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VCE Chemistry ½
Properties & Real-Life Use of Organic Chemicals [2.8]
Workbook

Outline:

Learning Objectives:

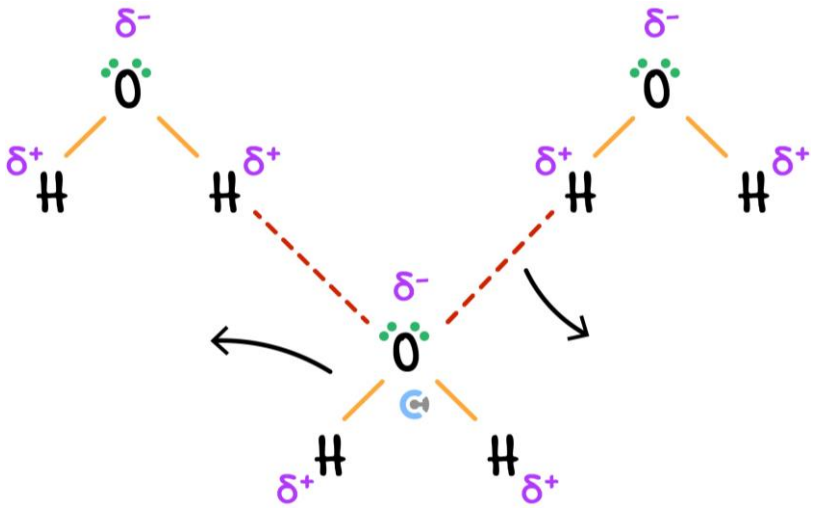
- ☐ **CH12 [2.8.1] -** Identify & Explain Wow Physical Properties of Branched/Unbranched Alkanes, Haloalkanes, Alkenes, Alcohols, Esters & Carboxylic Acids Compare
- ☐ **CH12 [2.8.2] -** Identify & Explain Renewable & Non-renewable Sources of Organic Matter & Their Impacts on Society, & the Limitations of Renewable Feedstocks
- ☐ **CH12 [2.8.3] -** Apply Sources of Organic Matter to Identify Real-life Compounds Used in Society

Section A: Properties of Organic Compounds

Sub-Section: Intermolecular Bonds

What is the difference between intramolecular bonding and intermolecular bonding?

Intramolecular Bonds vs Intermolecular Bonds



Intermolecular Bond	Intramolecular Bond
Happens _____ molecules.	Happens _____ molecules.

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Active Recall: What are the three types of intermolecular bonds? What requirements need to be met for them to form?

Intermolecular Bond	Requirements

Active Recall: Does a substance with stronger intermolecular bonds have a higher or lower melting point? Why?

_____

_____

_____

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REMINDER: Don't forget! Electronegativity Difference for each type of IMB

	Non-Polar Covalent Bond	Polar Covalent Bond	Ionic Bond
Electronegativity Difference	0-0.4	0.4-1.8	> 1.8
Distribution of Electrons	Electrons are shared roughly equally.	Electrons are attracted to the more electronegative atom.	Electrons are completely transferred to the more electronegative atom.
Examples	$F_2, C-H, N_2$	$N-H, O-H, HCl$	$NaCl, MgF_2$

Sample Response: Melting Point

- Substance x has stronger intermolecular bonding.
- More thermal energy is required to vibrate and weaken (for the melting point) / break (for the boiling point) the intermolecular bonds.
- This leads to a higher melting/boiling point.

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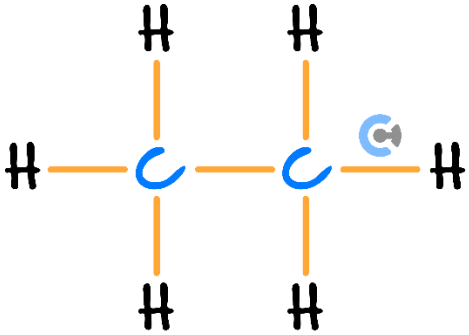
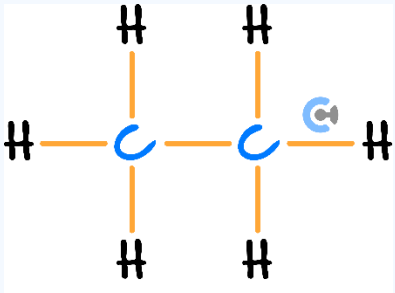
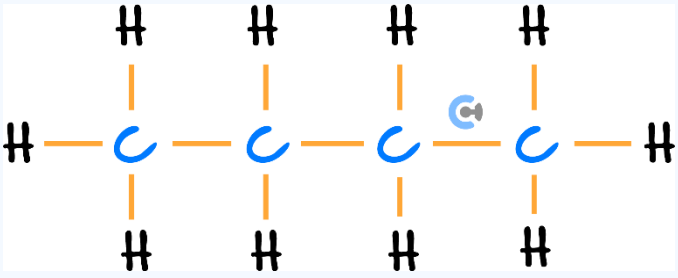
Sub-Section: Hydrocarbons IMB

Exploration: Intermolecular Bonds of Alkanes – Carbon Length

- Consider IMB in **ethane**.

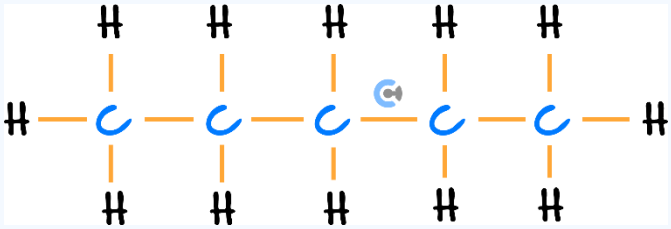
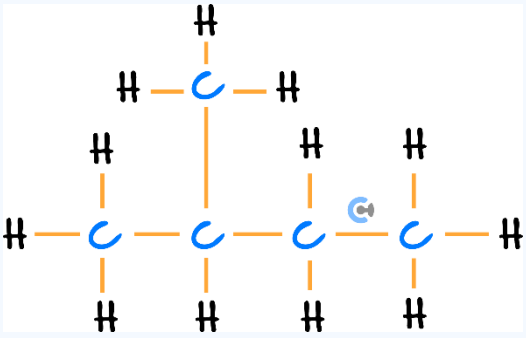


- Electronegativity difference between carbon (C) and hydrogen (H): _____
- Ethane Polarity: [Polar] / [Non-polar]
- Strongest type of intermolecular bond for ethane: _____

Ethane	Butane
	
[Smaller] / [Larger] molecule	[Smaller] / [Larger] molecule
[Stronger] / [Weaker] dispersion forces	[Stronger] / [Weaker] dispersion forces
[Higher] / [Lower] melting point	[Higher] / [Lower] melting point

Discussion: Intermolecular Bonds of Alkanes - Branching

- Compare pentane and methyl butane:

Pentane	Methylbutane
	

- **Larger Molecule:** [Pentane] / [Methyl butane] / [Neither]
- Which molecule has stronger intermolecular bonds, and thus a higher melting point?

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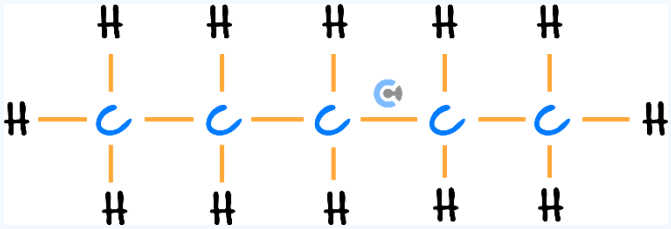
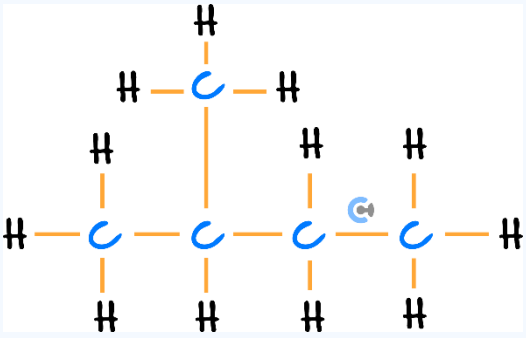
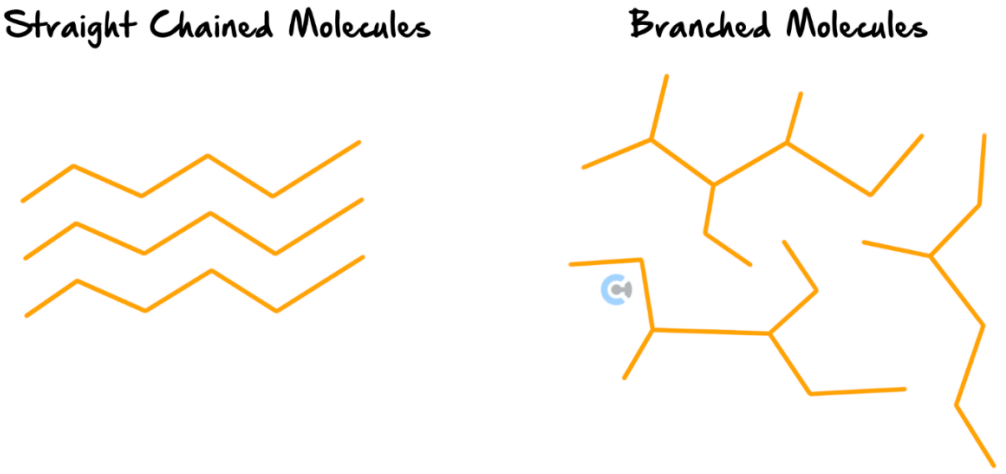
Exploration: Intermolecular Bonds of Alkanes - Branching

- Consider pentane and methyl butane:

Pentane	Methylbutane
	



- **Branched Molecule:** The **side chains prevent** the molecules from **packing** _____ **together**.
- **Conclusion**: branched molecules have [stronger] / [weaker] dispersion forces
- Substance with stronger intermolecular bonds: [Straight-chained] / [Branched]

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Analogy: Clothes

- Imagine having straight, folded clothes vs messy, unfolded clothes:

- Which one is able to pack closer together? [Straight & folded] / [Messy & branched]

Hydrocarbon difference in IMB

Length of Carbon Chain	Branching
Stronger IMB: [Shorter] / [Longer] carbon chains	**Stronger IMB:** [Straight-chained] / [Branched]
Reasoning: Has greater _____.	**Reasoning:** Can pack more _____.

Space for Personal Notes

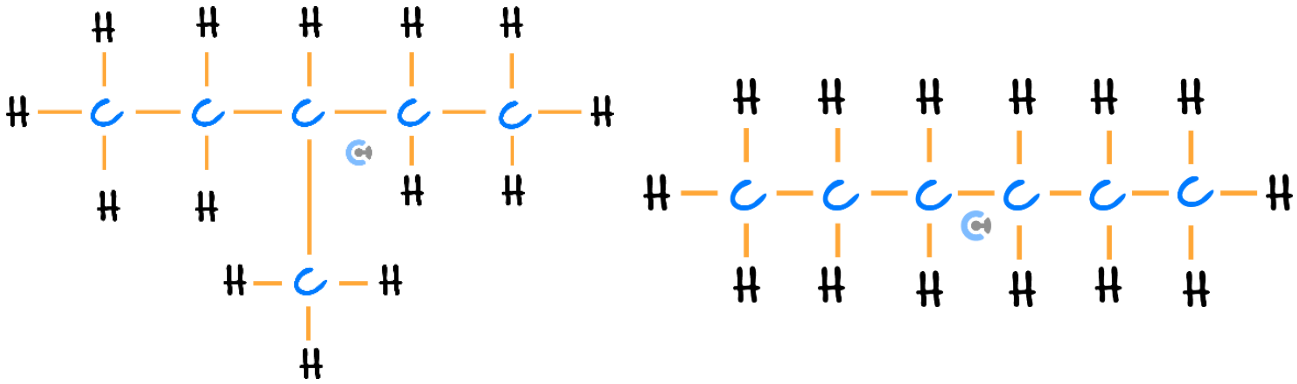
Try some questions!

