CHAPTER II

SPOT TESTS FOR DETECTION OF IRON AND SILVER
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Spot tests involve the addition of a drop or two of the sample solution to obtain distinctive colours or precipitates. An excellent account on spot tests has been given by West\(^1\). The most complete collection of spot test procedures for inorganic qualitative analysis is given in the excellent treatise of Feigl\(^2\).

Organic reagents for use in spot tests have been classified by Feigl as follows\(^3\):

- those which react with an anion or cation to give a salt which is coloured or insoluble.

- those that give inner complexes of characteristic properties.

- those that form addition compounds of characteristic properties.

- those that form adsorption complexes or coloured lakes and thus render precipitates easier to detect.
those that are oxidised or reduced by inorganic anion or cation present with a resultant colour change.

those that undergo particular reactions because of the catalytic effects of the anion or cation in question.

The minimum quantity of material expressed in the millionth of a gram which can be identified by any reaction is known as the identification limit.\(^4\)

The degree of dilution prevailing at a given identification limit is termed concentration limit by Hahn\(^5\) and its reciprocal value as dilution limit by Heller\(^6\).

The dilution value can be calculated by the following expression:

\[
\text{Dilution limit} = \frac{\text{Volume of solution in ml.} \times 10^6}{\text{Identification limit in \(\mu g\)}}
\]

**Spot test detection of Iron:**

Phenolic aldehydes, ketones and their derivatives give characteristic colours with ferric ions.

The work in this laboratory has been planned with a view to carry out systematic investigations of phenolic carbonyl compounds and their derivatives as reagents for the spot test detection of iron.

The spot plate sensitivity tests were made by transferring 0.05 ml. of a standard ferric solution to a
white porcelain spot plate (or a filter paper) and adding 0.05 ml. of 1% solution of the reagent in ethyl alcohol. Blanks of ferric ions were light yellow in colour at higher concentrations of ferric ions and colourless at lower concentrations of ferric ions. Blanks of reagents were colourless. Identification limit was ascertained from the lowest concentration of the test solution to give a colour distinguishable from the blank. From this value, the dilution limit and concentration limit were calculated.

The effect of pH was observed by testing with:

1. a drop of ferric nitrate solution + a drop of 0.1N nitric acid + a drop of the reagent,
2. a drop of ferric nitrate solution + a drop of buffer of pH 3.0 + a drop of reagent,
3. a drop of ferric nitrate solution + a drop of reagent + a drop of 0.1N sodium hydroxide.

A summary of the colours, identification limits, concentration limits, and dilution limits of the reagents investigated is given in Table II-1.

The effect of diverse ions on detection of ferric ions was also studied by carrying out spot tests on synthetic solutions containing a known proportion of ferric ions and the interfering ion.
It was observed that at 5.6 p.p.m. concentration of ferric ions, 560 p.p.m. of the following ions do not interfere: Na⁺, K⁺, Cs⁺, Ca⁺, Sr⁺, Ba²⁺, Fe²⁺, Zn²⁺, Co²⁺, Be²⁺, Mg²⁺, Mn²⁺, NH₄⁺, UO₂²⁺, Cl⁻, Br⁻, NO₃⁻, SO₄²⁻, ClO₄⁻. With m-hydroxy benzaldehyde, p-hydroxy benzaldehyde, protocatechualdehyde, gentisaldehyde, m-hydroxy benzaldoxime, p-hydroxy benzyldoxime and gentisaldoxime, 40 p.p.m. Cu²⁺, Ni²⁺, Cr³⁺ and Co³⁺ are tolerated. With 0-hydroxy acetophenone, 0-hydroxypropiophenone, 0-hydroxybutyrophenone, 2,6 dihydroxyacetophenone, 2,4,6 trihydroxyacetophenone, 4 hydroxy 3 acetylbenzoic acid, 0-hydroxy acetophenone oxime, 2,4 dihydroxy acetophenone oxime, and 4 hydroxy 3 acetyloxime benzoic acid, 56 p.p.m. Cu²⁺, Ni²⁺, Cr³⁺ and Co³⁺ are tolerated.

A summary of the reagents reported in literature for the spot test detection of ferric ions is given in Table II-3. It can be seen that protocatechualdehyde, gentisaldehyde and gentisaldoxime are highly sensitive reagents for the spot test detection of ferric ions. The other more sensitive reagents reported in literature are (1) zinc ferrocyanide (0.069), (2) mononitrosochromotropic acid (0.01-6⁴), (3) α nitroso β naphthol (0.029), (4) salicylaldoxime (0.028) and (5) β resorcylaldoxime (0.028). However, the suggested reagents are highly specific.
Spot Test detection of Silver:

During a study in colour reactions of phenolic aldehydes and ketones, it was observed that silver ions give a grey colour with gentisaldehyde and gentisaldoxime. Similar colour reaction is given by sodium gentisate also. This colour reaction has been investigated for spot test detection of silver.

