CH. 18

18,20) Consider 2.50 L of a buffer solution made from NaOH and 3.50 M H_3PO_4 at pH 2.11 that has a total concentration of phosphate containing species of 0.154 M.

What volume of 3.50 M H_3PO_4 was required to make the buffer solution?
(L)

What mass of NaOH was required to make the buffer solution?
(g)

How many mL of 2.00 M HCl must be added to the buffer solution to change its pH by 1.25 units?
(ml)

After the HCl is dissolved, is the solution still a buffer?
(yes,no)

24,26) Sleeping pills often contain barbital, which is weakly acidic (pK_a = 8.00). For analysis of the barbital content of a sleeping pill, a titration is carried out with strong base. It takes 12.00 mL of 0.200 M base to reach the stoichiometric point. If the initial acid concentration is 0.0120 M and the solution volume is 200. mL, what is the pH of the solution after adding the following volumes of base solution:

0.0 mL added base

4.8 mL added base

6.00 mL added base

12.00 mL added base

13.2 mL added base

The most suitable indicator for this titration would have pK_{In} closest to what value?

28) Calculate the pH at the second stoichiometric point when 226 mL of 0.025 M solution of tartaric acid (K_{a1} = 9.2E-4, K_{a2} = 4.3E-5) is titrated with 1.00 M NaOH.

What is the pH at the second stoichiometric point?

The most suitable indicator for this titration would have pK_{In} closest to what value?

30) A sample of carbonic acid (0.125 L, 0.179 M, pK_{a1} = 6.35, pK_{a2} = 10.33) was titrated with 1.43 M NaOH. Calculate the pH at the following points:

Before the titration.

At the 1st midpoint.
At the 1st stoichiometric point.

At the 2nd midpoint.

At the 2nd stoichiometric point.

36) The solubility of sodium sulfate (Na_2SO_4) in water is 9.5 g/100 mL. What is K_{sp} for sodium sulfate?

38) How many grams of BaF_2 (K_{sp} = 1.8E-7) will dissolve in 0.636 L of 1.00E-1 M NaF solution?

40,42) For $FeCO_3$ dissolving in acid solution, determine the following.

The value of K_{eq} for $FeCO_3$ dissolving in acid solution, given that K_{a2} = 4.7E-11 for H_2CO_3. The K_{sp} for $FeCO_3$ is 3.1E-11.

The concentration of Fe^{2+} in a solution obtained by treating solid $FeCO_3$ with 0.318 M HNO_3.

52)Calculate the mass of $FeCO_3$ that will dissolve in 0.49 L of a solution that is 0.20 M in oxalate anion ($C_2O_4^{2-}$). ←

$$Fe^{2+} + 3C_2O_4^{2-} \text{-->} [Fe(C_2O_4)_3]^{3-} \quad K_f = 3.3E20$$

The K_{sp} for $FeCO_3$ is 3.1E-11.

54) The pH of an NH_4^+/NH_3 buffer solution is 7.60. Calculate the acid/conjugate base ratio for the solution. K_b for NH_3 is 1.8E-5.

66.) When silver sulfate dissolves in water at 25 ^oC, the equilibrium concentration of Ag^+ is 3.0E-2 M. Use this information to calculate K_{sp} for Ag_2SO_4.

70) The solubility of calcium arsenate, $Ca_3(AsO_4)_2$, in water is 0.036 g/L. Use this information to calculate K_{sp} for this salt.

74) Calculate the following when 0.250 L of 0.219 M $AgNO_3$ solution is mixed with 0.350 L of 0.300 M Na_2CO_3 solution. K_{sp} for Ag_2CO_3 is 8.46E-12.

What mass of the precipitate forms?

What is the concentration of Ag^+ remaining in solution?

76)If 0.025 g of $Fe(OH)_3$ is added to 2.84 L of water, what mass will dissolve? K_{sp} is 2.8E-39.

84) A biochemist wants to use X-ray diffraction to determine the structure of a protein. The biochemist must isolate crystals of the protein from solutions buffered to pH 5.20. Acetic acid/acetate ion would be a good choice for the buffer. What would the ratio of [acid]/[conjugate base] need to be in this buffer?

86) The pH of an acetic acid-acetate buffer is 4.04. What is the $[A^-]/[HA]$ concentration ratio?