Question 1

In the following scenario:

i. Circle which molecule has a **lower** melting point.

ii. Write the main reason (in 1-3 words) as to why the chosen molecule has a lower melting point.



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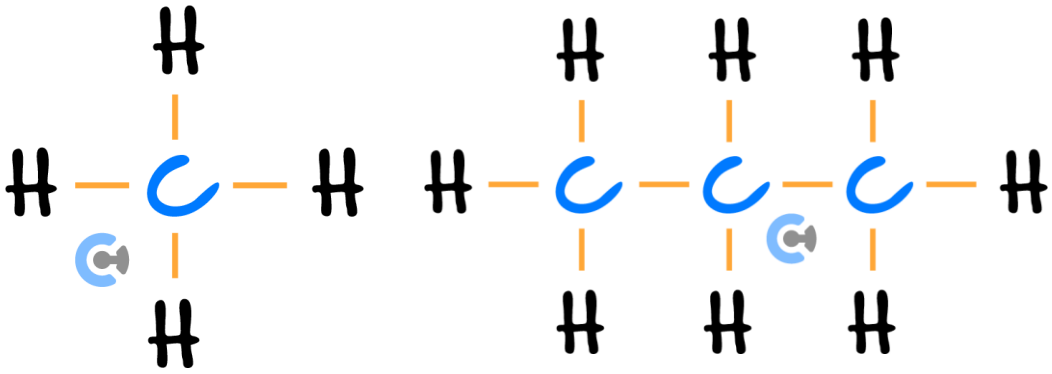
Question 2

In each scenario,:

i. Circle which molecule has a **higher** melting point.

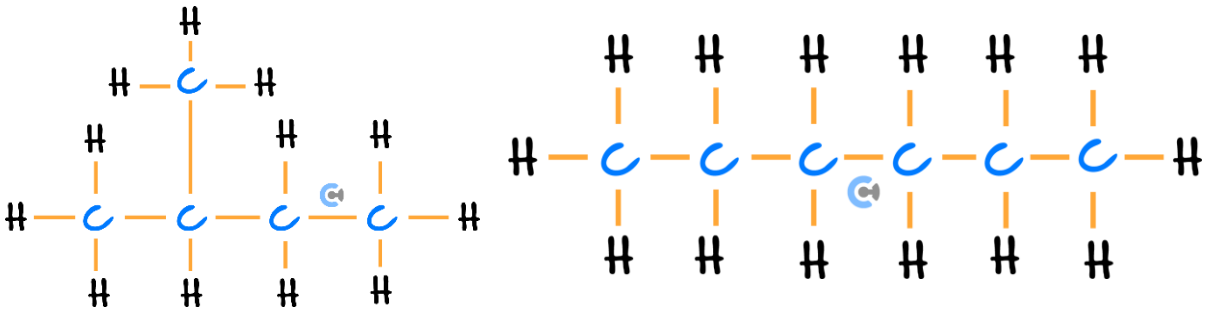
ii. Write the main reason (in 1-3 words) as to why the chosen molecule has a higher melting point.

a.



_____

b.



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Sub-Section: Writing Explanations

Let's look at a question together!

Question 3 (2 marks) **Walkthrough.**

Explain whether ethane or butane has a higher boiling point.

_____

_____

_____

_____

_____

Sample Response: Linking Branching to Melting / Boiling Point

- Substance x has stronger intermolecular bonding - It is straight-chained and can pack closer together.
- Substance y has side chains (e.g. methyl, ethyl etc) which prevent the molecule from packing closely together, thereby weakening the strength of the dispersion forces.
- **Less thermal energy** is required to **vibrate and break the intermolecular bonds**, thereby leading to a **lower melting point** in substances with **side chains**.

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Your Turn!

Question 4

Explain whether octane or 3-ethyl-2,4-dimethylpentane has a greater melting point.

Question 5 Additional Question.

Explain whether octane or ethane has a greater melting point.

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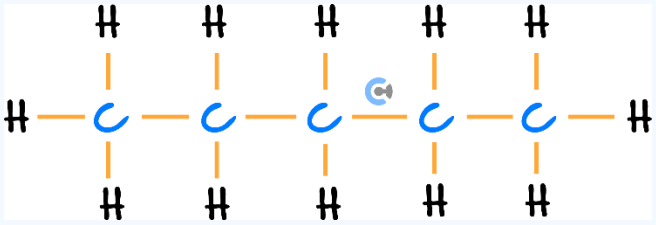
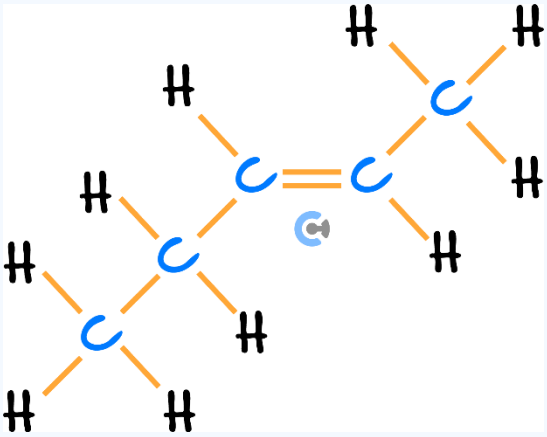
Discussion: Alkanes vs Alkenes

- Does pentane, or pent-2-ene have stronger intermolecular bonding?

Pentane	Pent-2-ene
	
C_5H_{12}	C_5H_{10}

Misconception

"Because pent-2-ene has a C=C double bond, it has stronger intermolecular bonding!"

TRUTH: A C=C bond is an intramolecular bond, and is irrelevant to intermolecular bonding!

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Sub-Section: Alkanes vs Alkenes

Saturated vs Unsaturated

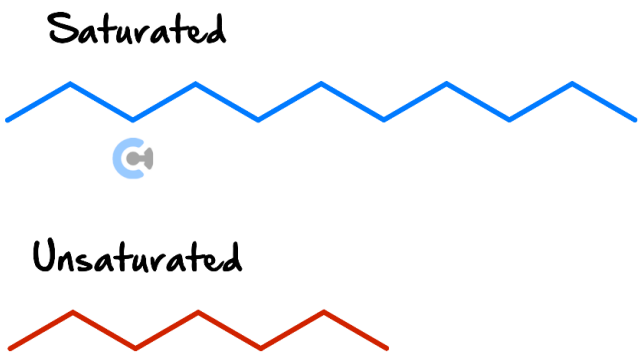
- Saturated vs Unsaturated is an **alternative** way to label alkanes and alkenes

Saturated	Unsaturated
[Alkane] / [Alkene]	[Alkane] / [Alkene]

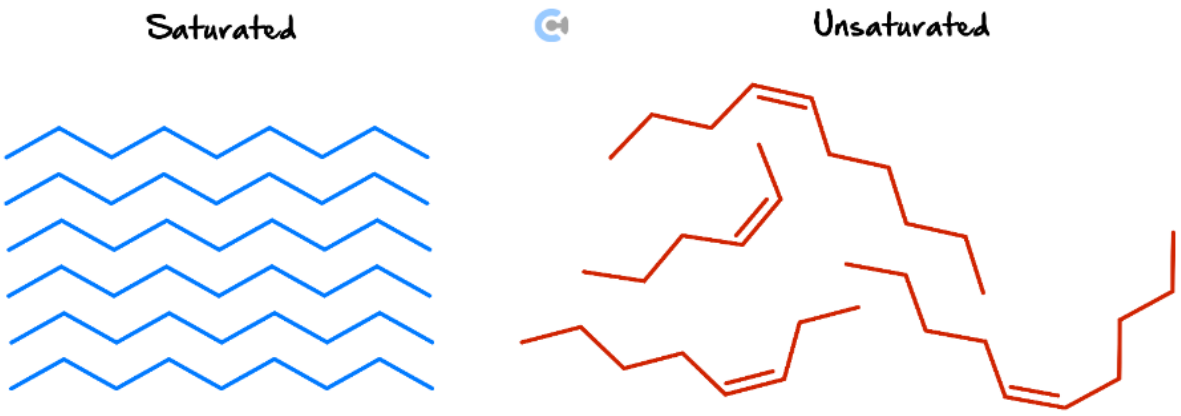
- **Context**: Covered more in VCE Chemistry ¾!

Exploration: Alkanes vs Alkenes

- Consider alkanes vs alkenes.
- Complete this below: *(Label Below)*



- **Result:**



- In alkenes, it forms: Permanent _____ in its molecular structure.
- Result: Molecules are not able to _____ as tightly.
- Strength of Dispersion Forces within Alkene: [Strengthens] / [Weakens]
- Melting Point of Alkenes: [Higher] / [Lower]

Question 6 (3 marks) **Walkthrough.**

Compare the melting point of pentane vs pent-2-ene.

_____

_____

_____

_____

_____

_____

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Sample Response: Melting Point - C = C bonds

- Molecule x contains a C = C bond, which forms a permanent kink in its chain.
- This prevents molecules from packing tightly together.
- This decreases the strength of intermolecular forces between molecule x, decreasing the strength of dispersion forces.
- As a result, less energy is required to vibrate and break the intermolecular bonds, resulting in a lower melting point of the molecule x.

TIP: When comparing alkanes to alkenes, it is easier to explain from the POV of the alkene rather than the alkane!

Your Turn!

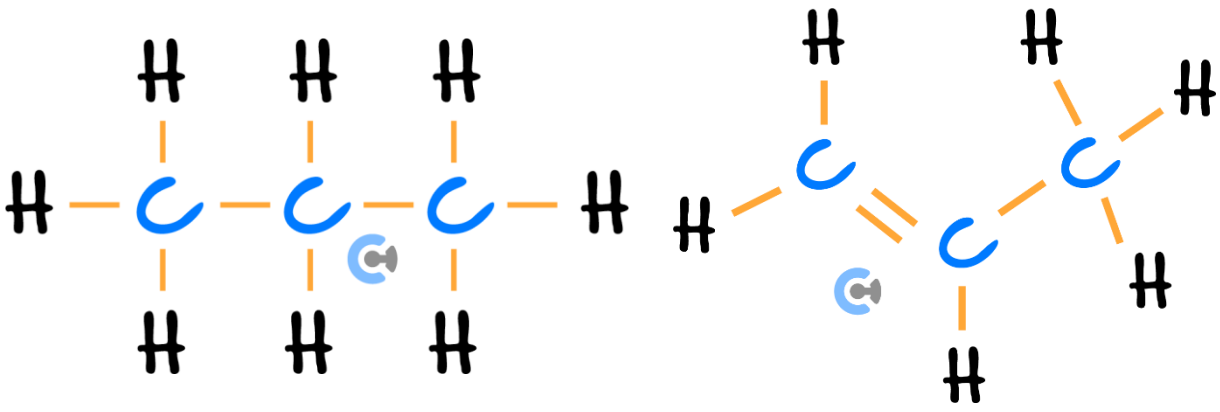
Question 7

In each scenario:

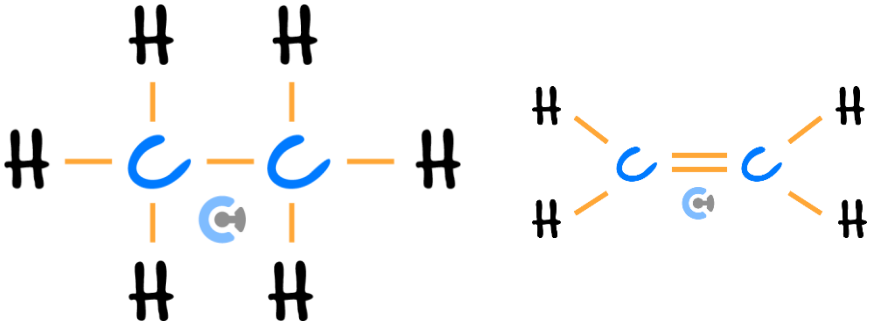
i. Circle which molecule has a **higher** melting point.

ii. Write the main reason (in 1-3 words) as to why the chosen molecule has a higher melting point.

a.



b.



