CHEMISTRY 101 FINAL EXAM

SECTIONS 572-580
Dr. Joy Heising

FORM 4M

December 7, 2001

Directions:

1. Fill out your scantron sheet.
   a. Do not forget to include your **SIGNATURE and ID number**.
   b. Dept = CHEM, Course No. = 101
   c. If you want your scores posted, mark A under the option column

2. Use a #1 or #2 pencil for marking the answer sheets. Fill in the appropriate circles completely.

3. DO NOT write on the envelope.

4. Read each question **carefully**, then choose the **best answer** for each question. There is no penalty for guessing.

5. You may write on the exam questions. The last page is a sheet of scrap paper.

6. When finished, put the scanning sheet back in the envelope and turn it in. You may keep the exam questions.

7. This examination consists of 40 multiple choice questions (6 points each). The total point value for the exam is **240 points**.

Some helpful equations/constants:

$PV = nRT$ $\quad R = 0.0821 \frac{atm \cdot L}{mol \cdot K}$ $\quad R = 62.4 \frac{torr \cdot L}{mol \cdot K}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\quad N_1V_1 = N_2V_2$

$P_{tot} = P_a + P_b + \ldots$
$n_{tot} = n_a + n_b + \ldots$

1. Which statement is **INCORRECT**? In one mole of $MgCl_2$ there are

a) 6.022×10^{23} Mg atoms
b) 6.022×10^{23} formula units
c) 2 chloride ions
d) 24.3 g of magnesium
e) 2 moles of chloride ions

2. An unknown binary tantalum sulfide compound contains 65.3% Ta and 34.7% S. The empirical formula of the compound is:

a) TaS
b) TaS_2
c) TaS_3
d) Ta_2S_3
e) Ta_3S_4

3. Which of the following name and formula combinations is **INCORRECT**?

a) barium phosphate	$Ba_3(PO_4)_2$
b) ammonium iodide	NH_4I
c) sodium sulfate	Na_2S
d) dichlorine heptoxide	Cl_2O_7
e) hydrogen cyanide	HCN

4. What is the oxidation number of Fe in $Fe_2(SO_4)_3$?

a) +2
b) +3
c) +4
d) +5
e) +6

5. What is the oxidation number of Se in Na_2SeO_4?

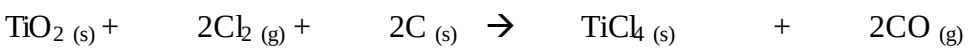
a) +2
b) +3
c) +4
d) +5
e) +6

6. What is the coefficient for CO when the following equation is balanced with the **smallest whole number coefficients**?

$$Fe_2O_3 + CO \rightarrow CO_2 + Fe$$

a) 5
b) 6
c) 3
d) 4
e) 1

7. Consider the following reaction to make titanium tetrachloride, a compound used in the synthesis of materials for nuclear waste cleanup:



$$TiO_{2\,(s)} + 2Cl_{2\,(g)} + 2C_{(s)} \rightarrow TiCl_{4\,(s)} + 2CO_{(g)}$$

If 50.0 g of each reactant are combined, what is the maximum amount of $TiCl_4$ that will be formed?

a) 50.0 g
b) 134 g
c) 119 g
d) 66.9 g
e) 19.7 g

8. Calculate the molarity of a solution that contains 46.2 g of H_3PO_4 in 850 mL.

a) 0.471 M
b) 5.33 M
c) 0.555 M
d) 5.55×10^{-4} M
e) 5.33×10^{4} M

9. Rank the acids in the expected order of **increasing** acid strength:

a) $H_3PO_2 < H_3PO_3 < H_3PO_4 < H_2PO_2^-$
b) $H_3PO_4 < H_3PO_3 < H_3PO_2 < H_2PO_2^-$
c) $H_2PO_2^- < H_3PO_2 < H_3PO_3 < H_3PO_4$
d) $H_2PO_2^- < H_3PO_4 < H_3PO_3 < H_3PO_2$
e) $H_3PO_2 < H_2PO_2^- < H_3PO_3 < H_3PO_4$

10. Given the following **net** ionic equation, which statement is **INCORRECT**?

$$H_3PO_{4\,(aq)} + 3OH^-_{(aq)} \rightarrow 3H_2O_{(l)} + PO_4^{3-}{}_{(aq)}$$

a) phosphoric acid is completely neutralized.
b) there are spectator ions in the total ionic equation.
c) this is the net ionic equation for a strong acid reacting with a soluble base.
d) this is an example of an arrhenius acid/base reaction.
e) a soluble salt is formed.

