

CHEM 132 Final Exam Practice

Based on OERs, ACS Exam Review workbook, published ACS Chemistry Olympiad Exams, Openstax Chemistry, and others.

1. A 20.00 mL sample of a $\text{Ba}(\text{OH})_2$ solution is titrated with 0.245 M HCl. If 27.15 mL of HCl is required, what is the molarity of the $\text{Ba}(\text{OH})_2$ solution?

- (A) 0.166 M (B) 0.180 M
(C) 0.333 M (D) 0.666 M

5. A current of 0.15 A is passed through an aqueous solution of K_2PtCl_4 . How long will it take to deposit 1.00 g Pt(s) ($M=195.1$)?

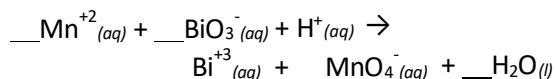
- (A) 1600 s (B) 3300 s
(C) 6600 s (D) 13000 s

2. $\text{Fe}^{+3}_{(aq)} + \text{SCN}^{-}_{(aq)} \leftrightarrow \text{FeSCN}^{+2}_{(aq)}$

The equilibrium constant for this reaction can best be determined by means of

- (A) chromatography (B) conductance
(C) ion exchange (D) spectrophotometer

3. What is the coefficient for $\text{H}^{+}_{(aq)}$ when the equation is balanced with whole number coefficients?



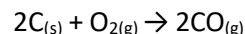
- (A) 3 (B) 4 (C) 7 (D) 14

4. Calculate the hydronium ion concentration in 50.0 mL of 0.10 M NaH_2AsO_4 .

($K_1 = 6.0 \times 10^{-3}$, $K_2 = 1.1 \times 10^{-7}$, $K_3 = 3.0 \times 10^{-12}$)

- (A) 2.4×10^{-2} (B) 1.6×10^{-3}
(C) 1.0×10^{-4} (D) 2.5×10^{-5}

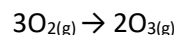
6. What are the signs of ΔH and ΔS for this reaction?



ΔH ΔS

- | | | |
|-----|---|---|
| (A) | - | - |
| (B) | - | + |
| (C) | + | + |
| (D) | + | - |

7. The rate of formation of $\text{O}_3(g)$ is $2.0 \times 10^{-7} \text{ mol.L}^{-1}$ for reaction.



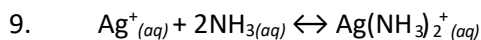
What is the rate of disappearance of $\text{O}_{2(g)}$ in mol.L^{-1} ?

- (A) 1.3×10^{-7} (B) 2.0×10^{-7}
(C) 3.0×10^{-7} (D) 4.5×10^{-7}

8. Which statements are true?

- S° values for all elements in their standard states are positive.
- S° values for all aqueous ions are positive.
- ΔS° values for all spontaneous reactions are positive.

- (A) 1 only (B) 1 and 2 only
(C) 2 and 3 only (D) 1, 2, and 3



For this reaction, $K = 1.7 \times 10^7$ at 25°C . What is the value of ΔG° in kJ?

- (A) -41.2 (B) -17.9 (C) +17.9 (D) +41.2

10. What is the sign of ΔG° and the value of K for an electrochemical cell for which $E^\circ_{\text{cell}} = 0.80\text{ V}$?

	ΔG°	K
(A)	-	> 1
(B)	+	> 1
(C)	+	< 1
(D)	-	< 1

11. The reaction between $\text{NO}_{(g)}$ and $\text{O}_{2(g)}$ to $\text{NO}_{2(g)}$ is second order in $\text{NO}_{(g)}$ and first order in $\text{O}_{2(g)}$. By what factor will the reaction rate change if the concentrations of both reactants are doubled?

- (A) 2 (B) 4 (C) 6 (D) 8

12. The decomposition of ethane into two methyl radicals has a first order rate constant of $5.5 \times 10^{-4}\text{ sec}^{-1}$ at 700°C . What is the half-life for this decomposition in minutes?