Question 8

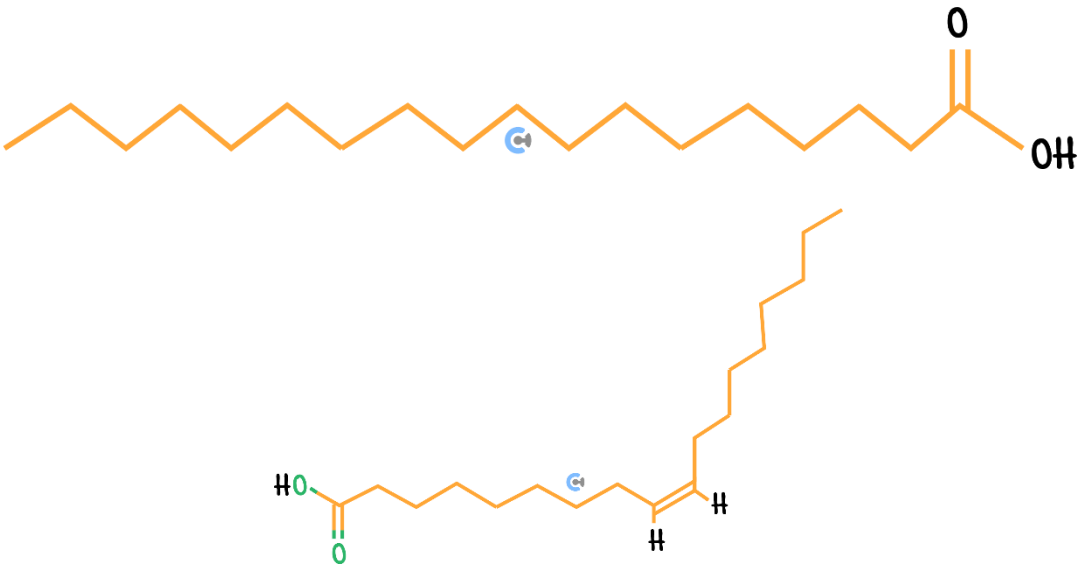
In each scenario:

i. Label the primary functional group present in each molecule.

ii. Circle which molecule has a boiling melting point.

iii. Write the main reason (in 1-3 words) as to why the chosen molecule has a higher boiling point.

a. Stearic acid vs oleic acid:



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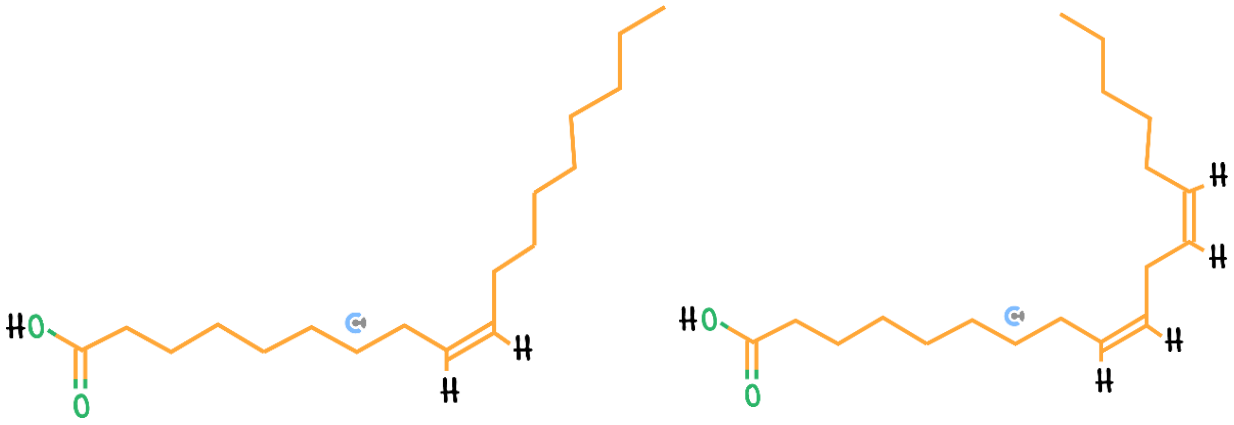
b. Oleic acid (1 C = C bond) vs linoleic acid (2 C = C bonds):



_____

NOTE: The more C = C bonds, the _____ the melting point!

ALSO NOTE: Fatty acids will be covered more in VCE Chemistry ¾ in Food Chemistry!

Try Explaining a Question!

Question 9 (2 marks)

Explain whether butane or but-2-ene has a higher melting point.

_____

_____

_____

_____

_____

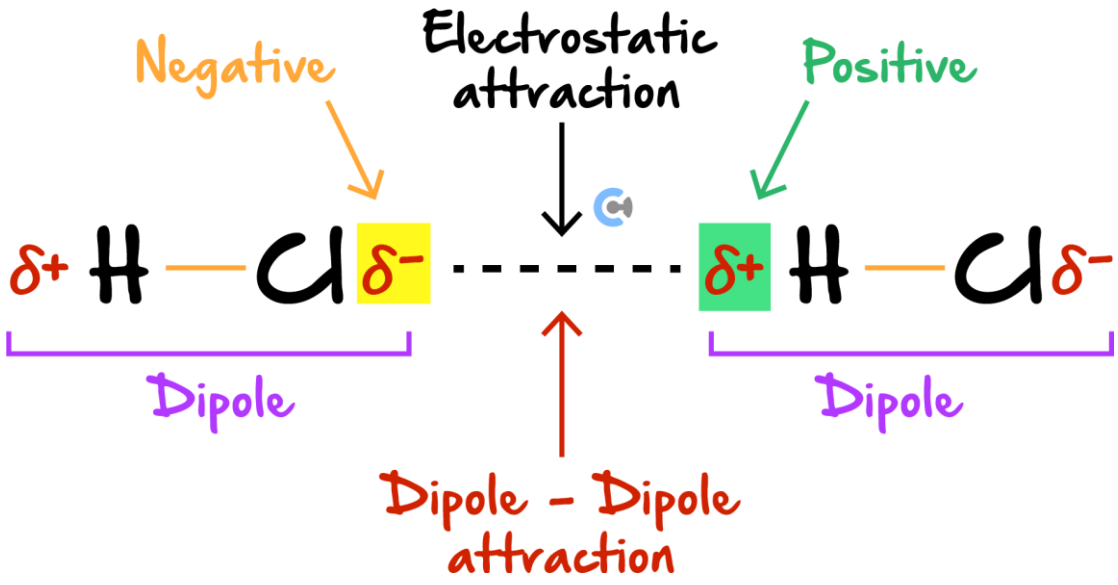
Sub-Section: Other Functional Groups

Active Recall: Place a number next to each of the types of intermolecular bonds, ranking them in terms of relative strength.

Dipole-dipole attraction	
Dispersion forces	
Hydrogen bonding	

REMINDER: Don't Forget! Dipole-Dipole Attraction

- Dispersion forces can occur in **all** molecules.
- Dipole-dipole attractions only occur in _____ molecules.
- Consider hydrochloric acid (HCl) molecules:



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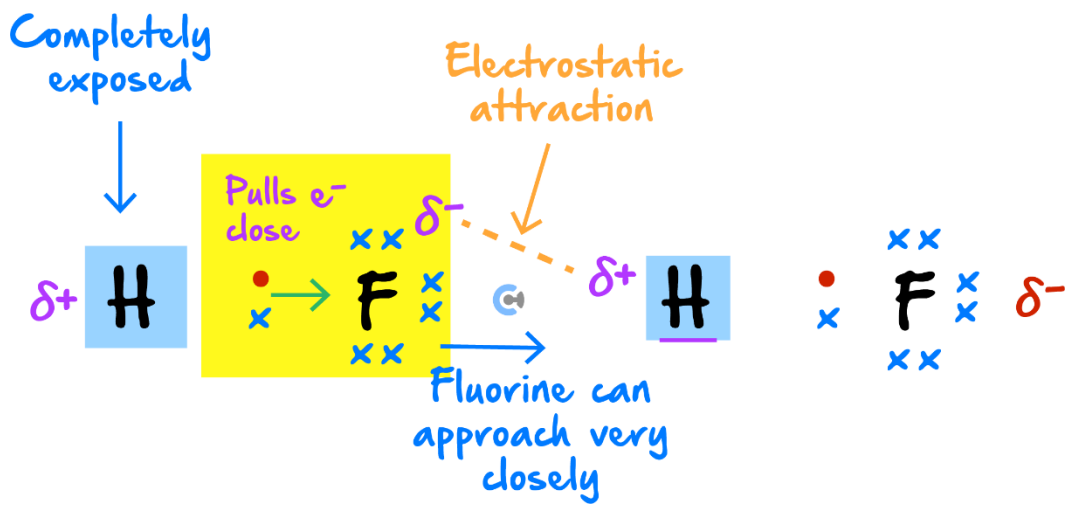
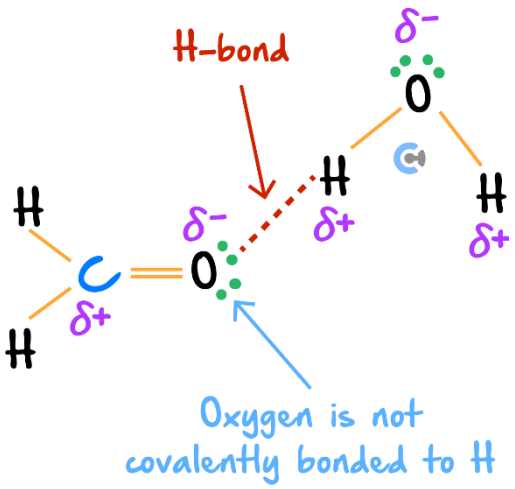
REMINDER: Don't Forget! Hydrogen Bonds



- Stronger Type of Dipole-Dipole Bond.
- Occurs between **hydrogen** and one of the following:
  - _____
  - _____
  - _____
- Example:



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Misconception

"Hydrogen Bonds can form between F, O, N and any H atom."

TRUTH: The hydrogen atom itself must also be covalently bonded to fluorine, oxygen or nitrogen.

Intermolecular Bonding Strength Ranking

Dispersion Forces	Dipole-Dipole Attraction	Hydrogen Bonds
Occurs between non-polar molecules.	Occurs between polar molecules.	Occurs between FON and hydrogen, covalently bonded to FON.

