule is
(A) tetrahedral
(B) trigonal bipyramidal
(C) octahedral
(D) pyramidal
(E) trigonal planar

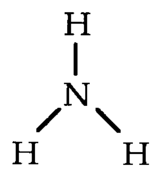
1801. Which best describes the geometry of the ammonia molecule, NH_3?

(A)


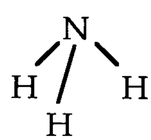
linear

(B)


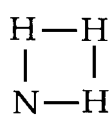
T–shaped

(C)


planar triangular

(D)


trigonal pyramidal

(E)


Square- shaped

1897. Which formula represents a compound whose molecules are tetrahedral?
(A) BH_3
(B) C_2H_2
(C) CH_4
(D) H_2O
(E) C_2H_6

1899. The shape of the BCl_3 molecule is
(A) linear
(B) octahedral
(C) planar triangular
(D) trigonal pyramidal
(E) tetrahedral

1900. A molecule of CH_4 is
(A) bent and polar
(B) linear and nonpolar
(C) tetrahedral and nonpolar
(D) trigonal pyramidal and polar
(E) trigonal planar and nonpolar

1901. A molecule of NH_3 is
(A) bent and polar
(B) linear and nonpolar
(C) tetrahedral and nonpolar
(D) trigonal pyramidal and polar
(E) trigonal planar and nonpolar

1902. The shape of the CO_2 (carbon dioxide) molecule is
(A) bent
(B) octagonal
(C) pyramidal
(D) tetrahedral
(E) linear

1903. The shape of CH_2Cl_2 is
(A) linear
(B) planar
(C) pyramidal
(D) tetrahedral
(E) seesaw

1904. The shape of the CH_4 molecule is
(A) octahedral
(B) rectangular
(C) tetrahedral
(D) square planar
(E) trigonal planar

1905. The H–N–H bond angle in NH_3 is less than the H–C–H angle in CH_4 due to the
(A) pair of nonbonded electrons in ammonia.
(B) repulsion between hydrogen atoms in ammonia.
(C) attraction between hydrogen atoms in methane.
(D) tetrahedral shape of ammonia and methane molecules.
(E) larger size of the nitrogen atom than the carbon atom.

1906. The bonding orbitals on the boron atom in BF_3 molecule are
(A) *s* orbitals
(B) *sp* orbitals
(C) sp^2 orbitals
(D) sp^3 orbitals
(E) *p* orbitals

1907. The shape of a water molecule is
(A) bent
(B) planar
(C) pyramidal
(D) tetrahedral
(E) octahedral

1908. What is the structural shape of the SF_6 molecule?
(A) linear
(B) octahedral
(C) tetrahedral
(D) square planar
(E) hexahedral

1911. The shape of an NH_3 molecule is
(A) linear
(B) tetrahedral
(C) planar triangular
(D) trigonal pyramidal
(E) bipyramidal

2067. The shape of methane molecules, CH_4, is
(A) bent
(B) triangular
(C) tetrahedral
(D) octahedral
(E) planar

2068. The molecule carbon dioxide, CO_2,
(A) is bent
(B) is linear
(C) has two nonbonding electrons
(D) has one double and one single bond
(E) trigonal planar

2069. The shape of the ammonia (NH_3) molecule is
(A) linear
(B) tetrahedral
(C) trigonal planar
(D) trigonal pyramidal
(E) square planar

2070. A molecule of CO_2 (carbon dioxide) is
(A) bent and polar
(B) linear and polar
(C) bent and nonpolar
(D) pyramidal and polar
(E) linear and nonpolar

3897. Carbon dioxide is
(A) linear and polar
(B) linear and nonpolar
(C) bent and polar
(D) bent and nonpolar
(E) trigonal planar and polar

UNIT II

STATES OF MATTER

2658. A sample of gas occupies 850 ml at 0°C and 710 mmHg. Which expression allows computation of the volume of this sample at standard pressure at constant temperature.

