

CHEMISTRY 101 FINAL EXAM

SECTIONS 572-580

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FORM 4N

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:

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

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad N_1 V_1 = N_2 V_2$$

$$P_{\text{tot}} = P_a + P_b + \dots$$

$$n_{\text{tot}} = n_a + n_b + \dots$$

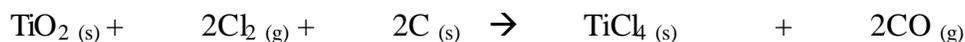
1. Which statement is **INCORRECT**? In one mole of Li_2CO_3 there are
- a) 2 atoms of lithium
 - b) 13.8 g of lithium
 - c) 6.022×10^{23} formula units
 - d) 6.022×10^{23} C atoms
 - e) 3 moles of oxygen
2. An unknown binary tantalum sulfide compound contains 73.8% Ta and 26.2% S. The empirical formula of the compound is:
- a) TaS
 - b) TaS₂
 - c) TaS₃
 - d) Ta₂S₃
 - e) Ta₃S₄
3. Which of the following name and formula combinations is **INCORRECT**?
- | | |
|------------------------------------|-----------------------|
| a) N ₂ O ₄ | dinitrogen tetraoxide |
| b) H ₂ O ₂ | hydrogen peroxide |
| c) CuO | copper (I) oxide |
| d) HClO ₄ | perchloric acid |
| e) Cs ₂ SO ₄ | cesium sulfate |
4. What is the oxidation number of Fe in $\text{Fe}_3(\text{PO}_4)_2$?
- a) +2
 - b) +3
 - c) +4
 - d) +5
 - e) +6
5. What is the oxidation number of Mn in H_2MnO_3 ?
- a) +2
 - b) +3
 - c) +4
 - d) +5
 - e) +6

6. Balance the following equation with the **smallest whole number coefficients**. What is the coefficient for HCl in the balanced equation?



- a) 4
- b) 6
- c) 3
- d) 12
- e) 2

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



If 75.0 g of each reactant are combined, what is the maximum amount of TiCl_4 that will be formed?

- a) 75.0 g
- b) 179 g
- c) 100 g
- d) 202 g
- e) 29.6 g

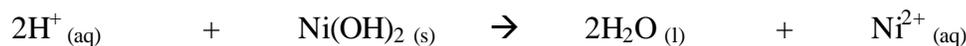
8. Calculate the molarity of a solution that contains 30.3 g of H_3PO_4 in 750 mL.

- a) 0.309 M
- e) 2.43×10^4 M
- b) 0.412 M
- c) 2.43 M
- d) 4.12×10^{-4} M

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

- a) $\text{H}_3\text{PO}_2 > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_4 > \text{H}_2\text{PO}_2^-$
- b) $\text{H}_2\text{PO}_2^- > \text{H}_3\text{PO}_4 > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_2$
- c) $\text{H}_2\text{PO}_2^- > \text{H}_3\text{PO}_2 > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_4$
- d) $\text{H}_3\text{PO}_4 > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_2 > \text{H}_2\text{PO}_2^-$
- e) $\text{H}_3\text{PO}_4 > \text{H}_2\text{PO}_2^- > \text{H}_3\text{PO}_3 > \text{H}_3\text{PO}_2$

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



- a) the nickel hydroxide is completely neutralized.
- b) there are no spectator ions in the total ionic equation.
- c) this is the net ionic equation for a strong acid reacting with an insoluble 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 ^{41}K isotope.

- a) 19 p 22 n 22 e
- b) 41 p 19 n 41 e
- c) 19 p 22 n 19 e
- d) 19 p 16 n 19 e
- e) 15 p 26 n 15 e

12. For a neutral phosphorus atom, $[\text{Ne}]3s^23p^3$, 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 electron is not paired with another electron in the orbital.
- d) the direction of the occupied orbital is not designated in this electron configuration.
- e) a plausible value for the angular quantum number of the electron is 2.

