All components are intended for educational research only. They are not to be used for diagnostic or drug purposes, nor administered to or consumed by humans or animals.
None of the experiment components have been prepared from human sources.

### Major Section Headings

<table>
<thead>
<tr>
<th>Experiment Components</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>2</td>
</tr>
<tr>
<td>Background Information</td>
<td>3</td>
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<td>Experimental Procedures</td>
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<td>8</td>
</tr>
</tbody>
</table>

Instructor’s Guide
- Pre-Lab Preparations | 9
- Expected Results     | 10
- Answers to Study Questions | 10
- Material Safety Data Sheets | 11

### Experiment Components

- **Storage:** Entire experiment can be stored in the refrigerator.

All components of this experiment are intended for educational research only. They are not to be used for diagnostic or drug purposes, nor administered to or consumed by humans or animals.

This experiment provides enough reagents for 4 experiment sets, for a total of 8 separations.

- **Dyes:**
  - A Brilliant Blue
  - B Blue-Red
  - C Yellow
  - D Light Blue
  - E Mixture of A-D

- **Solvents:**
  - F Aqueous potassium acetate (10x concentrate)
  - G Aqueous sodium citrate:isopropanol

- 1 10 x 20 cm thin layer, cellulose based plate
- 20 5 microliter glass capillary pipets

### Requirements

- 250 ml beakers (6 to 7 cm in diameter)
- Metric rulers
- Pencils
- 5 or 10 ml pipets
- Pipet pumps
Principles and Practice of Thin Layer Chromatography

Thin layer chromatography (TLC) is an invaluable method used in chemistry and biochemistry for the separation and analysis of a wide variety of molecular mixtures. TLC methods can be used to separate mixtures of inorganic ions, organic molecules and biorganic compounds such as pigments, lipids, amino acids, nucleotides and sugars. The TLC plate typically consists of a 0.1 mm thick layer of adsorbent material bonded to a glass or plastic support. The adsorbent consists of many microscopic plates. These surfaces provide a large area for chromatographic separation. After a small volume of sample solution is applied to the adsorbent surface and allowed to dry, the plate is placed in a beaker or tank containing the appropriate solvent. Only the edge of the plate nearest the samples is in contact with the solvent. The solvent is drawn into the dry adsorbent material and travels up the plate through the samples. The migration rate of the sample components over the adsorbent depends on their chemical structure.

An understanding of TLC requires an introduction and the general principles by which they work. Adsorption chromatography was discovered by the botanist Tswett in 1903. He observed that ether solutions of plant pigments, such as the chlorophylls, could be separated into different colored zones by passing them through a column containing calcium carbonate. Significant development of adsorption chromatography occurred in the early 1930’s when it was used in the preparative chemistry of pigments. During this period, preparative separation of colorless organic compounds was accomplished with the advent of the appropriate chemical detection methods. Silica gels and paper strips were used in the 1940’s for the separation of water soluble substances, such as amino acids and sugars. Other common adsorption chromatography materials include magnesium carbonate, magnesium silicate, alumina and activated charcoal. Most adsorption materials can have surface charges. Substances that are adsorbed to these materials are polar or polarizable molecules. An example of a polar molecule is water.

As shown in Figure 1, the molecule has no net charge. The oxygen atom has slightly more negative charge than the hydrogen atoms, which consequently have slightly more positive charge. This is because the oxygen nucleus attracts the negatively charged electrons in the chemical bonds more strongly than the hydrogen nuclei. Therefore, even though the water molecule is overall electrically neutral, its individual atoms do possess partial negative or positive charge. Molecules that exhibit these properties are called polar. Molecules that contain opposite charges, or partial opposite charges, possess a dipole. The adsorbent material has many polar and fully charged (ionic) chemical groups.

![Figure 1](image_url)
on its surface. Polar sample molecules can interact with these groups by dipole-dipole and dipole-ion interactions. These interactions basically involve the attraction between regions with opposite charges. Such interactions are shown in Figure 2.

Many types of molecules can have a net positive or negative charge. Charged sample molecules interact with the adsorption surface by the same chemical forces discussed. TLC plates can also be prepared to contain a large amount of chemical groups with net positive or negative charges on the surface. Charged sample molecules can be efficiently separated on these plates with solvents having the appropriate pH and salt concentrations. This type of TLC is called ion exchange and involves the interaction of compounds with opposite net charges. Ion-exchange TLC typically involves stronger interactions than adsorption TLC.

