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Final Exam
Chemistry 102, Prof. D. Naud
June 23, 1997

Name_____

I.D. No. _____ Signature_____

Note to Students: Some questions are straight multiple choice questions. Other multiple choice questions have the fill-in option. Fill in the correct answer ONLY when you cannot find the answer as a choice.

Straight multiple choice:

What is the chemical formula of potassium hydroxide?

A) K_2OH B) KOH C) NaOH D) RbOH

ANSWER: Circle letter B

Multiple choice with "fill-in option."

What is the pH of neutral water?

A) Two B) Three C) Ten D) _____

Answer: Because seven cannot be found as a multiple choice question, write the answer "Seven" in the blank space next to choice D).

All problems are worth 1 point each. There is no partial credit. Be careful with your math and use three to four significant figures in your answer. **Take the time to review your work!**

1 What is a valid acid-base conjugate pair for the following reaction?

$$OH^- + CH_3OH \longleftrightarrow \; ? \; + \; ?$$

A) O^{2-} + CH_3OH B) H_2O + $CH_3OH_2^+$ C) H_2O + $CH_3OH_2^+$ D)_____

2. What is the hydrogen ion concentration of a 2.00 L solution having a pOH = 9.50?

A) 3.16×10^{-10} M B) 6.32×10^{-10} M C) 6.32×10^{-5} M D)

3. What is the pH of a 0.0200 M $Ca(OH)_2$ solution?

A) 1.70 B) 12.30 C) 1.40 D)____

4. (No partial credit) Which of the different rankings of acid strengths is correct? (There can be more than one correct answer, circle all that are correct.)

A) HI < HBr < HCl B) $HBrO_4$ > $HBrO_3$ > $HBrO_2$ > HBrO

C) $HClO_4$ < $HClO_3$ < $HClO_2$ < HClO D) HIO < $HClO_4$

5. Which of the following reactions is an example of a Lewis acid - Lewis base reaction?

A) Zn^{2+} + Cl^- ⟶ $ZnCl^+$ B) Ag^+ + e^- ⟶ Ag^0

C) $CH_3\bullet$ + $Cl\bullet$ ⟶ CH_3Cl D) None of these

6. The concentration of a 200 mL solution of nitrous acid is 0.10 moles per liter. What is the pH of that solution given that the pK_b of nitrous acid is equal to 10.65?

A) 2.88 B) 5.83 C) 8.18 D)____

7. The pH of a 0.175 M solution of a weak monoprotic acid is 3.85. What is the pKa of the acid?

A) 2.89 B) 3.09 C) 5.54 D) _____

8. The molar heat of fusion of isopropyl alcohol is 5.11 kJ/mol. Calculate the entropy change for the solid to liquid transition for isopropyl alcohol (m.p. = -89.5°C).

A) 0.0278 J/(K mol) B) -57.1 J/(K mol) C) -0.0571 J/(K mol) D)_____

9. (No partial credit) Which of the following relation(s) is/are true when a rubber band is stretched? (Circle all of the relations which are true)

A) $\Delta H > 0$ B) $\Delta G < 0$ C) $\Delta S > 0$ D) $\Delta G > 0$ and $\Delta S > 0$
D) $\Delta H < 0$ and $\Delta S < 0$ E) $\Delta H < 0$ and $\Delta G > 0$ F) $\Delta H < 0$ and $\Delta G < 0$ G) None of the above

10. Calculate the equilibrium constant, Keq, for the following reaction at 25°C given that the ΔG^{o}_{rxt} is -11.66 kJ. R=8.314 J/(K mol)

$$Br_2 \text{ (gas)} + 2NO \text{ (gas)} \overset{Keq}{\rightleftharpoons} 2NOBr \text{ (gas)}$$

A) 1.000 B) 170.2 C) 50,800 D) _____

11. For the same reaction given above (#10) calculate the **standard entropy change** using the **standard enthalpy** data.
$H^{o}_{f}(Br_2 \text{ gas}) = 30.68$ kJ/(mol)
$H^{o}_{f}(NO \text{ gas}) = 90.29$ kJ/(mol)
$H^{o}_{f}(NOBr \text{ gas}) = 81.76$ kJ/(mol)

A) -130 J/K B) -199 J/K C) 130 J/K D)_____

12. Calculate the solubility of $Al(OH)_3$ (in grams/liter) in a solution buffered to pOH = 9.00. The molecular weight of $Al(OH)_3$ is 78.0 grams per mole; the Ksp of $Al(OH)_3$ is 1.80×10^{-33}.

