ANSWERS TO MISCELLANEOUS PROBLEMS.

1. Silver, 54.124. Copper 45.876. Total 100 grams.
2. 357.12 grams.
3. CH_4. Two liters.
4. 34.42 cubic centimeters.
5. 0.7727 liters.
6. 3822° Centigrade.
7. 9.266+ millimeters.
8. 18.58 per cent.
9. 0.001 per cent. (One-thousandth of one per cent.)
10. 207.1.
11. 1.435 ton = 2870 lbs.
12. 0.6155 grams.
13. 117.1° C.
14. Original volume of CO = 18.6, of H_2 = 27.9 c.c. Volume of oxygen added = 40 c.c.
15. 7.437 grams.
16. 55.
17. 0.006 gram.
18. Weight = 1.359 grams. Volume = 892 c.c.
19. Formula Al_2Cl_6. Wt. of 1 liter, 11.93 grams.
20. Excess in weight, 41.2 grams. In volume, 54.28 liters.
21. NaCl in excess 0.59 gram.
22. 2.8 grams.
23. 3.94 grams.
24. 172.8 grams.
25. At. wt. = 7.
26. 974.66 c.c.
27. 12.998 meters.
28. Sp. gr. = 2.486.
29. One-fourth.
30. 1.2910 grams.
31. At. wt. = 65.
32. At. wt. = 19.
33. Excess of FeS = 0.102 lb.
34. Zinc excess = 0.01 lb.
35. NH_3 excess 0.669 gram in weight, and 878 c.c. in volume. HCl def. 1.43 grams in weight, and 872 c.c. in volume.

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36. H_2SO_4 excess = 0.76+ gram. NH_3 deficit = 0.264 gram.
37. 68+ tons.
38. 200 liters.
39. 29.72 c.c.
40. CO_2 gas to air as 2 to 3.
41.

Silica	7.31 per cent.
Alumina	2.46 per cent.
Ferric oxide	85.00 per cent.
Manganous oxide (MnO)	2.56 per cent.
Magnesia (MgO)	1.60 per cent.
Water	1.03 per cent.
Total	99.96 per cent.

Loss 0.04 per cent. Metallic iron = 59.45 per cent.

42. Atomic weight = 65.
43. Assay = 7.38 oz. to ton.
44. Gold = 24 oz. to ton. Silver = 650 oz. to ton.
45. Weight of salt, 64.1 kilograms.
46. 48,667 lbs.
47. The answer is the square root of the product of the two weights. In this instance the square root is nearly the same as the mean of the two numbers, viz: 10.65.
48. $2 \times 2.5 = 5$. Square root of 5 = 2.236+.
49. The C_6H_6 must be considered as reduced to its vapor volume. We then have: C_6H_6 = 13.2 liters. O_2 = 99 liters. CO_2 = 79.2 liters.
50. Mercury being at 76 cm., water stands at 1033.296 cm.; alcohol stands at 1275.674 cm.; acid stands at 558.535 cm.
51. Weight = 1.149 grams.
52. Assay, 6 oz. to ton.
53. Assay, 0.47 oz. to ton.
54. Assay before drying 51 per cent.
55. Assay of "charge" = 45.45 per cent.
56. Formula, C_6H_6.
57. Formula of the "ferric" salt;

$$(NH_4)_2 SO_4, Fe_2(SO_4)_3 + 14H_2O$$

Formula of the "ferrous" salt:

$$(NH_4)_2SO_4, FeSO_4 + 6H_2O$$

58. Assay of the mixture, 85 ounces.
59. Precipitate weighs 8.51 grams.

60. The silver is in excess by 0.36 gram.
61. Weight = 1.323 grams.
62. Hydrogen = 12.4 liters.   Oxygen = 6.2 liters.
63. Zinc = 26.78 kilos.
64. Volume is 479 times that of the liquid.
65. Assays "dry" 56 ounces.
66. $20,322 \frac{58}{100}$ lbs.
67. The "wet" assay would be represented by $\dfrac{(100-a) \times b}{100}$
68. Take 281.7 lbs. of No. 2.
69. FeS_2 58.31 tons.

