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CHEMICAL ENGINEERING REFRESHER COURSE

CHEMISTRY AND BIOCHEMICAL ENGINEERING SET 2

1. Calculate the ΔH for the following reaction using the bond energies given below:

   H-H (g) + I-I (g) → 2H-I (g)

   Bond energies: H-H = 436 kJ/mol, I-I = 151 kJ/mol, H-I = 297 kJ/mol

   a. +290 kJ
   b. -290 kJ
   c. +7 kJ
   d. -7 kJ

2. The average atomic mass of Ga is 69.72. Naturally occurring Ga is composed of ^{69}Ga, which has an atomic mass of 68.91, and of ^{71}Ga, which has an atomic mass of 70.93. What percentage of naturally occurring Ga is ^{71}Ga?

   a. 30.%
   b. 40.%
   c. 50.%
   d. 60.%

3. Sodium Hypobromite

   a. NaBrO
   b. NaBrO2
   c. NaBrO3
   d. NaBrO4

4. Which of the following carbonates is *most* soluble in water?

   a. $MgCO_3$ ($K_{sp} = 3.5 \times 10^{-8}$)
   b. $BaCO_3$ ($K_{sp} = 2.0 \times 10^{-9}$)
   c. $CdCO_3$ ($K_{sp} = 1.8 \times 10^{-14}$)
   d. Hg_2CO_3 ($K_{sp} = 8.9 \times 10^{-17}$)

5. Consider the following reaction. What combination of changed conditions would cause it to proceed more to the right as written?

   $CS_2(g) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$ $\Delta H\ldots = —1110$ kJ/mol

   a. raising the temperature and increasing the pressure
   b. raising the temperature and decreasing the pressure
   c. lowering the temperature and increasing the pressure
   d. lowering the temperature and decreasing the pressure

6. Consider the following reaction: $H_2(g) + I_2(g) <---> 2\ HI(g)$

   If the value of K_c for this reaction is 25 at 1100 K, and initially only 4.00 M HI(g) is present, what is the equilibrium concentration of $I_2(g)$?

   a. 2.00 M
   b. 0.571 M
   c. 0.148 M
   d. 0.363

7. Bombardment of uranium-235 with a neutron generates tellurium-135, 3 neutrons, and

   a. zirconium-98.
   b. krypton-101.
   c. krypton-103.
   d. strontium-99.

8. Carbon-11 is a radioactive isotope of carbon. Its half-life is 20 minutes. What fraction of the initial number of C-11 atoms in a sample will have decayed away after 80 minutes?
   a. 1/16
   b. 1/8
   c. 1/4
   d. 7/8

9. Choose the most feasible reaction sequence to synthesize para nitro benzoic acid.
   I. Nitration II. Alkylation III. Oxidation
   a. I, II, III
   b. II, III, I
   c. II, I, III
   d. III, II, I

10. Which among the following aromatic compounds is more reactive than benzene towards Aromatic Substitution reactions?
   a. Chlorobenzene
   b. Nitrobenzene
   c. Phenyl ethanoate
   d. Ethyl benzoate

11. Which among choices A-D, shows the proper arrangement of the given molecules (I-V) in Increasing volatility?
   I. ethanoic Acid
   II. propanone
   III. 1 – propanol
   IV. 2 – propanol
   V. Formaldehyde
   a. IV, III, I, II
   b. V, III, II, I
   c. III, IV, II, I
   d. None of these.

12. Name the compound: CH2CHC(CH2CH3)2CH3.
   a. 3,3 – diethyl 1 – butene
   b. 3,3 – diethyl 2 – butene
   c. 3 – ethyl, 3 – methyl 1 – pentene
   d. 3 – ethyl, 3 – methyl 2 – pentene

13. Triethylamine is a molecule in which the nitrogen atom is _____ hybridized and the CNC bond angle is _____.
   a. sp2; >109.5°
   b. sp2; <109.5°
   c. sp3; >109.5°
   d. sp3; <109.5°

14. Ethanol + ____ → Ethyl acetate
   a. Acetic Acid
   b. Ethanoyl chloride
   c. Acetic anhydride
   d. All of the above

15. Identify the major product of this reaction.
   a. 2-methyl-2-butene
   b. 2-methyl propene
   c. 2-chloro-2-methyl propane
   d. 1-chloro-2-methyl propane