A) 5.08×10^{-7} g/L B) 5.20×10^{-6} g/L C) 3.31×10^{-15} g/L D)_____

13 What is the Ksp expression for $Ca_3(PO_4)_2$?

A) $[Ca^{2+}]^3[PO_4^{3-}]^2$ B) $[Ca^{2+}][PO_4^{3-}]^2$ C) $[Ca^{2+}][PO_4^{3-}]$ D)_____

14. A 0.20 mole quantity of silver nitrate is added to a liter of 1.20 M NaCN solution. What is the concentration of silver ions at equilibrium. $K_f = 1.0 \times 10^{21}$?

$$Ag^{1+} + 2\,CN^{1-} \overset{K_f}{\rightleftharpoons} [Ag(CN)_2]^{1-}$$

A) 1.31×10^{-11} M B) 2.10×10^{-11} M C) 9.82×10^{-21} M D)_____

15. What is the third law of thermodynamics?

A) The entropy of any substance is zero at 298 K.
B) The entropy of an element is zero at zero K.
C) The entropy of a perfect crystalline substance is zero at 298 K.
D) The entropy of an element is zero at 298 K.
E) None of the above.

16. What is the Ksp of mercury (I) chloride, Hg_2Cl_2 in terms of its molar solubility, s?

A) $4s^4$ B) $16s^3$ C) $16s^4$ D)_____

17 The pH of a solution containing equal amounts of ammonia and hydrogen chloride is:

A) less than 7 B) more than 7 C) equal to 7 D) Can not be predicted

18. Silver nitrate is slowly added to a solution that is 0.0100 M in chloride ions and 0.0100 M in bromide ions. Calculate the concentration of silver ions (in moles per liter) required to initiate the precipitation of silver bromide. The Ksp's of silver bromide and silver chloride are 7.70×10^{-13} and 1.00×10^{-10} respectively.

A) 0.00902 M B) 1.52×10^{-9} C) 7.70×10^{-10} D) _____

19. Calculate the pH of a solution containing 1.00 M NH_3 and 0.650 M NH_4Cl. The pK_b of NH_3 is 4.74.

A) 4.93 B) 4.55 C) 9.45 D) _____

20. Which series of compounds correctly represents an aldehyde, a carboxylic acid, an amine and an ester?

A) $H_2C{-}CH_2$, CH_3OH, CH_3NH_2 and $H_2C{=}O$

B) $H_2C{=}O$, CH_3CO_2H, CH_3NH_2 and $CH_3CH_2CH_2COOCH_3$

C) CH_3OH, CH_3CO_2H, $H_2C{-}CH_2$ and CH_3NH_2

D) CH_3CO_2H, CH_3Br, CH_3NH_2 and $H_2C{=}O$

E) $CH_3CH_2CH_2COOCH_3$, CH_3CH_2OH, CH_3NH_2 and $H_2C{-}O$

21. What is the Ka of phenol (C_6H_5OH) given that the pK_b of phenoxide ion ($C_6H_5O^{1-}$) is 4.11?

A) 1.29×10^{-10} B) 7.76×10^{-5} C) 4.40×10^{-8} D) _____

22. (No partial credit) Circle any one or more statement that is true.

A) Zone refining is a process of purifying metals by electrolysis.
B) The addition of hydrogen to compounds containing multiple bonds is called halogenation.
C) Water reacts with calcium carbide to give propyne gas.
D) Cyanide ponds are used in industry to extract minute quantities of cyanide from ore.
E) Graphite is the most stable allotrope of carbon at standard temperature and pressure conditions.
F) None of the above

23. What products are generated when sodium cyanide and hydrogen chloride are reacted together?

A) sodium chloride and hydrogen cyanide gas
B) sodium carbide, nitrogen, and chlorine gas
C) sodium nitride and chloromethane
D) _____

24. Nitrogen forms compounds with H_2 and O_2 in which the oxidation number of nitrogen varies *from ? to ?*.

A) from -5 to +3 B) from -3 to +4 C) from -3 to +3 D) from -3 to +5 E) _____

25. Which statement is true with regards to an open can of Pepsi?

A) The pH of Pepsi increases with time.
B) The pH of Pepsi decreases with time.
C) Pepsi goes flat but the pH remains constant.
D) The gas that gives Pepsi its effervescence is nitrogen gas.
E) The pressure inside a Pepsi can is from gases derived from the decomposition of water.

26. Which of the following reactions is an example of where two radicals react to form a non-radical product? (i.e. "termination step")

A) $CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$
B) $Cl_2 + Br_2 \rightarrow 2\ ClBr$
C) $2CH_3\bullet \longrightarrow CH_3CH_3$
D) $CH_2{=}CH_2 + HCl \rightarrow CH_3CH_2Cl$
E) $H^+ + F^- \longrightarrow HF$

27. (No partial credit) Circle all the metals which can be called as alkali metals. (There can be one or more answer.)

