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Problem 3-31

Acid rain has a pH of less than 5.6.

(a) Give a reason why natural rain has a pH of around 5.6. Give a chemical equation to support your answer.

(b) Acid rain may be 50 times more acidic than natural rain. One of the major acids present in acid rain originates mainly from burning coal. Give the name of the acid and give equations to show how it is formed.

(c) The second major acid responsible for acid rain originates mainly from internal combustion engines. Give the name of this acid and state two different ways in which its production can be reduced.

Problem 3-32

Select the pair of compounds in which chromium is in the same oxidation state.

A Cr_2O_3 and CrO_3	B CrO_3 and $CrCl_3$
C K_2CrO_4 and $K_2Cr_2O_7$	D Cr^{2+} and CrO_2

Problem 3-33

Determine the oxidation number of sulfur in $Na_2S_4O_6$.

A +6	B +3	C +2.5	D +2

Problem 3-34

Assign oxidation states to all elements in the compounds listed below:

(a) NH_4^+	(b) $SnCl_2$	(c) H_2O	(d) NO_3^-
(e) PbO_2	(f) PO_4^{3-}	(g) ClO_4^-	(h) HOCl

Problem 3-35

Determine the names of the compounds listed below, using their oxidation numbers.

(a) HNO_3	(b) HNO_2	(c) H_3PO_4
(d) PbO_2	(e) $PbSO_4$	

Problem 4-1

A large iron cube at high temperature, T_h, is brought into contact with a small iron cube at lower temperature, T_c. Examine the changes that occur, assuming that both objects are insulated from all other objects.

Problem 4-2

The temperature of a volume of water increases from 300 K to 310 K. Give the temperature increase in °C.

Problem 4-3

When a sample of $NH_4SCN_{(s)}$ is mixed with $Ba(OH)_2{\cdot}8H_2O_{(s)}$ in a glass beaker, the mixture changes to a liquid and the temperature falls sufficiently to freeze the beaker to the table. Which statement is true about the reaction?

A	The process is endothermic and ΔH is negative.
B	The process is endothermic and ΔH is positive.
C	The process is exothermic and ΔH is negative.
D	The process is exothermic and ΔH is positive.

Problem 4-4

Which one of the statements below is true of all exothermic reactions?

A	They produce gases.
B	They give out heat.
C	They occur quickly.
D	They involve combustion.

Problem 5-49

Which statement below is correct?

A A catalyst increases the rate of the forward reaction only

B A catalyst increases the rate of the forward and backward reactions

C A catalyst increases the yield of product formed

D A catalyst increases the activation energy of a reaction

Problem 5-50

Which statements below are correct for the effects of catalyst and temperature on the rate of reaction?

	Adding a catalyst	**Increasing the temperature**
A	collision frequency increases	collision frequency increases
B	activation energy decreases	collision frequency increases
C	collision frequency increases	activation energy increases
D	activation energy increases	activation energy decreases

Problem 5-51

In the reaction between marble (calcium carbonate) and hydrochloric acid, which set of conditions produces the highest rate of reaction?

$CaCO_{3(s)} + 2HCl \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

A marble chips and 1.0 mol/dm^3 HCl

B marble powder and 1.0 mol/dm^3 HCl

C marble chips and 0.1 mol/dm^3 HCl

D marble powder and 0.1 mol/dm^3 HCl

Problem 5-52

A sugar cube cannot be ignited with a match, but a sugar cube coated in ashes will ignite. Propose a reason for this observation

Problem 1-99 Solution

Given: A graph of consecutive wavelength differences against potassium emission wavelength

Find: The series-limit wavelength and potassium ionization energy

At convergence, $\Delta\lambda$ tends to zero. Extrapolating the graph to the horizontal axis gives approximately 285 nm

$E_{ion} = hcN_A / \lambda$

$E_{ion} = (6.626 \times 10^{-34})(3.00 \times 10^{8})(6.022 \times 10^{23}) / (285 \times 10^{-9})$

$E_{ion} \approx 4.20 \times 10^{5}$ J·mol^{-1}

Final answer: $\lambda_{limit} \approx 285$ nm; ionization energy ≈ 420 kJ·mol^{-1}

Problem 1-100 Solution

Given: Amounts of C_2H_5OH, H_2O, and $Ca(HCO_3)_2$

Find: The number of hydrogen atoms in each sample

Each ethanol molecule contains 6 H atoms, each water molecule contains 2, and each calcium hydrogencarbonate formula unit contains 2