Spot tests were carried out with a drop of silver nitrate solution + a drop of 1% reagent + a drop of 0.1N sodium hydroxide. Development of grey colour indicated the presence of silver. At 2.67 p.p.m. concentration of silver, 50 p.p.m. of Na⁺, K⁺, Ca²⁺, Sr²⁺, Ba²⁺, Fe³⁺, Zn²⁺, Cd²⁺, Be²⁺, Mg²⁺, Mn²⁺, NH₄⁺, UO₂²⁺, Cl⁻, Br⁻, NO₃⁻, SO₄²⁻, CIO₄⁻, and 10 p.p.m. Cu²⁺, Ni²⁺, Co²⁺ are tolerated. Fe³⁺ interferes at all levels, but it can be masked with oxalic acid.

The identification concentration and dilution limits of the reagents are given in Table II-2.

A summary of the reagents reported in literature for the spot test detection of silver is given in Table II-4. While the suggested reagents are not very sensitive, they are quite selective reagents for the detection of silver ions.
**TABLE II-1**
SUMMARY OF THE COLOURS, IDENTIFICATION LIMITS, CONCENTRATION LIMITS, AND DILUTION LIMITS OF THE COMPOUNDS INVESTIGATED AS REAGENTS FOR THE SPOT TEST DETECTION OF FERRIC IONS.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Colour with ferric ion</th>
<th>pH</th>
<th>Identification limit (μg)</th>
<th>Dilution limit</th>
<th>Concentration limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. m-hydroxy benzaldehyde</td>
<td>Violet</td>
<td>3.0</td>
<td>3.2</td>
<td>1.563 x 10⁴</td>
<td>6.3 x 10⁵</td>
</tr>
<tr>
<td>2. p-hydroxy benzaldehyde</td>
<td>Violet</td>
<td>3.0</td>
<td>3.4</td>
<td>1.473 x 10⁴</td>
<td>6.8 x 10⁵</td>
</tr>
<tr>
<td>3. Protocatechualdehyde</td>
<td>Green</td>
<td>3.0</td>
<td>0.042</td>
<td>1.339 x 10⁶</td>
<td>8.4 x 10⁷</td>
</tr>
<tr>
<td>4. Gentisaldehyde</td>
<td>Blue</td>
<td>3.0</td>
<td>0.049</td>
<td>1.021 x 10⁶</td>
<td>9.8 x 10⁷</td>
</tr>
<tr>
<td>5. m-hydroxy benzaldoxime</td>
<td>Reddish violet</td>
<td>3.0</td>
<td>2.8</td>
<td>1.785 x 10⁴</td>
<td>5.6 x 10⁵</td>
</tr>
<tr>
<td>6. p-hydroxy benzaldoxime</td>
<td>-do-</td>
<td>3.0</td>
<td>2.9</td>
<td>1.724 x 10⁴</td>
<td>5.8 x 10⁵</td>
</tr>
<tr>
<td>7. Gentisaldoxime</td>
<td>Blue</td>
<td>3.0</td>
<td>0.042</td>
<td>1.339 x 10⁶</td>
<td>8.4 x 10⁷</td>
</tr>
<tr>
<td>8. o-hydroxyacetophenone</td>
<td>Violet</td>
<td>3.0</td>
<td>3.0</td>
<td>1.667 x 10⁴</td>
<td>5.9 x 10⁵</td>
</tr>
<tr>
<td>9. o-hydroxypropiophenone</td>
<td>Violet</td>
<td>3.0</td>
<td>3.2</td>
<td>1.563 x 10⁴</td>
<td>6.3 x 10⁵</td>
</tr>
<tr>
<td>10. o-hydroxybutyrophenone</td>
<td>Violet</td>
<td>3.0</td>
<td>3.4</td>
<td>1.473 x 10⁴</td>
<td>6.8 x 10⁵</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>11</td>
<td>2,6 dihydroxyacetophenone</td>
<td>Grey</td>
<td>3.0</td>
<td>3.2</td>
<td>1.563x10^4</td>
</tr>
<tr>
<td>12</td>
<td>2,4,6 trihydroxyacetophenone</td>
<td>Reddish purple</td>
<td>3.0</td>
<td>3.0</td>
<td>1.667x10^4</td>
</tr>
<tr>
<td>13</td>
<td>4-hydroxy 3 acetyl benzoic acid</td>
<td>Purple</td>
<td>3.0</td>
<td>2.0</td>
<td>2.500x10^4</td>
</tr>
<tr>
<td>14</td>
<td>o-hydroxy acetophenone oxide</td>
<td>Reddish brown</td>
<td>3.0</td>
<td>0.9</td>
<td>5.556x10^4</td>
</tr>
<tr>
<td>15</td>
<td>2,4 dihydroxy acetophenone oxide</td>
<td>Purple</td>
<td>2.6</td>
<td>0.8</td>
<td>6.2500x10^4</td>
</tr>
<tr>
<td>16</td>
<td>4 hydroxy 3 acetyl oxime benzoic acid</td>
<td>Reddish brown</td>
<td>3.0</td>
<td>0.9</td>
<td>5.556x10^4</td>
</tr>
</tbody>
</table>
## TABLE II-2