11. Give the number of protons, neutrons, and electrons in the ^{22}Ne isotope.

a) 10 p 12 n 10 e
b) 10 p 10 n 12 e
c) 10 p 12 n 12 e
d) 12 p 10 n 12 e
e) 10 p 22 n 10 e

12. For a neutral silicon atom, [Ne]$3s^2 3p^2$, which statement about the 'outermost' electron (the 'last' added electron) is **INCORRECT**?

a) *3* represents the overall energy level of the occupied orbital.
b) *p* represents the shape of the occupied orbital.
c) the direction of the occupied orbital is not designated in this electron configuration.
d) the electron is paired with another electron in the orbital.
e) a plausible value for the angular quantum number of the electron is –1.

13. Which one of the following ground state electron configurations is **incorrect**?

a) $_{20}$Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
b) $_{25}$Mn [Ar]$4s^2 4d^5$
c) $_{29}$Cu [Ar]$3d^{10} 4s^1$
d) $_{50}$Sn [Kr]$4d^{10} 5s^2 5p^2$
e) $_{54}$Xe [Kr]$4d^{10} 5s^2 5p^6$

14. Arrange the following set of ions in order of **increasing** ionic radii.

Ca^{2+}, Cl^-, K^+, P^{3-}, S^{2-}

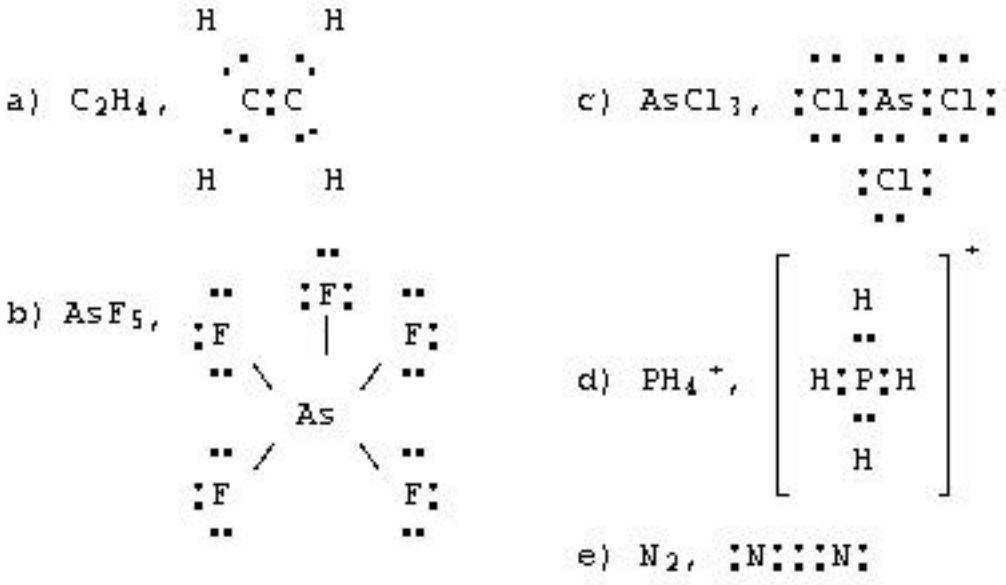
a) $Ca^{2+} < K^+ < P^{3-} < S^{2-} < Cl^-$
b) $Ca^{2+} < K^+ < Cl^- < S^{2-} < P^{3-}$
c) $K^+ < Cl^- < Ca^{2+} < S^{2-} < P^{3-}$
d) $P^{3-} < S^{2-} < Cl^- < K^+ < Ca^{2+}$
e) $Cl^- < S^{2-} < P^{3-} < Ca^{2+} < K^+$

15. Arrange the following elements in order of **decreasing** electronegativities.

Al, Cs, Mg, Na, P

a) Cs > Na > Mg > Al > P
b) P > Al > Mg > Na > Cs
c) Al > Mg > Na > Cs > P
d) P > Al > Mg > Cs > Na
e) P > Cs > Na > Mg > Al

16. Which of the following Lewis dot formulas is **INCORRECT**?



17. Which molecule is **incorrectly** matched with the **molecular** (or **ionic**) geometry?

Molecule	Molecular (or Ionic) Geometry
a) SeF_6	octahedral
b) ClO_2^-	angular
c) SO_3	pyramidal
d) SF_4	tetrahedral
e) $BeCl_2$	linear

