Which of the following is true about the scientific method?

- **A)** A hypothesis is a set of observations that are explained by an experiment.
- **B)** Researchers design experiments to prove the conclusions they have already reached.
- **C)** The purpose of performing an experiment is to confirm or contradict a hypothesis.
- **D)** To be useful, data must be qualitative.
- **E)** Quantitative data are usually in the form of descriptive observations.

A 9.4-g sample of powdered titanium was added to a graduated cylinder originally containing 6.8 mL of water. After addition of the titanium, the water level in the graduated cylinder was 8.9 mL. What is the density of titanium?

- **A)** 1.4 g/cm^3
- **B)** 4.5 g/cm^3
- **C)** 1.1 g/cm^3
- **D)** 0.22 g/cm^3

At one atmosphere pressure, mercury solidifies at -38.0 ^oF. Express this temperature in degrees Celsius and Kelvin.

- **A)** -126 ^oC and 147 K
- **B)** -39 ^oC and 234 K
- **C)** -21 ^oC and 252 K
- **D)** 39 ^oC and 312 K
- **E)** -68 ^oC and 205 K

How many significant figures are there in the number 0.0203610 g?

- **A)** 8
- **B)** 7
- **C)** 6
- **D)** 5

A sample of a liquid has a density of 2.1 g/mL. What volume of the liquid has a mass of 4.242 g?

- **A)** 8.9 mL
- **B)** 2.0 mL
- **C)** 2.02 mL
- **D)** 2.020 mL
- **E)** 0.50 mL

The density of magnesium is 1.7 g/cm^3, and the density of iron is 7.9 g/cm^3. Consider a block of iron with a mass of 819 g. What is the mass of a block of magnesium that has the same volume as the block of iron?

- **A)** 1.8×10^2 g
- **B)** 61 g
- **C)** 2.8×10^3 g
- **D)** 3.8×10^3 g
- **E)** None of the above.

The recommended daily allowance (RDA) of calcium is 1200 mg. Calcium carbonate contains 12% calcium by mass. How many grams of calcium carbonate are needed to provide the RDA of calcium?

- **A)** 1.3 g
- **B)** 1.4 g
- **C)** 0.14 g
- **D)** 10. g
- **E)** 0.19 g

Table salt (sodium chloride) is 42.7% sodium. How many grams of salt contain 76.0 g of sodium?

- **A)** 32.5 g
- **B)** 178 g
- **C)** 3.25×10^3 g
- **D)** 1.78 g
- **E)** 1.78×10^4 g

Assume that magnesium consists of three isotopes having the abundances and masses given below. According to these data, calculate the average atomic mass of magnesium.

isotope	abundance	mass
^{24}Mg	78.70%	23.985 amu
^{25}Mg	10.13%	24.986 amu
^{26}Mg	11.17%	25.983 amu

- **A)** 25.00 amu
- **B)** 2.431 amu
- **C)** 2431 amu
- **D)** 24.31 amu
- **E)** None of the above.

One mole of H_2

- **A)** contains 6.0×10^{23} H atoms.
- **B)** contains 6.0×10^{23} H_2 molecules.
- **C)** contains 1 g of H_2.
- **D)** is equivalent to 6.02×10^{23} g of H_2.
- **E)** None of the above.

How many oxygen atoms are present in 5.2 g of O_2?

- **A)** 5.4×10^{-25} atoms
- **B)** 9.8×10^{22} atoms
- **C)** 2.0×10^{23} atoms
- **D)** 3.1×10^{24} atoms
- **E)** 6.3×10^{24} atoms

How many potassium atoms are present in 57.7 g of potassium hexafluoromanganate(IV), K_2MnF_6?

- **A)** 0.470 atoms
- **B)** 2.81×10^{23} atoms
- **C)** 0.233 atoms
- **D)** 1.41×10^{23} atoms
- **E)** 9.84×10^{23} atoms

What is the mass of 5.45×10^{-3} mol of glucose, $C_6H_{12}O_6$?

