

Amount K ₂ O added. Parts per million.	Amount K ₂ O recovered. Parts per million.
1..... 1.0	0.92
2..... 1.0	0.8
3..... 1.0	1.0
4..... 1.0	1.2
5..... 2.0	1.9
6..... 2.0	2.1
7..... 2.0	2.0
8..... 2.0	2.0
9..... 3.0	3.2
10..... 3.0	3.2
11..... 3.0	2.8
12..... 3.0	2.8
13..... 4.0	4.4
14..... 4.0	4.0
15..... 4.0	4.0
16..... 4.0	4.4
17..... 5.0	5.0
18..... 5.0	5.0
19..... 5.0	4.9
20..... 10.0	11.6
21..... 10.0	11.2

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THE DELICACY OF TESTS EMPLOYED FOR THE DETECTION OF METALS.

BY FLORENCE JACKSON.

Received June 24, 1903.

THE work in the following paper was undertaken for the purpose of determining the comparative delicacy of the tests employed in the ordinary methods used in qualitative analysis in detecting metals. To this end, solutions of salts were made of such strength that 1 cc. of the solution contained 5 mg. of the element under consideration or 1 part in 200. The weaker solutions were made from the standard by diluting with distilled water. When (as in the case of silver chloride) ammonia present in the water might exert a solvent influence, water free from ammonia was used. The reagents used were of the strength employed in the Wellesley College Chemical Laboratory (see table at the end), and were added drop by drop to 1 cc. of the solution under consideration.

The experiments were carried through twice, new standard solu-

tions being used the second time and, in cases of discrepancy, further tests were made.

The figures under the "final tests" were chosen as the probable limit of detection, if the element was not known to be present. They do not, therefore, usually represent the extreme limit indicated under the experimental conditions of this paper. This may account for the discrepancy between my figures and those given by other authorities.

FINAL TESTS. SUMMARY BY REAGENTS.

(A) HCl.

(a) Sp. gr. 1.035

Ag	1 : 64,000	{	1 : 1,000,000. Comey. Mulder.
		{	1 : 378,000. Harting.
		{	1 : 200,000. Lassaigne.
		{	1 : 189,000. Pfaff.
Hg ^I	1 : 16,000	1 :	327,000. Fresenius.
Pb	1 : 500	1 :	1,077. Wormley.

(b) Sp. gr. 1.1 As above except

Hg^I 1 : 8,000

(B) NaCl.

Ag	1 : 32,000
Hg ^I	1 : 15,000
Pb	1 : 1,000

(C) H₂S.

As ^{III}	1 : 1,024,000	1 : 13,200.	Wormley.
Sb	1 : 512,000	1 : 24,000.	Wormley.
Bi.Ag.Sn ^{III}	1 :	64,000	
As. ^V Hg. ^I Sn ^{IV}	1 :	32,000	As 1 : 1530. Wormley.
	{	Pb 1 : 1,000,000.	Prescott and Sullivan.
	{	1 : 26,900.	Wormley.
Cd.Cu.Pb.Hg ^{II}	1 : 16,000	{	Hg ^{II} 1 : 46,000. Green coloration { Las-
		{	1 : 23,000. Brown " { saigne.
		{	1 : 6,770. Wormley.
	{	Cu 1 : 100,000.	Prescott and Sullivan.
	{	1 : 12,500.	Wormley.

(D) NH₄OH.

Mn	1 : 64,000	
Mg	1 : 32,000	
Co.Fe. ^{III} Pb	1 : 16,000	
Al.Bi.Cu.Fe. ^{II} Hg. ^{I-II} Sn. ^{II} Zn	1 : 8,000	Hg ^{II} 1 : 13,500. Wormley.
	Cu	{ 1 : 20,000. Prescott and Sullivan.
		{ 1 : 12,500. Wormley.
	Zn	1 : 12,500. Wormley.
Cd.Cr.Ni.Sn ^{IV}	1 : 4,000	
Sb	1 : 1,000	1 : 1,200. Wormley.
Ag.(NH ₄ OH 1 : 10)	1 : 500	