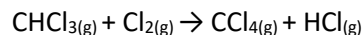
- (A) 9.1 (B) 15 (C) 21 (D) 30

13. The dependence of the rate constant of a reaction on temperature is given by the equation

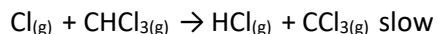
$k = e^{-E_a/RT}$. Under what conditions is k the smallest?

- (A) high T and large E_a (B) high T and small E_a
 (C) low T and large E_a (D) low T and small E_a

14. The reaction



is believed to proceed by this mechanism:

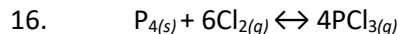


What rate equation is consistent with this mechanism?

- (A) Rate = $k [\text{Cl}_2]$
 (B) Rate = $k [\text{Cl}][\text{CHCl}_3]$
 (C) Rate = $k [\text{Cl}_2][\text{CHCl}_3]$
 (D) Rate = $k [\text{Cl}_2]^{1/2}[\text{CHCl}_3]$

15. The activation energy of a certain reaction is 87 kJ/mol . What is the ratio of the rate constants for this reaction when the temperature is decreased from 37°C to 15°C ?

- (A) 5/1 (B) 8.3/1 (C) 13/1 (D) 24/1



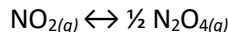
Phosphorous reacts with chlorine as shown. What is the equilibrium constant expression, K_p , for this reaction?

- (A) $\frac{4P_{\text{PCl}_3}}{6P_{\text{PCl}_3} \cdot P_{\text{Cl}_2}}$ (B) $\frac{4P_{\text{PCl}_3}}{6P_{\text{Cl}_2}}$
 (C) $\frac{P_{\text{PCl}_3}}{P_{\text{PCl}_3} \cdot P_{\text{Cl}_2}^6}$ (D) $\frac{P_{\text{PCl}_3}^4}{P_{\text{Cl}_2}^6}$

17. The equilibrium constant for the reaction



is 6.10×10^{-3} at 25°C . Calculate the value of K for this reaction:

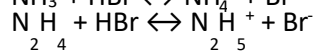
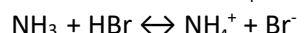
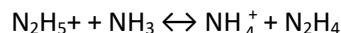


- (A) 327 (B) 164 (C) 12.8 (D) 3.05×10^{-3}

18. The ion-product constant for water at 45°C is 4.0×10^{-14} . What is the pH of pure water at this temperature?

- (A) 6.7 (B) 7.0 (C) 7.3 (D) 13.4

19. The position of equilibrium lies to the right in each of these reactions.



Based on this information, what is the order of acid strength?

- (A) $\text{HBr} > \text{N}_2\text{H}_5^+ > \text{NH}_4^+$ (B) $\text{N}_2\text{H}_5^+ > \text{N}_2\text{H}_4 > \text{NH}_4^+$
(C) $\text{NH}_3 > \text{N}_2\text{H}_4 > \text{Br}^-$ (D) $\text{N}_2\text{H}_5^+ > \text{HBr} > \text{NH}_4^+$

20. HCN is a weak acid ($K_a = 6.2 \times 10^{-10}$). NH_3 is a weak base ($K_b = 1.8 \times 10^{-5}$). A 1.0 M solution of NH_4CN would be

- (A) strongly acidic (B) weakly acidic
(C) neutral (D) weakly basic

21. What is the percent ionization of a 0.010 M HCN solution? ($K_a = 6.2 \times 10^{-10}$)

- (A) 0.0025% (B) 0.025%
(C) 0.25% (D) 2.5%

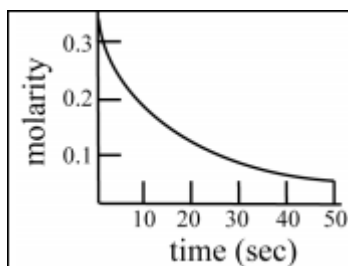
22. How many moles of HCOONa must be added to 1.0 L of 0.10 M HCOOH to prepare a buffer solution with a pH of 3.4? ($\text{HCOOH } K_a = 2 \times 10^{-4}$)