(A) $\mathbf{850\text{ ml} \times \frac{710\text{ mm}}{760\text{ mm}}}$

(B) $850\text{ ml} \times \frac{760\text{ mm}}{710\text{ mm}}$

(C) $\frac{1}{850\text{ ml}} \times \frac{710\text{ mm}}{760\text{ mm}}$

(D) $\frac{1}{850\text{ ml}} \times \frac{760\text{ mm}}{710\text{ mm}}$

(E) $\frac{273\text{ K}}{850\text{ ml}} \times \frac{760\text{ mm}}{710\text{ mm}}$

2664. A gas occupies a volume of 2.0 liters at 13 atm. How many liters is occupied by this gas at 1.0 atm and the same temperature?

(A) 0.15
(B) 13
(C) 26
(D) 4.0
(E) 0.06

2674. A weather balloon contains 12 liters of hydrogen at 740 mmHg pressure. At this same temperature, at what pressure will the volume become 20 liters?

(A) 370 mmHg
(B) 444 mmHg
(C) 760 mmHg
(D) 888 mmHg
(E) 1230 mmHg

2682. A gas occupies a 1.5 liter container at 25°C and 2.0 atmospheres. If the gas is transferred to a 3.0 liter container at the same temperature, what will be the new pressure ?

(A) 1.0 atm
(B) 2.0 atm
(C) 3.0 atm
(D) 5.0 atm
(E) 6.0 atm

2687. The volume of a confined gas can be reduced by the application of pressure at constant temperature. The change in volume may be explained by the fact that gaseous molecules

(A) take up space.
(B) are in constant motion.
(C) are relatively far apart.
(D) collide without loss of energy.
(E) all have the same velocity.

2715. If a volume of 2000 mL of a gas has the pressure increased from 1000 to 2500 mmHg, temperature remaining constant, what will be its new volume in mL?

(A) 800
(B) 1250
(C) 2000
(D) 3200
(E) 5000

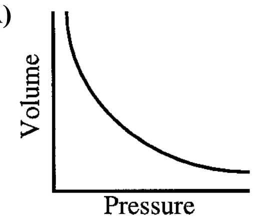
2717. An amount of a gas with a volume of 6,300 mL is changed from a pressure of 4,800 to 1,600 mmHg at constant temperature. What would be the approximate new volume?

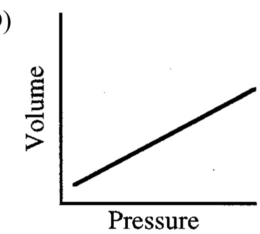
(A) 1,600 mL
(B) 2,100 mL
(C) 4,800 mL
(D) 9,600 mL
(E) 19,000 mL

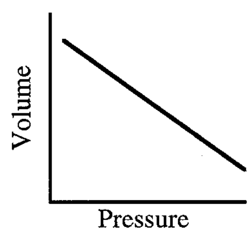
2732. Which are inversely proportional?

(A) pressure and moles
(B) pressure and temperature
(C) temperature and volume
(D) pressure and volume
(E) volume and moles

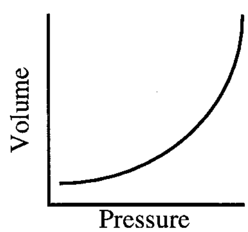
2768. Which curve represents the relationship between the volume of an ideal gas and its pressure for a certain number of molecules at a constant temperature?

(A)


(D)


(B)


(E) None of the above.

(C)


2779. A given mass of dry gas is kept at constant temperature. When the pressure is doubled, the volume is

(A) halved
(B) doubled
(C) unchanged
(D) increased by a factor of four
(E) decreased by a factor of four

UNIT III

REACTIONS

341. What is the hydrogen ion concentration, $[H^+(aq)]$, in a 0.02 M aqueous solution of nitric acid, HNO_3?

(A) 1×10^2 M
(B) 2×10^1 M
(C) 2×10^{-2} M
(D) 2×10^{-12} M
(E) 2×10^{-32} M

344. Which gas in moist air will cause respiratory irritation to humans?

(A) He
(B) N_2
(C) O_2
(D) CO_2
(E) SO_2

355. What is the difference between a 1.0 M solution of a weak acid and a 1.0 M solution of a strong acid? The weak acid

(A) is more dilute
(B) does not turn litmus red
(C) does not conduct electricity
(D) has fewer hydronium ions per liter
(E) has more metal ions per liter

368. In the reaction:

$NH_3(aq) + H_2PO_4^-(aq) \leftrightarrow NH_4^+(aq) + HPO_4^{2-}(aq)$

the dihydrogen phosphate ion, $H_2PO_4^-$, acts as

(A) an acid
(B) a base
(C) a reducing agent
(D) an oxidizing agent
(E) a catalyst

374. Which statement accounts for the facts that:

I Hydrogen chloride in a nonpolar solvent does not conduct electricity.
II A water solution of hydrogen chloride, HCl, is an excellent conductor of electricity.