TLC is generally very sensitive to small differences in chemical structure. The structure affects the strength and type of interactions between sample and adsorbent. In addition, different sample molecules will have different solubilities in a given solvent. Differences in solubility are also dependent upon chemical structure. The composition of the solvent can easily be varied to provide a virtually unlimited set of conditions for chromatography. For example, aqueous sodium citrate:isopropanol (solvent G) is less polar than aqueous potassium acetate (solvent F) since it contains isopropanol and less water. Isopropanol is much less polar than water. The dyes in this experiment migrate differently on the same kind of TLC plate depending on whether solvent G or F is used.

Solubility differences exhibited by sample molecules between two liquid phases is the basis of partition chromatography. The most obvious example of a two-phase liquid system is oil and water. In partition TLC the solvent is called the mobile phase. The liquid that is associated with the surface of the TLC plate is called the stationary phase. The stationary phase consists of molecular layers of fluid on the surface of the TLC plate.
BACKGROUND INFORMATION

Sample molecules will have a preferred distribution between the stationary and mobile phases depending on their structure. Samples that have little or no solubility in the mobile phase and high solubility in the stationary phase will migrate slowly. Conversely, samples that have little solubility in the stationary phase but are highly soluble in the mobile phase will have the fastest migration rates.

An example of the partition process is chromatography on paper or on cellulose TLC plates. The stationary phase consists of the water molecules hydrating the cellulose fibers (cellulose is a polymer of glucose). This hydration water does not behave like the “free” liquid and is roughly analogous to a very concentrated aqueous solution of a sugar or polysaccharide, i.e., gel-like. In practice, both partition and adsorption processes operate simultaneously, to different degrees, in the same TLC experiment. For instance, certain sample molecules could interact directly with the cellulose fibers which would involve an adsorption process.

In this experiment, a mixture of dyes will be separated on a cellulose-based TLC plate using two different solvent systems. The solvent should be allowed to develop about half the distance of the plate. The dye molecules contain different types and amounts of charged and polar chemical groups. They also differ from one another with respect to their molecular weights, geometry and the positions and numbers of carbon-carbon double bonds.

After the experiment is completed and the plate is partially dry, a faint wavy line can be observed at the last location of the leading edge of the solvent in the adsorbent. This line is called the solvent front. The distance traveled by the sample from its origin divided by the distance of the solvent front from the sample origin is defined as the RF. A substance that does not migrate from the sample origin has an RF = 0, while one that is not adsorbed at all (migrated with the front) has a RF = 1. The RF is a characteristic value for a particular substance chromatographed with a given adsorbent and solvent system. The RF cannot be greater than one (1.0).
EXPERIMENTAL PROCEDURES

EXPERIMENT OBJECTIVE

To gain a basic understanding of chromatographic theory and methods through the use of thin layer chromatography to achieve the separation of a mixture of dyes.

LABORATORY SAFETY

Gloves and safety goggles should be worn routinely as good laboratory practice.

General Instructions for Applying Dye to the Thin Layer Plate

1. Use a fresh or rinsed capillary pipet for each dye stock. Each graduation mark on the pipet corresponds to 1 microliter. The total calibrated volume is 5 microliters.

2. Tap each tube of dye to dislodge any fluid from inside the cap.

3. Place the end of the capillary pipet nearest a graduation mark just below the surface of the dye in the microtest tube. Allow the liquid to reach the second or third graduation mark and then withdraw the pipet from the tube.

4. To apply the dye to the thin layer plate:
   - Hold the pipet vertically and touch the end to the sample origin line on the adsorbent thin layer plate until the level of dye has dropped to the next graduation mark.
   - Quickly lift the pipet away from the adsorbent plate.

APPLICATION OF DYES TO PLATE F AND G

1. Obtain two thin layer plates. At the top (edge opposite the sample origin line), label one plate F and the second plate G.

