Chemistry 3A – Fall 2025 **Version B**

Sections 43957-43958

Midterm Examination #3

Select the **BEST** response for the question. Point values: multiple choice 3 pt; true/false 1 pt

1. An aqueous solution of sodium sulfate (Na_2SO_4) is prepared. Which of these is a ***true*** statement about this solution?
   a) Sodium sulfate (Na_2SO_4) is the *solvent* and water (H_2O) is the *solute*
   b) In nonsaturating aqueous solutions, sodium sulfate dissolves fully to form ions Na^+ and SO_4^{2-}
   c) It is impossible to Na_2SO_4 dissolve in water because water will not dissolve ionic compounds
   d) Sodium sulfate will form a precipitate and precipitates are not visible in solutions

2. Convert a pressure of **595 torr** to atmospheres (**atm**)
   a) 0.783 atm b) 1.28 atm c) 0.0595 atm d) 7.83 atm

3. Which of these shows that the volume of a gas is directly proportional to the amount of a gas in moles ($V = k \times n$) ?
   a) Boyle's Law b) Charles' Law c) Gay-Lussac's Law
   d) Avogadro's Law e) Ideal Gas Law

4. A gas has an initial pressure P_1=10.0 atm and volume V_1 = 10.0 L. The pressure is reduced to P_2 = 1.00 atm. What is new volume V_2 in liters (L) if all else (temperature, moles) is constant?
   a) 0.100 L b) 50.0 L c) 10.0 L d) 1.00 L

5. Which of these is important for gases to be considered ideal, and for the ideal gas law equation to work?
   a) the gas molecules must be packed closely together
   b) intermolecular attractions are very important for the molecules
   c) gases should be able to easily fill a container
   d) kinetic energy or the energy dependent on motion is not a consideration for understanding gases

6. An ideal gas of n = 1.00 mol at a temperature T = 273 K is contained in a volume V = 100.0 L. What is the pressure in atmosphere (atm)?
   a) 0.0224 atm b) 0.224 atm c) 2.24 atm d) 22.4 atm

7. Which of the statements below is a true statement regarding *electrolytes*?
   a) The ionic solute dissolving will make a very good conductor of electric current
   b) The ionic compounds that dissolve in solution do so (almost) entirely
   c) Molecules like ethanol and glucose make good electrolytes
   d) Both (a) and (b)

8. Which of the statements below refer to the meaning of "like dissolves like"?
   a) It refers to combustion reactions with oxygen in the atmosphere
   b) It means that the compound calcium fluoride (CaF_2) will dissolve in a nonpolar solvent like octane (C_8H_{18})
   c) It means polar solutes will dissolve in polar solvents
   d) It means that gases whose volume is reduced by half will see their pressures reduced by half

9. A dilution of a C_1 = 0.50 *M* NaCl stock solution was used to make a V_2 = 500 mL of a C_2 = 0.10 M NaCl solution. What volume aliquot V_1 was used.
   a) 20 mL b) 50 mL c) 100 mL d) 250 mL

10. Which reaction below shows a **halogen replacement** (single replacement) reaction type?
   a) Cl_2 (*g*) + 2 NaBr (*aq*) ⟶ 2 NaCl (*aq*) + Br_2 (*l*)
   b) Mg (*s*) + $Cu(NO_3)_2$ (*aq*) ⟶ $Mg(NO_3)_2$ (*aq*) + Cu (*s*)
   c) Zn (*s*) + 2 HCl (*aq*) ⟶ $ZnCl_2$ (*aq*) + H_2 (*g*)
   d) H_2O (*l*) ⟶ H_2 (*g*) + 2 O_2 (*g*)

11. Which of the following is true about pressure as related to gases?
   a) Pressure is force exerted by gas molecules colliding with a surface over a given area ($P = F/A$)
   b) Pressure is always (only) measured in units of atmospheres (atm)
   c) Pressure is defined as the number of moles of gas present in a container
   d) Pressure is a measure of the total energy of gas molecules in a container

12. Which of these solutes will have a greater effect on elevating the boiling point temperature of a solvent given they completely dissolve?
   a) ethanol (CH_3CH_2OH) b) glucose ($C_6H_{12}O_6$) c) NaCl d) $(NH_4)_2SO_4$

13. In written chemical reaction equations, which of these symbols refers to a *gaseous* phase?
   a) (*s*) b) (*l*) c) (*g*) d) (*aq*) e) none of these

14. Precipitation reaction $Pb(NO_3)_2$ (*aq*) + NaCl (*aq*) ⟶ $PbCl_2$ (*s*) + $NaNO_3$ (*aq*) is shown. What is true about balancing this reaction?
   a) Balancing requires changing the chemical formula of NaCl to $NaCl_2$
   b) The reaction equation should only ever be balanced by adjusting the whole-number coefficients of the compounds
   c) Removing NaCl from the reactants would make the equation balanced
   d) Balancing requires changing $PbCl_2$ from solid (*s*) to aqueous (*aq*) to match other products

