Q1.
Express the result of the following mathematical operation to the correct number of significant figures.

$$\frac{9.875\times 10^2 - 9.795 \times 10^2}{9.875 \times 10^2} \times 105$$

A) 8.5×10^{-1}
B) 8.52×10^{-1}
C) 9×10^{-1}
D) 8.100×10^{-3}
E) 8.576×10^{-2}

Q2.
In which molecule does the central atom have sp^2 hybridization?

A) SO_2
B) PH_3
C) NH_3
D) H_2O
E) H_2S

Q3.
Which one of the following species has the highest bond energy?

A) CN^-
B) O_2^-
C) B_2
D) O_2^+
E) NO^-

Q4.
How many electrons are involved in pi (π) bonding in benzene, C_6H_6?

A) 6
B) 2
C) 3
D) 12
E) 18

Q5.

How many of the following species are paramagnetic?

F_2, B_2, O_2, N_2

A) 2
B) 1
C) 0
D) 3
E) 4

Q6.
Which one of the following is the correct order of deceasing boiling points?

A) HF > HI > HBr > HCl
B) HF > HCl > HBr > HI
C) HI > HBr > HCl > HF
D) HI > HF > HBr > HCl
E) HI > HBr > HF > HCl

Q7.
X-rays of wavelength 0.220 nm are diffracted by atomic layers separated by a distance of 282 pm. Assuming first-order diffraction (n = 1), calculate the angle of diffraction.

A) 23.0^o
B) 18.2^o
C) 34.5^o
D) 5.26^o
E) 41.3^o

Q8.
Gold (Au) crystallizes in a face-centered cubic lattice. If the density of the gold is 19.32 g/cm^3, calculate the length of the edge (side) of the unit cell.

A) 4.076×10^{-10} m
B) 5.083×10^{-10} m
C) 6.253×10^{-10} m
D) 5.482×10^{-10} m
E) 4.851×10^{-10} m

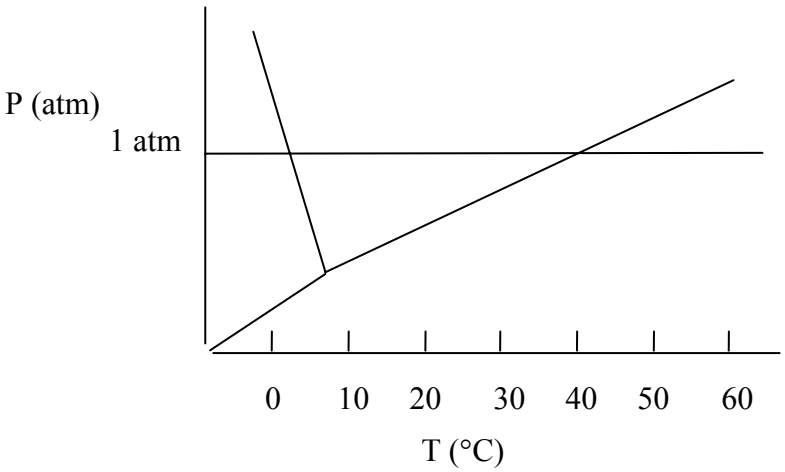
Q9.
Which one of the following molecules has London dispersion forces only?

A) I_2
B) NH_3
C) H_2O
D) HF
E) NaCl

Q10.
What is the boiling point of water at a pressure of 520. torr?
(ΔH_{vap} = 40.7 kJ/mol)

A) 89.5 ^{o}C
B) 97.4 ^{o}C
C) 78 ^{o}C
D) 100.^{o}C
E) 81.3 ^{o}C

Q11.
The following is the phase diagram of compound X.



Which statement is **FALSE** about the compound X?

A) The melting point of X increases with the increase of pressure.
B) The boiling point of X increases with the increase of pressure.
C) At 25 ^{o}C and 1 atm pressure, X is a liquid.
D) The triple point temperature of X is about 8 ^{o}C.
E) The normal boiling point of X is about 40 ^{o}C.

Q12.
A 9.68 gram sample of a compound is dissolved in 250.grams of benzene. The freezing point of this solution is 1.02^{o}C below that of pure benzene. What is the molar mass of this compound? (K_f for benzene = 5.12 ^{o}C · kg/mol)

A) 194 g/mol
B) 48.6 g/mol
C) 389 g/mol
D) 7.71 g/mol
E) 97.2 g/mol

Q13.
When a nonvolatile solute is added to a volatile solvent, the solution vapor pressure _____, the boiling point _____, the freezing point _____, and the osmotic pressure across a semipermeable membrane _____.