2. For each plate:
   - Start the application of dyes with Brilliant Blue (A) towards the left side of the plate. Apply 1 microliter to each plate
   - Using a fresh or rinsed pipet, apply 1 microliter of Blue-Red (B) to the right of dye A on both plates. Leave a small space between the samples.
EXPERIMENTAL PROCEDURES

Student Experimental Procedures, continued

4. Apply 1 microliter of Yellow (C) to the right of dye B on both plates.

5. Apply 1 microliter of Light Blue (D) to the right of dye C on both plates.

6. Apply 1 microliter of the mixture (E) to the right of dye D on both plates.

7. Let the sample spots dry for 5 minutes.

CHROMATOGRAPHY

8. Place the bottom edge of plate F (edge nearest sample origin line) into a beaker containing aqueous potassium acetate (solvent F).

   It is important that the level of the solvent is lower than the sample origin. Stand the plate straight up using the wall of the beaker as a support.

9. In the same manner, place plate G into a beaker containing aqueous sodium citrate:isopropanol (solvent G).

10. Let the plates stand in solvent for approximately 12 minutes.

    The solvent front should not reach the top of the plates in this time.

11. Before the solvent front reaches the top edge, remove the plates and lay them flat (adsorbent side up) on a paper towel to dry.

12. Calculate the \( R_F \) of samples A - D on both plates:

   • In millimeters, measure the distances from the sample origin to the approximate center of each spot. This may be more difficult with dye D.

   • The \( R_F \) is the distance traveled by the sample from its origin, divided by the distance of the solvent front from the origin. The \( R_F \) cannot be greater than 1.

\[
R_F = \frac{\text{Distance traveled by sample}}{\text{Distance traveled by front}}
\]
Study Questions

1. Are the $R_f$ values of the dyes the same in solvent F and solvent G?

2. Assume that partition chromatography was only operating during the experiment. Which dyes were more soluble in solvent F? Which dyes were more soluble in solvent G?

3. Assume that only adsorption chromatography was operating during the experiment. Which dye was adsorbed most strongly in solvent F? Which dye was least absorbed in solvent F?

4. Assume that a solvent having more isopropanol than solvent G was used in the experiment. Predict whether dye A would migrate a smaller or larger distance in this solvent than in solvent F or G. Why?

5. TLC can be one of several methods used to help identify an unknown compound. Explain how this might be accomplished using the dyes as an example.
GENERAL INFORMATION

PREPARATION OF THIN LAYER PLATES

1. Handle the plate by its edges. Divide the plate into eight (8) 5 x 5 cm squares by lightly drawing a line using a blunt pencil and the straight edge of a ruler on the cellulose adsorbent.

2. Carefully cut the plate into 8 pieces with a sharp pair of scissors. Do not use a paper cutter. You will need two pieces for each experiment set.

3. Measure 1 cm up from an edge on each piece and lightly draw a straight line across using a pencil. Do not press hard, otherwise you will scrape the cellulose off of its support. This line will be the sample origin.

PREPARATION OF SOLVENTS

(to be prepared just before the lab)

1. The Aqueous potassium acetate (Solvent F) is a 10x concentrate. Add 1 ml for every 9 ml of distilled water.

2. Aqueous sodium citrate:isopropanol (Solvent G) is used undiluted.

3. For each group performing the experiment, label two beakers - one 250 ml beaker “F” and another “G”.

4. Add approximately 4 ml of diluted Aqueous potassium acetate (F) to each beaker F (or just enough fluid to cover the bottom).

5. Add approximately 4 ml of Aqueous sodium citrate:isopropanol (G) to each beaker G.

PREPARATION OF DYES

(to be prepared just before the lab)

1. Add 150 µl distilled water to each tube of dye (components A-E). Allow sample to hydrate for 5 minutes. Use a vortex to mix the samples or tap them with your finger to mix until the color of each dye has been evenly distributed.

2. Dyes can be aliquoted, 15 µl each sample per tube for 4 or 8 groups.
Please refer to the kit insert for the Answers to Study Questions
## Section I - Hazardous Ingredients/Identify Information

**Identity** (As Used on Label and List)

| Blue-Red |

<p>| Section II - Hazardous Ingredients/Identify Information |</p>
<table>
<thead>
<tr>
<th>Hazardous Components</th>
<th>Specific Identity; Common Name(s)</th>
<th>OSHA PEL</th>
<th>ACGIH TLV</th>
<th>Recommended % (Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol (Methyl Alcohol)</td>
<td>200ppm</td>
<td>No data</td>
<td>90-100%</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