18. Which one of the following molecules is **polar**?

a) AsF_5
b) NCl_3
c) CO_2
d) CF_4
e) SiH_4

19. How many **lone pairs** of electrons are there on the Xe atom in the XeF_4 molecule?

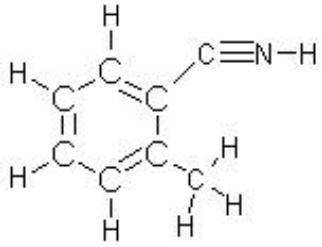
a) one
b) two
c) three
d) four
e) zero

20. What is the hybridization of the central I atom in I_3^- ?

a) *sp*
b) sp^2
c) sp^3
d) sp^3d
e) sp^3d^2

21. Methylbenzonitrile has how many σ and π bonds?

a) 13 σ and 4 π bonds
b) 13 σ and 9 π bonds
c) 17 σ and 5 π bonds
d) 17 σ and 4 π bonds
e) 13 σ and 5 π bonds



22. For the system as written below, the Brönsted-Lowry **acidic** species are

$$H_2C_4H_4O_{4\,(aq)} + H_2O_{(l)} \;?\; HC_4H_4O_4^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

a) $H_2C_4H_4O_4$ and H_2O
b) H_2O and H_3O^+
c) H_3O^+ and $HC_4H_4O_4^-$
d) $H_2C_4H_4O_4$ and $HC_4H_4O_4^-$
e) H_3O^+ and $H_2C_4H_4O_4$

23. Which statement about the following reaction is **TRUE**:

$Cr(OH)_{3\,(s)} + OH^-_{(aq)} \rightarrow Cr(OH)_4^-{}_{(aq)}$

a) this is an example of an Arrhenius acid/base reaction.
b) $Cr(OH)_3$ is acting as a base.
c) The reaction as written is a total ionic equation.
d) OH^- is an electron pair donor.
e) the chromium atom oxidation state changes from 3+ to 4+.

24. One mole of $Ca(OH)_2$ has _____ equivalents of the base.

a) 1/2
b) 1
c) 2
d) 3
e) 4

25. Which of the following is **not** an example of an acid/base reaction with an amphoteric species?

a) $K_2HPO_4 + HCl \rightarrow KH_2PO_4 + KCl$
b) $K_2HPO_4 + KOH \rightarrow K_3PO_4 + H_2O$
c) $H_2O + HBr \rightarrow H_3O^+ +$ Br-
d) $K_3PO_4 + HBr \rightarrow K_2HPO_4 + KBr$
e) $Zn(OH)_2 + 2OH^- \rightarrow [Zn(OH)_4]^{2-}$

26. Consider the following acid/base reaction:

$H_2SO_{4\,(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + Na_2SO_{4\,(aq)}$ (UNBALANCED)

If 5.50 ml of a 3.00 N solution of NaOH reacts completely with 7.00 ml of a H_2SO_4 solution, what is the molarity of the H_2SO_4 solution?

a) 1.18 M
b) 1.50 M
c) 2.36 M
d) 4.70 M
e) 3.00 M

27. When balanced, what is the total number of electrons transferred?

$C_2O_4^{2-}{}_{(aq)} + Mn^{7+}{}_{(aq)} \rightarrow CO_{2(g)} + Mn^{2+}{}_{(aq)}$ (UNBALANCED)

a) 2
b) 5
c) 6
d) 7
e) 10

28. The volume of a sample of gas is 433 ml at 150 torr and 445 K. What volume will the gas occupy at 500 torr and 977 K?

a) 1190 L
b) 0.285 L
c) 1.20 L
d) 285 L
e) 157 ml

29. A 27.0 g sample of gaseous methane (CH_4) occupies a volume of 4.00 L at 31°C. Calculate the pressure exerted by the $CH_{4\,(g)}$.

a) 10.5 atm
b) 5.49 atm
c) 17.2 atm
d) 42.1 atm
e) 15.8 atm

30. A 20.0 L vessel contains 0.5 g $H_{2\,(g)}$, 0.5 g $O_{2\,(g)}$, and 0.5 g $H_2O_{\,(g)}$ at 40°C. The total pressure in the flask is:

a) 5690 torr
b) 427 torr
c) 285 torr
d) 146 torr
e) 8540 torr

31. The Haber process, discovered by the Germans during World War II, converts gaseous nitrogen and gaseous hydrogen into gaseous ammonia, NH_3, which is used in the production of fertilizers and explosives. Haber was unsuccessful in obtaining 100% yield by his method; however, if **you** were to discover a process to make **500 mL** of **hydrogen** react completely with excess **nitrogen** (at constant temperature & pressure), what volume of **NH_3** would you obtain?

a) 0.500 L
b) 0.167 L
c) 0.333 L
d) 1.50 L
e) there is insufficient information given for this calculation.

