

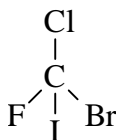
Useful constants and other information:

$R = 0.0821 \text{ L}\cdot\text{atm}/\text{K}\cdot\text{mole}$ $R = 8.314 \text{ J}/\text{K}\cdot\text{mole}$ $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ $1 \text{ atm} = 760 \text{ torr}$
 Specific heat of $\text{H}_2\text{O}(\text{l}) = 4.184 \text{ J}/\text{g}\cdot^\circ\text{C}$ $1 \text{ cal} = 4.184 \text{ J}$ $c = 3 \times 10^8 \text{ m/s}$

PART I.

- Rank the following elements in order of increasing atomic radius: P, Al, Cl, F, S
- Write out the chemical equation for the second ionization energy of fluorine.
- Draw the correct Lewis symbol for the neutral boron atom.
- Draw the correct Lewis symbol for the Ca^{2+} ion.
- Write out the correct electronic configuration of the Cr^{3+} ion.
- Write out the correct electronic configuration for the neutral bromine atom.
- Arrange the following isoelectronic series of ions in order of decreasing radius:
 Al^{3+} , Na^+ , F^- , N^{3-}

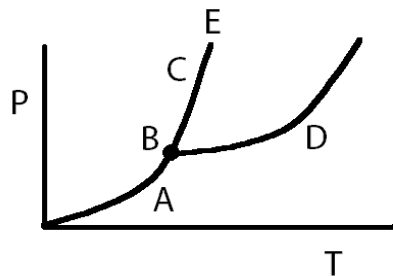
- In the following molecule, which atom will have the smallest build up of negative charge?



- Balance the following equation: $___ \text{Na}_2\text{CO}_3 + ___ \text{HCl} \rightarrow ___ \text{NaCl} + ___ \text{CO}_2 + ___ \text{H}_2\text{O}$
- Of the pairs of substances below, which pair involves ion-dipole attraction?
 - $\text{C}_6\text{H}_{11}\text{O}_6$, CH_3OH
 - RbI , LiNO_3
 - C_{10}H_8 , C_6H_6
 - KBr , H_2O
- Which one of the following exhibits dipole-dipole interactions between molecules?
 - XeF_4
 - CH_3OCH_3
 - CO_2
 - AlCl_3
- The principle difference in the normal boiling points of ICl (90° and molar mass = 162) and Br_2 (59°C and molar mass = 160) is due to:

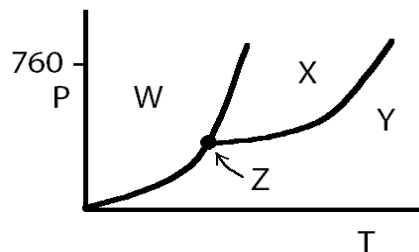
- A) London-dispersion forces
B) dipole-dipole interactions
C) mainly hydrogen bonding but also dipole-dipole interactions
D) both dipole-dipole interactions and London-dispersion forces
13. Hydrogen bonding is a special case of:
- A) London-dispersion forces
B) ion-dipole attraction
C) dipole-dipole attraction
D) none of these
14. The intermolecular force responsible for the fact that OH_2 has the highest boiling point in the set OH_2 , SH_2 , SeH_2 , TeH_2 is/are:
- A) hydrogen bonding
B) dipole-dipole interactions
C) London-dispersion forces
D) ion-dipole interactions
15. Which of the following substances would have the greatest surface tension at 25°C ?
- A) CH_4
B) CH_3Cl
C) CH_3OH
D) CO_2
16. The direct conversion of a solid to a gas is called:
- A) fusion
B) vaporization
C) condensation
D) boiling
E) sublimation
17. The enthalpy of fusion of water is 6.0 kJ/mol and the heat capacity of water is $75 \text{ J/mol}\cdot^\circ\text{C}$. How many kJ of heat would it take to convert 50 g of ice to liquid water at 22°C ?
- A) 3.8×10^2
B) 21
C) 17
D) 0.46
18. The critical temperature and pressure of CS_2 are 279°C and 78 atm, respectively. At temperatures above 279°C , CS_2 can only exist as:
- A) solid
B) liquid
C) liquid and gas
D) gas

19. On the diagram to the right, which curve corresponds to the conditions of temperature and pressure under which the solid and the gas states of a substance are directly interconverted?