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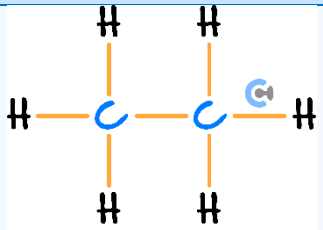
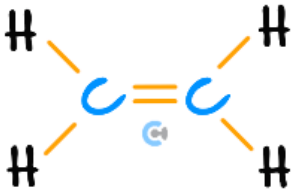
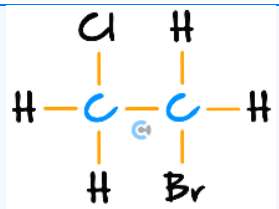
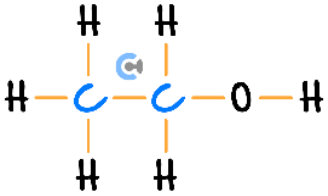
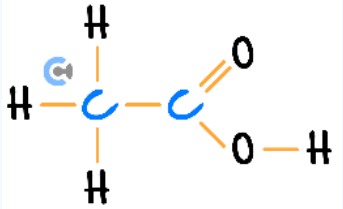
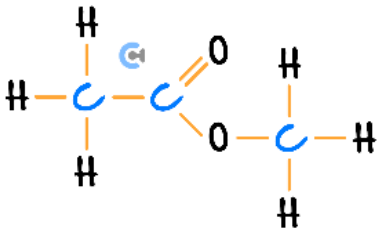
Exploration: Strongest Type of Intermolecular Bonding for each functional group

Functional Group	Structural Formula	Strongest Intermolecular Force With Itself
Alkanes		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]
Alkenes		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]
Haloalkanes		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]
Alcohols		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]
Carboxylic Acids		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]
Esters		[Dispersion Forces]/ [Dipole-Dipole]/ [Hydrogen-Bonding]

NOTE: As esters do not have hydrogen covalently bonded to one of FON, it cannot undergo hydrogen bonds with itself!

Try some questions!

Question 10

In the following scenario:

i. Label the primary functional group present in each molecule.

ii. Circle which molecule has a boiling melting point.

iii. Write the main reason (in 1-3 words) as to why the chosen molecule has a higher boiling point.

Space for Personal Notes

Question 11

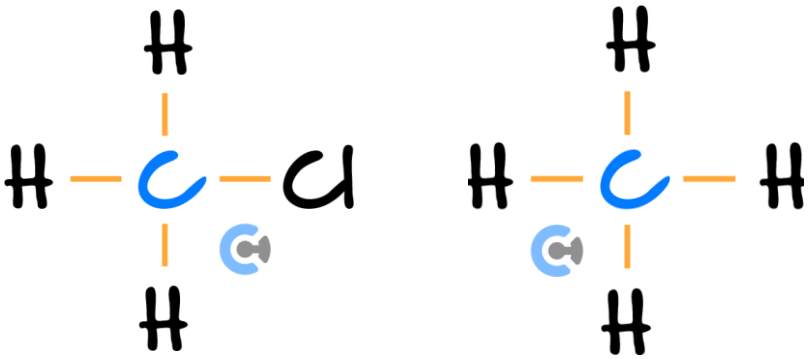
In each scenario,

i. Label the primary functional group present in each molecule.

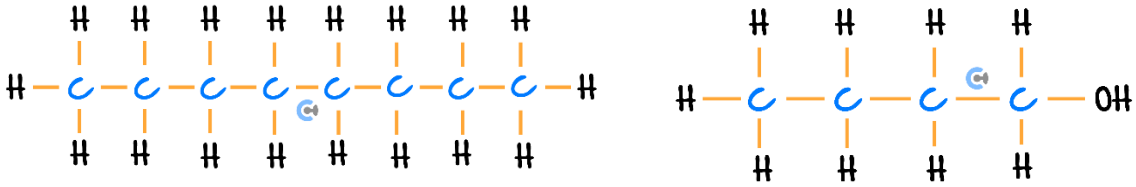
ii. Circle which molecule has a boiling melting point.

iii. Write the main reason (in 1-3 words) as to why the chosen molecule has a higher boiling point.

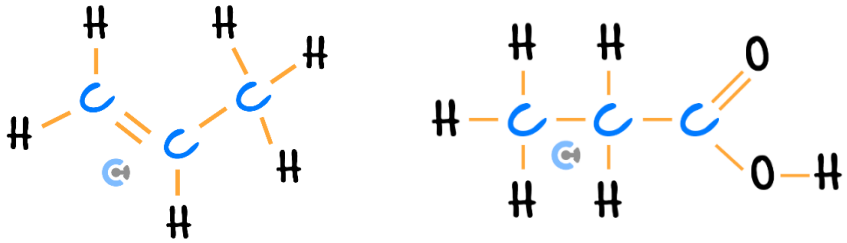
a.



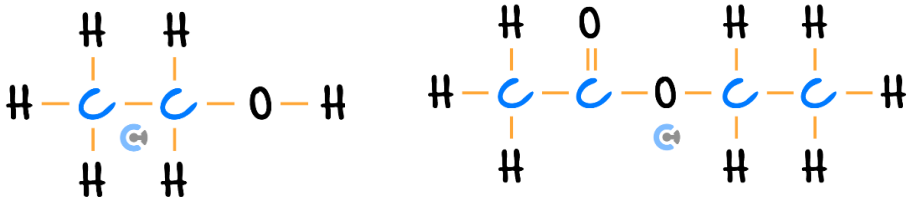
b.



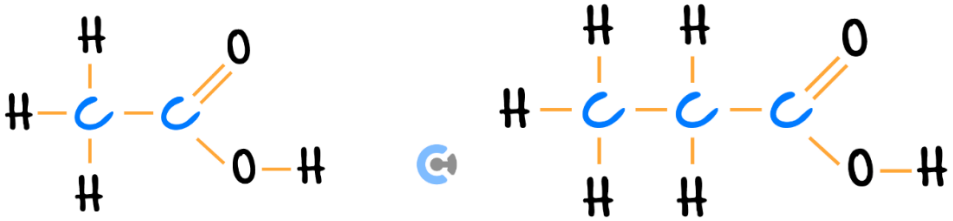
c.



d.



e.



NOTE: If two substances have the same functional group, the one with a longer carbon chain has a higher melting point, as it has even stronger dispersion forces!

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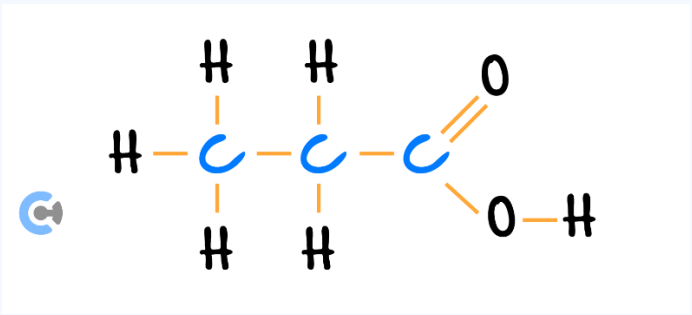
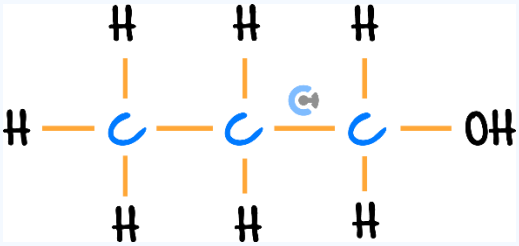
Sub-Section: Dimers

Discussion: Do carboxylic acids or alcohols have stronger intermolecular bonding?

Carboxylic acids	Alcohols
	
Strongest Intermolecular Bond: [Dispersion Forces] / [Dipole-Dipole Attraction] / [Hydrogen Bonds]	**Strongest Intermolecular Bond:** [Dispersion Forces] / [Dipole-Dipole Attraction] / [Hydrogen Bonds]

[Carboxylic acid] / [Alcohol] / [Both]

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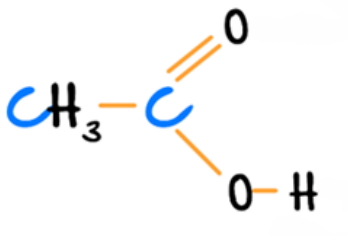
Exploration: Carboxylic Acids Bonding

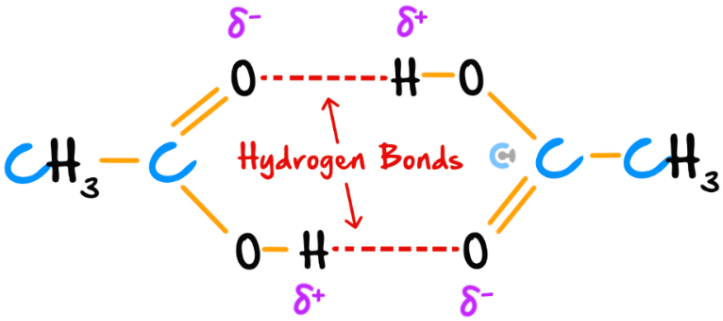
- Carboxylic acid special bonding:

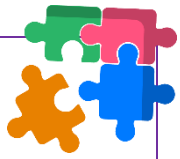


- **Conclusion**: Form a _____ of hydrogen bonds with each other.
- **System Formed:** _____
- Dimers have the _____ hydrogen bonding of all the functional groups.

Dimer

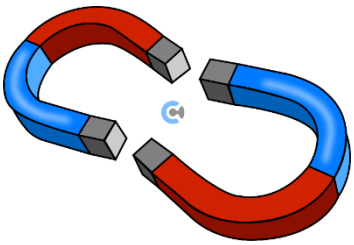
- **Definition**: The union of two carboxylic acids forming hydrogen bonds with one another.





Analogy: Horseshoe Magnets

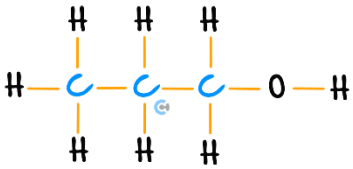
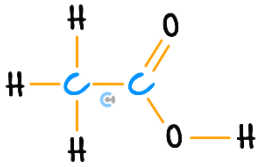
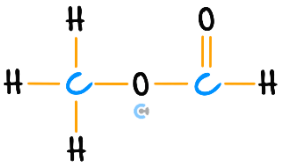
- You can think about dimers like two horseshoe magnets stuck together!



Try some questions!

Question 12 (1 mark)

The following table provides information about three organic compounds, X, Y and Z.

Compound	Structural formula	Molar mass ($g\ mol^{-1}$)	Boiling point (°C)
X		60	97
Y		60	118
Z		60	?

Which one of the following is the best estimate for the boiling point of compound Z?

A. 31°C

B. 101°C

C. 114°C

D. 156°C

Space for Personal Notes

Question 13 (1 mark)

A student wants to use a physical property to distinguish between two alcohols, octan-1-ol and propan-1-ol. Both alcohols are colourless liquids at standard laboratory conditions (SLC).