- (A) 0.01 (B) 0.05 (C) 0.1 (D) 0.2

23. The acid-base indicator methyl red has a K_a of 1×10^{-5} . Its acidic form is red while its alkaline form is yellow. If methyl red is added to a colorless solution with a pH = 7, the color will be

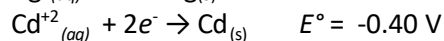
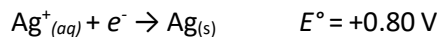
- (A) pink (B) red (C) orange (D) yellow

24. For the reaction represented by the accompanying diagram, which reaction rate is the greatest?



- (A) Average rate
(b) final rate
(c) Initial rate
(d) rate at 20 seconds

25. Consider a voltaic cell based on these half-cells.



Identify the anode and give the voltage of this cell under standard conditions.

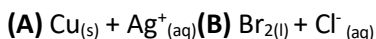
(A) Ag: $E_{\text{cell}} = 0.40 \text{ V}$

(B) Ag: $E_{\text{cell}} = 2.00 \text{ V}$

(C) Cd: $E_{\text{cell}} = 1.20 \text{ V}$

(D) Cd: $E_{\text{cell}} = 2.00 \text{ V}$

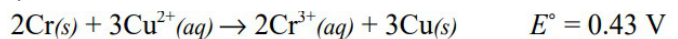
26. Which two species react spontaneously?



27. When aluminum oxide is electrolyzed in the industrial process for the production of aluminum metal, aluminum is produced at one electrode and oxygen gas is produced at the other. For a given quantity of electricity, what is the ratio of moles of aluminum to moles of oxygen gas?

- (A) 1:1 (B) 2:1 (C) 2:3 (D) 4:3

Use the following reaction to answer the next two questions:



28. Which expression gives the value for ΔG° in $\text{kJ}\cdot\text{mol}^{-1}$ for this reaction at 25°C ?

(A) $-6 \times 8.31 \times 0.43 \times 1000$

(B) $\frac{-6 \times 96500 \times 0.43 \times 1000}{8.31}$

(C) $\frac{-6 \times 96500 \times 0.43}{1000}$

(D) $\frac{-6 \times 8.31 \times 0.43}{1000}$

29. What is the voltage for this cell when $[\text{Cu}^{+2}] = 1.0 \text{ M}$ and $[\text{Cr}^{+3}] = 0.010 \text{ M}$?

- (A) 1.2 (B) 0.87 (C) 0.47 (D) 0.39

30. Which element can exhibit more than one oxidation state in compounds?

- (I) Cr (II) Pb (III) Sr

- (A) I only (B) I and II only
(C) II and III only (D) I, II, and III

31. Which aqueous solution has a freezing point closest to that of $0.30 \text{ M C}_{12}\text{H}_{22}\text{O}_{11}$?

- (A) 0.075 M AlCl_3 (B) 0.15 M CuCl_2
(C) 0.30 M NaCl (D) $0.60 \text{ M C}_6\text{H}_{12}\text{O}_6$

32. For a substance with the values of ΔH_{vap} and ΔS_{vap} given below, what is its normal boiling point in $^\circ\text{C}$?