- (E) NaOH.
- | | | | | |
|---|---|---------------------|----|--|
| Mn | 1 | : 128,000 | | |
| Fe ¹¹ | 1 | : 32,000 | | |
| Al.Cu.Co.Hg. ¹ Ni | 1 | : 16,000 | Cu | 1 : 125,000. Wormley. |
| NH ₃ .Bi.Cr.Fe. ¹¹ Ag | 1 | : 8,000 | | |
| | | Cd.Zn | 1 | : 4,000 |
| | | Sn ^{11-1V} | 1 | : 2,000 |
| | | Sb | 1 | : 1,000 1 : 1,200. Wormley. |
| | | Pb.Hg ¹¹ | 1 | : 500 Hg ¹¹ 1 : 677. Wormley. |
- (F) K₂CrO₄.
- | | | | | |
|--------------------|---|-----------|---|-----------------------|
| Ba | 1 | : 256,000 | | |
| Pb | 1 | : 32,000 | { | 1 : 111,982. Harting. |
| | | | { | 1 : 107,700. Wormley. |
| Cu | 1 | : 16,000 | 1 | : 50,000. Wormley. |
| Ag | 1 | : 8,000 | | |
| Bi.Hg ¹ | 1 | : 4,000 | | |
| Cd | 1 | : 1,000 | | |
| Hg ¹¹ | 1 | : 333 | | |
| Sr | 1 | : 200 | | |
- (G) KI.
- | | | | | |
|--------------------------|---|---------|---|-------------------------|
| Ag.Cu.Pb.Hg ¹ | 1 | : 8,000 | { | Ag 1 : 47,250. Harting. |
| | | | { | Pb 1 : 21,540. Wormley. |
| | | | { | Cu 1 : 12,500. Wormley. |
| Hg ¹¹ | 1 | : 2,000 | 1 | : 3,380. Wormley. |
- (H) Na₂HPO₄.
- | | | | |
|-------|---|-----------|--|
| Mg | 1 | : 128,000 | (Addition of NH ₄ Cl and NH ₄ OH.) |
| Ca | 1 | : 16,000 | |
| Ag.Sr | 1 | : 8,000 | |
| Ba | 1 | : 4,000 | |
- (I) (NH₄)₂S.
- | | | | | |
|----------------------|---|-----------|---|-------------------|
| Co | 1 | : 512,000 | 1 | : 309,000. Pfaff. |
| Fe ¹¹⁻¹¹¹ | 1 | : 128,000 | | |
| Ni | 1 | : 64,000 | | |
| Al.Cr.Mn.Zn | 1 | : 8,000 | | |
- (J) H₂O.
- | | | | | |
|----|---|---------|--|--|
| Sb | 1 | : 2,000 | | |
| Bi | 1 | : 4,000 | | |
- (K) Na₂CO₃.
- | | | | | |
|---|---|----------|----|----------------------|
| Sr | 1 | : 64,000 | | |
| Bi.Mn.Ag | 1 | : 32,000 | | |
| Cu.Fe. ¹¹¹ Hg. ¹ Ni | 1 | : 16,000 | Cu | 1 : 12,500. Wormley. |
| Al.Ba.Co.Fe. ¹¹ Zn | 1 | : 8,000 | Zn | 1 : 12,500. Wormley. |
| Cd.Ca.Cr.Pb.Mg | 1 | : 4,000 | Pb | 1 : 53,850. Wormley. |
| Hg ¹¹ | 1 | : 250 | | |
- (L) H₂SO₄.
- | | | | | |
|-----------------|---|-----------|---|-----------------------------|
| Ba | 1 | : 256,000 | 1 | : 79,300. Harting. |
| Pb | 1 | : 16,000 | 1 | : 21,540. Wormley. |
| Sr | 1 | : 8,000 | 1 | : 23,100-25,200. Fresenius. |
| Ca | 1 | : 2,000 | | |
| Hg ¹ | 1 | : 1,000 | | |