- **A)** 0.158 g
- **B)** 982 g
- **C)** 3.31×10^4 g
- **D)** 0.982 g
- **E)** None of the above.

Determine the mass percent of iron in $Fe_4[Fe(CN)_6]_3$.

- **A)** 45% Fe
- **B)** 26% Fe
- **C)** 33% Fe
- **D)** 58% Fe
- **E)** None of the above.

A compound composed of hydrogen and carbon contains 85.7% C and 14.3% H, and has a molar mass of 84 g/mol. What is the molecular formula of the compound?

- **A)** CH_2
- **B)** C_2H_4
- **C)** CH_3
- **D)** C_3H_6
- **E)** C_6H_{12}

When it is correctly balanced, the correct coefficients for the equation below are $PCl_3 + H_2O$ ----> H_3PO_3 + HCl

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

Hydrochloric acid can be prepared using the reaction described by the chemical equation: 2 NaCl(s) + H_2SO_4(l) ----> 2 HCl(g) + Na_2 SO_4(s). How many grams of HCl can be prepared from 393 g of H_2SO_4 and 4.00 moles of NaCl?

- **A)** 4.00 g
- **B)** 2.49 g
- **C)** 146 g
- **D)** 284 g
- **E)** None of the above.

Calculate the percent yield of iron if 950 g of Fe_3O_4 underwent the reaction shown in the chemical equation below and 533 g of Fe was isolated from the reaction mixture. Fe_3O_4 (s) + 2 C(s) ----> 2 CO_2 (g) + 3 Fe(s)

- **A)** 25.9%
- **B)** 77.5%
- **C)** 56.1%
- **D)** None of the above.

Which of the following compounds is most likely to dissolve in water?

- **A)** $BaSO_4$
- **B)** AgBr
- **C)** $CaCO_3$
- **D)** Na_2S
- **E)** None of these compounds would dissolve in water.

Which of the following is the correct net ionic equation for the reaction that occurs when solutions of $Pb(ClO_3)_2$ and Na_2SO_4 are mixed?

- **A)** $ClO_3^-(aq) + Na^+(aq) \text{ ----> } NaClO_3(s)$
- **B)** $Pb^{2+}(aq) + SO_4^{2-}(aq) \text{ ----> } PbSO_4(s)$
- **C)** $Pb(ClO_3)_2(aq) + Na_2SO_4(aq) \text{ ----> } PbSO_4(s) + 2\ NaClO_3(aq)$
- **D)** $Pb^{2+}(aq) + 2\ ClO_3^-(aq) + 2\ Na^+(aq) + SO_4^{2-}(aq) \text{ ----> } PbSO_4(s) + 2\ Na^+(aq) + 2\ ClO_3^-(aq)$
- **E)** None of the above

Which of the following is the chemical formula of the salt produced by the neutralization of potassium hydroxide with nitric acid?

- **A)** KOH
- **B)** HNO_3
- **C)** H_2O
- **D)** KNO_3

What element is oxidized in the following reaction?
$Cd(s) + NiO_2(s) + 2\ H_2O(l) \text{ ----> } Cd(OH)_2(aq) + Ni(OH)_2(aq)$

- **A)** Cd
- **B)** H
- **C)** Ni
- **D)** O
- **E)** None of the elements are oxidized. This is not an oxidation-reduction reaction.

In the following reaction, which element is the oxidizing agent?
$3\ Cu(s) + 8\ HNO_3(aq) \text{ ----> } 3\ Cu(NO_3)_2(aq) + 2\ NO(g) + 4\ H_2O\ (l)$

- **A)** Cu
- **B)** H
- **C)** O
- **D)** N
- **E)** There is no oxidizing agent. This is not an oxidation-reduction reaction.

Which of the following is an example of a metal displacement reaction?