70.

ANALYSIS BY SALTS.		ANALYSIS BY RADICALS.	
$CaSO_4$	37.43	Chlorine	32.72
$CaCO_3$	3.21	SO_3	22.01
$MgCl_2$	18.00	Mg	4.60
NaCl	21.82	CaO	17.22
KCl	12.78	K	6.70
		Na	8.58
	93.24		91.83
Parts in 100,000.		CO_2 required	1.41
			93.24

71. Three atmospheres.
72. Carbon = 1.25 per cent.
73. Take for analysis 2.7838 grams.
    Example.—Take 2.7838 grams, find weight of $Mg_2P_2O_7$
    = 0.0215.   Then per cent. of phosphorus is 0.215.
74. Assay is 104.95 ounces.
75. Volume = 2.976 liters.
76. Weight of the acid = 9.8 grams.
77. At. wt. of "M" = 23.
78. Take 124.87 grams.
79. Gold, 24.75 oz. to ton.   Silver, 219.3 oz. to ton.
80. 52 per cent.
81. 899° C.
82. Volume of the gas = 2.50 liters.
83. Since gaseous molecules occupy equal volumes, the equa-
    tions shown in the question indicate the answer.   The
    dissociated gases are respectively twice the volumes of
    the original substances.   For example: $H_2SO_4 = H_2O$
    $+ SO_3$.   We have 2 liters of density 18, and 2 liters of
    density 80.   Thus the density becomes $\frac{98}{2}$ instead of 98.

84. 5.4202 grams in 1 liter.
85. At. wt. = 63.
86. (*a*) Density of the mixture 37.45.   (*b*) Volume of per-
    manent gas, 2.96 liters.
87. At 1175+ millimeters.
88. 60.44 c.c., at the new p. and t.
89. 91° C. $\left(V' = 1.33 = 1 + \dfrac{t}{273} \right)$
90. Sp. gr. = 1.75.
91. Crucible, 13.0302 grams.   CaO = 0.1736 grams.
92. Sp. gr. of mineral = 5.
93. First ore 3.4 tons.   Second ore 6.8 tons.
94. They must be taken, as to weight, in the ratio of their
    respective specific gravities, which is the same as to say
    that they must be taken in equal bulk.
    Example.—Gold, sp. gr. 19.3; silver, sp. gr. 10.5.   If we
    take 19.3 grams of gold and 10.5 grams of silver we shall
    evidently have one cubic centimeter of each, and sp. gr.
    of the alloy would be $\dfrac{19.3 + 10.5}{2} = 14.9$.
95. One-fourth of an atmosphere.
96. H_2S gas, 10 c.c. in one liter.   Solid constituents as below:

CaO	8.735	CaO	8.735	$CaSO_4$	21.20
SO_3 with the above	12.465	Mg	6.660	Na_2SO_4	28.14
Na_2O	12.280	Na	54.720	NaCl	115.96
SO_3 with the above	15.860	SO_3	28.330	$MgCl_2$	26.08
Na (in NaCl)	45.620	Cl	89.760		
Cl with the above	70.340	O*	3.175		
Mg	6.660				
Cl_2 with the above	19.420				
	191.380		191.380		191.38

Note that NaCl as determined in the analysis does not
indicate the actual NaCl in the water, but is necessarily
greater.

97. Half an atmosphere.
98. Atomic weight = 23.6.
99. Density of mixture = 12.   Density of steam 18.

*With the Na_2O in Na_2O, SO_3, otherwise Na_2SO_4.

100. Complete analysis as below:

|			
Silica..........	8.05 per cent.	Zinc in ZnS........	15.28
Ferric oxide.....	12.70 per cent.	Zinc in ZnSO$_4$......	18.88
Zinc sulphide....	22.72 per cent.	Zinc in ZnO.......	8.03
Zinc sulphate....	46.49 per cent.		
Zinc oxide......	9.98 per cent.	Total zinc........	42.19
	99.94 per cent.	Metallic iron.......	8.88
Loss..........	0.06 per cent.	Total sulphur......	16.66
		Total SO$_3$..........	23.01
Total........	100.00 per cent.	Oxygen in ZnO.....	1.95
Sulphur in ZnS..	7.44 per cent.	Oxygen in Fe$_2$O$_3$.....	3.82
Sulphur in SO$_3$..	9.22 per cent.		