IDENTIFICATION, CONCENTRATION AND DILUTION LIMITS OF THE REAGENTS FOR SPOT TEST DETECTION OF SILVER

<table>
<thead>
<tr>
<th>Substance</th>
<th>Identification limit $\mu$g</th>
<th>Dilution limit $\text{cm}^3$</th>
<th>Concentration limit $\text{mg}l^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gentisaldehyde</td>
<td>1.06</td>
<td>4.718x10^4</td>
<td>2.12x10^-5</td>
</tr>
<tr>
<td>Gentisaldoxime</td>
<td>0.53</td>
<td>9.434x10^4</td>
<td>1.06x10^-5</td>
</tr>
<tr>
<td>Sodium gentisate</td>
<td>2.67</td>
<td>1.873x10^4</td>
<td>5.34x10^-5</td>
</tr>
</tbody>
</table>
**TABLE II-3**

A SUMMARY OF THE REAGENTS REPORTED FOR SPOT TEST DETECTION OF FERRIC IONS.

<table>
<thead>
<tr>
<th>No. of Reagent</th>
<th>Reagent</th>
<th>Colour with ferric ion</th>
<th>Sensitivity (γ)</th>
<th>Identification limit (Dilution limit)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rubeanic acid + trisodiumpentacyanoamino ferrate</td>
<td>Green</td>
<td>-</td>
<td>-</td>
<td>1A</td>
</tr>
<tr>
<td>2</td>
<td>Sodium carbonate</td>
<td>a. Apple green (If Fe³⁺ content not more than 5% of the Nickel)</td>
<td>-</td>
<td>-</td>
<td>2A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Yellow brown if ferric content more than 5% Nickel</td>
<td>-</td>
<td>-</td>
<td>2A</td>
</tr>
<tr>
<td>3</td>
<td>Salicylaldoxime</td>
<td>Violet</td>
<td>0.5</td>
<td>-</td>
<td>3A</td>
</tr>
<tr>
<td>4</td>
<td>1:8 Naphthylamine sulfonate</td>
<td>Intense blue</td>
<td>-</td>
<td>1:3500</td>
<td>4A</td>
</tr>
<tr>
<td>5</td>
<td>O-aminophenol</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
<td>5A</td>
</tr>
<tr>
<td>6</td>
<td>Ethylene glycol bis (2-aminoethylether) N,N,N',N'-tetra acetic acid (EGTA)</td>
<td>Yellow</td>
<td>0.18</td>
<td>-</td>
<td>6A</td>
</tr>
<tr>
<td>7</td>
<td>3-Furoinoxime</td>
<td>Red</td>
<td>0.32 (2x10⁻⁶)</td>
<td>-</td>
<td>7A</td>
</tr>
<tr>
<td>8</td>
<td>Thiocyanate</td>
<td>-</td>
<td>0.11</td>
<td>-</td>
<td>8A</td>
</tr>
<tr>
<td>9</td>
<td>6-Phenylsalicylic acid</td>
<td>Purple</td>
<td>-</td>
<td>-</td>
<td>9A</td>
</tr>
<tr>
<td>10</td>
<td>Zinc ferrocyanide</td>
<td>Spt turns blue after 30-60 min.</td>
<td>0.06</td>
<td>-</td>
<td>10A</td>
</tr>
<tr>
<td>11</td>
<td>1-methyl-2-mercaptothiazole + NH₄SCN</td>
<td>Red</td>
<td>-</td>
<td>-</td>
<td>11A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>---</td>
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<td>--------------------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>12</td>
<td>Mononitrosoochromotropic acid</td>
<td>Pink to violet</td>
<td>0.01-6</td>
<td>-</td>
<td>12A</td>
</tr>
<tr>
<td>13</td>
<td>α-SNADNS-6[6(6-sulfo-1-Naphthylazo) Chromotropic acid]</td>
<td>Violet</td>
<td>2.0</td>
<td>-</td>
<td>13A</td>
</tr>
<tr>
<td>14</td>
<td>β-SNADNS-6[6(6-sulfo-2 Naphthylazo) Chromotropic acid]</td>
<td>do-</td>
<td>1.5</td>
<td>-</td>
<td>13A</td>
</tr>
<tr>
<td>15</td>
<td>Na-salicylate</td>
<td>Violet</td>
<td>&gt; 4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>K₄Fe(CN)₆</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>Phenothiazine</td>