($\Delta H_{\text{vap}} = 59.0 \text{ kJ}\cdot\text{mol}^{-1}$; $\Delta S_{\text{vap}} = 93.65 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$)

- (A) 357 (B) 630 (C) 1314 (D) 1587

33. What is the order of the boiling points (from lowest to highest) for the hydrogen halides?

- (A) $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$ (B) $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
(C) $\text{HCl} < \text{HF} < \text{HBr} < \text{HI}$ (D) $\text{HCl} < \text{HBr} < \text{HI} < \text{HF}$

34. Which phase change for water has positive values for both ΔH° and ΔG° ?

- (A) (l) \rightarrow (s) at 250 K (B) (l) \rightarrow (s) at 350 K
(C) (l) \rightarrow (g) at 350 K (D) (l) \rightarrow (g) at 450 K

35. When solid CuSO_4 dissolves in water to make a 1 M solution, the temperature of the system increases. When solid NH_4NO_3 dissolves in water to make a 1 M solution, the temperature of the system decreases. Which statement(s) must be correct for these dissolving processes?

- I ΔH° values for both processes have the same sign.
II ΔG° values for both processes have the same sign.

- (A) I only (B) II only
(C) Both I and II (D) Neither I nor II

36. Which set of relationship could apply to the same electrochemical cell?

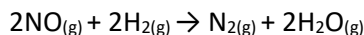
- (A) $\Delta^\circ G > 0$; $E^\circ = 0$ (B) $\Delta^\circ G < 0$; $E^\circ = 0$
(C) $\Delta^\circ G > 0$; $E^\circ > 0$ (D) $\Delta^\circ G < 0$; $E^\circ > 0$

37. The rate constant for a reaction is affected by which factors?

- I Increase in temperature
II concentration of the reactants
III presence of a catalyst

- (A) I and II only (B) I and III only
(C) II and III only (D) I, II, and III

38. The rate data given were obtained for the reaction



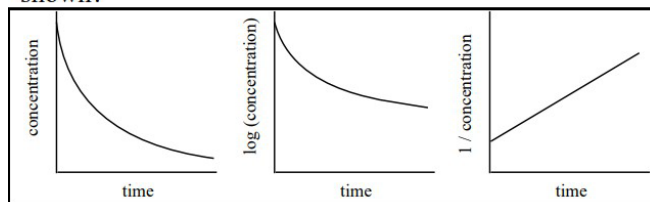
What is the rate law for this reaction?

NO pressure (atm)	H ₂ pressure	Rate (atm.sec ⁻¹)
0.375	0.500	6.43×10^{-4}
0.375	0.250	3.15×10^{-4}
0.188	0.500	1.56×10^{-4}

- (A) Rate = $k P_{\text{NO}}$ (B) Rate = $k P_{\text{NO}}^2$
(C) Rate = $k P_{\text{NO}} P_{\text{H}_2}^2$ (D) Rate = $k P_{\text{NO}}^2 P_{\text{H}_2}$

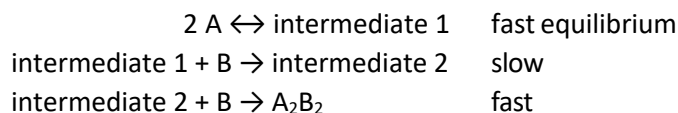
39.

What is the order of a reaction that produces the graphs shown?



- (A) zero order (B) first order
(C) second order (D) some other order

40. What is the rate law for the hypothetical reaction with the mechanism shown?



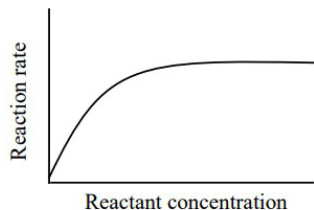
- (A) Rate = $k[A]^2$ (B) Rate = $[B]^2$
(C) Rate = $k[A][B]$ (D) Rate = $k[A]^2[B]$

41. According to the Arrhenius equation $k = Ae^{-E_a/RT}$, a plot of $\ln k$ against $1/T$ yields

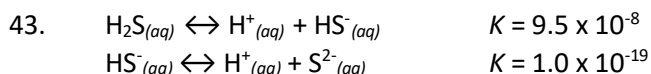
- (A) E_a as the slope and A as the intercept
(B) E_a/R as the slope and A as the intercept
(C) E_a/R as the slope and $\ln A$ as the intercept
(D) $-E_a/R$ as the slope and $\ln A$ as the intercept

42.