101. Atomic weight = 55.
102. Sp. gr. of the acid = 1.162.
103. Atomic weight = 55.
104. 7.143 liters air. 1.5 liters oxygen.
105. 2612 liters.
106. Sp. gr. = 2.5.
107. (a) Density of mix. = 49.5. (b) Den. of COCl$_2$ = 99.
     (c) Each 3 liters.
108. Weight deficit = 2.7+ grams.
109. MnO$_2$ required, 22.35 grams. Weight of air, 35.74 grams.
110. (1) 0.3707. (2) 2.698.
111. For CO, $\frac{1}{2}$. CH$_4$, 2. C$_2$H$_4$, 3. C$_2$H$_2$, 2$\frac{1}{2}$. H$_2$S, 1$\frac{1}{2}$.
     PH$_3$, 2 liters.
112. Wt. of KOH = 0.2808 gram.
113. Wt. of excess oxygen, 4.287 grams. Volume, 3 liters.
     Original volumes: oxygen, 7 liters; CO, 8 liters.
114. Analysis by elements, etc.

Silica................................	46.27 per cent.
Stannic oxide.........................	8.24 per cent.
Arsenic................................	3.66 per cent.
Sulphur................................	18.93 per cent.
Copper................................	4.26 per cent.
Iron...................................	18.35 per cent.
Total.....................	99.71 per cent.
Loss...................................	.29 per cent.

     Metallic tin = 6.49 per cent.
115. (1) 252.45. (2) 254.

116. In HCl, 0.045. In HBr, 0.045. In H$_2$S, 0.09. In NH$_3$, 0.135. In CH$_4$, 0.18. In (C$_2$H$_5$), 0.225. In C$_2$H$_6$, 0.27.
117. (1) 9.67 grams. (2) 21.29 grams. (3) 1.806 liters.
118. (1) NaOH made up to 7.2375 liters. (2) Take 0.6653 of HCl solution.
119. Trial figure by analysis found by 33.83 : 66.17 = 35.45 : 69.34. But if we now multiply by the specific heat, 69.34 × 0.0308 = 2.13+. This figure (2.13) is about $\frac{1}{3}$ of the average constant under the law of Dulong and Petit. We therefore take 69.34 × 3 = 208 as atomic weight.
120. 87.2 per cent. of MnO$_2$.
121. 0.0009342 gram.
122. (1) Sp. gr. = 1.00634. (2) 1.987 liter.
123. (1) Sp. gr. of air = 0.001293. Sp. gr. of water = 773.
124. Gain of 2.3 cents per lb., i.e., NaCy as compared with price of KCy should bring 24.3 cents per lb.
125. (1) 20.24 per cent. (2) 33.977 grams. (3) 6.8565 liters. (4) 13.713 liters.
126. 32.07.
127. Atomic weight 194.3. Formula RCl$_4$.
128. (1) 3.16 grams. (2) 0.0056 iron.
129. (1) H$_2$SO$_4$ = 34.3 grams. (2) Zinc, 22.75 grams. (3) Hydrogen at 16° and 740 mm. = 8.523 liters.
130. Copper 1.272 grams.
131. 4492 cubic meters.
132. (1) 1760.446 grams. (2) NH$_4$Cl, 2387.9. KOH (95 per cent.) = 3390.9 grams.
133. Radius of sphere = 5.8872 meters. Volume 854,700 liters. Weight of hydrogen $\frac{1}{13}$ of a metric ton = 76,923 grams. Zinc required = 2495+ kilos. Sulphuric acid = 3742+ kilos.
134. 39 kilograms.
135. 1$\frac{1}{2}$ liters.
136. Limestone = 4.434 kilos. Acid = 12.531 kilos.
137. 771 lbs.
138. NaCl = 40 per cent. KCl = 60 per cent.
139. NaCl, 51.96. H$_2$SO$_4$, 44.93 lbs.
140. Salt, 3948. Acid, 3809. Water, 7800 (lbs.).
141. Sp. gr. of the solid = 2. Of the liquid = 1.466.
142. 122.408 kilograms.