<td>-</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>2-Theonyltrifluoride acetone (TTA)</td>
<td>Red or pink</td>
<td>0.5</td>
<td>1:10000</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>6-methoxy-1,2,3,4, tetrahydroquinoline as sulfonate (talline)</td>
<td>Green</td>
<td>0.3</td>
<td>1:150,000</td>
<td>18A</td>
</tr>
<tr>
<td>20</td>
<td>Formyldeoxybenzoin</td>
<td>Purple-brown ppt.</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Oxine</td>
<td>Green</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>β-Naphthylsulfide</td>
<td>Yellow</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>2,4-dihydroxyacetophenone</td>
<td>Red</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Resorcyllaldoxime (0.2%)</td>
<td>Purple</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>Quercetin</td>
<td>Olivegreen</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>α-nitro-β-naphthol</td>
<td>Green</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>27</td>
<td>Chlorpromazine-HCL</td>
<td>Red</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Ferron</td>
<td>Dull green</td>
<td>0.2-0.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>Acetoacetanilide</td>
<td>Violet</td>
<td>2.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>4-amino-5-ethylimidazole</td>
<td>Red brown</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>5-amino-4-methyl imidazole</td>
<td>Deep red</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------</td>
<td>-----------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>32</td>
<td>Cinnamohydroxamic acid</td>
<td>Violet complex</td>
<td>4.7</td>
<td>-</td>
<td>37A</td>
</tr>
<tr>
<td>33</td>
<td>1-phenethyl-carbethoxy-2-oxo-3-hydroxypyrroline</td>
<td>Deep red</td>
<td>12</td>
<td>-</td>
<td>38A</td>
</tr>
<tr>
<td>34</td>
<td>2-thiobarbituric acid</td>
<td>Rose</td>
<td>&gt; 0.2</td>
<td>-</td>
<td>39A</td>
</tr>
<tr>
<td>35</td>
<td>1% aq. soln. of p-amino-NN-diethylaniline</td>
<td>Rose</td>
<td>0.06</td>
<td>1:80000</td>
<td>39A</td>
</tr>
<tr>
<td>36</td>
<td>Thiazolylhydrazine derivs.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>41A</td>
</tr>
<tr>
<td>37</td>
<td>Phenylhydrazine</td>
<td>Yellow</td>
<td>80</td>
<td>-</td>
<td>42A</td>
</tr>
<tr>
<td>38</td>
<td>Salicylaldehyde</td>
<td>Violet</td>
<td>0.056</td>
<td>0.893x10^6</td>
<td>49A</td>
</tr>
<tr>
<td>39</td>
<td>β-resorcylaldehyde</td>
<td>-do-</td>
<td>0.042</td>
<td>1.339x10^6</td>
<td>49A</td>
</tr>
<tr>
<td>40</td>
<td>Salicylaldoxime</td>
<td>Reddish violet</td>
<td>0.028</td>
<td>1.786x10^6</td>
<td>49A</td>
</tr>
<tr>
<td>41</td>
<td>β-resorcylaldoxime</td>
<td>-do-</td>
<td>-do-</td>
<td>1.786x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>42</td>
<td>2,4 dihydroxypropionophene</td>
<td>Purple</td>
<td>2.8</td>
<td>1.786x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>43</td>
<td>2,4 dihydroxybutyrophenone</td>
<td>-do-</td>
<td>2.9</td>