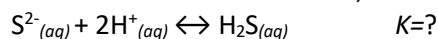
Curves with the shape shown are often observed for reactions involving catalysts. The level portion of the curve is best attributed to the fact that



- (A) product is no longer being formed.
- (B) the reaction has reached equilibrium.
- (C) all the catalytic sites are occupied.
- (D) all the reactant has been consumed.



Given the equilibrium constants provided, what is the equilibrium constant for the reaction;



- (A) 9.5×10^{-27}
- (B) 9.7×10^{-14}
- (C) 9.5×10^{11}
- (D) 1.0×10^{26}

44. In the galvanic cell



Which of the following changes will increase the cell potential?

- I. Dilution of the Al^{3+} solution to 0.001 M
- II. Dilution of the Cu^{2+} solution to 0.001 M
- III. Increasing the surface area of the Al(s) electrode

- (A) I only
- (B) II only
- (C) III only
- (D) I and III only

45. When the acids; HClO_3 , H_3BO_3 , H_3PO_4 , are arranged in order of increase strength, which order is correct?

- (A) $\text{H}_3\text{BO}_3 < \text{H}_3\text{PO}_4 < \text{HClO}_3$
- (A) $\text{HClO}_3 < \text{H}_3\text{BO}_3 < \text{H}_3\text{PO}_4$
- (A) $\text{H}_3\text{PO}_4 < \text{HClO}_3 < \text{H}_3\text{BO}_3$
- (A) $\text{H}_3\text{BO}_3 < \text{HClO}_3 < \text{H}_3\text{PO}_4$

46. A buffer solution results from mixing equal volumes of which solutions?

- I 0.10 M HCl and 0.20 M NH_3
- II 0.10 M HNO_2 and 0.10 M NaNO_2
- III 0.20 M HCl and 0.10 M NaCl

- (A) II only
- (B) I and II only
- (C) I and III only
- (D) I, II, and III

47. A solution is 0.10 M in Ag^+ , Ca^{+2} , Mg^{+2} and Al^{+3} ions. Which compound will precipitate at the lowest $[\text{PO}_4^{-3}]$ when a solution of Na_3PO_4 is added.

- (A) Ag_3PO_4 ($K_{sp} = 1 \times 10^{-16}$)
- (B) $\text{Ca}_3(\text{PO}_4)_2$ ($K_{sp} = 1 \times 10^{-33}$)
- (C) $\text{Mg}_3(\text{PO}_4)_2$ ($K_{sp} = 1 \times 10^{-24}$)
- (D) AlPO_4 ($K_{sp} = 1 \times 10^{-20}$)

48. Which salt is significantly more soluble in a strong acid than in water?

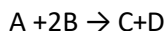
- (A) PbF_2
- (B) PbCl_2
- (C) PbBr_2
- (D) PbI_2

49. Which is the weakest oxidizing agent in a 1 M aqueous solution?

- (A) $\text{Ag}^+(\text{aq})$
- (B) $\text{Cu}^{+2}(\text{aq})$
- (C) $\text{H}^+(\text{aq})$
- (D) $\text{Zn}^{+2}(\text{aq})$

- (A) Ms^{-1} (B) s^{-1}
(C) $\text{M}^{-1}\text{s}^{-1}$ (D) k is dimensionless

58. What is the rate law for the following reaction?



$[A]_0 \text{ M}$	$[B]_0 \text{ M}$	Initial rate M s^{-1}
0.050	0.100	0.085
0.050	0.200	0.170
0.100	0.300	0.510

- (A) Rate = $k[A]$ (B) Rate = $k[B]$
 (C) Rate = $k[A][B]$ (D) Rate = $k[A][B]^2$

59. Hydrogen peroxide, $\text{H}_2\text{O}_{2(aq)}$, decomposes into water and oxygen. Adding a small amount of $\text{FeCl}_{3(aq)}$ increases the rate of gas evolution in this reaction. What is the best description of the role of FeCl_3 ?