143. Zinc = 348.07. Sulphuric acid = 524.79. Potassium chlorate = 218.66. Answers in grams. The two equations have to be written:

$$6Zn + 6H_2SO_4 = 6ZnSO_4 + 6H_2 \text{ and } 2KClO_3 = KCl + 3 O_2$$
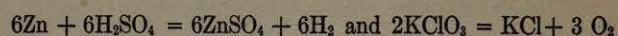
144.

ANALYSIS BY BASES, ETC.		ANALYSIS BY COMPOUNDS.	
Silica	12.06	Silica	12.06
Lime	9.28	Calcium carbonate	10.60
Magnesia	6.41	Magnesium carbonate	13.40
Iron (Fe)	1.46	Ferrous carbonate	3.03
Sodium	15.41	Sodium carbonate	16.22
Radical SO_3	4.77	Calcium sulphate	8.11
Chlorine	12.91	Sodium chloride	21.28
		Total parts in 100,000	84.70

145. To one liter of the HCl add 500 c.c. water.
  To one liter of the KOH add $266\frac{2}{3}$ c.c. water.

146. Weight of limestone 43.779 kilos. Of acid 140.909 kilos. Volume of the gas at zero, 9512 liters. Its weight, 18.685 kilos.

147. $Na_2SnO_3, 4H_2O$.

148. 5.35.

149. 2600 meters.

150. One gram.

151. 62 grams.

152. $H_2S_2O_7$ or $2SO_3 + H_2O$.

153. Each one-tenth of a liter.

154. 20 c.m.

155. 344.42 meters.

156. 9 millimeters.

157. 3 per cent.

158. 100 liters.

159. 736.6, 762, 787.4 millimeters.

160. 30.71, 30.31, 29.92, 29.53, 29.13 inches.

161. 0.166 or one-sixth.

162. HgC_4H_{10} or $Hg(C_2H_5)_2$.

163. 132.35 cubic centimeters.

164. Atomic weight 52.4.

165. Atomic weight 120.2.

166. $ZnSO_4$ = 247.7. $FeSO_4$ = 542.86. $(NH_4)_2SO_4$ = 63.34 grams.

167. Chlorine at zero = 83.099 liters. At 20° C. = 89.187 liters. Hydrochloric acid gas exactly double chlorine by the equation. Weight of ortho-phosphoric acid = 145.42 grams.

168. (a) P_2H. (b) Ag_3AsS_3. (c) $KClO_4$. (d) Ag_2OFH.

169.

(a)		(b)	
Mercury	71.68 per cent.	Gold	77.22 per cent.
Hydrogen	0.36 per cent.	Oxygen	9.42 per cent.
Nitrogen	5.02 per cent.	Nitrogen	11.01 per cent.
Oxygen	22.94 per cent.	Hydrogen	2.35 per cent.
	100.00 per cent.		100.00 per cent.

(c)		(d)	
Lead	77.53 per cent.	Tin	32.36 per cent.
Carbon	17.98 per cent.	Chlorine	57.85 per cent.
Hydrogen	4.49 per cent.	Nitrogen	7.62 per cent.
		Hydrogen	2.17 per cent.
	100.00 per cent.		100.00 per cent.

170. Volume of one gram = 14.2857 c.c.
  Gas at 100° occupies 812.7 times volume of liquid, = 11.61 liters.
  Minus 238.5° Centigrade.

171. 8.12 lbs.

172. Analysis summed to exact 100 by difference, as below:

Copper (by difference)	99.956 per cent.
Iron	0.016 per cent.
Arsenic	0.010 per cent.
Lead	0.018 per cent.
	100.000 per cent.

173. 574,165,721,516 metric tons of carbon.
  1,071,776,013,496,363 cubic meters of carbon dioxide gas.

174. $CaCO_3$ unacted on = 10 grams.
  Weight of solution = 194.66 grams.
  Volume of HCl gas 17.92 liters.