<td>1.724x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>44</td>
<td>4-hydroxy 3, propionyl benzoic acid</td>
<td>-do-</td>
<td>2.2</td>
<td>2.278x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>45</td>
<td>4-hydroxy 3, butyryl benzoic acid</td>
<td>-do-</td>
<td>2.5</td>
<td>2.0x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>46</td>
<td>0-hydroxy propiophenone oxime</td>
<td>Reddish brown</td>
<td>1.0</td>
<td>5.0x10^4</td>
<td>49A, 47A</td>
</tr>
<tr>
<td>47</td>
<td>0-hydroxy butyrophenone oxime</td>
<td>-do-</td>
<td>1.1</td>
<td>4.545x10^4</td>
<td>49A, 47A</td>
</tr>
<tr>
<td>48</td>
<td>2,4 dihydroxy propiophenone oxime</td>
<td>Purple</td>
<td>1.1</td>
<td>4.545x10^4</td>
<td>49A, 46A</td>
</tr>
<tr>
<td>49</td>
<td>2,4 dihydroxy butyrophenone oxime</td>
<td>-do-</td>
<td>1.6</td>
<td>3.123x10^4</td>
<td>49A, 46A</td>
</tr>
<tr>
<td>50</td>
<td>4-hydroxy 3 propionyl oxime benzoic acid</td>
<td>Reddish brown</td>
<td>1.0</td>
<td>5.0x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>51</td>
<td>4-hydroxy 3 butyryl oxime benzoic acid</td>
<td>-do-</td>
<td>1.5</td>
<td>3.33x10^4</td>
<td>49A</td>
</tr>
<tr>
<td>No. of Reagent</td>
<td>Reagent</td>
<td>Colour with Ag⁺ ion</td>
<td>Sensitivity (γ)</td>
<td>Dilution limit</td>
<td>Ref</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Rubeanic acid+Trisodium pentacyanoamino ferrate</td>
<td>Greyish brown</td>
<td>-</td>
<td>-</td>
<td>1A</td>
</tr>
<tr>
<td>2</td>
<td>Arylphosphonic acids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1B</td>
</tr>
<tr>
<td>3</td>
<td>Variamine blue</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2B</td>
</tr>
<tr>
<td>4</td>
<td>Phenothiazine</td>
<td>Green</td>
<td>3</td>
<td>-</td>
<td>16A</td>
</tr>
<tr>
<td>5</td>
<td>6-methoxy:1,2,3,4-tetrahydroquinoline sulfate (Tallin)</td>
<td>Green</td>
<td>3</td>
<td>(1:5000)</td>
<td>18A</td>
</tr>
<tr>
<td>6</td>
<td>β-naphthyl sulfide + NH₄OH</td>
<td>Greenish yellow</td>
<td>-</td>
<td>-</td>
<td>21A</td>
</tr>
<tr>
<td>7</td>
<td>Hemipyocyanine</td>
<td>Blue</td>
<td>-</td>
<td>-</td>
<td>3B</td>
</tr>
<tr>
<td>8</td>
<td>Pyrogallol sulfonaphthalein and its dibromo derivatives</td>
<td>Gold yellow</td>
<td>4.7-5.7</td>
<td>-</td>
<td>4B</td>
</tr>
<tr>
<td>9</td>
<td>1-thiocyanato-2,4-dinitrobenzene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6B</td>
</tr>
<tr>
<td>10</td>
<td>Dihydroxymaleic acid (0.01N) pyrrolidine der.</td>
<td>Darkens</td>
<td>0.1-2</td>
<td>-</td>
<td>7B</td>
</tr>
<tr>
<td>11</td>
<td>Rhodanines</td>
<td>-</td>
<td>&lt; 1</td>
<td>-</td>
<td>8B</td>
</tr>
<tr>
<td>12</td>
<td>Formylcarboxylic acid</td>
<td>Red</td>
<td>230</td>
<td>1:136,000</td>
<td>10B</td>
</tr>
<tr>
<td>13</td>
<td>p-Dimethylaminobenzylidenene thiobarbituric acid and its derivatives</td>
<td>Reddish</td>
<td>0.02</td>
<td>1:5000,000</td>
<td>11B</td>
</tr>
<tr>
<td>14</td>
<td>Trithiobarbituric acid</td>
<td>-</td>
<td>-</td>
<td>1:20,000,000</td>
<td>12B</td>
</tr>
<tr>
<td>15</td>
<td>Wolcin</td>
<td>-</td>
<td>8.5</td>
<td>-</td>
