PENNSTATE

Cosmetic Chemistry

A Lesson on the Science and Art of Perfumery

Since the Dawn of Time…

Perfumery is the earliest form of chemistry in history. In fact, the world's first ever chemist was a female perfumer named Tapputi of Mesopotamia. Perfume has played an important role in countless cultures since 1000 BC. Stories told in ancient texts and wall paintings show us that perfume was first used by the Egyptians as part of religious ceremonies to please the gods and ward off evil spirits. As time went on, perfumes were used by the wealthy for personal care purposes, home fragrances, and as a means to cover up the stench of illness or of city living. Over the centuries, fragrances have become a multi-billion dollar industry, accessible to everyone, and with applications in cosmetics, personal care, home fragrances, medical treatment, and even the food and beverage industry.

Where Do Fragrance Oils Come From?

Perfume is a mixture of fragrant essential oils and solvents. The component of the perfume that provides the characteristic scent is extracted from natural plant or animal sources or can be made by chemists in the lab. To make the earliest fragrances, the Egyptians used the ancient method of "pressing" – literally squeezing fragrant oils from flowers and other plants, then mixing it with animal fat or other oils. Extraction methods have advanced over the centuries, providing scientists with efficient means of harvesting the "smell" from nature. Other than extraction, chemists can also create hundreds of different fragrance oils though synthetic formulation – mixing various chemicals together to get a specific fragrance.

Fragrance Basics

Perfumes come in many forms; the two most common types are formulated with an alcohol-based or oil-based carrier. The "carrier" is the solvent that the aromatic oils are dissolved in and acts to deliver the oils to the skin. When applied, the carrier evaporates, leaving behind the fragrance oils that give the perfume its characteristic smell. Perfume types reflect the concentration of aromatic compounds in a solvent, which is typically ethanol or a mix of water and ethanol. The more concentrated the fragrance, the longer the scent will last on the skin. The concentration by percent/volume of fragrance oil for the three most common types of perfumes is as follows:

Eau de Parfum (Highest Quality Perfume): 10-20% aromatic compounds
Eau de Toilette (Lower Quality Perfume): 5-15% aromatic compounds
Perfume mist/body spray: 3-8% aromatic compounds

Many times, the aroma of a perfume is a result of not one single fragrance, but a medley of various scents known as "notes". The careful combination of notes leads to a unique fragrance experience dependent upon the evaporation process of the fragrance oils themselves. The notes unfold over time with the immediate impression of the head (top) note, leading to the deeper heart (middle) notes, followed by the lingering scent of the base notes. Head notes are typically bright, fruity scents; heart notes are clean and floral; base notes are deep, warm, and spicy.

The careful combination of head, heart, and base notes is what makes each fragrance a unique and inspired work of art – something you'll get a chance to create today! Use your imagination to create your very own perfume, cologne, or body wash that will have your Valentine's Day crush falling in love.

http://en.wikipedia.org/wiki/Perfume

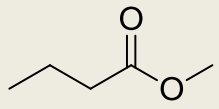
The Chemistry of Fragrance Blends

With the introduction of the organic chemist, the perfume industry moved out of the garden and into the lab. Inspired by nature and dreamed up by creative minds, synthetic molecules allow for longer lasting, more stable fragrances that can be produced in greater quantities. This opened up endless possibilities, creating an art out of perfume design. Much of this art lies in the careful combination of head, heart, and base notes which evaporate off the body at different rates.

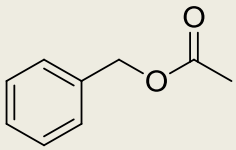
* ***Head notes*** *consist of small, light molecules that evaporate quickly*
* ***Heart notes*** *are medium sized molecules that begin to emerge after much of the head notes have evaporated*
* ***Base notes*** *are large, heavy molecules that take the longest to evaporate, lingering on the skin for many hours*

To understand just how these notes behave and why a certain perfume smells the way it does, we turn to some very simple chemistry. **Evaporation** is the process by which molecules in the liquid phase become gaseous. This phenomenon can be controlled by the attractive forces between the molecules in the liquid known as **intermolecular forces**. The more tightly these molecules cling to each other, the more slowly the liquid will evaporate. Intermolecular forces are largely controlled by the **mass** of the molecule. Big molecules like to stick together and take longer to evaporate than small molecules which can't cling to each other as strongly.