(A) Water is an electrolyte
(B) Hydrogen chloride ionizes in water
(C) Hydrogen chloride is a nonelectrolyte
(D) Hydrogen chloride releases electrons in water solutions
(E) Hydrogen chloride is an ionic substance

386. The name of a water solution of hydrogen fluoride, HF(g), is

(A) fluoric acid
(B) fluorous acid
(C) perfluoric acid
(D) hydrofluoric acid
(E) hypofluorous acid

401. What is the name of the 1.0 M aqueous acid solution made using $HBrO_4$ as the solute?

(A) bromic acid
(B) bromous acid
(C) perbromic acid
(D) hydrobromic acid
(E) hypobromous acid

391. Base your answer to the following question on the data from the chart below.

Acid		H+		Base	K_a
H_2SO_4	↔	H^+	+	HSO_4^-	Very Large
H_2SO_3	↔	H^+	+	HSO_3^-	1.5×10^{-2}
HSO_4^-	↔	H^+	+	SO_4^{2-}	1.2×10^{-2}
H_3PO_4	↔	H^+	+	$H_2PO_4^-$	7.5×10^{-3}
H_2CO_3	↔	H^+	+	HCO_3^-	4.3×10^{-7}
HSO_3^-	↔	H^+	+	SO_3^{2-}	1.0×10^{-7}
$H_2PO_4^-$	↔	H^+	+	HPO_4^{2-}	6.2×10^{-8}
NH_4^+	↔	H^+	+	NH_3	5.7×10^{-10}
HCO_3^-	↔	H^+	+	CO_3^{2-}	5.6×10^{-11}

Which can never be an acid?

(A) NH_4^+
(B) HSO_3^-
(C) SO_4^{2-}
(D) H_3PO_4
(E) HCO_3^-

398. Base your answer to the following question on the data from the chart below.

Acid		H+		Base	K_a
H_3O^+	↔	H^+	+	H_2O	1.0×10^0
HOOCCOOH	↔	H^+	+	$HOOCCOO^-$	5.9×10^{-2}
HNO_2	↔	H^+	+	NO_2^-	4.6×10^{-4}
$HOOCCOO^-$	↔	H^+	+	$OOCCOO^{2-}$	6.4×10^{-5}
H_2S	↔	H^+	+	HS^-	9.1×10^{-8}
NH_4^+	↔	H^+	+	NH_3	5.7×10^{-10}

Which can never be an acid?

(A) HS^-
(B) H_2O
(C) NH_3
(D) NO_2^-
(E) $HOOCCOO^-$

402. What is the name of the 0.1 M aqueous acid solution made using H_2S as the solute?

(A) salicylic acid
(B) sulfuric acid
(C) sulfurous acid
(D) hydrosulfurous acid
(E) hydrosulfuric acid

403. What is the name of the 1.0 M aqueous acid solution made using H_3PO_3 as the solute?
(A) phosphoric acid
(B) phosphorous acid
(C) potassium hydroxide
(D) hydrophosphoric acid
(E) hypophosphorous acid

404. What is the name of the 1.0 M aqueous acid solution made using CH_3COOH as the solute?
(A) ammonia
(B) acetic acid
(C) oxalic acid
(D) carbonic acid
(E) ethanoic acid

405. What is the formula of the compound which is used as the solute to make the 1.0 M aqueous acid solution that is called chlorous acid?
(A) HCl
(B) HClO
(C) $HClO_2$
(D) $HClO_3$
(E) $HClO_4$