A) decreases, increases, decreases, increases
B) increases, increases, decreases, increases
C) increases, decreases, increases, decreases
D) decreases, decreases, increases, decreases
E) decreases, increases, decreases, decreases

Q14.
A 0.20 *M* solution of $MgSO_4$ has an observed osmotic pressure of 7.8 atm at 25°C. Determine the observed van't Hoff factor for this solution.

A) 1.6
B) 0.32
C) 19
D) 1.8
E) 2.0

Q15.
.What volume of a 0.661 *M* solution of $CaCl_2$ contains 1.28 g of solute?

A) 17.4 mL
B) 57.3 mL
C) 1.94 mL
D) 7.62 mL
E) 82.6 mL

Q16.
In a styrofoam-cup calorimeter, 0.836 g of NH_4NO_3 is mixed with 150.0 g of water. If the temperature is dropped by 0.413°C, calculate the molar heat of solution of NH_4NO_3 assuming no heat loss to the calorimeter.
(Specific heat capacity of the solution = 4.18 J/g °C)

A) + 24.9 kJ/mol
B) + 249 J/mol
C) + 2.49 kJ/mol
D) –2.49 kJ/mol
E) –249 J/mol

Q17.

At a given temperature, you have a mixture of benzene and toluene. The mole fraction of benzene in the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of toluene in the vapor above the solution.
(vapor pressure of pure benzene = 745 torr and vapor pressure of pure toluene = 290. torr)

A) 0.213
B) 0.778
C) 0.590
D) 0.641
E) 0.359

Q18.
Which one of the following is an alkaline earth metal?

A) Ca
B) Na
C) Pb
D) Al
E) Zn

Q19.
The isotope of an unknown element X has a mass number of 79. The most stable ion of the isotope has 36 electrons and forms a binary compound with sodium having a formula of Na_2X. Which one of the following is **TRUE**?

A) The element X is Se.
B) The element X is Sr.
C) The isotope of X has 38 protons.
D) The isotope of X has 44 neutrons.
E) The isotope of X has 36 protons.

Q20.
Which one of the following is named **incorrectly**?

A) MgH_2 - Magnesium dihydride
B) P_2O_5 - Diphosphorus pentoxide
C) $FeCl_3$ - Iron(III) chloride
D) $AlCl_3$ - Aluminum chloride
E) Rb_2O_2 - Rubidium peroxide

Q21.
An endothermic reaction causes the surroundings to

A) decrease in temperature.
B) become acidic.

C) condense.
D) warm up.
E) increase in temperature.

Q22.
Consider the following reaction:

$C_4H_{10}(g) + 13/2\ O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$ $\Delta H = -2658$ kJ

What mass of CO_2 in grams is produced when the heat released from the reaction is 1.5×10^3 kJ.

A) 99
B) 198
C) 396
D) 50
E) 25

Q23.
Use the information given below to determine ΔH for the following reaction:

$$3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$$

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$ $\Delta H = -2043$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = -483.6$ kJ

A) −105 kJ
B) +105 kJ
C) −589 kJ
D) +589 kJ
E) −4191 kJ

Q24.
Choose the geometry of $SeCl_4$ molecule.

A) Sea-saw
B) Tetrahedral
C) Square planar
D) Octahedral
E) Trigonal bipyramidal

Q25.
Which one of the following has polar bonds but non-polar in nature?

A) $XeCl_4$

B) HCl
C) SO_2
D) PCl_3
E) ICl_5

Q26.
Which one of the following statements is **TRUE** about the lattice energy?

A) It is directly proportional to the charges on the ions.
B) It is inversely proportional to the charges on the ions.
C) It is directly proportional to the ionic radii.
D) It is independent of the charges on the ions.
E) It is independent of the ionic radii.

Q27.
Which one of the following sets of ions is an isoelectronic series?