- A) A
- B) B
- C) C
- D) D
- E) E

20. Using the phase diagram shown right, identify the region that corresponds to the solid phase.



- A) W
- B) X
- C) Y
- D) Z

21. Which one of the following is equal in value to the expression for molarity?

- A) mol solute/L solvent
- B) mol solute/mL solvent
- C) mmol solute/mL solution
- D) mol solute/kg solvent
- E) μ mol solute/L solution

22. Which of the following results in the formation of 0.200 M K_2SO_4 solution?

- A) dilution of 250.0 mL of 1.00 M K_2SO_4 to a final volume of 1.00 L
- B) dissolving 43.6 g of K_2SO_4 in water to a final volume of 250.0 mL
- C) diluting 20.0 mL of 5.00 M K_2SO_4 solution to a final volume of 500.0 mL
- D) dissolving 20.2 g of K_2SO_4 in water and diluting to 250.0 ml and then taking 25.0 mL of this solution and diluting to a final volume of 500.0 mL

23. What is the molarity of CH_3OH in a solution prepared by dissolving 11.7 g of CH_3OH to a final volume of 230 mL of solution?

- A) 11.9 M
- B) 1.59×10^{-3} M
- C) 0.0841 M
- D) 1.59 M

24. What is the new concentration, in M, of aqueous methanol, if 0.200 L of a 2.00 M solution is diluted to a final volume of 0.800 L?

- A) 0.800 M
- B) 0.200 M
- C) 0.500 M
- D) 0.400 M

- E) 8.00 M
25. Which one of the following will not break into ions upon dissolving in water?
- A) C_2H_6SO
 B) KBr
 C) $CsNO_3$
 D) MgI
 E) HBr
26. Which one of the following is not an electrolyte?
- A) HCl
 B) Rb_2SO_4
 C) Ar
 D) KOH
27. Which ion is/are spectator ions in the formation of a precipitate ($BaSO_4$) when solutions of aqueous BaI_2 and K_2SO_4 are mixed?
- A) Ba^{2+} only
 B) K^+ only
 C) Ba^{2+} and SO_4^{2-}
 D) K^+ and I^-
 E) SO_4^{2-} and I^-
28. The balanced molecular equation for precipitation of AgI when aqueous solutions of $AgNO_3$ and NaI are mixed is:
- A) $AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$
 B) $AgNO_3(aq) + NaI(aq) \rightarrow AgI(aq) + NaNO_3(s)$
 C) $AgNO_3(s) + NaI(s) \rightarrow AgI(aq) + NaNO_3(aq)$
 D) $AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(s)$
 E) $AgNO_3(s) + NaI(s) \rightarrow AgI(s) + NaNO_3(aq)$
29. The balanced net ionic equation for the formation of an aqueous solution of $Al(NO_3)_3$ by mixing solid $Al(OH)_3$ and aqueous nitric acid is:
- A) $Al(OH)_3(aq) + 3 HNO_3(aq) \rightarrow 3 H_2O(l) + Al(NO_3)_3(aq)$
 B) $Al(OH)_3(aq) + 3 NO_3^-(aq) \rightarrow 3 OH^-(aq) + Al(NO_3)_3(aq)$
 C) $Al(OH)_3(aq) + 3 NO_3^-(aq) \rightarrow 3 OH^-(aq) + Al(NO_3)_3(s)$
 D) $Al(OH)_3(aq) + 3 H^+(aq) \rightarrow 3 H_2O(l) + Al^{3+}(aq)$
 E) $Al(OH)_3(aq) + 3 HNO_3(aq) \rightarrow 3 H_2O(l) + Al^{3+}(aq) + NO_3^-(aq)$

PART II

1. Calculate the amount of heat (in kJ) needed to convert 1 mole of ice at $-16^\circ C$ to steam at a temperature of $183^\circ C$. (heat capacity of ice = $2.09 J/g \cdot ^\circ C$, heat capacity of water = $4.18 J/g \cdot ^\circ C$, heat capacity of steam = $1.84 J/g \cdot ^\circ C$, $\Delta H_{\text{fusion}} = 6.01 kJ/mol$, $\Delta H_{\text{vaporization}} = 40.67 kJ/mol$)

2. Calculate the concentration of arsenic acid (H_3AsO_4) in a solution if 25.00 mL of that solution required 35.21 mL of 0.1894 M KOH for titration.
3. Write out the net ionic equation for the reaction that occurs when aqueous silver (I) nitrate and aqueous magnesium chloride are mixed.
4. Balance the following oxidation-reduction reaction:
$$\text{HPbO}_2^- (\text{aq}) + \text{Re}(\text{s}) \rightarrow \text{Pb}(\text{s}) + \text{ReO}_4^- (\text{aq})$$