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

- a) $_{19}\text{K} \quad 1s^22s^22p^63s^23p^64s^1$
- b) $_{47}\text{Ag} \quad [\text{Kr}]4d^{10}5s^1$
- c) $_{26}\text{Fe} \quad [\text{Ar}]4s^24d^6$
- d) $_{51}\text{Sb} \quad [\text{Kr}]4d^{10}5s^25p^3$
- e) $_{54}\text{Xe} \quad [\text{Kr}]4d^{10}5s^25p^6$

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



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

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

- a) CCl_4
- b) SCl_6
- c) SeCl_2
- d) PCl_5
- e) SiH_4

19. How many **lone pairs** of electrons are there on the S atom in the SCl_4 molecule?

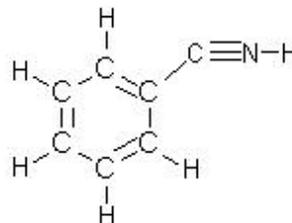
- a) one
- b) two
- c) three
- d) four
- e) zero

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. Benzonitrile has how many σ and π bonds?

- a) 10 σ and 4 π bonds
- b) 10 σ and 9 π bonds
- c) 14 σ and 4 π bonds
- d) 14 σ and 5 π bonds
- e) 10 σ and 5 π bonds

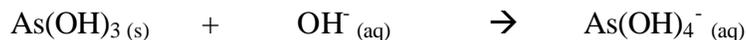


22. For the system as written below, the Brønsted-Lowry **acidic** species are



- a) $\text{H}_2\text{C}_4\text{H}_4\text{O}_6$ and H_2O
- b) H_2O and H_3O^+
- c) H_3O^+ and $\text{H}_2\text{C}_4\text{H}_4\text{O}_6$
- d) H_3O^+ and $\text{HC}_4\text{H}_4\text{O}_6^-$
- e) $\text{H}_2\text{C}_4\text{H}_4\text{O}_6$ and $\text{HC}_4\text{H}_4\text{O}_6^-$

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



- a) this is an example of an Arrhenius acid/base reaction.
- b) As(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 arsenic atom oxidation state changes from 3+ to 4+.

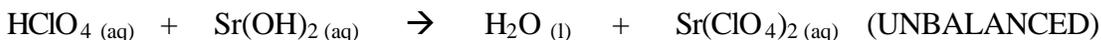
24. One mole of H_3AsO_4 has _____ equivalents of the acid.

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

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

- a) $\text{Na}_2\text{HPO}_4 + \text{HBr} \rightarrow \text{NaH}_2\text{PO}_4 + \text{NaBr}$
- b) $\text{Na}_2\text{HPO}_4 + \text{NaOH} \rightarrow \text{Na}_3\text{PO}_4 + \text{H}_2\text{O}$
- c) $\text{H}_2\text{O} + \text{HI} \rightarrow \text{H}_3\text{O}^+ + \text{I}^-$
- d) $\text{Na}_3\text{PO}_4 + \text{HBr} \rightarrow \text{Na}_2\text{HPO}_4 + \text{NaBr}$
- e) $\text{Sn(OH)}_2 + 2\text{OH}^- \rightarrow [\text{Sn(OH)}_4]^{2-}$

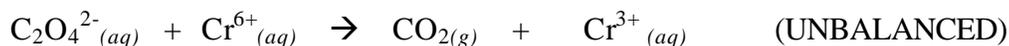
26. Consider the following acid/base reaction:



If 7.50 ml of a 3.00 N solution of HClO_4 reacts completely with 13.0 ml of a Sr(OH)_2 solution, what is the molarity of the Sr(OH)_2 solution?