- (M) SnCl_2 .
 Hg^{I} I : 32,000
 Hg^{II} I : 16,000 I : 13,500. Wormley.
- (N) KCN .
 Co I : 16,000
 Cu.Ni I : 2,000
 Cd I : 1,000
- (O) $\text{K}_4\text{Fe}(\text{CN})_6$.
 Fe^{III} I : 64,000
 $\text{Fe.}^{\text{II}}\text{Pb}$ I : 32,000 Pb I : 10,770. Wormley.
 Cu I : 16,000 { I : 100,000. Prescott and Sullivan.
 I : 31,250. Wormley.
- (P) $(\text{NH}_4)_2\text{CO}_3$.
 Sr I : 16,000 I : 95,200. Conley.
 $\text{Ca.Co.Fe}^{\text{III}}$ I : 8,000 Ca I : 163,000. Fresenius.
 Ba.Fe^{II} I : 4,000 Ba I : 201,000. Fresenius.
 Mg I : 200
- (Q) $(\text{NH}_4)_2\text{C}_2\text{O}_4$.
 Ca I : 64,000
 Sr I : 32,000
 Ba I : 2,000
- (R) CaSO_4 .
 Ba I : 64,000
 Sr I : 1,000
- (S) H_2SiF_6 .
 Ba I : 2,000
 K I : 200
 Na I : 143
- (T) H_2PtCl_6 .
 NH_3 I : 2,000
 K I : 200

STRENGTH OF REAGENTS EMPLOYED.

$(\text{NH}_4)_2\text{CO}_3$	175 grams to a liter + 100 cc. concentrated NH_4OH .
NH_4OH	Diluted 1 : 3 and 1 : 10.
$(\text{NH}_4)_2\text{C}_2\text{O}_4$	40 grams to a liter.
$(\text{NH}_4)_2\text{S}$	Saturate NH_4OH (0.96) with H_2S .
HCl	Sp. gr. 1.12 and 1.035.
HNO_3	Sp. gr. 1.2.
H_2SO_4	Diluted 1 : 5.
H_2S	From Kipp generator. Washed in H_2O .
HgCl_2	25 grams to a liter.
MgSO_4	50 " " " "
K_2CrO_4	50 " " " "
KCN	50 " " " "
KCNS	5 " " " "
$\text{K}_4\text{Fe}(\text{CN})_6$	75 " " " "
KI	25 " " " "
Na_2CO_3	250 " " " " Crystallized salt.
NaCl	50 " " " "
NaOH	150 " " " "
Na_2HPO_4	50 " " " "
SnCl_2	Su dissolved in HCl + 4 parts of H_2O .

The results obtained from these experiments agree, in general, with facts already known. The work has value chiefly, as it seems to me, in the collection of definite data for future investigation rather than in any new facts brought to light by the figures given.

WELLESLEY COLLEGE,
June, 1903.

A LECTURE EXPERIMENT WITH AN UNDISSOCIATED SALT.

By D. MCINTOSH.
Received June 12, 1903.

WHEN a sulphocyanate is added to a ferric salt, the deep red color produced is thought, for a number of reasons, to be due to the undissociated ferric sulphocyanate. These may be briefly stated: First, neither the ferric nor the sulphocyanate ion is colored; second, the crystals of ferric sulphocyanate, which can contain no ions, are similarly colored; third, in ether, in which salts are but slightly dissociated, the color is unchanged; fourth, an excess of a sulphocyanate increases the color, while the addition of sulphate ions weakens it.

If, then, ferric sulphocyanate were placed in a tube between two layers of a colorless liquid, the passage of a current should not increase the rate of diffusion; if, on the other hand, the color were due to a complex cation or anion, the color should move either to the cathode or anode.

If a solution of ferric sulphocyanate be placed in a U-tube, and carefully covered over with a less dense electrolyte (dilute hydrochloric acid), a current of $\frac{1}{100}$ ampere may be passed through it for several hours without the relative positions of the color-boundaries changing. The experiment can be made quite striking, by arranging in series two other tubes containing¹ potassium copper tartrate covered with dilute potassium hydroxide, and copper sulphate with ammonium hydroxide covered with ammonium hydroxide. In the first case, the color-boundaries remain stationary, while in the second and third they move towards the anode and cathode respectively.

¹ Massoni: *Ztschr. phys. Chem.*, **29**, 501 (1899).