175. Tons of coal = 1,500,000,000,000.
  Area of coal field = 134,513 square miles nearly.

176. Weight of the P_2O_5 = 171.42 grams
  Specific gravity of the nitric acid = 1.52.

177. Weight of hydrogen = 0.02805 gm. Volume = 0.31416 liter.
  Weight of sodium = 0.64515 gm. Vol. = 0.6651 cubic cm.
  Radius of pellet = 0.5415 cm. Weight of NaOH = 1.122 grams.

178. 77.07 per cent. MnO_2.   0.167 liters chlorine.

179. 56.81 grams.

180.

ANALYSIS BY "PROXIMATES."	ANALYSIS BY ELEMENTS, ETC.
SiO_2...... 36.18 per cent.	SiO_2...... 36.18 per cent.
FeS_2...... 12.25 per cent.	Fe........ 10.27 per cent.
PbS....... 8.46 per cent.	Pb........ 7.33 per cent.
ZnS....... 16.18 per cent.	Zn........ 10.87 per cent.
Fe_2O_3..... 6.57 per cent.	S.......... 13.00 per cent.
$CaCO_3$.... 20.36 per cent.	CaO........ 11.41 per cent.
	CO_2....... 8.95 per cent.
	O(with Fe_2O_3) 1.99 per cent.
100.00 per cent.	100.00 per cent.

181. 2.683 liters.

182. Sp. gr. of heavier liquid = 1.5252.

183. 66.4 per cent.

184. Weight of $BaSO_4$ = 0.0025 gram.

185. 438.8 cubic feet.

186. Atomic weight = 100.

187. MgO = 2.018.   NaOH = 4.006.   Zn = 3.270. $CaCO_3$ = 5.005.

188. 12, 24, 36 and 48, respectively.

189. Mol. wt. = 104.4.

190. 31.39 per cent. tin.

191. Zinc = 7.521 grams.   Hydrogen = 2.670 liters.

192. Per cent. nitrogen = 6.39.

193. Copper weighs 0.8 gram.

194. Vol. of oxygen required = 157.5 c.c.

    Vol. of CO_2 produced = 129.8 at 100° C.

    Vol. of H_2O produced = 191.3 at 100° C.

195. Analysis by volume:

CO_2....................................	20 per cent.
CO.....................................	45 per cent.
H_2....................................	35 per cent.
	100 per cent.

196.

Silver with the chloride.............	= 0.1855 gram.
Silver with the bromide.............	= 0.0705 gram.
Silver chloride (AgCl)...............	= 0.2464 gram.
Silver bromide (AgBr).............	= 0.1227 gram.
Chlorine.............................	= 0.0609+ gram.
Bromine.............................	= 0.0522+ gram.

197. Nitrogen, 6 per cent.

198. Silver bromide = 0.4173.   Silver iodide = 0.5217 gram.

199. CO_2 = 210,560 liters; H_2O(1) = 169.2 kilos; (2) = 157.21 kilos.

200. 5.4167 grams.

201. (1) 604.8 cu. m. CO_2 gas.   (2) 1244.4432 cu. m. H_2 gas.

202. Specific gravity = 2.689.

203. $KMnO_4$ = 0.5643. $K_2Cr_2O_7$ = 0.8750 gram.

204. Error = $0.0034 or thirty-four hundredths of one cent.

205. 164 millionths of one milligram.

206. 1.281 grams.

207. 9103 millimeters.

208. $KClO_4$.

209. 46.8 approximate molecular weight.

210. 129 approx. mol. wt.

211. 994.68 lbs. MnO_2 of 85 per cent. MnO_2.

    Vol. of chlorine, 136.44 cu. ft., normal t and p.

212. 818 mm.

213. CO_2 gas by 0.643 gram.

214. 100 grams.

215. $CaCO_3$ = 446.75 grams.   HCl = 200 liters.   Weight = 326+ grams.

216. Practically equal.

217. $2HNO_3, 3H_2O$.

218. 1000 millimeters.

219.