- **A)** $2\ P(s) + 3\ Cl_2(g) \text{ ----> } 2\ PCl_3(g)$
- **B)** $CaBr_2(aq) + H_2SO_4(aq) \text{ ----> } CaSO_4(s) + 2\ HBr(aq)$
- **C)** $2\ Na(s) + 2\ H_2O(l) \text{ ----> } 2\ NaOH(aq) + H_2(g)$
- **D)** $C_3H_8(g) + 5\ O_2(g) \text{ ----> } 3\ CO_2(g) + 4\ H_2O(g)$
- **E)** $Fe_2O_3(s) + 2\ Al(s) \text{ ----> } 2\ Fe(s) + Al_2O_3(s)$

How many grams of lead nitrate, $Pb(NO_3)_2$, are needed to make 0.500 L of 0.105 M $Pb(NO_3)_2$?

- **A)** 5.25×10^{-2} g
- **B)** 34.8 g
- **C)** 17.4 g
- **D)** 165.6 g
- **E)** None of the above

To analyze for barium in an unknown white powder, an excess of sodium sulfate solution was added to a 0.624 g sample of the powder dissolved in water. A white precipitate of $BaSO_4$ was isolated, dried, and found to weigh 0.438 g. What is the mass percent of Ba in the white powder?

- **A)** 0.267%
- **B)** 41.3%
- **C)** 58.9%
- **D)** 70.2%
- **E)** None of the above

The acidic substance in vinegar is acetic acid, $HC_2H_3O_2$. When 4.00 g of a certain vinegar sample was titrated with 0.200 M NaOH, 25.56 mL of the NaOH solution were required to reach the equivalence point. What is the percent composition by mass of $HC_2H_3O_2$ in the vinegar?

- **A)** 7.68%
- **B)** 30.7%
- **C)** 76.8%
- **D)** 3.84%
- **E)** None of the above

The mass percent of iron in an iron ore can be determined by converting Fe to Fe^{2+} in acid solution, and then titrating the dissolved sample with $KMnO_4$ solution. A 2.51 g ore sample dissolved in acid required 28.62 mL of 0.0821 M $KMnO_4$ to reach the equivalence point. Calculate the mass percent of iron in the ore.

$8\ H^+(aq) + 5\ Fe^{2+}(aq) + MnO_4^-(aq) \text{ ----> } 5\ Fe^{3+}(aq) + Mn^{2+}(aq) + 4\ H_2O(l)$

- **A)** 1.05%
- **B)** 3.82%
- **C)** 5.23%
- **D)** 26.1%
- **E)** None of the above

A solution able to conduct electricity contains a dissolved substance called a/an:

- **A)** precipitate
- **B)** electrolyte
- **C)** nonelectrolyte
- **D)** equilibrium

Which of the following are examples of soluble compounds?

- **A)** Hydroxides
- **B)** Chromates
- **C)** Sulfides
- **D)** Nitrates

Which of the following is incorrectly paired?

- **A)** $Ba(OH)_2$; weak electrolyte
- **B)** NaOH; strong electrolyte
- **C)** H_3PO_4; triprotic acid
- **D)** H_2SO_4; diprotic acid

Which statement is false concerning oxidation numbers?

- **A)** An element's oxidation number is constant and unchanging.
- **B)** Atoms of free elements have an oxidation number of zero.
- **C)** An atom's oxidation state signifies the number of charges for that atom in a molecule.
- **D)** Oxidation numbers allow easy identification of which atoms gained or lost electrons.

A sample of gas occupies 2.78×10^3 mL at 25^oC and 760 mm Hg. What volume will the gas sample occupy at the same temperature and 475 mm Hg?

- **A)** 0.130 L
- **B)** 1.04 L
- **C)** 1.74 L
- **D)** 4.45 L
- **E)** None of the above

A steel tank contains carbon dioxide at a pressure of 13.0 atm when the temperature is 34^oC. What will be the internal gas pressure when the tank and its contents are heated to 100^oC.