16. Doubling the concentration of HCl,
   a. Does not affect the rate of reaction
   b. Speeds up the reaction
   c. Slows down the reaction
   d. Insufficient data

17. Which of the following salts give acidic aqueous solutions?
   (1) KNO3 (2) KCH3COO (3) NH4NO3 (4) RbI
   (5) (NH4)2SO4 (6) BaCl2 (7) NaCN (8) KNO2
   a. 2, 7, 8
   b. 3, 5
   c. 2, 4, 6
   d. 1, 4, 7, 8

18-20) A 500-mg sample containing NaOH (40), Na2CO3 (106), NaHCO3 (84), either alone or in compatible combination is treated with 12.95 mL of 0.100 M HCl to reach the phenolphthalein endpoint and an additional of 18.76 mL to reach the methyl red endpoint.

18. Identify the compounds (aside from the inerts) present in the sample
    I. NaOH
    II. Na_2CO_3
    III. $NaHCO_3$
    a. I and II
    b. II and III
    c. I and III
    d. I, II and III

19. Calculate the % Sodium Carbonate
    a. 27.5
    b. 57.2
    c. 72.5
    d. 52.7

20. Calculate the percentage of inert in the sample.
    a. 27.5%
    b. 62.8%
    c. 9.8%
    d. 15.2%

21. An iron ore is analyzed for iron content by dissolving in acid and converting all iron species to Fe^{2+}. Fe^{2+} ions are then titrated with standard 0.0150 M $K_2Cr_2O_7$ solution, converting them to Fe^{3+}. 35.6 mL is required to titrate the iron in a 1.68-g ore sample. Calculate % Fe_2O_3 MW: (Fe = 55.85, O = 16)
    a. 23.15
    b. 15.23
    c. 25.13
    d. 13.25

22. The pH of a household white vinegar solution is 2.45. This vinegar has a density of 1.09 g/mL. What is the mass percentage of acetic acid in the solution?
    a. 1%
    b. 10%
    c. 8%
    d. 4%

23. A 750.25-mg of alloy nickel was dissolved and treated to remove the impurities. The ammoniacal solution was treated with 50 mL of 0.1075 M KCN and the excess cyanide required 2.25 mL of 0.00925 M AgNO3. Determine %Ni (58.7) in the alloy.
    a. 20.86%
    b. 37.69%
    c. 10.43%
    d. 41.27%

24. The Tl in a 9.76-g sample of rodenticide was oxidized to the trivalent state and treated with an unmeasured excess Mg/EDTA solution. The reaction is

$$Tl^{3+} + MgY^{2-} \rightarrow TlY^{-} + Mg^{2+}$$

Titration of the liberated Mg 2+ required 13.34 mL of 0.03560 M EDTA. Calculate the percentage of Tl_2SO_4 (504.8 g/mol) in the sample.
    a. 3.21
    b. 2.45
    c. 1.23
    d. 4.25

25. Secondary Metabolites are mostly produced during?
    a. Lag phase
    b. Exponential Phase
    c. Stationary Phase
    d. Decline Phase

26. DNA contains the following except.
    a. Nitrogen
    b. Phosphates
    c. Glucose
    d. Hydrogen Bonds

27. A reversible competitive inhibitor can be mitigated by:
    a. Increasing amount of product
    b. Increasing amount of substrate
    c. Increasing amount of Enzyme
    d. None of these.

28. Identify the incorrect molecule – bond pair.
    a. Amino acids; glycosidic bond
    b. N-base pair; H-bond
    c. Monosaccharide; peptide bond
    d. All of these are correct.

29-30) The kinetic properties of the ATPase enzyme, isolated from yeast, which catalyzes the hydrolysis of ATP to form ADP and Pi, are assessed by measuring initial rates in solution, with various ATP concentrations S0 and a total ATPase concentration E0 = 0.60 μM. From these experiments, it is determined that: Vmax = 1.20 μM/s; km = 40 μM.

29. Calculate the values of kcat and the catalytic efficiency (s-1) for ATPase under these conditions.
    a. 0.02, 3
    b. 2, 0.03
    c. 0.03, 2
    d. 3, 0.02

30. An inhibitor molecule is added at a concentration of 0.1 mM, and the experiments are repeated. The apparent Vmax and KM are now found to be 1.2 μM/s, and 80 μM, respectively. Identify the type of this inhibitor.
    a. Competitive
    b. Uncompetitive
    c. Non-competitive
    d. Mixed

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