The student should use:

A. Density because propan-1-ol has a much higher density than octan-1-ol.

B. Melting point because propan-1-ol has a higher melting point than octan-1-ol.

C. Boiling point because octan-1-ol has a higher boiling point than propan-1-ol.

D. Electrical conductivity because octan-1-ol has a higher conductivity than propan-1-ol.

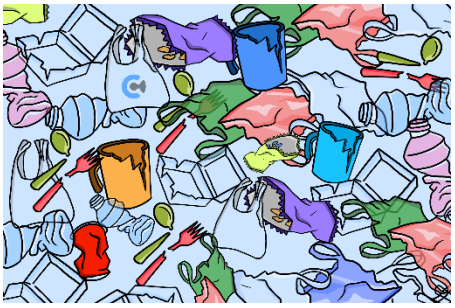
Space for Personal Notes

Section B: Real-Life Use of Organic Chemicals

Sub-Section: Fossil Fuels

Context

- A lot of the chemicals used nowadays are derived from _____ **fuels**!
- **Examples**: Cosmetics, clothes, tools, plastics, bags, solvents, pharmaceuticals, adhesives, dyes and paints etc.
- Many **polymers** (covered next week) are made from fossil fuels!






Space for Personal Notes

Discussion: What is a fossil fuel?

Fossil Fuel

- **Definition:** A fossil fuel is a fuel which is obtained _____.
- Fossil fuels and biofuels will be covered in depth next year in VCE Chemistry ¾!

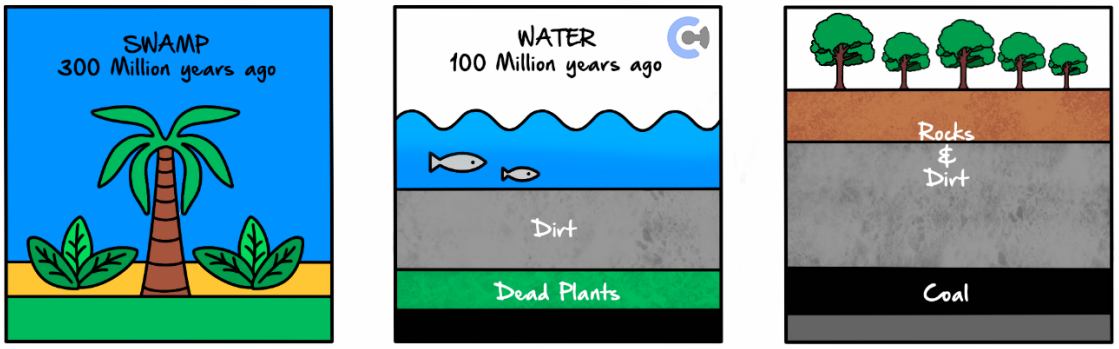
Discussion: What are some examples of fossil fuels which give organic compounds?

- _____
- _____
- _____

NOTE: The non-renewable processes are briefly covered in VCE Chemistry ¾!

- Coal:

How coal was formed:

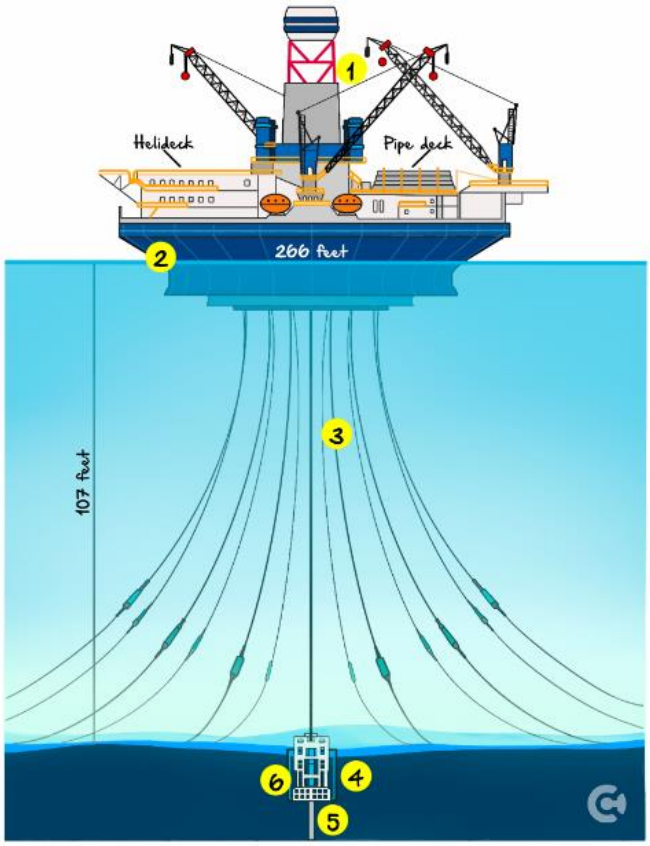


Before the dinosaurs, many giant plants died in swamps.

Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

- Crude Oil:



- Natural Gas:

<u>Discussion:</u> What are some downsides of using fossil fuels?

- _____.
- _____.
- _____.
- _____.
- _____.

NOTE: The biggest downside of fossil fuels is that they are unable to be replenished _____ in a _____!

ALSO NOTE: This aligns with the definition of 'renewability' which is covered in depth in VCE Chemistry ¾!

What is a greenhouse gas?

<u>Greenhouse Gas</u>

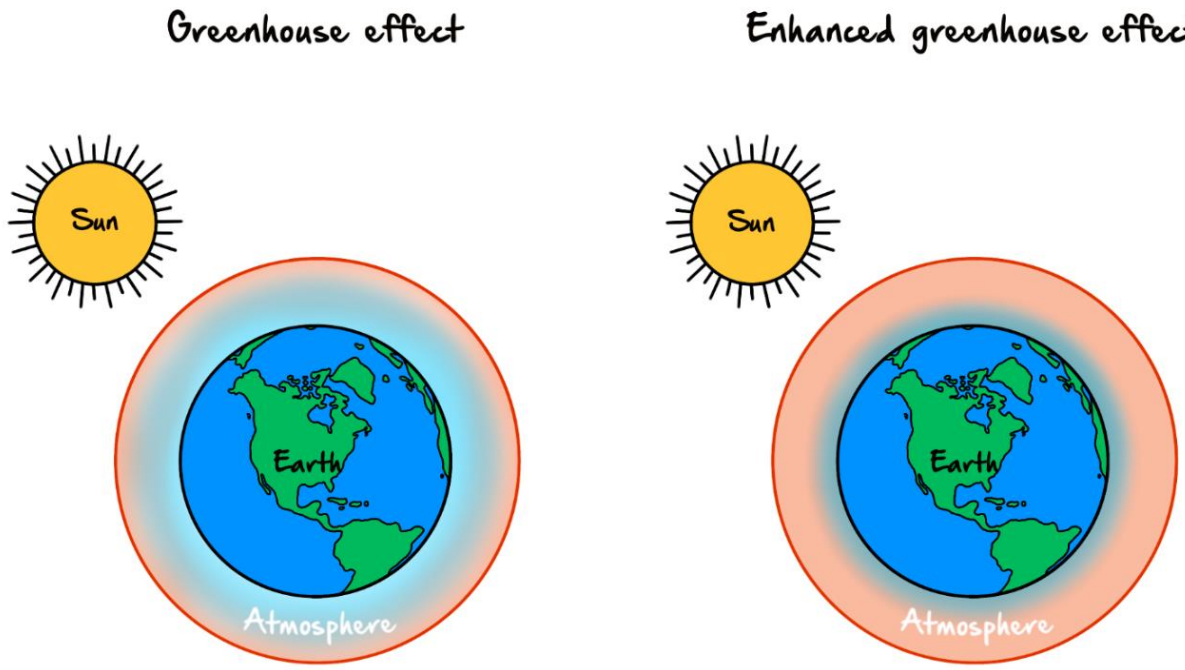
- **Definition:** A gas which _____.

<u>Discussion:</u> **What are some common examples of greenhouse gases?**

Space for Personal Notes

Greenhouse Effect

- They lead to accelerated climate change and global warming.



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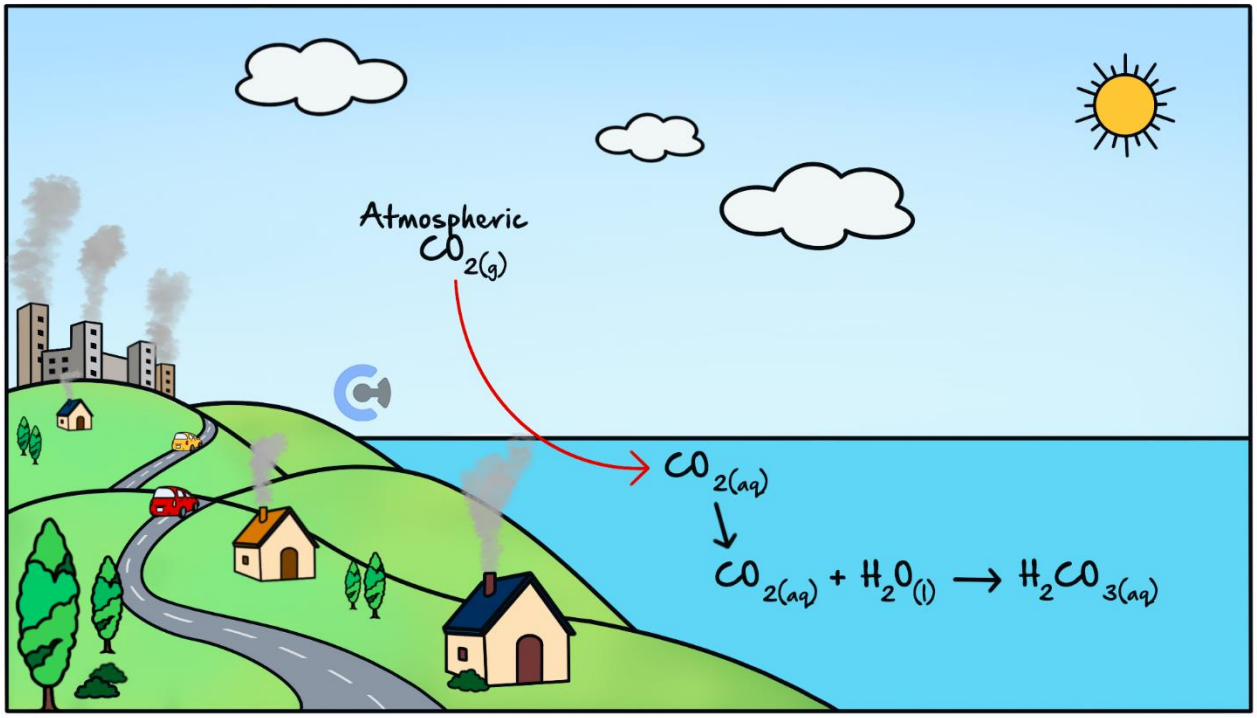
Extension: Greenhouse Gases also lead to Ocean Acidity



- Increased ocean acidity leads to _____ to aquatic life.
- Shells in creatures are composed of: _____.
- **Acid decomposes the $CaCO_3$ reaction:**

$$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l)$$

- **Result on wildlife:** This higher ocean acidity inhibits shell growth in marine animals and is suspected to cause reproductive disorders in some fishes.

Question 14 (1 mark)

What is the definition of a fossil fuel?

A. A fuel that can be replenished naturally within a human lifetime.

B. A fuel that is available in unlimited quantities.

C. A fuel which is obtained non-renewably.

D. A renewable source of energy.

Question 15 (1 mark)

Why are greenhouse gases considered harmful?

A. They decrease the temperature of the Earth.

B. They lead to accelerated climate change and global warming.

C. They increase the oxygen levels in the atmosphere.

D. They are not harmful; they are beneficial to the environment.

Question 16

a. List three downsides of fossil fuels.

_____

b. Name two sources of fossil fuels.