406. What is the formula of the compound which is used as the solute to make the 0.1 M aqueous acid solution that is called carbonic acid?
(A) H_2CO_3
(B) $H_2C_2O_4$
(C) H_2CrO_4
(D) HCOOH
(E) CH_3COOH

463. Ninety (90.0) mL of distilled water is added to an Erlemeyer flask containing 10.0 mL of 0.095 M HCl solution. How many moles of H_3O^+ are present in the flask?
(A) 0.00
(B) 0.0095
(C) 0.095
(D) 0.95
(E) 9.5

3225. Which is correctly named?
(A) NH_4^+ ammonia ion
(B) $Mn(CO_3)_2$ magnesium carbonate
(C) NH_4ClO ammonium hypochlorite
(D) Na_2SO_3 sodium sulfate
(E) H_3PO_4 hydrogen phosphite

3226. Gaseous chlorine when dissolved in water, produces an aqueous solution that
(A) has a pH more acidic than 7 and has no redox properties
(B) has a pH more basic than 7 and is an oxidizing agent.
(C) is neutral and is a reducing agent.
(D) has a pH more acidic than 7 and is an oxidizing agent.
(E) has a pH more acidic than 7 and is a reducing agent.

3227. Which equilibrium constant expressions represents the first ionization of H_3PO_4 in water?
(A) $K = \frac{[H_3O^+]^3[H_3PO_4^{3-}]}{[H_3PO_4]}$
(B) $K = \frac{[H_3O^+][HPO_4^{2-}]}{[H_2PO_4^-]}$
(C) $K = \frac{[H_3O^+][H_2PO_4^-]}{[H_3PO_4]}$
(D) $K = \frac{[H_3O^+][PO_4^{3-}]}{[HPO_4^{2-}]}$
(E) $K = \frac{[H_3O^+][H_3PO_4]}{[H_2PO_4]}$

3228. Which properties is an acid expected to have?

I electrical conductivity in water
II increase hydroxide ion concentration
III neutralize basic solutions
IV have a pH greater than 7
V ionize in water

(A) I, III and V only
(B) I, III and IV only
(C) II, III and V only
(D) I, II, III, and V only
(E) I, III, IV and V only

3229. When $NaHCO_3(aq)$ reacts with $NH_3(aq)$, the Brönsted–Lowry acid is
(A) NH_3
(B) HCO_3^-
(C) CO_3^{2-}
(D) H_2O
(E) Na^+

3230. Water is a Brönsted–Lowry acid when reacting with
(A) NH_3
(B) H_2S
(C) HCN
(D) HNO_3
(E) H_2SO_4

3233. Which two act as Brönsted–Lowry acids?

$H_2BO_3^-(aq) + HCO_3^-(aq) \leftrightarrow$
$H_2CO_3(aq)^+ HBO_3^{2-}(aq)$

(A) HCO_3^- and H_2CO_3
(B) $H_2BO_3^-$ and H_2CO_3
(C) HCO_3^- and HBO_3^{2-}
(D) $H_2BO_3^-$ and HBO_3^{2-}
(E) $H_2BO_3^-$ and HCO_3^-

UNIT IV

STOICHIOMETRY

792. A mole is
(A) 22.4 L
(B) 6.02×10^{23} particles
(C) one molecule
(D) one molar mass
(E) 16 g of oxygen

793. The number of particles in a mole is
(A) 23×10^6
(B) 2.06×10^{23}
(C) 10×6.02^{23}
(D) 2.24×10^{23}
(E) 6.02×10^{23}

794. A mass of 5.58 g of iron consists of the same number of atoms as
(A) 1.00 g of hydrogen
(B) 20.0 g of calcium
(C) 20.7 g of lead
(D) 23.0 g of sodium
(E) 32.0 g of sulfur

795. How many moles of atoms are in 1.0 mole of $Fe_3(Fe(CN)_6)_2$?
(A) 16
(B) 17
(C) 26
(D) 29
(E) 39

796. The total number of atoms represented by the formula $Na_2CO_3 \bullet 10H_2O$ is
(A) 15
(B) 16
(C) 27
(D) 36
(E) 38