- a) 0.866 M
- b) 1.73 M
- d) 1.50 M
- c) 3.46 M
- e) 3.00 M

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



- a) 2
- b) 3
- c) 5
- d) 6
- e) 10

28. The volume of a sample of gas is 327 ml at 300 torr and 345 K. What volume will the gas occupy at 200 torr and 838 K?
- a) 1190 L
 - b) 0.285 L
 - c) 1.20 L
 - d) 285 L
 - e) 157 ml
29. A 17.0 g sample of gaseous acetylene (C_2H_2) occupies a volume of 3.00 L at $34^\circ C$. Calculate the pressure exerted by the C_2H_2 (g).
- a) 10.5 atm
 - b) 5.49 atm
 - c) 16.5 atm
 - d) 42.1 atm
 - e) 15.8 atm
30. A 20.0 L vessel contains 0.75 g H_2 (g), 0.75 g O_2 (g), and 0.75 g H_2O (g) at $40^\circ C$. The total pressure in the flask is:
- a) 2197 torr
 - b) 427 torr
 - c) 285 torr
 - d) 569 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 **750 mL** of **hydrogen** react completely with excess **nitrogen** (at constant temperature & pressure), what volume of **NH_3** would you obtain?
- a) 2.25 L
 - b) 0.250 L
 - c) 0.500 L
 - d) 0.750 L
 - e) there is insufficient information given for this calculation.

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

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

33. The boiling points of these group IV hydrides increase in the order $\text{CH}_4 < \text{SiH}_4 < \text{GeH}_4 < \text{SnH}_4$ due to the increasing intermolecular _____.

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

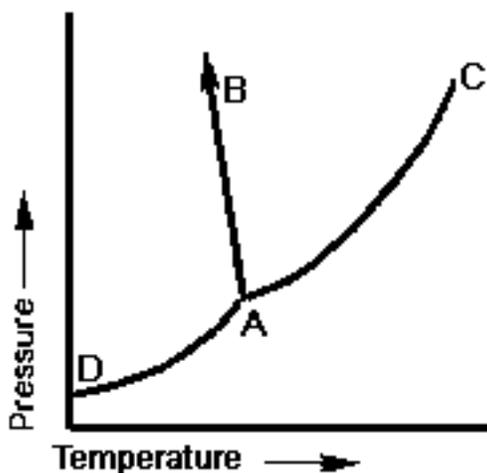
34. How much heat would be required to convert 156.2 g of solid benzene, C_6H_6 (s), at 5.5°C into benzene vapor, C_6H_6 (g), at 100.0°C ?

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

heat capacity of C_6H_6 (l) = 1.74 J/g $^\circ\text{C}$
heat capacity of C_6H_6 (g) = 1.05 J/g $^\circ\text{C}$

- 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 CO₂.
- e) The slope of line AB is negative, showing that the solid converts to the liquid with increasing pressure at constant temperature.

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

- a) CH₃CH₂OH
- b) CH₃COOH
- c) CCl₄
- d) CH₃CN
- e) HOCH₂CH₂OH

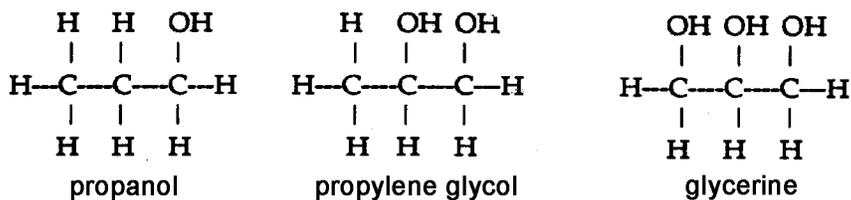
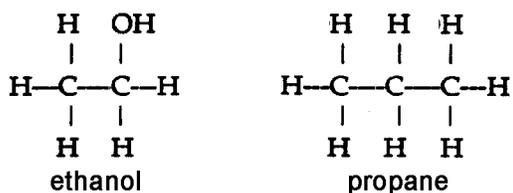
37. Which of the following compounds is **not** miscible with hexane, C₆H₁₄?

- a) CH₃CH₂CH₃
- b) C₆H₆
- c) CCl₄
- d) CH₃CN
- e) C₅H₁₂

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

- a) PH_3
- b) CF_4
- c) K_2SO_4
- d) Ar
- e) HF

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



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

40. What primary force of attraction would operate between NH_3 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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