_____

Space for Personal Notes

Sub-Section: Circular vs Linear Economy

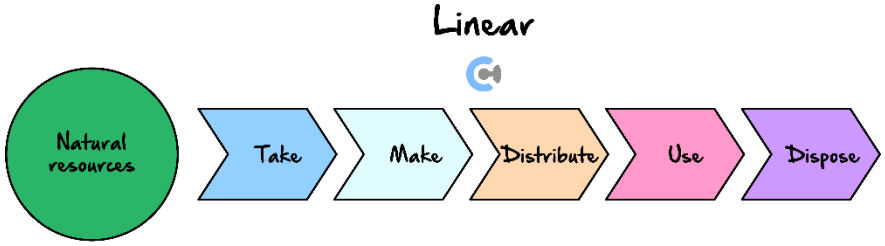
What is a circular and linear economy?

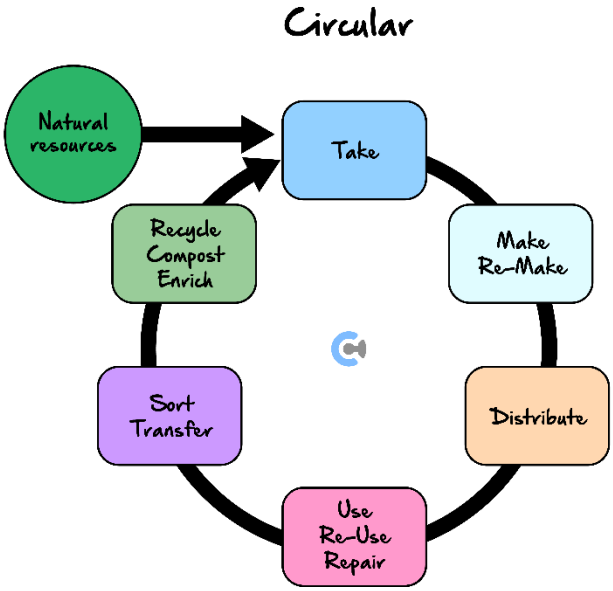
Context

- Watch the following video (in your own time) for more information!
- **Video Link**: https://www.youtube.com/watch?v=zCRKvDyyHml
- A lot of the content is derived from this video!

Linear vs Circular Economy

- **Data Book:** Page 23.

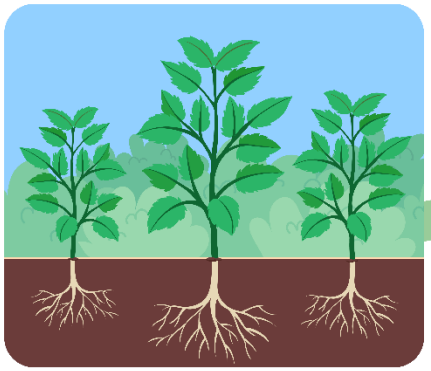




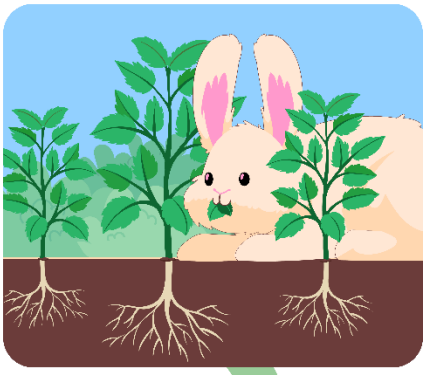
First, let's look at what happens in nature!

Exploration: Nature

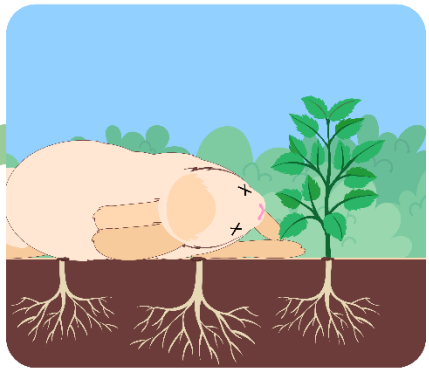
1. Nutrients taken up by _____



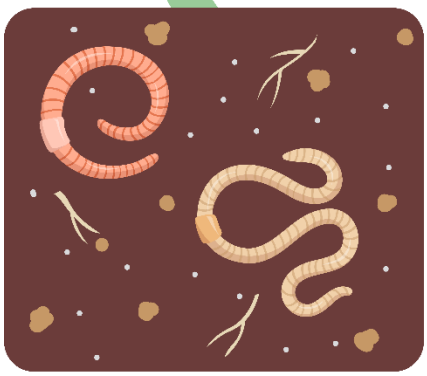
2. Nutrients eaten by _____



3. Animals produce droppings and eventually _____



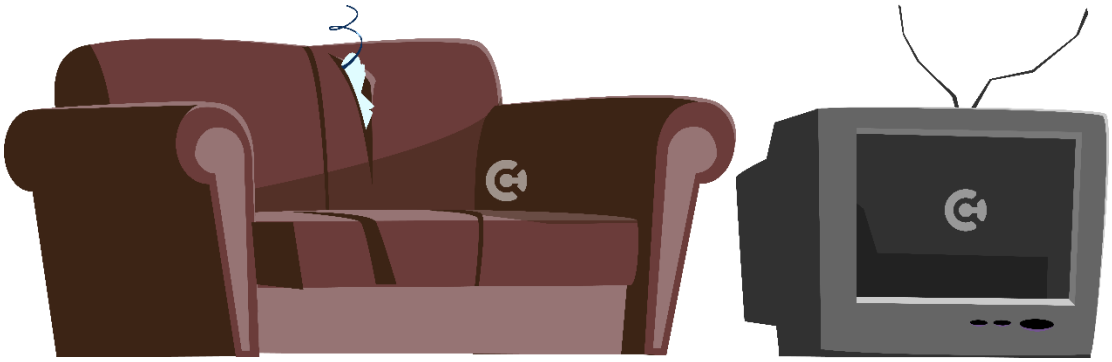
4. Decomposers, such as worms, bacteria and fungi, _____ nutrients to the _____



- Type of Economy: [Linear] / [Circular]

What do humans do?

Discussion: When you get a new couch or a new TV, what do you do with the old one?



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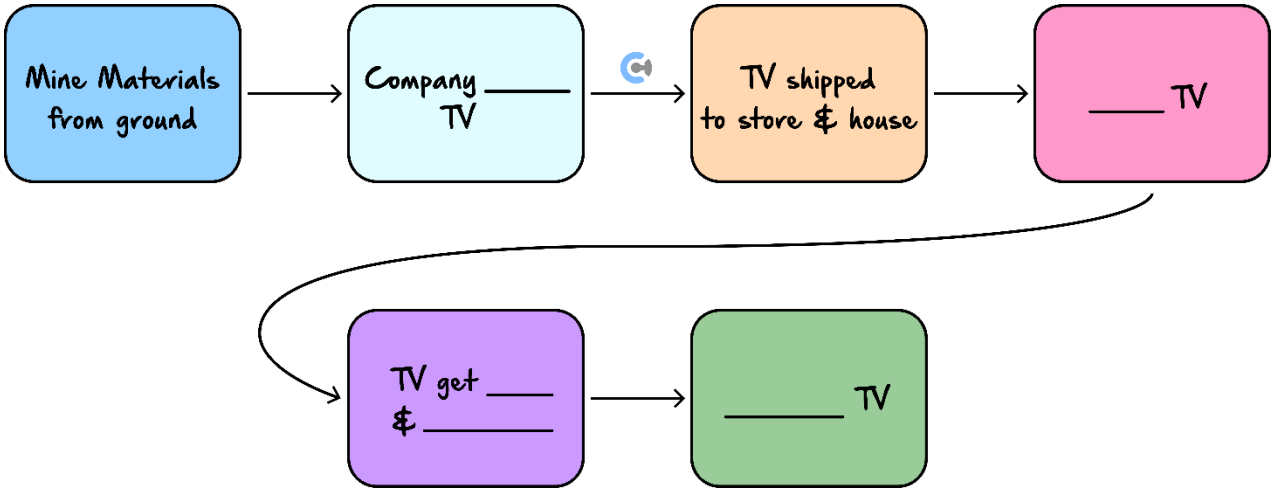
Exploration: Humans

- Consider the lifespan of a TV.



- The parts and materials in the TV have been disposed of.

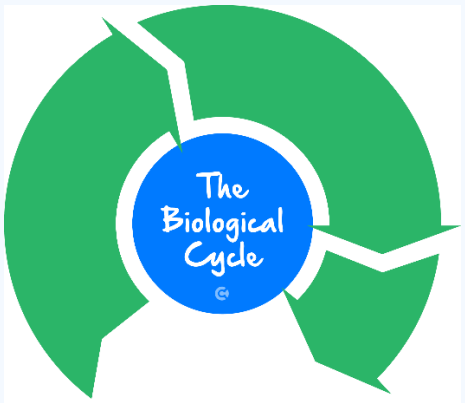
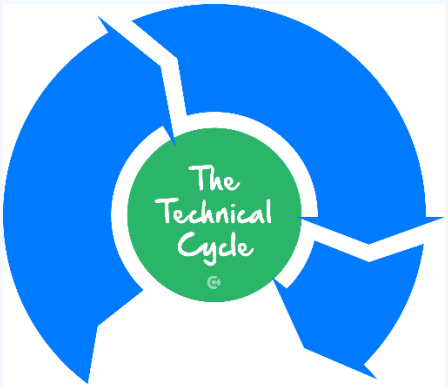
- **Type of Economy:** [Linear] / [Circular]
- What happens to the amount of usable metal present in the Earth? _____
- **Other Downsides of Landfill:**
  - _____.
  - _____.

- **Way of Thinking:** If the Earth naturally works in a circular economy, why can't humans?

Space for Personal Notes

How can our waste help build more resources rather than reduce them?

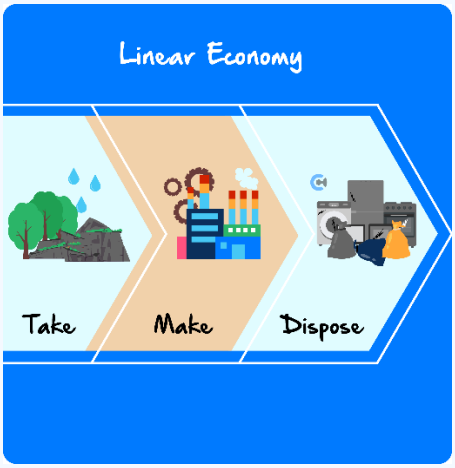
Types of Resources

Biological Resources	Technical Resources
Definition: Naturally occurring living things or products derived from living organisms.	**Definition:** Human-made tools, systems, or technologies created to solve problems or perform tasks.
➢ **Forests (trees, plants)** ➢ **Animals (livestock, fish, wildlife)** ➢ **Crops (wheat, rice, corn)** ➢ **Microorganisms (yeast, bacteria)** ➢ **Medicinal plants** ➢ **Genetic material (seeds, DNA)** ➢ **Renewable biomass (wood, algae, biofuel plants)**	➢ Machines (tractors, computers, factory robots) ➢ Software & apps (agriculture monitoring software, lab analysis tools) ➢ Vehicles (trucks, drones) ➢ Tools (microscopes, harvesting equipment) ➢ Artificial systems (irrigation systems, renewable energy systems) ➢ Data networks (internet, sensors) ➢ Laboratory technology (CRISPR tools, fermentation tanks)
Goal: Goes back into _____ for _____ value.	**Goal**: Reuse parts to make the next _____.
	

Discussion: How should food be packaged?