ELEMENTS AND RADICALS.		SALTS.	
CaO.............	0.05912	$CaSO_4$...........	0.0322
Cl..............	1.37549	$CaCO_3$...........	0.0819
SO_3...........	0.01894	$MgCl_2$...........	0.0211
Na.............	0.89910	Na_2CO_3..........	0.0416
Mg.............	0.00533	NaCl............	2.2408
CO_2...........	0.05332		
O(Na_2CO_3).......	0.00630		
Total.........	2.41760	Total..........	2.4176

These are weights. "Parts per 100,000" may be found by simply dividing by 100.

220. Sphere, 43.9824.   Cylinder, 65.9736.   Cube, 84.000 grams.

221. Zinc = 6.174. NH_3 = 7.179. H_2SO_4 = 9.308 (grams).

222. K_2H.
223. 66.66 c.c.
224. 12.12 per cent.
225. Copper, 60; tin, 10; zinc, 30 per cent.
226.

Sulphur... 0.055 per cent.	Phosphorus. 0.059 per cent.
Silicon..... 0.196 per cent.	Manganese. 0.342 per cent.

227. Molecular weight = 34.9.
228. Minus 58° Centigrade.
229. 980.3 c.c. acid, and 19.7 c.c. water.
230. Volume: Nitrogen = 451 liters. Carbon dioxide = 58 liters. Total, 509 liters.
    Weight: Nitrogen = 563.7 grams. Carbon dioxide = 113.9 grams. Total, 677.6 grams.

$$\text{Density} = \frac{(451 \times 28) + (58 \times 44)}{509} = 29.82.$$

231. For Fe; 934.56 + 65.44 water. For H_2SO_3; 818.3 + 181.7 water.
    For $H_2C_2O_4$; 581.5 + 418.5 water. (Cubic centimeters.)
    For Fe; 1 liter + 70 c.c. water. For H_2SO_3; 1 liter + 222 c.c. water.
    For $H_2C_2O_4$; 1 liter + 719.7 c.c. water.
232. 85.84 grams.
233. 1.464 per cent. nitrogen.
234. C_6H_6. (Second datum suffices. First gives analysis, not formula.)
235. Radius = 19.929 centimeters.
236. $CO_2 = 1.427$. $H_2O = 0.2413$. Pt $= 1.052$. AgBr $= 1.0159$.
237. R = 1.44 (+) or 1.441 (−) centimeters. Volume = 12.52 c.c. Weight = 21.786 grams.
238. Molecular weight about 126. ($C_{10}H_8 = 128$.)
239. Analysis:

Carbon..................................	39.08 per cent.
Hydrogen................................	2.18 per cent.
Nitrogen................................	15.23 per cent.
Oxygen..................................	43.51 per cent.
Total..................................	100.00 per cent.

Formula: $C_6H_4N_2O_5$.

240. Oxygen = 1.265 gram = 0.885 liter. Air = 4.215 liters = 0.15 cu. ft.
241. If a dyad, at. wt. = 100. If a triad, at. wt. = 150.
242. Impurities = 5.93 per cent.
243. MnO_2 = 384 grams. Hydrochloric acid solution = 3222 grams. Volume of hydrochloric acid = 2.929 liters.
244. Available chlorine = 44.37 per cent. Will dissolve 820.7 grams gold.
245. 230.003 liters of HCl gas, at 10° and 670 mm.
246. Excess of iron, 0.319 lb. Sulphuric acid used, 1.191 lbs. Deficit of sulphuric acid, 0.559 lb.
247. 124.27 c.c.
248. At. wt. of "M" = 22.32.
249. At. wt. = 100.
250. At. wts. = 24 and 40.
251. Pressure 5709.2 mm., or 7.512 atmospheres. Weight 164.5 kilos.
252. 762.526 liters.
253. Add 0.85 c.c. ammonia solution.
254. HCl solution, 2220.3 c.c. NaOH solution, 3050.1 c.c.
255.

(1) Crude ore contains by assay.......... 139 lbs. of lead.
    Products contain by assay........... 134.5 lbs. of lead.
    Discrepancy (deficit)................ 4.5 lbs. of lead.
(2) Assay of tailings should be 1.26 per cent.