<td>13B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>16</td>
<td>Na-rhodizonate</td>
<td>-</td>
<td>12</td>
<td>-</td>
<td>13B</td>
</tr>
<tr>
<td>17</td>
<td>1 drop of FeSO₄ + 1-2 drops of complexon III</td>
<td>Black or Grey</td>
<td>-</td>
<td>-</td>
<td>14B</td>
</tr>
<tr>
<td>18</td>
<td>Thioanilide</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15B</td>
</tr>
<tr>
<td>19</td>
<td>N phenylthioglycolamide</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15B</td>
</tr>
<tr>
<td>20</td>
<td>O-aminobenzoic acid, and its bromo derivative</td>
<td>Reddish brown or dark yellow</td>
<td>1</td>
<td>1:50000</td>
<td>16B, 27B</td>
</tr>
<tr>
<td>21</td>
<td>4-hydroxybenzothiazole</td>
<td>Blue-green fluorescence</td>
<td>-</td>
<td>-</td>
<td>17B</td>
</tr>
<tr>
<td>22</td>
<td>5-p-tolylazo-8-quinolinol</td>
<td>Reddish brown</td>
<td>8</td>
<td>1:6250</td>
<td>18B</td>
</tr>
<tr>
<td>23</td>
<td>Biphenyldiazobis-(8-quinolinol)</td>
<td>darkviolet</td>
<td>12</td>
<td>1:4200</td>
<td>18B</td>
</tr>
<tr>
<td>24</td>
<td>5-(p-ethoxy-phenylazo) 8-quinolinol</td>
<td>Violet-Brown</td>
<td>10</td>
<td>1:5000</td>
<td>18B</td>
</tr>
<tr>
<td>25</td>
<td>Manganese chloride</td>
<td>-</td>
<td>0.04</td>
<td>-</td>
<td>19B</td>
</tr>
<tr>
<td>26</td>
<td>Chromotropic acid</td>
<td>White ppt., which darkens rapidly</td>
<td>-</td>
<td>-</td>
<td>24B</td>
</tr>
<tr>
<td>27</td>
<td>Cupric thiocyanate</td>
<td>Brownish gray</td>
<td>-</td>
<td>-</td>
<td>25B</td>
</tr>
<tr>
<td>28</td>
<td>Benzopurpurin 4B</td>
<td>Brown ring outside the inner redspot</td>
<td>30</td>
<td>-</td>
<td>26B</td>
</tr>
<tr>
<td>29</td>
<td>EDTA</td>
<td>Green-fluorescence</td>
<td>0.1</td>
<td>1:10500</td>
<td>28B</td>
</tr>
<tr>
<td>30</td>
<td>Potassium guaiacol sulfonate</td>
<td>Gray black</td>
<td>0.2</td>
<td>-</td>
<td>29B</td>
</tr>
<tr>
<td>31</td>
<td>AS₂S₃</td>
<td>Black brown stain or ring</td>
<td>-</td>
<td>1:300,000</td>
<td>30B</td>
</tr>
<tr>
<td>32</td>
<td>ZnS</td>
<td>-</td>
<td>-</td>
<td>1:30,000, 1:50,000</td>
<td>31B</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>33</td>
<td>2,2'-bibenzothiazoline</td>
<td>Red-brown ppt.</td>
<td>2</td>
<td>-</td>
<td>32B</td>
</tr>
<tr>
<td>34</td>
<td>Zolon red</td>
<td>Deep blue</td>
<td></td>
<td>1:60000</td>
<td>33B</td>
</tr>
<tr>
<td>35</td>
<td>1 drop of 1% K₄Fe(CN)₆ soln. + 1 drop of Na(NH₃)₂ +1 drop of 1% alcoholic 2,2'-dipyridyl soln. + 1 drop of test soln.</td>
<td>Red</td>
<td>2</td>
<td>-</td>
<td>34B</td>
</tr>
<tr>
<td>36</td>
<td>Ni dimethyl glyoxime + KCN (0.4%)</td>
<td>Red</td>
<td>-</td>
<td>1:100,000</td>
<td>35B</td>
</tr>
<tr>
<td>37</td>
<td>1 drop of aq. K₄Fe(CN)₆, 1 drop of mixt. of satd. aq. soln. of nitrosobenzene + acetate buffer of pH 3.5 + 1 drop of sample solution</td>
<td>Deep pink</td>
<td>0.11</td>
<td>-</td>
<td>36B</td>
</tr>
<tr>
<td>38</td>
<td>Phenylhydrazine</td>
<td>Black gray</td>
<td>0.5</td>
<td>-</td>
<td>42A</td>
</tr>
</tbody>
</table>
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