98) Determine the solubility (in g/L) of silver carbonate (Ag_2CO_3, K_{sp} = 8.46E-12) in a pH = 10.74 buffer containing CO_3^{2-} and HCO_3^- at a total concentration of 0.748 M.
(g/L)

102) Seawater is approximately 0.50 M each in Na^+ and Cl^- ions. By evaporation, NaCl (K_{sp} = 6.2) can be precipitated from this solution. If 316 L of seawater is evaporated, at what volume will the first solid NaCl appear?
(L)

CH 19

36) A cell that consists of a standard hydrogen half-cell and a Cu/Cu^{2+} half-cell has E^o = 0.34 V. If the cell contains 0.00146 M concentrations of HCl and $CuSO_4$, what potential does it produce?
(V)

40)A digital watch draws 0.20 mA of current provided by a mercury battery, whose net reaction is: ←

$$HgO(s) + Zn(s) \rightarrow ZnO(s) + Hg(l)$$

If a partially used battery contains 1.59 g of each of these four substances, for how many more hours will the watch run? The Faraday constant is 96485 C/mol.
(hr)

50) A portable CD player that draws 150 milliamperes of current is powered by Ni-Cd rechargeable batteries. Compute the mass of Cd consumed when a disk is played whose

length is 59 minutes. The Faraday constant is 96485 C/mol.

$$2NiO(OH)(s) + Cd(s) + 2H_2O(l) \underset{\leftarrow}{\rightarrow} 2Ni(OH)_2(s) + Cd(OH)_2(s)$$

(g)

56) When Thomas Edison first sold electricity, he used zinc coulometers to measure charge consumption. If the zinc plate in one of Edison's coulometers increased in mass by 8.24 g, how much charge had been consumed? The Faraday constant is 96485 C/mol. (C)

82) Consider the decomposition reaction of hydrogen peroxide:

$$2\ H_2O_2 \underset{\leftarrow}{\rightarrow} 2\ H_2O + O_2$$

Using standard reduction potentials (see Appendix F), determine K_{eq} for the decomposition reaction.

84) Electrolytic reactions, like other chemical reactions, are not 100% efficient. In a copper purification apparatus depositing Cu from a $CuSO_4$ solution, operation for 7.00 hours at a constant current of 4.73 A deposits 34.1 g of Cu metal. What is the efficiency?

86) A galvanic cell is constructed using a silver wire coated with silver chloride and a nickel wire immersed in a beaker containing 0.0440 M $NiCl_2$.

Calculate the potential of the cell.

88) Given that E^o = -0.34 V for the reduction of Tl^+ to Tl, find the voltage developed by a cell consisting of Tl metal dipping in an aqueous solution that is 0.44 M in Tl^+, connected by a porous bridge to a 0.57 M aqueous solution of HCl in contact with a Pt electrode over which H_2 gas is bubbling at p = 0.80 bar.

96) A chemist wanted to determine E^o for the Ru^{3+}/Ru reduction reaction. The chemist had all the equipment needed to make potential measurements, but the only chemicals available were $RuCl_3$, a piece of ruthenium wire, $CuSO_4$, copper wire, and water. A standard galvanic cell was constructed from these materials. If the cell had a measured voltage of 1.44 V, with the ruthenium wire being negative, determine E^o for Ru^{3+}/Ru. (V)

CH 22

6) Compute the energy released in joules per event and in kilojoules per mole when antiprotons (the antimatter corresponding to protons) annihilate with protons. The mass of a proton is 1.673E-27 kg.

Calculate the energy per event. The speed of light is 2.998E8 m/s.
(j/event)

Calculate the energy per one mole of events.
)kj/mol)

8) Use atomic masses to compute the total binding energy and the binding energy per nucleon for elemental cobalt, which has just one stable nuclide. Molar masses (g/mol) are: Co 58.933, p 1.007276, n 1.008665, e 0.0005486. The speed of light is 2.998E8 m/s.

What is the total molar binding energy.
(kj/mol)

What is the molar binding energy per nucleon.
$kJ*mol^{-1}*nucleon^{-1}$

18) A radioactive nuclide of mass number 94 has been prepared by neutron bombardment. If 4.7 μg of this nuclide registers 20. counts per minute on a radioactivity counter, what is the half-life of this nuclide?
(min)

20) Radon-222 decays by the following sequence of emissions: α, α, β, β, α, β, β, α. Identify the unstable intermediates and the final product. Enter element symbol followed by a hyphen and then the mass number, i.e., enter ^{1}H as **H-1**.
(what are the first to the seventh intermediates, and the final?)