797. How many atoms are in one molecule of sucrose, $C_{12}H_{22}O_{11}$?
(A) 12
(B) 34
(C) 36
(D) 45
(E) 55

798. The number of molecules in 2.0 moles of carbon dioxide, CO_2, is
(A) 1.8×10^{24}
(B) 6.0×10^{23}
(C) 1.2×10^{24}
(D) 3.6×10^{24}
(E) 4.48×10^{24}

799. How many atoms are in the formula $Na_2S_2O_3 \bullet 5\ H_2O$?
(A) 12
(B) 18
(C) 22
(D) 29
(E) 32

3069. A 71–gram sample of Cl_2 contains approximately the same number of molecules as
(A) 1.0 g of H_2
(B) 32 g of O_2
(C) 40 g of Ne
(D) 36 g of H_2O
(E) 2 g of He

801. The number of oxygen atoms in the formula $MgSO_4 \bullet 7\ H_2O$ is
(A) 5
(B) 7
(C) 11
(D) 21
(E) 27

802. How many moles of nitrogen atoms are there in 1.0 mole of $(NH_4)_3PO_4(s)$?
(A) 3
(B) 4
(C) 12
(D) 16
(E) 20

1179. The molar mass of an element is equal to
(A) the mass of an atom of the element in grams.
(B) the atomic mass of the element in grams.
(C) the number of atoms in a mole of the element.
(D) the number of atoms in a gram of the element.
(E) the number of electrons in an atom in grams.

1181. The mass of one mole of any substance is
(A) equal to one gram
(B) equal to 6.02×10^{23} grams
(C) equal to the number of atoms in the substance
(D) equal to its formula mass in grams
(E) equal to the number of neutrons in an atom in grams

3062. The mole is
(A) grams of carbon
(B) liters of gas at STP
(C) a number of particles
(D) grams of oxygen gas at STP
(E) grams of nucleons

3063. What is the molar mass of elemental sulfur, $_{16}S$?
(A) 16 $g \bullet mol^{-1}$
(B) 32 $g \bullet mol^{-1}$
(C) 64 $g \bullet mol^{-1}$
(D) 16 amu
(E) 32 amu

3064. What is the molar mass of magnesium phosphate, $Mg_3(PO_4)_2$?
(A) 59 $g \bullet mol^{-1}$
(B) 119 $g \bullet mol^{-1}$
(C) 130 $g \bullet mol^{-1}$
(D) 238 $g \bullet mol^{-1}$
(E) 260 $g \bullet mol^{-1}$

3065. Which sample of nitrogen gas at STP occupies the largest volume?
(A) 14 liters
(B) 14 moles
(C) 14 grams
(D) 1.4×10^{24} molecules
(E) 4.2×10^{24} molecules

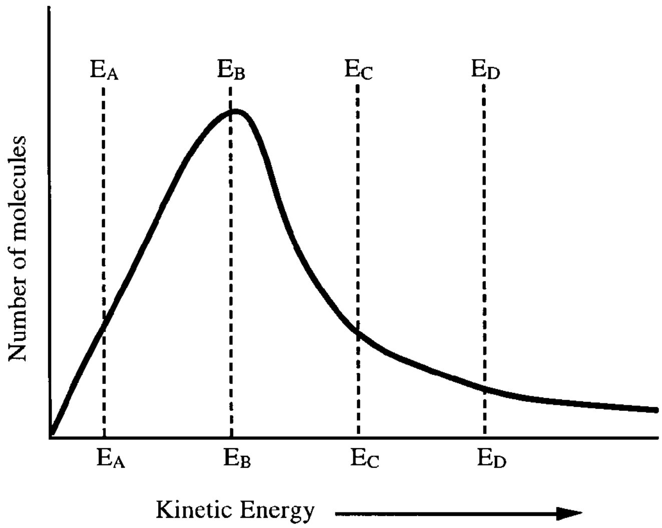
800. How many atoms are represented in the formula $Mg(OH)_{2?}$
(A) 6
(B) 2
(C) 3
(D) 4
(E) 5

UNIT V

EQUILIBRIUM AND KINETICS

A. Catalysts

Base your answers to questions **515** and **516** on the graph below which shows the number of molecules with a given kinetic energy plotted as a function of kinetic energy. Four catalysts are available, A, B, C and D, which have associated reaction activation energies E_A, E_B, E_C, and E_D respectively.