A) K^+, Ca^{2+}, Cl^-, S^{2-}
B) Na^+, K^+, Rb^+, Cs^+
C) Li^+, Be^{2+}, B^+, C^{2-}
D) Na^+, Mg^{2+}, S^{2-}, Cl^-
E) K^+, Ca^+, Cl^-, S^-

Q28.
A 1.42 g sample of pure compound with formula M_2SO_4, was dissolved in water and treated with an excess of $CaCl_2$, resulting in the precipitation of all the sulfate ions as calcium sulfate. The precipitate was dried and found to weigh 1.36 g. Determine the atomic mass of M.

A) 23
B) 142
C) 100.
D) 136
E) 16

Q29.
A 75.0 mL of 0.250 *M* hydrochloric acid is added to 225.0 mL of 0.0550 *M* $Ba(OH)_2$ solution. What is the concentration of the excess H^+ or OH^- ions left in this solution?

$2HCl(aq) + Ba(OH)_2\ (aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$

A) 2.00×10^{-2} *M* OH^-
B) 1.88×10^{-2} *M* H^+
C) 1.24×10^{-2} *M* OH^-
D) 2.48×10^{-2} *M* OH^-

E) 2.48 x 10^{-2} *M* H^+

Q30.
When the following oxidation-reduction reaction is balanced in the **basic** medium, what is the coefficient of OH^- in the solution?

$NO_2^-(aq) + Al(s) \rightarrow NH_3(g) + AlO_2^-(aq)$

A) 1
B) 2
C) 3
D) 4
E) 6

Q31.
The electron configuration for V^{3+} ion is,

A) $1s^2 2s^2\ 2p^6 3s^2 3p^6 3d^2$
B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$
C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$
E) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Q32.
Which one of the following sets of quantum numbers has the maximum number of electrons?

A) $n = 4, l = 3$
B) $n = 2, l = 1$
C) $n = 3, l = 2$
D) $n = 5, l = 0$
E) $n = 5, l = 1$

Q33.
Which of the following statement(s) is/are **TRUE**?

I. The de Broglie wavelength can be determined if the mass and the velocity of a particle are known.
II. The energy of a photon is directly proportional to its wavelength.
III. Hydrogen emits a continuous spectrum of light.
IV. A line spectrum is emitted when atoms have discrete energy levels.

A) I and IV
B) II and IV
C) IV only
D) I and III

E) II and III

Q34.
What is the energy of one mole of photons having a wavelength of 185 nm?

A) 647 kJ
B) 1.07×10^{-18} J
C) 9.76×10^{38} J
D) 2.16×10^{-3} J
E) 2.16×10^{-3} kJ

Q35.
A 2.747 g manganese metal, Mn, is reacted with excess HCl gas to produce 3.22 L of $H_2(g)$ at 100^oC and 0.951 atm and a manganese chloride, $MnCl_x$. What is the formula of manganese chloride compound produced in the reaction?

A) $MnCl_4$
B) $MnCl_5$
C) $MnCl_7$
D) $MnCl_2$
E) $MnCl_3$

Q36.
A mixture of O_2 and N_2 gases in a 200. mL container has a pressure of 0.960 atm at 35^oC. If there is 0.00200 mol of N_2 is present, what is the partial pressure of O_2?

A) 0.707 atm
B) 0.736 atm
C) 0.253 atm
D) 0.00192 atm
E) 0.00537 atm

Q37.
Which one of the following statements is **TRUE** for gases?

A) Gas particles are very small compared to the average distance between the particles.
B) The pressure of a confined gas increases when its temperature decreases at a constant volume.
C) The ideal gas approaches the real gas behavior at moderate temperature and pressure.
D) The rate of effusion for a gas is directly proportional to its molar mass.
E) The molar volume of an ideal gas is 22.4 liters at all temperatures and pressures.

Q38.

A compound is composed of element X and hydrogen. Analysis shows the compound to be 80% X by mass, with three times as many hydrogen atoms as X atoms per molecule. Which element is X?

A) C
B) He
C) F
D) S
E) P

Q39.
Consider the following reaction;

$$2A + B \rightarrow 3C + D$$

If 3.0 mol of A and 2.0 mol of B react to form an actual yield of 4.0 mol of C, what is the percent yield of this reaction?

A) 89%
B) 67%
C) 75%
D) 50%
E) 100%

Q40.
An atom of bromine has a mass about four times that of an atom of neon. How many grams of neon will contain the same number of atoms as 1000. g of bromine?

A) 250.g Ne
B) 4 g Ne
C) 400.g Ne
D) 1000.g Ne
E) 4000.g Ne