32. Which statement about liquids is **false**?

a) In the absence of a phase change, the viscosity of a liquid increases as temperature decreases.
b) If the adhesive forces are stronger than the cohesive forces, capillary action is less likely to occur.
c) The shape of a meniscus depends on the difference between the strengths of cohesive forces and adhesive forces.
d) Liquids with strong cohesive forces have high heats of vaporization.
e) Vaporization of liquids can occur below their normal boiling points at one atmosphere pressure.

33. The boiling points of the halogens increase in the order $F_2 < Cl_2 < Br_2 < I_2$ due to the increasing intermolecular _____.

a) ion-ion forces
b) dipole-dipole forces
c) hydrogen bonding
d) dispersion forces
e) ion-dipole forces

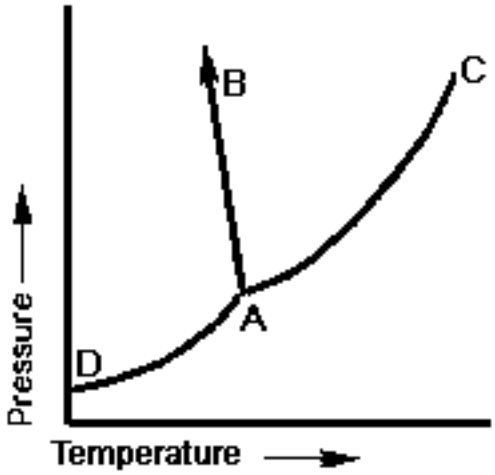
34. How much heat would be required to convert 234.3 g of solid benzene, C_6H_6 (s), at 5.5ºC into benzene vapor, C_6H_6 (g), at 100.0ºC?

mp of C_6H_6 (s) = 5.5ºC heat of fusion at 5.5ºC = 127 J/g
bp of C_6H_6 (l) = 80.1ºC heat of vaporization at 80.1ºC = 395 J/g

heat capacity of C_6H_6 (l) = 1.74 J/gºC
heat capacity of C_6H_6 (g) = 1.05 J/gºC

a) 105 kJ
b) 158 kJ
c) 53 kJ
d) 32 kJ
e) 5049 kJ

35. A sketch of the phase diagram (not to scale) of an unidentified substance is given below. Which statement is **false**?



a) Line AD is the sublimation curve - solid and vapor are in equilibrium.
b) Point A is the triple point - solid, liquid, and vapor are at equilibrium.
c) Line AC is the vapor pressure curve - liquid and gas (vapor) are in equilibrium.
d) This could be the phase diagram for H_2O.
e) The slope of line AB is negative, showing that the molecules become closer to one another as the solid is formed.

36. Which of the following compounds is **not** miscible with water?

a) CH_3OH
b) CH_3COOH
c) CCl_4
d) CH_3CN
e) $HOCH_2CH_2OH$

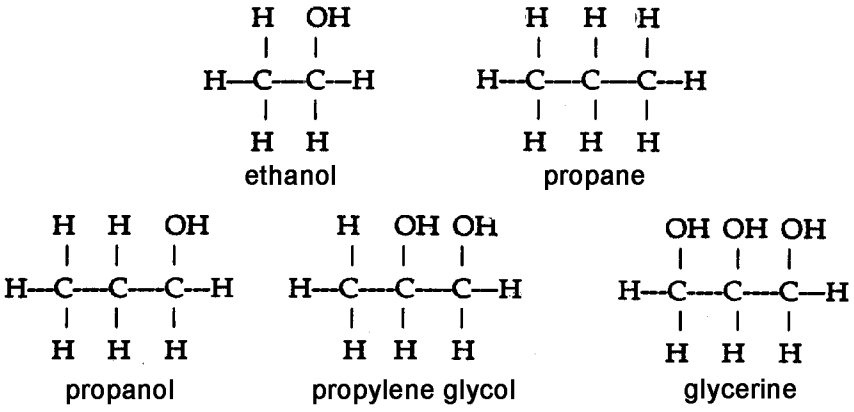
37. Which of the following compounds is **not** miscible with pentane, C_5H_{12}?

a) CF_4
b) C_6H_{14}
c) $CH_3CH_2CH_3$
d) CH_3CN
e) C_6H_6

38. Which one of the following boils at the **lowest** temperature?

a) KNO_3
b) CCl_4
c) Kr
d) NH_3
e) AsH_3

39. Which species would you expect to be the **most** viscous?



a) ethanol
b) propane
c) propanol
d) propylene glycol
e) glycerine

40. What primary force of attraction would operate between HF molecules in a liquid?

a) ion-ion forces
b) dipole-dipole forces
c) hydrogen bonding
d) dispersion forces
e) ion-dipole forces

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