515. Which catalyst has an activation energy which results in the *shortest reaction time*?
   (A) Catalyst 'A' associated with energy E_a
   (B) Catalyst 'B' associated with energy E_b
   (C) Catalyst 'C' associated with energy E_c
   (D) Catalyst 'D' associated with energy E_d
   (E) It cannot be determined by the information given.

516. Which catalyst will have an activation energy which will result in the *slowest reaction rate* ?
   (A) Catalyst 'A' associated with energy E_a
   (B) Catalyst 'B' associated with energy E_b
   (C) Catalyst 'C' associated with energy E_c
   (D) Catalyst 'D' associated with energy E_d
   (E) It cannot be determined from the information given

B. Concentration

504. Why does a higher gaseous partial pressure increase the reaction rate?
   (A) Increased activation energy
   (B) Increased number of collisions
   (C) Increased average kinetic energy
   (D) Increased energy for effective collisions
   (E) Increased product potential energy

522. Why does increased concentration increase reaction rate?
   (A) Increased activation energy
   (B) Increased number of collisions
   (C) Increased average kinetic energy
   (D) Increased energy for effective collisions
   (E) Increased energy of reactants

3928. Given the equilibrium reaction $N_2 + 3\ H_2 \leftrightarrow 2\ NH_3 + 92.4$ kJ/mol, which of the following could increase the reverse reaction rate.
   (A) increasing the $[N_2]$
   (B) increasing the $[H_2]$
   (C) increasing the $[NH_3]$
   (D) decreasing the $[NH_3]$
   (E) decreasing the temperature

3929. When a reactant is added to a reation at equilibrium, the equilibrium shifts towards the product side. Which of the following best desribes this phenomenon?
   (A) Graham's law
   (B) the second law of thermodynamics
   (C) Gibb's free energy
   (D) collision theory of reaction rates
   (E) Boyle's law

3930. Given the reaction $H_2(g) + I_2(g) + \text{heat} \leftrightarrow 2\ HI(g)$, what effect will increasing the pressure have?
   (A) increase the $[H_2]$
   (B) increase the $[I_2]$
   (C) increase the [HI]
   (D) decrease the [HI]
   (E) none of the above

643. Which compound *cannot* be formed spontaneously from its elements at 298 K.

STANDARD ENERGIES OF FORMATION OF COMPOUNDSAT 1 atm AND 298 K

	Compound	Enthalpy of Formation $kJ \cdot mol^{-1}$ (H_{f°)	Free Energy Formation $kJ \cdot mol^{-1}$ (G_{f°)
(A)	Hydrogen fluoride HF(g)	-271	-273
(B)	Iodine Chloride ICl(g)	18	-5
(C)	Nitrogen (IV) oxide NO_2 (g)	33	51
(D)	Water H_2O(g)	-242	-228

(A) A (B) B **(C) C** (D) D (E) Both A and B

671. List the compound which *cannot* be formed spontaneously from its elements at 298 K.

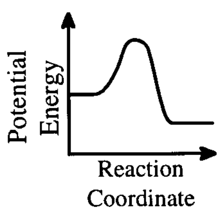
STANDARD ENERGIES OF FORMATION OF COMPOUNDS AT 1 atm AND 298 K

Compound	Enthalpy of Formation $kJ \cdot mol^{-1}$ (H_{f°)	Free Energy Formation $kJ \cdot mol^{-1}$ (G_{f°)
Nitrogen (IV) oxide NO_2 (g)	33	51
Sodium chloride NaCl(s)	-411	-384
Sulfur dioxide SO_2(g)	-297	-300
Water H_2O(g)	-242	-228

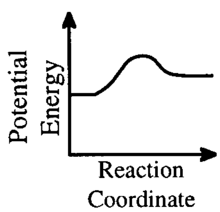
(A) nitrogen (IV) oxide
(B) sodium chloride
(C) sulfur dioxide
(D) water(g)
(E) both nitrogen (IV) oxide and water(g)

618. Four reactions are represented by the reaction diagrams shown at the same scale. Which exothermic reaction occurs most spontaneously?