- **A)** 38.2 atm
- **B)** 9.40 atm
- **C)** 10.7 atm
- **D)** 15.8 atm
- **E)** None of the above

Calculate the density of nitrogen gas, in grams per liter, at STP.

- **A)** 0.625 g/L
- **B)** 0.800 g/L
- **C)** 1.25 g/L
- **D)** 2.50 g/L
- **E)** None of the above

A gas evolved during the fermentation of alcohol had a volume of 19.4 L at 17°C and 746 mm Hg. How many moles of gas were collected?

- **A)** 1.25 mol
- **B)** 0.800 mol
- **C)** 10.5 mol
- **D)** 13.6 mol
- **E)** 608 mol

How many grams of carbon dioxide are contained in 550 mL of this gas at STP?

- **A)** 0.0245 g
- **B)** 0.0280 g
- **C)** 1080 g
- **D)** 0.560 g
- **E)** 1.1 g

A 1.325 g sample of an unknown vapor occupies 368 mL at 114°C and 946 mm Hg. The empirical formula of the compound is NO_2. What is the molecular formula of the compound?

- **A)** NO_2
- **B)** N_4O_8
- **C)** N_3O_6
- **D)** N_2O_4
- **E)** N_5O_{10}

An organic compound was analyzed and found to contain 55.8% C, 7.03% H, and 37.2% O. A 1.500 g sample of the compound was vaporized and found to occupy 530 cm^3 at 100°C and 740 torr. Which of the following is the correct molecular formula of the compound?

- **A)** C_2H_3O
- **B)** $C_6H_4O_2$
- **C)** C_3H_2O
- **D)** $C_4H_6O_2$
- **E)** $C_2H_3O_2$

What volume of chlorine gas at 646 torr and 32^{o}C would be produced by the reaction of 14.75 g of MnO_2 according to the following chemical equation?
$MnO_2(s) + 4\ HCl(aq) \text{ ----> } MnCl_2(aq) + Cl_2(g) + 2\ H_2O(l)$

- **A)** 5.00 L
- **B)** 0.170 L
- **C)** 2.33 L
- **D)** 0.200 L
- **E)** None of the above

A mixture of neon, argon, and xenon had a total pressure of 1560 mm Hg at 298 K. The mixture was found to contain 1.50 mol Ne, 2.65 mol Ar, and 1.75 mol Xe. What is the partial pressure of Xe?

- **A)** 701 mm Hg
- **B)** 658 mm Hg
- **C)** 396 mm Hg
- **D)** 463 mm Hg
- **E)** None of the above

Deviations from the ideal gas law are smaller at:

- **A)** low temperatures and high pressures
- **B)** low temperatures and low pressures
- **C)** high temperatures and high pressures
- **D)** high temperatures and low pressures

Which of the following correctly identifies Boyle's law?

- **A)** $PV=k_1$
- **B)** $V=k_2T$

The magnitude of one Kelvin, one Celsius degree, and one degree on the absolute temperature scale is the same.

- **A)** True
- **B)** False

The Kelvin temperature scale is useful when comparing:

- **A)** various gas samples at different densities
- **B)** volume of a gas sample with temperature at constant pressure
- **C)** pressure of gas samples at different volumes and constant temperature
- **D)** various liquids at constant pressure

Calculate the wavelength, in nanometers, of visible light having a frequency of $4.37 \times 10^{14} s^{-1}$.

- **A)** 12.0 nm
- **B)** 343 nm
- **C)** 686 nm
- **D)** 674 nm
- **E)** None of the above

For the hydrogen atom, $E_n = -(1/n^2)R_H$, where $R_H = 2.18 \times 10^{-18}$ J. The wavelength of the transition from the ground state to the n = 3 state is:

- **A)** 1.03×10^{-7} m
- **B)** 6.56×10^{-8} m
- **C)** -1.03×10^{-7} m
- **D)** -6.76×10^{-8} m
- **E)** 4.27×10^{-8} m

Which of the following is not a possible value of m_l for an electron with l = 2?