A) magnesium B) lithium C) gold D) iron E) nickel
F) sodium G) silver H) copper I) calcium J) barium

28. The formula for the most stable allotrope of sulfur (rhombic) is:

A) S_2 B) S_4 C) S_6 D) S_8 E) _____

29. Sulfuric acid is prepared from the reaction of water and one of its oxides. What is the formula of this sulfur oxide?

A) SO_2 B) S_2O_4 C) S_2O D)_____

30. Which of the following is an example of an amphoteric oxide?

A) Na_2O B) MgO C) Al_2O_3 D) SiO_2 E) None of the above

31. Which one of these compounds has an asymmetric carbon atom?

A) bromomethane B) 2-bromopropane C) 1-chloroethane
D) 2-nitrobutane E) 1,1-dinitroethane F) none of the above

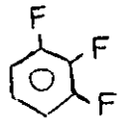
32. What is the correct chemical name for the following compound?

$CH_3CH_2CH_2CH(CH_3)CH(CH_3)CH_2CH_3$

A) 4,5-methylnonane B) 5,6-methylheptane C) 4,5-methylheptane

D)_____

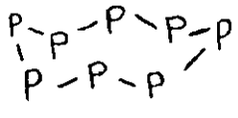
33. What is the chemical name for the following compound?



A) fluoro-ortho-difluorobenzene B) fluoro-para-difluorobenzene C) ortho-ortho-fluorobenzene

D) _____

34. What is the chemical structure of "White" phosphorus?

A) P=P—P B) 

C) 

D) _____

35. How will increasing the concentrations of the products in the equation below affect the overall cell emf, E_{cell}? Assume product concentrations are non-zero values.

$$A^{2+}(aq) + B^{1+}(aq) \rightleftharpoons A^{1+}(aq) + B^{2+}(aq)$$

A) Nothing, because the standard cell potential, E^{o}_{cell}, is a constant value.
B) Nothing, because the equilibrium constant of the above reaction is a constant value.
C) Nothing, because product concentration remains unchanged.
D) Cell emf, E_{cell}, will decrease.
E) Cell emf, E_{cell}, will increase.

36. What is the chemical that is produced when air is subjected to an electrical discharge (i.e. electrical sparks)?

A) CO B) N_2H_4 C) NH_3 D) HNO_3 E) _____

37. Circle the one statement that is true.

A) The combustion of carbon with oxygen gas is **not** an example of a redox reaction.
B) Electrolysis of water yields hydronium and hydroxide ions.
C) If one wants to make powerful batteries, then it's a good idea to use two metals with similar reduction potentials for the anode and cathode.
D) Fluorine is a good reducing agent.
E) A chemist can construct an electrochemical cell with only gold, gold (III) chloride, water and a salt bridge.
F) All of the above statements are false.

38. What is the principal product when the alkene, $CH_3CH_2CH_2C(CH_3)_2CH_2CH_2CH{=}CH_2$, reacts with HCl?

A) 5-methylheptane B) 1-chlorodecane C) 2-chloro-5-methylheptane

D) 2,2-dichlorodecane E) _____

39. What is the equilibrium constant of an electrochemical reaction if its standard cell potential is +0.01250 volts? The reaction is: $M^{1+} + N^{1-} \rightleftharpoons M^{2+} + N^{2-}$

A) 1.236 B) 0.6145 C) 1.112 D) 1.527 E) _____

40, 41, 42. Give your answer by circling the letter after the question.

Which reaction relates to the Mond process? **A B C D E F**

Which reaction relates to the Hall process? **A B C D E F**

Which reaction can be found in a blast furnace? **A B C D E F**

A) $Ni \longrightarrow Ni^{2+} + 2e^-$

B) $FeO + CO \longrightarrow Fe + CO_2$

C) $V_2O_5 + Ca \longrightarrow 5\,CaO + 2\,V$

D) $AlCl_3$ + electrical energy $\longrightarrow Al + 3/2\,Cl_2$

E) $Ni + 4\,CO \longrightarrow Ni(CO)_4$

F) None of the above

43. Calculate the cell potential for the following electrochemical cell. Assume the temperature to be 298K. The standard reduction potential for Cu^{2+} to copper metal is +0.340 volts.

Cu (solid) | Cu^{2+} (aq, 2.20 M) | (KCl sat'd sol.) | Cu^{2+} (aq, 0.0500 M) | Cu (solid)

A) +0.0971 V B) +0.224 V C) -0.0971 V D) -0.224 V E) _____