28) Compute the energy released in the following fission reaction:

$$^{235}U + n \rightleftarrows {}^{100}Mo + {}^{134}Sn + 2n$$

The nuclide masses in grams per mole are U 235.0439, Mo 99.9076, and Sn 133.9125. The neutron mass is 1.008665 grams per mole. The speed of light in 2.998E8 m/s.
kJ/mol

34) Compute the speed of an alpha particle with enough kinetic energy to fuse with lithium-6. Calculate nuclear radii using: $r = 1.2A^{1/3}$ fm (1 fm = 10^{-15} m).
(m/s)

42,44) A patient weighing 65 kg is given an intravenous dose of ^{99m}Tc, a radioactive isotope that decays by γ emission with energy of 1.35E7 kJ/mol and with a 6.0 hour half-life.

If 15.0 mL of a 2.50 nanomolar solution is administered and all of the radioactive nuclide decays within the patient's body, what total energy does the patient receive?
(J)

How many γ rays are emitted per second by the dose of ^{99m}Tc in part a.
(/s)

48) Uranium deposits are dated by determining the ratio of ^{238}U to its final decay product, ^{206}Pb. The half-life of ^{238}U is 4.5E9 yr. If the ratio of ^{238}U to ^{206}Pb in an ore sample is 1.33, what is the age of the ore?
(year)

54) Naturally occurring gold contains only one isotope, ^{197}Au. Molar masses (g/mol) are: Au 196.97, p 1.007276, n 1.008665, e 0.0005486. The speed of light is 2.998E8 m/s.

Compute the total molar binding energy.
Kj/mol

Compute the molar binding energy per nucleon.
kJ/mol*nucleon

58) A positron has the same mass as an electron (9.109E-31 kg). When a positron and an electron annihilate, both masses are converted entirely into the energy of a pair of γ rays.

Calculate the energy per γ ray. The speed of light is 2.998E8 m/s.
J

Calculate the energy per one mole of γ rays.
J/mol

60) Phosphorus-30, which has a half-life of 150 seconds, decays by positron emission.

How long will it take for 2 % of this nuclide to decay?
S

How long will it take for 99.5 % of this nuclide to decay?
S

64) What is the shelf life of a radioactive nuclide with half-life of 10.8 days if it loses its

usefulness when less than 15 % of the radioactivity remains?

68) The heaviest transuranium elements are formed by bombardment with relatively heavy nuclides such as ^{58}Fe. What nuclide could be formed by bombarding the stable bismuth nuclide with this nuclide? Identify the compound nucleus and final product resulting from each of the following nuclear reactions. Enter element symbol followed by a hyphen and then the mass number, i.e., enter ^{1}H as **H-1**.

82) Carbon-14 dating gives 3250 years as the age of a charcoal sample, assuming a constant level of cosmic radiation. If the cosmic radiation in the atmosphere was 23 % higher at the time the tree grew, what is the correct age of the sample?

Yr

88) Calculate the mass of ^{235}U that reacts in a 30-kiloton bomb, given that one nucleus releases 2.9×10^{-11} J. The designation "30-kiloton" means the same energy as 30×10^{3} metric tons of TNT (1 metric ton = 1000 kg), which releases 2500 kJ of energy per kilogram.

g

90) A radioactive counter gave a reading of 262 min^{-1} for a 14.2 mg sample of cobalt(II) chloride partially enriched with cobalt-60 ($t_{1/2}$ = 5.2 yr). What percentage of the cobalt atoms is cobalt-60?

(percent)

94) Fo how many years could ^{235}U supply the world's energy needs, given that uranium contains 0.72 % of ^{235}U, the worlds reserves of uranium are 1.0×10^{7} metric tons, world energy consumption is 2.0×10^{17} kJ/yr, and each ^{235}U nucleus releases 2.9×10^{-11} J?

(yr)

98) Uranium-238 undergoes eight consecutive α emissions to give stable lead. In a sample of uranium ore, all the α particles are quickly stopped, becoming trapped ^{4}He atoms. If analysis of a rock sample shows that it contains 0.000069 cm^{3} of helium-4 (measured at 1.0 atm and 298 K) and 2.4E-7 g of ^{238}U per gram of rock, estimate the age of the rock.

Yr