- (A) Transition state
 (B) Reaction intermediate
 (C) Heterogeneous catalyst
 (D) Homogeneous catalyst

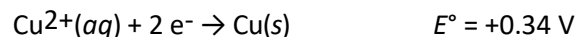
60. Which halogen has the highest standard entropy, S° ?

- (A) $\text{F}_{2(g)}$ (B) $\text{Cl}_{2(g)}$ (C) $\text{Br}_{2(l)}$ (D) $\text{I}_{2(s)}$

61. Which of the following statements is TRUE?

- (A) Positrons are similar in ionizing power and penetrating power to beta particles.
 (B) A positron is the antiparticle of the electron.
 (C) Beta decay occurs when a neutron changes into a proton while emitting an electron.
 (D) An alpha particle is a helium $2+$ ion.
 (E) All of the above are true.

62. A galvanic cell consists of one half-cell that contains $\text{Ag}(s)$ and $\text{Ag}^+(aq)$, and one half-cell that contains $\text{Cu}(s)$ and $\text{Cu}^{2+}(aq)$. What species are produced at the electrodes under standard conditions?



- (A) $\text{Ag}(aq)$ is formed at the cathode and, $\text{Cu}(s)$ is formed at the anode.
 (B) $\text{Ag}(s)$ is formed at the cathode, and $\text{Cu}^{2+}(aq)$ is formed at the anode.
 (C) $\text{Cu}(s)$ is formed at the cathode, and $\text{Ag}^+(aq)$ is formed at the anode.
 (D) $\text{Cu}^{2+}(aq)$ is formed at the cathode, and $\text{Cu}(s)$ is formed at the anode.

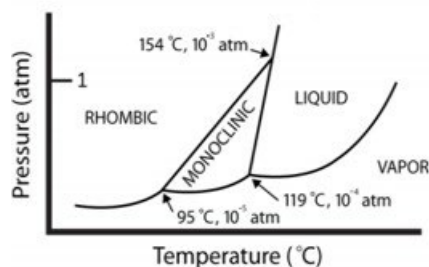
63. Which substance would be expected to exhibit the greatest surface tension at 25°C ?

- (A) CH_3OCH_3 (B) $\text{C}_2\text{H}_5\text{OH}$
 (C) $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ (D) $\text{CH}_2(\text{OH})\text{CH}_2\text{OH}$

64. How would the freezing point depression of a 0.05 m CaCl_2 solution compare with that of a NaCl solution? It would be

- (A) less than that for a 0.10 m NaCl solution
 (B) between that for a 0.10 m NaCl solution and a 0.20 m NaCl solution
 (C) between that for a 0.20 m NaCl solution and 0.30 m NaCl solution
 (D) Greater than that for a 0.30 m NaCl solution

65. The phase diagram for sulfur is shown below. Which statement about this diagram is correct?



- (A) The critical point is above 154°C and 10^3 atm .
 (B) There are only two triple point in this diagram.

- (C) Monoclinic sulfur is more dense than rhombic sulfur at any temperature.
 (D) Monoclinic sulfur forms rhombic sulfur at higher pressure or lower temperature.

66. Carbon tetrachloride, CCl_4 has a higher normal boiling point than chloroform, CHCl_3 (77°C and 61°C). Differences in which interactions contribute the most to this difference in boiling point?

- (A) Hydrogen bonding
 (B) Dipole-dipole interactions
 (C) London dispersion forces
 (D) Covalent bonding

67. The triple point of ammonia is 195.40 K at 0.006 bar , while its melting point is 195.42 K at 1 bar pressure. Which statement about ammonia is correct?