15. Which choice show pattern of a decomposition type reaction, e.g. 2 HgO (*s*) ⟶ 2 Hg (*l*) + O_2 (*g*)?
   a) A + B ⟶ AB b) AB ⟶ A + B
   c) AB + CD ⟶ AC + BD d) A + BC ⟶ AC + B

16. Which of these reactions of barium chloride ($BaCl_2$) and sodium sulfate (Na_2SO_4) shows the **net ionic equation**?
   a) $BaCl_2$ (*aq*) + Na_2SO_4 (*aq*) ⟶ $BaSO_4$ (*s*) + NaCl (*aq*)
   b) Ba^{2+} (*aq*) + 2 Cl^- (*aq*) + 2 Na^+ (*aq*) + SO_4^{2-} (*aq*) ⟶ $BaSO_4$ (*s*) + 2 Cl^- (*aq*) + 2 Na^+ (*aq*)
   c) Ba^{2+} (*aq*) + SO_4^{2-} (*aq*) ⟶ $BaSO_4$ (*s*)
   d) all of them show the form called the **net ionic equation**

17. Which of the statements below are true about written chemical reactions?
   a) Conservation of mass is not a consideration in the balancing of chemical reactions
   b) The chemical compounds to the left of the arrow are called "reactants"
   c) The chemical compounds to the left of the arrow are called "products"
   d) The number and type of atoms on both sides of the reaction arrow (⟶) might NOT be equal

18. 3.00 mol of potassium chloride (KCl) [molar mass = 74.55 g/mol] is dissolved in final 3.00 kg water. What is the **molality** of the KCl solution?
   a) 1.00 m b) 5.00 m c) 24.85 m d) 50.0 m

19. Lithium (Li) metal will react explosively with cold water in a vigorous redox reaction. Which of the reactions below is correctly balanced and shows what occurs?
  a) 2 Li (*s*) + 2 H_2O (*l*) ⟶ 2 O_2 (*g*) + 3 LiOH (*aq*)
  b) Li (*s*) + 3 H_2O (*l*) ⟶ H_2 (*g*) + LiOH (*aq*)
  c) 2 Li (*s*) + 2 H_2O (*l*) ⟶ H_2 (*g*) + 2 LiOH (*aq*)
  d) Li (*s*) + H_2O (*l*) ⟶ O_2 (*g*) + LiOH (*aq*)

20. This is written on the whiteboard: "Mg ⟶ Mg^{2+} + 2 e^-". What is true about what is written?
  a) This shows a reduction half-reaction because Mg is gaining electrons
  b) This shows is a gas as a product of the reaction
  c) Shows an oxidation half-reaction because Mg went from a zero charge state to a +2 charge state
  d) The number of protons should be shown on the left side of the half-reaction

21. How many moles are in 25.0 g of NaCl? (Use the Periodic Table to determine NaCl molar mass)
  a) 2.34 mol
  b) 0.427 mol
  c) 1.00 mol
  d) 0.234 mol
  e) 0.584 mol

22. 100.0 g of ammonium chloride (NH_4Cl) [molar mass = 53.50 g/mol] is dissolved in final 2.00 L water. What is the concentration of the NH_4Cl solution?
  a) 0.0374 M b) 0.2675 M c) 0.935 M d) 3.74 M

23. What statements are true concerning the **oxidation number** of molecule carbon dioxide (CO_2)?
  a) The oxidation number of **oxygen** (O atoms) is **–2**
  b) The oxygen atoms in the molecule are more **electronegative** than for carbon
  c) The oxidation number of **carbon** (the C atom) is **+4**
  d) statements (a), (b) and (c) are all true
  e) none of the statements above are true

24. Which statement is LEAST relevant or is INCORRECT regarding colligative properties of a solution?
  a) These properties depend only on the **numbe**r of solute particles dissolved in the solvent.
  b) **Molality** (*m*) is the required unit of concentration for calculating freezing and boiling point changes.
  c) A solution's change in boiling point and freezing point are examples of colligative properties
  d) To understand the effect of the solute, you must know the **oxidation numbers** of the atoms in the compound.

25. What happens to the solubility of most gases in water as temperature increases?
  a) It increases b) It decreases c) It remains constant
  d) It fluctuates randomly e) It depends on pressure only

Continue to next page for True-False questions

26. A decomposition reaction involves two compounds combining to form a larger complex product
a) true b) false

27. The oxidation number of a pure element is always zero.
a) true b) false

28. A strong electrolyte completely dissociates into ions in aqueous solution.
a) true b) false

29. The molarity of a solution is expressed in units of **mol/kg**.
a) true b) false

30. A precipitate is an insoluble compound (a substance forming a solid from solution).
a) true b) false

31. The equation $PV = nRT$ is known as the Ideal Gas Law equation.
a) true b) false

32. In chemical reaction equation, compounds to ***left*** of the ***reaction arrow*** are called **products**.
a) true b) false

33. Ionic compounds prefer to dissolve in polar solvents like water, not in nonpolar solvents.
a) true b) false

34. Electronegativity is unrelated to an element's tendency to gain or lose electrons.
a) true b) false

35. At Standard Temperature and Pressure (STP), the temperature is 0°C and the pressure is 1 atm.
a) true b) false