Plastic Packaging	Paper Packaging
	
[Biodegradable] / [Non-biodegradable]	[Biodegradable] / [Non-biodegradable]
Plastic Packaging Disposal: Typically thrown into landfill despite being recyclable.	**Paper Packaging Disposal:** Biodegrades into chemicals _____ by plants.

Discussion: How about TVs and washing machines?

Old way of thinking	New way of thinking
	
throw away → replace	*return → renew*

- **Electronic Waste Disposal:** Must be _____ for parts to make new TVs and washing machines.

Sub-Section: Biomass

Discussion: How can we get sources for organic chemicals in a circular economy?

- _____.
- _____.

Biomass

- **Definition:** A source of organic material which comes from plants and animals.

- Biomass is obtained by growing plants to obtain organic matter.

Discussion: Can we run out of organic matter sourced from plants?

Discussion: **Which green chemistry principle is attained by using biomass?**

NOTE: By using biomass, we can sustainably source organic matter!

ALSO NOTE: The green chemistry principle of 'use of renewable feedstocks' is very important!

Space for Personal Notes

Sub-Section: Limitations From Widespread Adoption of Renewable Feedstocks

Context

- At the moment, there are many limitations which restrict the widespread adoption of renewable feedstocks.

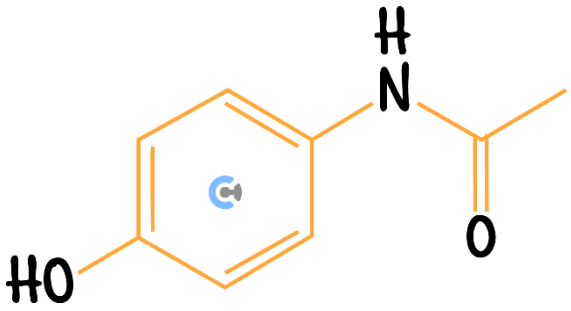
Discussion: What are some downsides of using farmland to source biomass?

- _____.
- _____.

Space for Personal Notes

Exploration: Paracetamol

- Below is the structure of paracetamol.

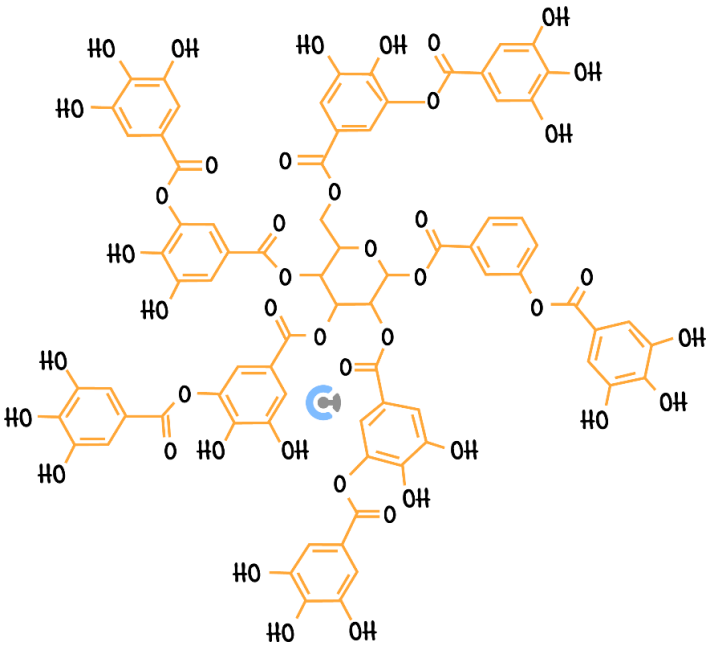


- Functional Groups: *(Label Above)*
- **Paracetamol can be sourced**: from both fossil fuels and biofuels.
- Sourcing it from biofuels is much more _____ than from fossil fuels!

NOTE: You are not expected to remember the structure of paracetamol!

Exploration: High-strength glue

- Below is the structure of high-strength glue:



- **Main Functional Groups:** _____
- **Intermolecular Bonds Formed:** _____
- **Strength of IMB:** [strong] / [weak]
- **Discovery**: It is _____ to _____ high-strength glue from biomass, whereby it is currently sourced from fossil fuels.
- **Conclusion**: Cannot use biomass to source high-strength glue!

NOTE: High-strength glue is high strength as the glue molecules form strong intermolecular bonds with itself!

ALSO NOTE: You are not expected to remember the structure of high-strength glue!

Examples of Chemicals & Limitations of Sourcing

- Here are some examples of chemicals, and the limitations which come from sourcing them.

Example	Limitation
Biomass	Food shortages, deforestation, habitat destruction
Plant-based paracetamol	Expensive
High-strength glue	Unable to source from biofuels
Specific coloured dyes (e.g. Indigo)	Requires additives from petrochemicals (crude oil)
Harvesting of saffron	Worker exploitation

- Green Chemistry Principle (page 23 of Data Book): _____.

Space for Personal Notes

Let's look at a question together!

Question 17 (5 marks) **Walkthrough.**

Acetone is an important organic solvent used in products like nail polish remover, adhesives, paints, and pharmaceuticals. Traditionally, acetone is made from fossil fuels using a process called the *cumene process*, which relies on crude oil derivatives. However, acetone can also be produced renewably through fermentation of plant-based biomass using certain bacteria (like *Clostridium acetobutylicum*), which break down sugars from plants into acetone, butanol, and ethanol (ABE fermentation).

a. State one environmental disadvantage of producing acetone using the cumene process. (1 mark)

_____

_____

b. Explain how the different sources of acetone lead to either linear or circular economy respectively. (4 marks)

_____

_____

_____

_____

_____

_____

Space for Personal Notes

Try some questions!

Question 18 (1 mark)

Which of the following is not a limitation of using farmland to source biomass?

A. Decreasing biodiversity.

B. Food shortages.

C. Deforestation.

D. Habitat destruction for farmland.

Question 19 (1 mark)

Which of the following chemicals is noted as being more expensive when sourced from biofuels rather than fossil fuels?

A. High-strength glue

B. Paracetamol

C. Specific coloured dyes

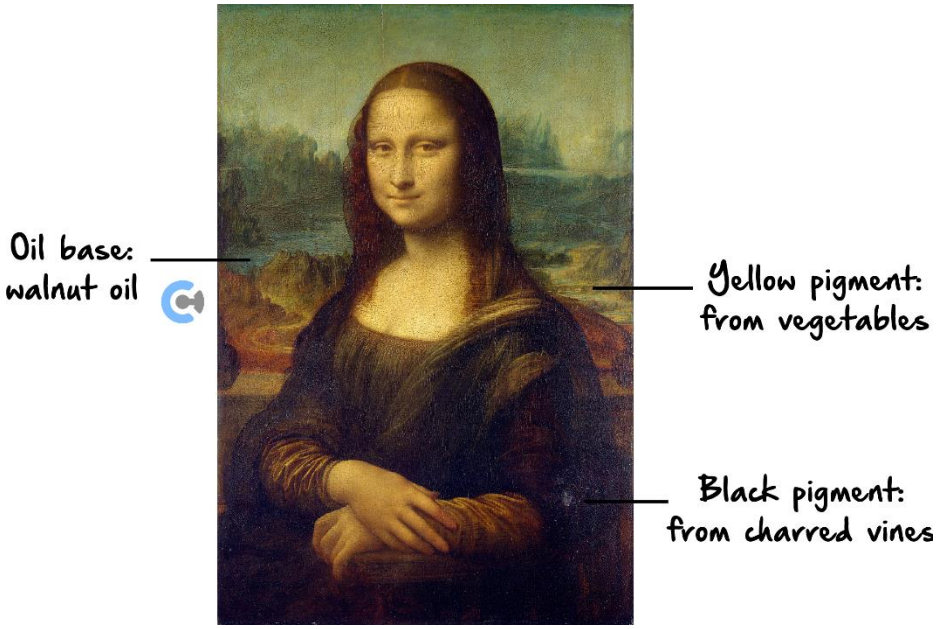
D. Biomass

Space for Personal Notes

Question 20

Paints are comprised of hydrocarbons, which can be sourced from either fossil fuels or biomass.

In Leonardo's the Mona Lisa, the paints are derived from the sources depicted in the image below. How could the feedstocks of these organic compounds be classified?



[Renewable] / [Non-renewable]

Space for Personal Notes

Question 21

Glue in a gluestick is sourced from polymers which are derived from fractions of compounds which are extracted from crude oil via fractional distillation. How could the feedstocks of these organic compounds be classified?

[Renewable] / [Non-renewable]

Question 22 (1 mark)

Which of the following substances cannot be derived from organic compounds?

A. Pharmaceuticals

B. Adhesives

C. Dyes

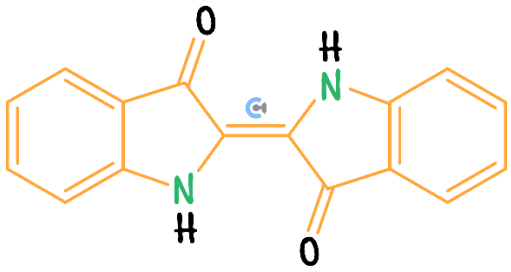
D. Salts

Space for Personal Notes

Question 23 (3 marks)

Indigo is a blue dye historically extracted from plants like *Indigofera tinctoria*. However, in modern industry, most indigo dye is made synthetically from fossil fuel-derived chemicals (like aniline, which comes from benzene — a crude oil product).

The structure of Indigo is shown below.



Indigo

a. Identify two functional groups present in indigo. (1 mark)

_____

_____

But there is growing interest in producing indigo renewably again — either directly from plant extraction or by using genetically engineered bacteria or yeast to convert plant sugars into indigo dye.

b. Compare **one** advantage of producing indigo dye using genetically engineered microbes vs direct extraction from plants. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Section C: Organic Compounds in Society

Context

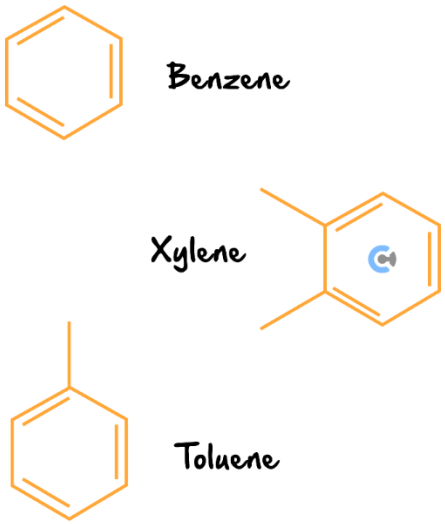
- There are various everyday objects which are made from organic compounds!
- **Examples**: Synthetic fabrics, food, natural medicines, pesticides, cosmetics, organic solvents, car parts, artificial hearts, etc.

Organic Solvents

- **Definition:** Organic solvents can have solutes dissolved in them!
- Solubility will be covered properly in U2 AOS 2!

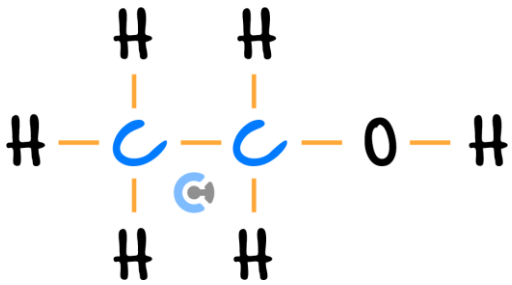
Exploration: Organic Solvents

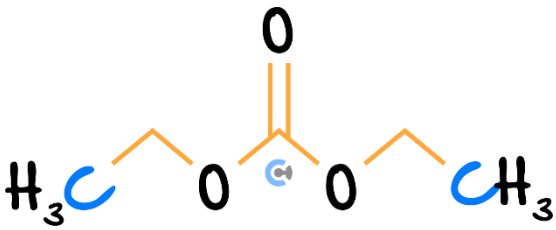
Examples Set A:



- What do you notice about these organic solvents?
  - _____
  - _____

Examples Set B:





- What do you notice about these organic solvents? _____

Relevance

- Where were polar and non-polar solvents used? _____
- **Use**: To _____ and _____ polar and non-polar solvents!