- (A) Solid ammonia is denser than liquid ammonia at 195.4 K .
 (B) Ammonia vapor cannot coexist with liquid ammonia at equilibrium at 195.5 K .
 (C) Ammonia vapor cannot coexist with solid ammonia at equilibrium at 195.3 K .
 (D) Solid ammonia and liquid cannot coexist at equilibrium at 195.5 K .

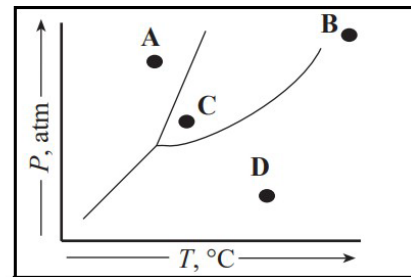
68. An aqueous solution of potassium sulfate (K_2SO_4) has a freezing point of -2.24°C . What is its molality?

($K_f -1.86^\circ\text{C}\cdot\text{mol}^{-1}$)

- (A) 0.401 m (B) 0.602 m
 (C) 1.20 m (D) 4.17 m

69.

Which point in the phase diagram best represents supercritical conditions?



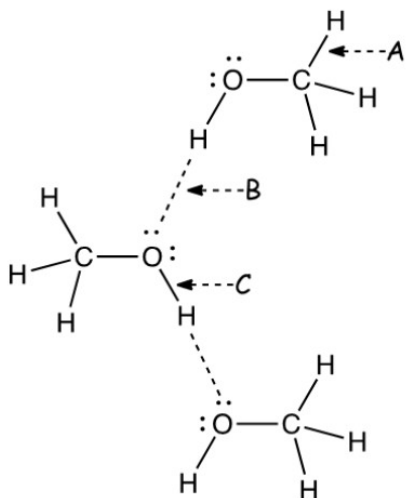
- (A) A (B) B (C) C (D) D

70. Interferon is a water-soluble protein. A solution prepared by dissolving 15.0 mg of interferon in 2.50 mL of H_2O exhibits an osmotic pressure of 5.80 mmHg at 25°C . What is the molar mass of interferon?

- (A) $1.92 \times 10^4\text{ g/mol}$ (B) $1.92 \times 10^7\text{ g/mol}$
 (C) $1.95 \times 10^6\text{ g/mol}$ (D) 1.61×10^3

71.

The diagram represents a molecular view of a sample of liquid methanol, CH_3OH . Which letters in the diagram show hydrogen bonds?



- (A) A only (B) B only
(C) C only (D) A and C

72. The value of which concentration unit for a solution changes with temperature?

- (A) molarity (B) molality
(C) mole fraction (D) mass percentage

73. A student wishes to determine the molar mass of a pure solid organic compound. Which measurement would be most useful?

- (A) melting point of the solid
(B) heat of combustion of the solid
(C) freezing point depression of the solid dissolved in pure benzene
(D) solubility in pure benzene

74. Which aqueous solution exhibits the largest freezing point depression?

- (A) 1.0 m KBr (B) 0.75 m $\text{C}_6\text{H}_{12}\text{O}_6$
(C) 0.5 m MgCl_2 (D) 0.25 m $\text{Ga}_2(\text{SO}_4)_3$

CHEM 132 ACS Final Exam Practice- Answers

1	A	12	C	23	D	34	C	45	A	56	B	67	A
2	D	13	C	24	C	35	B	46	B	57	A	68	A
3	D	14	D	25	C	36	D	47	D	58	C	69	B
4	D	15	C	26	A	37	B	48	A	59	D	70	A
5	C	16	D	27	D	38	D	49	D	60	B	71	B
6	B	17	C	28	C	39	C	50	D	61	E	72	A
7	C	18	A	29	C	40	D	51	A	62	B	73	C
8	A	19	A	30	B	41	D	52	A	63	D	74	A
9	A	20	D	31	A	42	C	53	B	64	A		
10	A	21	B	32	A	43	D	54	E	65	D		
11	D	22	B	33	D	44	A	55	C	66	C		