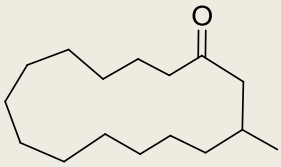
Below are examples of molecules that are commonly used as head, heart, and base notes



Methyl butyrate (apple)
- Head note
- Mass: 102.1 g/mol
- Weakest intermolecular forces
- Shortest evaporation rate



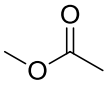
Benzyl acetate (jasmine)
- Heart note
- Mass: 150.2 g/mol
- Medium intermolecular forces
- Medium evaporation rate



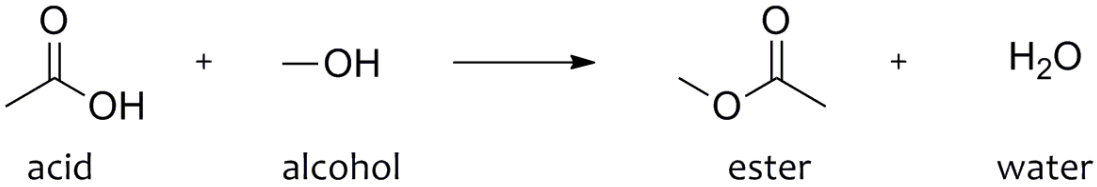
Muscone (musk)
- Base note
- Mass: 238.4 g/mol
- Strongest intermolecular forces
- Longest evaporation rate

Based on the synthetic molecule's intermolecular forces, and therefore evaporation rate, we smell different parts of the perfume at different times. Since head notes evaporate first, we smell them first, followed by the heart notes, then base notes. This is why a perfume's smell can seem to change as the day goes on.

Esters: Molecules that Smell Good!

In the previous examples, you may have noticed this sequence of atoms:  **This grouping of carbon atoms linked to oxygen atoms is known as the ester functionality. Esters are known for their characteristic smells and are frequently formulated in the lab to make the sweet, fruity, and/or flowery notes in our perfume.**

Chemists formulate esters by the reaction of carboxylic acids with alcohols (with water as a byproduct) in a reaction called **esterification**. Below is a general mechanism for making an ester.



By combining different acids and alcohols, various scents can be achieved.

Carboxylic Acid	**Alcohol**	**Scent**
Butyric Acid	Methanol	Pineapple
Butyric Acid	Ethanol	Strawberry
Formic Acid	Isobutanol	Raspberry
Pentanoic Acid	Pentanol	Apple
Acetic Acid	Isopentanol	Pear
Acetic Acid	Octanol	Orange
Acetic Acid	Benzanol	Jasmine

Types of Fragrance Oils

Head Notes	Heart Notes	Base Notes
Apple	Anise	Almond
Bay Rum	Carnation	Aloe Vera
Bergamot	Clove	Amber
Black Cherry	Daffodil	Arabian Sandalwood
Black Tea	Dogwood	Brown Sugar
Blue Berry	Forget-Me-Not	Caramel
Cantaloupe	Frangipani	Cedar
Cassis (Black Currant)	Freesia	Chocolate
Cherry	Geranium	Cinnamon
Citrus	Heather	Columbian Coffee
Coconut	Hibiscus	Dirt
Cranberry	Honeysuckle	Dragon's Blood
Cucumber	Hyacinth	Fern
Fig	Iris	Frakencense
Green Apple	Jasmine	Fresh Cotton
Guava	Lavender	Fresh Cut Grass
HAwiian Rain	Lilac	Heavenly Musk
Honeydew	Lily of the Valley	Honey Almond
Icey Pear	Lotus	Honey
Kiwi	Melissa	Leather
Lemon Verbena	Mimosa	Light Vanilla
Mango	Narcissus	Musk
Melon	Neroli	Myrrh
Peach	Orange Blossom	Nag Champa
Pear	Orchid	New Moon Hay
Pineapple	Papaya	Oak Moss
Pomegranate	Passion Flower	Ocean Sent
Rain	Peony	Patchouli
Raspberry	Pikaki	Powder
Strawberry	Plumera	Root Beer
Tangerine	Rose	Sea Breeze
Watermellon	Sugar	Spicy Vanilla
	Sweet Pea	Vanilla Spice
	Tea Rose	Vanilla Sugar
	Tuberose	Vetiver
	Violet	White Amber
	Water Lily	White Chocolate
	White Ginger	
	Wild Flowers	
	Wisteria	
	Ylang Ylang	

Sensory Lab
Custom Fragrance Activity
Data Sheet

Fragrance # 1 Name _____

Fragrance Oil Name	Type of Note	Number of Drops (total = 20)

Fragrance # 2 Name _____

Fragrance Oil Name	Type of Note	Number of Drops (total = 20)

Fragrance # 3 Name _____

Fragrance Oil Name	Type of Note	Number of Drops (total = 20)

Body Wash Name _____

Fragrance Oil Name	Type of Note	Number of Drops (total = 20)