- **A)** -1
- **B)** 0
- **C)** +1
- **D)** +2
- **E)** +3

The set of quantum numbers that correctly describes an electron in a 3p orbital is:

- **A)** n = 3; l = 0; $m_l = 0$; $m_s = 0$
- **B)** n = 3; l = 2; m_l = -2, -1, 0, 1, or 2; m_s = +1/2 or -1/2
- **C)** n = 3; l = 1; m_l = -1, 0, or 1; m_s = +1/2 or - 1/2
- **D)** n = 4; l = 0; m_l = -1, 0, or 1; m_s = +1/2 or -1/2
- **E)** None of the above

What is the total number of orbitals associated with the principal quantum number n = 2?

- **A)** 1
- **B)** 2
- **C)** 3
- **D)** 4
- **E)** None of the above

What is the maximum number of electrons that can be accommodated in the shell with n = 4?

- **A)** 32
- **B)** 18
- **C)** 24
- **D)** 10
- **E)** None of the above

An atom of chromium has ___ unpaired electrons and is ___.

- **A)** 3, diamagnetic
- **B)** 5, diamagnetic
- **C)** 3, paramagnetic
- **D)** 5, paramagnetic
- **E)** 6, paramagnetic

The electronic configuration and filling order of the element whose atomic number is 26 is:

- **A)** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^8$
- **B)** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
- **C)** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
- **D)** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4 4p^2$
- **E)** None of the above

An atom in its ground state contains 33 electrons. How many of these electrons are in p orbitals?

- **A)** 15
- **B)** 12
- **C)** 3
- **D)** 33
- **E)** None of the above

Using the noble gas core designation, which of the configurations below correctly describes the ground state electron configuration of Cu?

- **A)** $[Ne]4s^2 3d^9$
- **B)** $[Ar]4s^2 3d^9$
- **C)** $[Kr]4s^1 3d^{10}$
- **D)** $[Ar]4s^1 3d^{10}$
- **E)** None of the above

Bohr's Theory of the hydrogen atom was important because:

- **A)** It gave a fixed value or quantized the energy levels of electrons.
- **B)** It gave a fixed or quantized value to the nucleus of the atom.
- **C)** It identified the ground level energies of several atoms.
- **D)** None of the above

Energy emission by an electron is an energy releasing process, while energy absorption requires an input of energy.

- **A)** True
- **B)** False

De Broglie explained electron movements by relating them to:

- **A)** waves only
- **B)** particles only
- **C)** waves and particles
- **D)** none of the above

How many valence electrons are there in an atom of arsenic?

- **A)** 6
- **B)** 5
- **C)** 4
- **D)** 3
- **E)** 2

All of the following Groups contain representative elements except:

- **A)** Group 1A
- **B)** Group 3A
- **C)** Group 5A
- **D)** Group 5B
- **E)** Group 6A

The general electron configuration for the anion formed from a neutral atom of any Group VII element is:

- **A)** ns^2np^6
- **B)** ns^2np^5
- **C)** ns^2np^4
- **D)** ns^2np^3
- **E)** ns^2

Which of the species listed below is not isoelectronic with the others?

- **A)** O^-
- **B)** F^-
- **C)** Mg^{2+}
- **D)** Na^+
- **E)** N^{3-}

Which of the following atoms has the largest radius?

- **A)** N
- **B)** F
- **C)** Cl
- **D)** Li
- **E)** Na

Which of the following species has the largest radius?

- **A)** Cl
- **B)** Cl^-
- **C)** Al^{3+}
- **D)** Na^+
- **E)** F^-

Which of the following elements will have the largest first ionization energy?

- **A)** C
- **B)** Cl
- **C)** Na
- **D)** Al
- **E)** F

Which of the following elements will have the greatest electron affinity?

- **A)** Cl
- **B)** K
- **C)** He
- **D)** Na
- **E)** Rb

Which is incorrectly paired?

