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STUDY MATERIALS

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APPLICATION OF ANALYTICAL CHEMISTRY

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Study of the Use of Phenolphthalein in Trap Cases

(Forensic Chemistry – Anti-Corruption Investigation)

1.1 Introduction

Phenolphthalein is an organic compound used as an acid–base indicator. In forensic science, it is widely used in trap cases conducted by anti-corruption agencies to detect bribery.

When a bribe is given, currency notes are coated with phenolphthalein powder. Upon contact with sodium carbonate solution, a pink colour appears if the accused has touched the treated notes.

1.2 Chemical Information

- Chemical Name: 3,3-bis(4-hydroxyphenyl)-1(3H)-isobenzofuranone
- Molecular Formula: $C_{20}H_{14}O_4$
- Molecular Weight: 318.32 g/mol
- Nature: Weak organic acid
- Structure: Triphenylmethane derivative

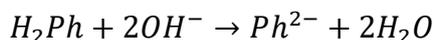
1.3 Acid–Base Behaviour

Phenolphthalein is:

- Colourless in acidic medium
- Pink in alkaline medium (pH 8.2–10)
- Colourless again in very strong alkali

Ionization Reaction:

In alkaline medium:



The pink colour is due to formation of the quinonoid ion structure.

1.4 Principle of Trap Case Detection

1. Currency notes are dusted with phenolphthalein powder.
2. The accused handles the notes.
3. Hand wash of the accused is taken in sodium carbonate solution.

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4. Appearance of pink colour confirms contact.

Reaction:

Phenolphthalein + Na_2CO_3 (alkaline medium) \rightarrow Pink coloured solution

1.5 Experimental Procedure

1. Prepare 2% sodium carbonate solution.
2. Collect hand wash of accused in clean glass beaker.
3. Add Na_2CO_3 solution.
4. Observe colour change.
5. Preserve solution as evidence.

1.6 Forensic Significance

- Used in anti-corruption bureau operations.
- Provides chemical evidence in court.
- Simple, rapid, and reliable test.

1.7 Limitations

- False positives if hands contaminated with alkaline substances.
- Must be properly documented.
- Only proves contact, not intent.

2 Analysis of Arson Accelerants

(Forensic Chemistry – Fire Investigation)

2.1 Introduction

Arson is deliberate setting of fire. Accelerants are flammable liquids used to start or spread fire rapidly.

Common accelerants:

- Gasoline
- Kerosene
- Diesel
- Alcohol/Paint thinners

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2.2 Chemical Nature of Accelerants

Most accelerants are:

- Volatile organic compounds (VOCs)
- Hydrocarbon mixtures
- Petroleum distillates

2.3 Evidence Collection

- Fire debris samples collected in airtight metal cans.
- Avoid contamination.
- Store at low temperature.

2.4 Extraction Techniques

1. Headspace Analysis

- Heat sample.
- Vapours collected for analysis.

2. Solvent Extraction

- Use organic solvent (e.g., pentane).
- Extract accelerant residues.

3. Solid Phase Microextraction (SPME)

- Fibre absorbs volatile compounds.
- Directly injected into GC.

2.5 Analytical Techniques

 Gas Chromatography (GC)

Most important method.

Separates hydrocarbons based on boiling point.

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GC-MS (Gas Chromatography–Mass Spectrometry)

- Identifies specific hydrocarbon patterns.
- Produces chromatogram.
- Compares with reference standards.

2.6 Interpretation

- Gasoline shows characteristic pattern of:
 - Toluene
 - Xylene
 - Ethylbenzene
 - Trimethylbenzene

Comparison with control sample confirms presence.

2.7 Challenges

- Evaporation during fire.
- Interference from pyrolysis products.
- Weather contamination.

2.8 Forensic Importance

- Confirms use of accelerant.
- Helps determine origin of fire.
- Used as court evidence.

3 Analysis of Gasoline

(Petroleum & Forensic Chemistry)

3.1 Introduction

Gasoline (petrol) is a volatile petroleum fraction used as fuel in internal combustion engines.

Boiling range: 30°C – 200°C

Main components: C₄ – C₁₂ hydrocarbons

3.2 Composition

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Gasoline contains:

- Paraffins (alkanes)
- Isoparaffins
- Olefins
- Aromatics
- Naphthenes

Additives:

- Ethanol
- Anti-knock agents
- Detergents

3.3 Physical Properties

- Colour: Pale yellow
- Highly volatile
- Low flash point (-40°C approx.)
- Density: ~0.71–0.77 g/cm³

3.4 Analytical Methods

1. Distillation Test

Determines:

- Boiling range
- Volatility profile

2. Octane Number Determination

- Research Octane Number (RON)
- Motor Octane Number (MON)

Measures anti-knock quality.

3. Gas Chromatography

- Separates hydrocarbon components.
- Detects adulteration.

4. Spectroscopic Methods

- FTIR for functional groups.
- UV for aromatic content.

3.5 Detection of Adulteration

Common adulterants:

Quantitative Estimations of a Given Organic Sample

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- Kerosene
- Solvents

Methods:

- Density measurement
- GC comparison
- Distillation curve analysis

3.6 Environmental Impact

- VOC emission
- Air pollution
- Benzene toxicity

3.7 Forensic Relevance

- Used in arson investigation.
- Comparison of crime scene sample with suspect sample.
- Source identification.

Comparison of Three Topics

| Topic | Field | Main Technique | Application |
|-------------------|------------------------|--------------------|-------------------------|
| Phenolphthalein | Forensic Chemistry | Acid-base reaction | Trap cases |
| Arson Accelerants | Forensic Investigation | GC-MS | Fire origin |
| Gasoline Analysis | Petroleum Chemistry | GC, Distillation | Fuel quality & forensic |