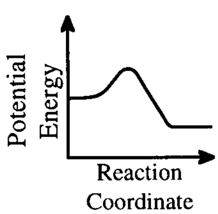
(A)



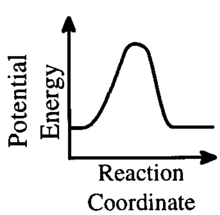
(D)



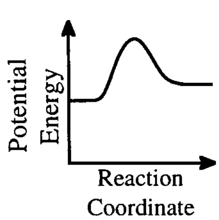
(B)



(E)



(C)



627. The data represents the standard entropy and free energy of four compounds formed from their respective elements at 298 K and 1.0 atm pressure.
For which of the four compounds will a temperature increase change the reaction from being nonspontaneous to spontaneous?

	Entropy of Formation (ΔS_f°) $J \cdot {}^\circ C^{-1} mol^{-1}$	Free Energy of Formation (ΔG_f°) $kJ \cdot mol^{-1}$
(A)	140	–100
(B)	90	70
(C)	–80	50
(D)	–200	–50

(A) A
(B) B
(C) C
(D) D
(E) Both B and C

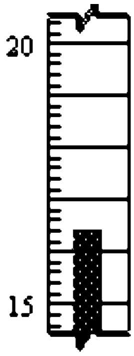
631. Which decreases during all spontaneous chemical reactions at 25°C and 1.0 atm?

(A) ΔG°
(B) ΔS°
(C) ΔH°
(D) $T\Delta S^\circ$
(E) $T\Delta H^\circ$

UNIT IX

LABORATORY

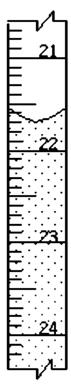
3. Most student thermometers have an uncertainty of 0.2 Centigrade degrees. Which is the proper reading of the thermometer shown in the illustration?



(A) 16.°C
(B) 16.4° C
(C) 16.40° C
(D) 16.45° C
(E) 16.405° C

6. Which measurement has the most uncertainty?
(A) 200 ± 1 g
(B) 1.0 ± 0.1 cm
(C) 10.0 ± 0.1 mL
(D) 2.00 ± 0.05 liter
(E) 500. ± 5 m

8. Which is the proper reading for the buret?



(A) 21.55 mL
(B) 21.7 mL
(C) 22.3 mL
(D) 22.45 mL
(E) 22.60 mL

3173. An unknown mass of an element reacts completely with 1.811 g of sulfur and 3.613 g of oxygen to produce 7.124 g of a compound containing the element, S, and O. What additional information is required to determine the unknown mass?
(A) The formula of the product.
(B) The balanced reaction equation.
(C) The molar mass of the unknown element.
(D) The electron configuration of the unknown element.
(E) No additional information is needed.

12. Copper (II) bromide, $CuBr_2$, changes to copper (I) bromide, CuBr when heated.

$2\ CuBr_2(s) \rightarrow 2\ CuBr(s) + Br_2(g)$

Which set of masses could occur in this experiment?

	test tube	test tube + $CuBr_2$	test tube + CuBr
(A)	20.000 g	18.300 g	18.906 g
(B)	20.000 g	20.705 g	19.548 g
(C)	20.000 g	21.636 g	22.105 g
(D)	20.000 g	23.295 g	22.117 g

(A) A
(B) B
(C) C
(D) D
(E) None of the above

3174. How many 100 mg tetracycline capsules can be made from 1 kg of tetracycline?
(A) 10
(B) 100
(C) 1,000
(D) 10,000
(E) 100,000

3175. An object having a mass of 16.85 grams is placed into a graduated cylinder containing water. The level of the water rose from 19.8 mL to 21.8 mL. Which density is expressed to the proper number of significant figures?
(A) 8 g•mL^{-1}
(B) 8.0 g•mL^{-1}
(C) 8.4 g•mL^{-1}
(D) 8.43 g•mL^{-1}
(E) 8.425 g•mL^{-1}

3176. Two samples are massed using different balances.

Sample	Mass
1	3.529 g
2	0.40 g

What is the *total* mass of the samples to the correct number of significant digits?
(A) 4 g
(B) 3.9 g
(C) 3.93 g
(D) 3.929 g
(E) 3.92900 g