- **A)** diamagnetic; silver
- **B)** diamagnetic; magnesium
- **C)** paramagnetic; iron
- **D)** paramagnetic; zirconium

What is the electron configuation of bromine?

- **A)** [Ar]
- **B)** $[Ar]3d^{10}4s^24p^5$
- **C)** $[Ne]3s^2$
- **D)** None of the above

What is the electron configuation of Rb^+?

- **A)** [Ne]
- **B)** [Ar]
- **C)** [Kr]
- **D)** [Xe]

Which of the following has the larger atomic radius, Cu or Cl_2

- **A)** Cu
- **B)** Cl_2

Which ion has the smallest ionic radius, Mg^{2+} or Ca^{2+}?

- **A)** Mg^{2+}
- **B)** Ca^{2+}

Which one of the following compounds is most likely to be ionic?

- **A)** HNF_2
- **B)** H_2CO
- **C)** N_2H_4
- **D)** $CaCl_2$
- **E)** ICl

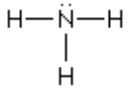
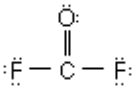
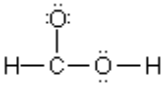
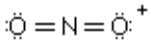
In $Ba(CN)_2$, the bonding is:

- **A)** essentially ionic
- **B)** essentially covalent
- **C)** both ionic and covalent
- **D)** neither ionic nor covalent

Which of the following represents the most polar bond?

- **A)** B-C
- **B)** S-O
- **C)** C-O
- **D)** B-O
- **E)** C-C

Which of the Lewis structure(s) is(are) incorrect?

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

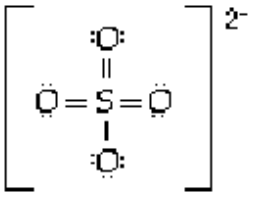
All of the following molecules contain only single bonds except:

- **A)** H_2O_2
- **B)** Cl_2
- **C)** CH_4
- **D)** H_2O
- **E)** SO_2

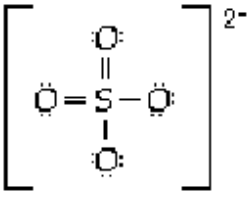
Ignoring resonance, the formal charge on the nitrogen atom in the nitrate ion is:

- **A)** +2
- **B)** +1
- **C)** 0
- **D)** -1
- **E)** -2

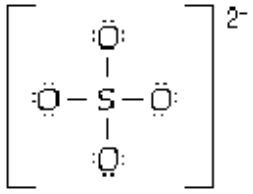
The sulfate ion is tetrahedral with four equal S-O distances of 149 pm. Ignoring resonance, which of the following is the most reasonable structure consistent with these facts?



A)



B)



C)

D) None of the above

In which of the following species does the central atom violate the octet rule?

A) CH_4

B) SF_4

C) PCl_4^+

D) CCl_3^+

E) NH_3

Which statement is false concerning ionic bonds and compounds?

A) Ionic bonds are a result of electrostatic forces.

B) Ionic bonds usually occur between elements with high and low electron affinities.

C) Elements of an ionic compound usually carry the same charge.

D) Lewis dot symbols are useful for tracking electrons.

In a Lewis structure of a compound:

A) the shared electrons are represented by either a line or two dots between the atoms.

B) all the electrons are represented for each atom.

C) only lone pairs of electrons are represented.

D) None of the above

Identify the correct statement comparing ionic and covalent compounds.

- **A)** Ionic compounds usually have a shorter bond length than covalent compounds.
- **B)** Ionic compounds usually have a higher heat of vaporization than covalent compounds.
- **C)** Covalent compounds usually have better electroconductivity than ionic compounds.
- **D)** Covalent compounds usually have a higher boiling point than ionic compounds.

Resonance structures are unique relatively stable structures rather than combinations of different structures.

- **A)** True
- **B)** False