### Section II - Physical/Chemical Characteristics

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>No data</td>
</tr>
<tr>
<td>Vapor Pressure (mm Hg)</td>
<td>No data</td>
</tr>
<tr>
<td>Vapor Density (Air = 1)</td>
<td>No data</td>
</tr>
<tr>
<td>Solubility in Water</td>
<td>Soluble</td>
</tr>
<tr>
<td>Appearance and Odor</td>
<td>Blue liquid, no odor</td>
</tr>
</tbody>
</table>

### Section IV - Physical/Chemical Characteristics

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point (Method Used)</td>
<td>No data</td>
</tr>
<tr>
<td>Extinguishing Media</td>
<td>Dry chemical, carbon dioxide, water spray or foam</td>
</tr>
<tr>
<td>Special Fire Fighting Procedures</td>
<td>Use agents suitable for type of surrounding fire. Keep upwind, avoid breathing hazardous sulfur oxides and bromides. Wear SCBA.</td>
</tr>
<tr>
<td>Soluble in Water</td>
<td>Complete (100%)</td>
</tr>
<tr>
<td>Appearance and Odor</td>
<td>Blue liquid/alcoholic, pungent odor</td>
</tr>
</tbody>
</table>

## Section V - Reactivity Data

<table>
<thead>
<tr>
<th>Stability</th>
<th>Conditions to Avoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable</td>
<td>Heat, flame, other sources of ignition</td>
</tr>
</tbody>
</table>

### Section VI - Health Hazard Data

**Route(s) of Entry:** Inhalation?

<table>
<thead>
<tr>
<th>Ingestion?</th>
<th>Irritation?</th>
<th>Combustion?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
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<td>Yes</td>
</tr>
</tbody>
</table>

**Health Hazards (Acute and Chronic):** Chronic kidney damage, liver damage

**Carcinogenicity:** NTP? IARC Monographs? OSHA Regulation?

<table>
<thead>
<tr>
<th>NTP</th>
<th>IARC Monographs</th>
<th>OSHA Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
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<td>No</td>
</tr>
</tbody>
</table>

**Medical Conditions Generally Aggravated by Exposure:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin disorders, skin disorders, skin disorders</td>
<td>Exposure</td>
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**Emergency First Aid Procedures:**

- Avoid eye and skin contact

## Section VII - Control Measures

### Respiratory Protection (Specify Type)

<table>
<thead>
<tr>
<th>Respiratory Protection</th>
<th>NIOSH/MSHA approved</th>
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<tbody>
<tr>
<td>Mechanical (General)</td>
<td>None</td>
</tr>
</tbody>
</table>

### Eye Protection

<table>
<thead>
<tr>
<th>Eye Protection</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splash-proof goggles</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Other Protective Clothing or Equipment

<table>
<thead>
<tr>
<th>PPE</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face shield, uniform, protective suit</td>
<td>No</td>
</tr>
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</table>

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**Material Safety Data Sheet**

May be used to comply with OSHA's Hazard Communication Standard: 29 CFR 1910.1200 Standard must be consulted for specific requirements.

**Identity** (As Used on Label and List)

| Blue-Red |

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<td>65°C</td>
</tr>
<tr>
<td>Vapor Pressure (mm Hg)</td>
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<tr>
<td>Vapor Density (Air = 1)</td>
<td>1.11</td>
</tr>
<tr>
<td>Solubility in Water</td>
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<tr>
<td>Flash Point (Method Used)</td>
<td>closed cup 124°C</td>
</tr>
<tr>
<td>Extinguishing Media</td>
<td>Use alcohol foam, dry chemical or carbon dioxide. (Water may be ineffective)</td>
</tr>
<tr>
<td>Special Fire Fighting Procedures</td>
<td>Wear protective gear and SCBA with full facepiece operated in positive pressure mode. Move containers from fire area if possible.</td>
</tr>
<tr>
<td>Soluble in Water</td>
<td>Complete (100%)</td>
</tr>
</tbody>
</table>

## Section VI - Reactivity Data

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### Section VI - Health Hazard Data

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</tbody>
</table>

**Emergency First Aid Procedures:**

- Avoid eye and skin contact

## Section VII - Control Measures

### Respiratory Protection (Specify Type) At concentrations above 200ppm, wear SCBA

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Mechanical (General)</td>
<td>None</td>
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### Eye Protection

<table>
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<tr>
<th>Eye Protection</th>
<th>Required</th>
</tr>
</thead>
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<tr>
<td>Safety goggles</td>
<td>No</td>
</tr>
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</table>

### Other Protective Clothing or Equipment

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</thead>
<tbody>
<tr>
<td>Face shield, uniform, protective suit</td>
<td>No</td>
</tr>
</tbody>
</table>
### Material Safety Data Sheet

**IDENTITY (As Used on Label and List)**

Light Blue

Note: Blank spaces are not permitted. If any item is not applicable, or if no information is available, the space must be marked to indicate that.