(a) n(H atoms) = (0.020 mol)(6) = 0.120 mol

$N = (0.120)(6.022 \times 10^{23}) = 7.23 \times 10^{22}$

(b) n(H atoms) = (2.50 mol)(2) = 5.00 mol

$N = (5.00)(6.022 \times 10^{23}) = 3.01 \times 10^{24}$

(c) n(H atoms) = (0.10 mol)(2) = 0.20 mol

$N = (0.20)(6.022 \times 10^{23}) = 1.20 \times 10^{23}$

Final answer: (a) 7.23×10^{22}. (b) 3.01×10^{24}. (c) 1.20×10^{23} hydrogen atoms

Problem 6-55 Solution
Given: $CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+$

Find: Identify a conjugate pair

Conjugate species differ by one proton. H_2O gains H^+ to become H_3O^+

Final answer: H_2O/H_3O^+

Problem 6-56 Solution
Given: Four species are considered for amphiprotic behaviour

Find: Identify the amphiprotic species

OH^- can accept H^+ to form H_2O and can donate H^+ to a sufficiently strong base to form O^{2-}. The other listed species do not both donate and accept a proton in the same sense

Final answer: OH^-

Problem 6-57 Solution
Given: CH_3OH is a very weak acid

Find: Property of its conjugate base CH_3O^-

The weaker an acid is, the stronger its conjugate base. Methoxide therefore has a strong tendency to accept a proton

Final answer: CH_3O^- is a strong Brønsted-Lowry base

Problem 6-58 Solution
Given: Acids X and Y are both 0.20 mol/dm^3, with pH 2 and 4

Find: Correct comparison

X has $[H^+] = 10^{-2}$, one hundred times that of Y at 10^{-4}. At equal analytical concentration, X is more extensively ionized and therefore stronger

Final answer: X is a stronger acid than Y

Problem 6-59 Solution
Given: Definitions of a Brønsted-Lowry base are listed

Find: Defining property

Final answer: It accepts H^+ ions

Problem	Answer
5-35	D — 52.2%
5-36	D — 13
5-37	A — 4.00 mol
5-38	153 g NaN_3; 54.0 g Na
5-39	NH_3 excess by 10.0 dm^3; N_2 = 25.0 dm^3
5-40	5.44×10^{-3}; 2.38×10^{-3}; 3.06×10^{-3} mol; 1.53×10^{-3} mol $CaCO_3$; 0.153 g; 81.5%
5-41	35.0%; 4.90 g; 84.1%
5-42	Colorimetry; gas volume; mass loss/conductivity
5-43	C
5-44	Mass loss; CO_2 volume; pH/concentration; rate falls as reactants are consumed
5-45	8.5×10^{-4} and 4.0×10^{-4} mol/(dm^3·s)
5-46	D
5-47	A
5-48	Two-molecule collision; it is more probable
5-49	B
5-50	B
5-51	B
5-52	Ash acts as a catalyst
5-53	$2CO + 2NO \rightarrow 2CO_2 + N_2$; large surface area; needs warm temperature; reduces but does not eliminate pollution
5-54	B
5-55	C
5-56	F intermediate; $2NO_2 + F_2 \rightarrow 2NO_2F$
5-57	Insufficient information; referenced table is missing
5-58	1 in NO; 1 in O_3; overall 2
5-59	$k[CH_3Cl]^2$; $k[OH^-]^2$; $k[CH_3Cl][OH^-]$
5-60	rate = $k[NO_2][CO]$
5-61	Yes; rate = $k[NO_2]^2$
5-62	C
5-63	$2AB_2 \rightarrow A_2 + 2B_2$; $k[AB_2]^2$; dm^3/(mol·time)
5-64	C
5-65	rate = $k[NO]^2[O_2]$
5-66	1.52×10^{-2}; 1.52×10^{-2} mol/(dm^3·s)
5-67	$dm^3\ mol^{-1}\ time^{-1}$; $time^{-1}$; $mol\ dm^{-3}\ time^{-1}$; $dm^6\ mol^{-2}\ time^{-1}$; $dm^3\ mol^{-1}\ time^{-1}$
5-68	rate = $k[N_2O_5]$
5-69	1.1×10^2 dm^3/(mol·min)