### Section I

**Manufacturer's Name**

EDVOTEK, Inc.

**Address**

14676 Rothgeb Drive
Rockville, MD 20850

**Emergency Telephone Number**

(301) 251-5990

**Data Prepared**

11-24-97

**Signature of Preparer (optional)**


### Section II - Hazardous Ingredients/Identify Information

**Hazardous Components (Specify Chemical Identity; Commodity Name(s) OSHA PEL ACGIH TLV Other Limits)**

This product contains no hazardous materials as defined by the OSHA Hazard Communication Standards.

### Section III - Physical/Chemical Characteristics

**Boiling Point**

No data

**Specific Gravity (H₂O = 1)**

No data

**Vapor Pressure (mm Hg.)**

No data

**Vapor Density (AIR = 1)**

No data

**Evaporation Rate**

(Butyl Acetate = 1)

No data

**Solubility in Water**

Soluble

**Appearance and Odor**

Aqua-blue liquid, no odor

### Section IV - Physical/Chemical Characteristics

**Flash Point (Method Used)**

No data

**Flammable Limits**

LEL No data UEL No data

**Extinguishing Media**

Dry chemical, carbon dioxide, water spray or foam

**Special Fire Fighting Procedures**

Move container from fire area. Avoid breathing toxic vapors of carbon and nitrogen oxides upon thermal decomposition. Use agents suitable for type of surrounding fire.

### Section V - Reactivity Data

**Stability**

Unstable

**Conditions to Avoid**

Flammable

**Incompatibility**

Strong oxidizing agents

**Hazardous Decomposition or Byproducts**

Toxic oxides of carbon and nitrogen (thermal decomposition)

### Section VI - Health Hazard Data

**Route(s) of Entry:**

Inhalation? Yes Skin? Yes Ingestion? Yes

**Health Hazards (Acute and Chronic)**

Chem. resistant gloves

**Carcinogenicity:**

NTP? Yes IARC Monographs? No OSHA Regulation? No

**Waste Disposal Method**

Observe all federal, state, and local laws for disposal.

**Emergency First Aid Procedures**

Treat symptomatically and supportively

### Section VII - Precautions for Safe Handling and Use

**Other Precautions**

Prevent skin/eye contact

### Section VIII - Control Measures

**Respiratory Protection (Specify Type)**

NIOSH/MSHA approved respirator

**Ventilation**

Yes

**Route(s) of Entry:**

Inhalation? Yes Skin? Yes Ingestion? Yes

**Medical Conditions Generally Aggravated by Exposure**

None

**Other Protective Clothing or Equipment**

Eye Protection: Splash proof goggles

**Other Protective Clothing or Equipment**

Chem. resistant gloves

**Work/Hygienic Practices**

Avoid contact with eyes, skin, and clothing
Material Safety Data Sheet

IDENTITY (As Used on Label and List)
Aqueous Potassium Acetate (10x)

Section I - Identification Information

Manufacturer's Name
EDVOTEK, Inc.
Address (Number, Street, City, State, Zip Code)
14676 Rothgeb Drive
Rockville, MD 20850

Emergency Telephone Number
(301) 251-5990

Telephone Number for Information
(301) 251-5990

Date Prepared
11-15-97

Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components [Specific Chemical Identity; Common Name(s)]
OSHA PEL ACGIH TLV RACIHM AHF SIC

This material contains no hazardous materials as defined by the OSHA Hazard Communication Standard.

Section III - Physical/Chemical Characteristics

Boiling Point
No data
Specific Gravity (H2O = 1) 1.6
Vapor Pressure (mm Hg.) No data
Melting Point No data
Vapor Density (AIR = 1) No data
Evaporation Rate (Butyl Acetate = 1) No data
Solubility in Water 100% at 20°C
Appearance and Odor Clear liquid, vinegar-like odor

Section IV - Physical/Chemical Characteristics

Flash Point (Method Used) Flammable Limits LEL UEL
Combustible N.D. N.D.

Extinguishing Media Dry chemical, CO2, Alcohol foam, water spray to cool fire exposed containers

Special Fire Fighting Procedures Wear SCBA
Unusual Fire and Explosion Hazards Vapor can travel distances to ignition source and flash back.

Section V - Reactivity Data

Stability Unstable Conditions to Avoid Stable None

Incompatibility None

Hazardous Decomposition or Byproducts Acid smoke

Section VI - Health Hazard Data

Route(s) of Entry:
Inhalation? Yes
Skin? No
Ingestion? Yes

Health Hazards (Acute and Chronic)
Acute inhalation: shortness of breath, increased heart rate, nausea, and vomiting

Carcinogenicity: NTP? Yes IARC Monographs? Yes OSHA Regulation? Yes

Signs and Symptoms of Exposure
Inhalation: shortness of breath, headache, nausea, vomiting
Skin: possible dermatitis

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in case Material is Released for Spilled
Take up spills w/ absorbent material. Do not allow to go into sewer system.

Waste Disposal Method
Follow all federal, state, and local regulations.

Precautions to be Taken in Handling and Storing
Avoid eye contact.

Other Precautions None

Section VIII - Control Measures

Respiratory Protection (Specify Type) Supplied-air respirator
Ventilation Local Exhaust No Special None
Mechanical (General) Gen. dilution veg. Other None

Protective Gloves Yes Eye Protection Splash proof goggles
Other Protective Clothing or Equipment None

Work/Hygienic Practices Prevent eye contact, wear goggles

Material Safety Data Sheet

IDENTITY (As Used on Label and List)
Aqueous Sodium Citrate: Isopropanol

Section I - Identification Information

Manufacturer's Name
EDVOTEK, Inc.
Address (Number, Street, City, State, Zip Code)
14676 Rothgeb Drive
Rockville, MD 20850

Emergency Telephone Number
(301) 251-5990

Telephone Number for Information
(301) 251-5990

Date Prepared
09/16/97

Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components [Specific Chemical Identity; Common Name(s)]
OSHA PEL ACGIH TLV RACIHM AHF SIC

CAS# 67-63-0

Section III - Physical/Chemical Characteristics

Boiling Point
For 1% solution
No data
Specific Gravity (H2O = 1) No data
Vapor Pressure (mm Hg.) No data
Melting Point No data
Vapor Density (AIR = 1) No data
Evaporation Rate (Butyl Acetate = 1) No data
Solubility in Water Miscible
Appearance and Odor Clear, colorless liquid, characteristic odor

Section IV - Physical/Chemical Characteristics

Flash Point (Method Used) Flammable Limits LEL UEL
No data

Extinguishing Media Dry chemical, CO2, Alcohol foam, water spray to cool fire exposed containers

Special Fire Fighting Procedures Wear SCBA and protective clothing to prevent contact with skin and eyes

Unusual Fire and Explosion Hazards Vapor can travel distances to ignition source and flash back.

Section V - Reactivity Data

Stability Unstable Conditions to Avoid Stable None

Incompatibility None

Hazardous Decomposition or Byproducts Carbon Monoxide

Section VI - Health Hazard Data

Route(s) of Entry:
Inhalation? Yes
Skin? Yes
Ingestion? Yes

Health Hazards (Acute and Chronic)
Acute inhalation: tightness in chest, nausea, vomiting

Carcinogenicity: NTP? Yes IARC Monographs? Yes OSHA Regulation? Yes

Signs and Symptoms of Exposure
Inhalation: tightness in chest, nausea, vomiting
Skin: possible dermatitis

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in case Material is Released for Spilled
Take up spill w/ absorbent material. Do not allow to go into sewer system.

Waste Disposal Method
Follow all federal, state, and local regulations.

Precautions to be Taken in Handling and Storing
Keep container closed. Store in cool area away from ignition sources. Do not breathe the vapors.

Other Precautions Electrically ground all equipment when handling.

Section VIII - Control Measures

Respiratory Protection (Specify Type) NIOSH/MSHA approved air supplied respirator
Ventilation Local Exhaust No Special None
Mechanical (General) No Other None

Protective Gloves Butyl rubber, PVC or equivalent Eye Protection Splash proof goggles
Other Protective Clothing or Equipment None

Work/Hygienic Practices Wash thoroughly after handling. Do not take internally.