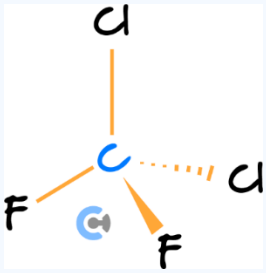
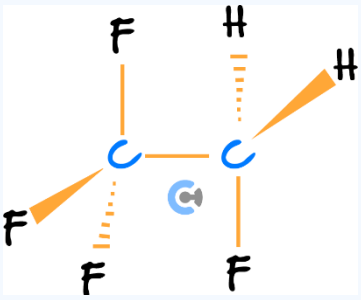
NOTE: Organic solvents can be polar or non-polar. (We'll cover later on in the year!)

ALSO NOTE: Organic solvents help with the extraction of one material from another, but this is not covered!

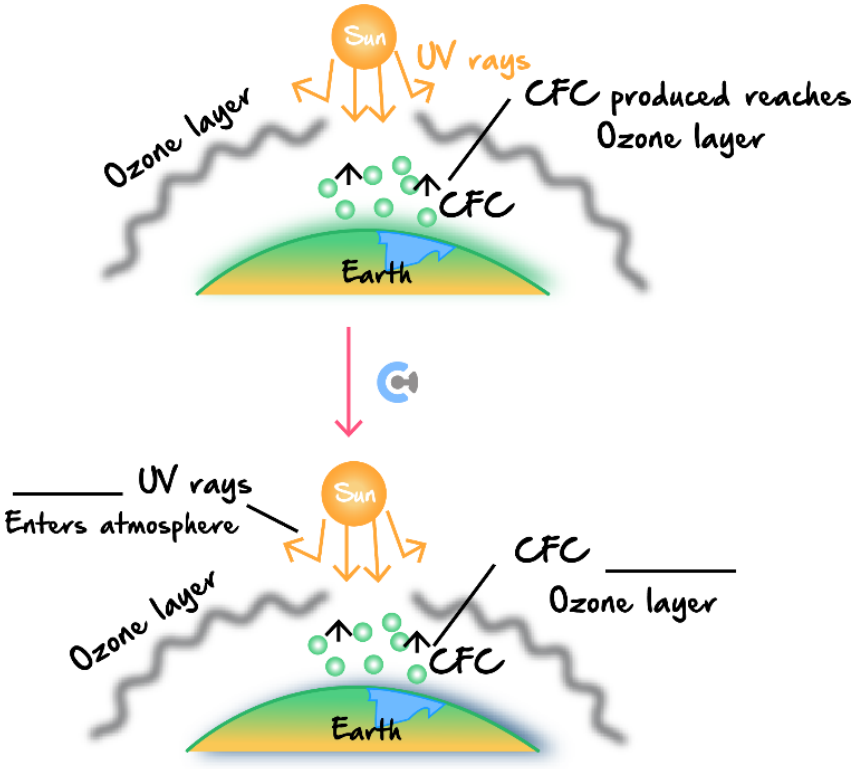
Space for Personal Notes

Exploration: CFC

- The following molecules were used in air-conditioning and refrigeration in the 1930s:

Molecule #1	Molecule #2
	
Name:	Name:

- CFCs are chemicals that can deplete the ozone layer.



- More UV rays which pass through the Earth lead to: _____

- **Result**: CFCs have been _____, to allow the ozone layer to replenish itself.

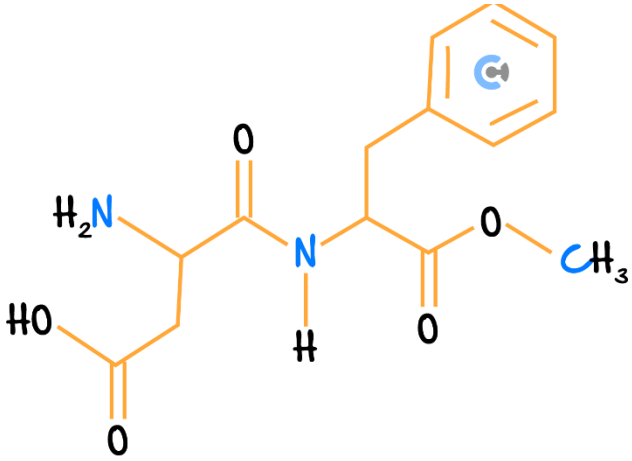
Sub-Section: Food Additives

Context

- Some artificial food additives, such as sweeteners are added to processed foods.

Exploration: Aspartame

- Many artificial sweeteners exist. One such sweetener is known as _____.
- **Structure**:



Aspartame

- **Functional Groups Present:** *(Label Above)*
- **Purpose of Artificial Sweeteners:** Used to reduce sugar added to foods.
- **Sweetness of Aspartame:** Roughly _____ sweeter than natural sugars.
- Energy Content of Natural Sugar vs Aspartame: [Higher] / [Lower] / [Same]

- To achieve a certain level of sweetness, if:

Natural Sugar	Aspartame
$20.0\ g$	
$320\ kJ$	

- **Amount of Aspartame Needed:** [Higher] / [Lower] amount of aspartame added.
- For the same sweetness, which results in lower energy content? [Natural sugar] / [Aspartame]
- **Result**: Artificial sweetener is used in diet drinks!

Product	Main ingredients	Energy ($kJ/100\ mL$)
Diet Coke ®	Carbonated water, caramel, aspartame, phosphoric acid, potassium benzoate, caffeine.	1.5
Coke Zero ®	Carbonated water, caramel, aspartame, phosphoric acid, potassium benzoate, caffeine.	1.4
Coke ®	Carbonated water, cane sugar, caramel, food acid, phosphoric acid, caffeine.	180

Benefit	Hazard
	Is associated with an increased risk of heart disease. It has also been recently labelled as a carcinogen.

Aspartame

- **Sweetness of Aspartame:** _____ sweeter than natural sugars.
- **Energy Output of Aspartame:** [Higher] / [Lower] / [Same] as natural sugars.
- **Amount of Aspartame Used:** Much _____ needed for the same sweetness.
- **Effect on Energy Content:** [Higher] / [Lower] energy content as [more] / [less] aspartame is added.

Try some questions!

Question 24 (1 mark)

Aspartame is used as a sweetener in place of sucrose.

Compared to 1 gram of sucrose, 1 gram of aspartame contains:

A. Double the amount of energy and has much greater sweetness.

B. About the same amount of energy and has much greater sweetness.

C. Double the amount of energy and about the same sweetness.

D. About the same amount of energy and about the same sweetness.

Question 25 (1 mark)

A soft drink company sells two similar orange soft drinks. A simplified version of the label on each is shown in the table below.

Soft drink *A*	**Soft drink *B***
Carbonated water	Carbonated water
Caramel colouring	Caramel colouring
Aspartame (1 g)	Sucrose (10 g)
Orange flavour	Orange flavour

When compared with soft drink *A*, soft drink *B* has:

A. Significantly higher energy content and a significantly higher sweetness level.

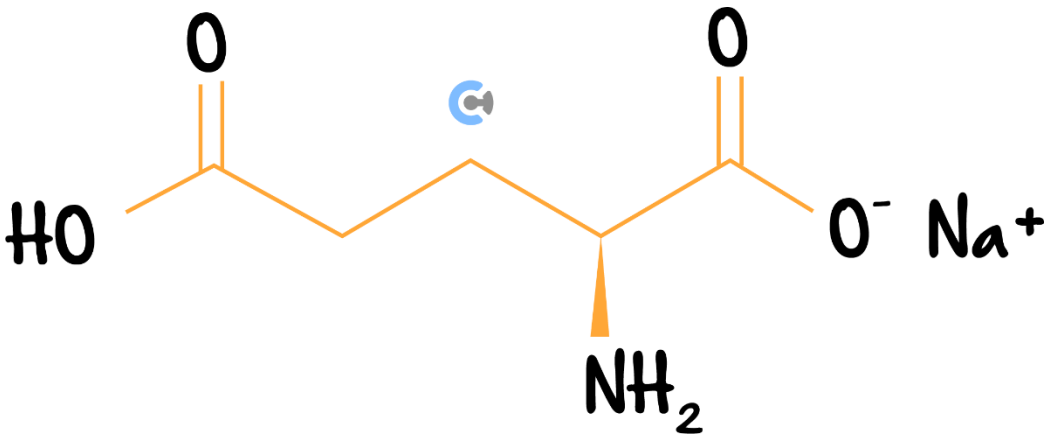
B. Significantly higher energy content but a significantly lower sweetness level.

C. Significantly higher energy content but a similar sweetness level.

D. Similar energy content and a higher sweetness level.

Exploration: Monosodium glutamate (MSG)

- Monosodium glutamate (MSG):



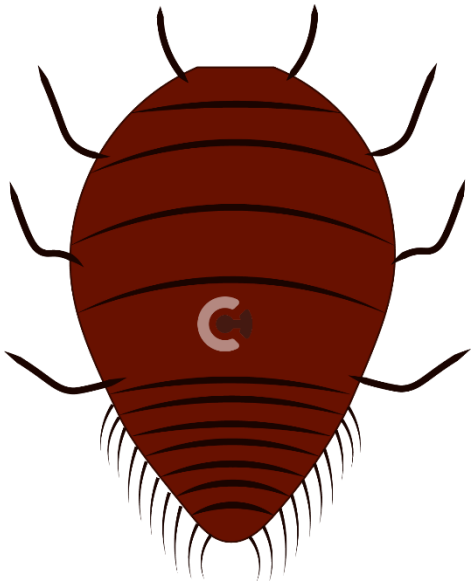
- **Functional Groups:** *(Label Above)*

Benefit	Hazard
	Suggested that some people may react to MSG with headaches and numbness.

Space for Personal Notes

Exploration: Red Food Dye

- Food dye, such as red food dye is obtained from various sources.
- Red food dye can be sourced from cochineal, which is an invertebrate.



Benefit	Hazard
	Food colourings can cause asthma or hyperactivity in children, and some colourings are suspected of increasing the risk of cancer; cochineal can cause allergic reactions.

Space for Personal Notes

Sub-Section: Other Everyday Organic Compounds

Exploration: Other Everyday Organic Compounds

- Other everyday organic compounds are typically made from plastics which are made from **polymers**. We cover polymers in the next few booklets, so we won't touch on them here!
- **Synthetic fabrics**: Made of plastics, which are primarily made of **polymers**.
  - **Examples**: Lycra, Viscose, Polyester, Nylon.
- **Car Parts**: Dashboards, instrument panels, and synthetic leather coverings all are made from organic compounds.
  - **Examples**: Polypropene, polyurethane, polyamides, PVC.
- **Artificial Heart**: Made from segmented polyurethane.

Property	Explanation
Durable	Must last for years without damage.
Inert	Must not react with fluids in the body, must not conduct electricity.
Flexible	Able to slightly change shape in response to movement.
Adhesive	Needs texture to enable red blood cells to stick to it.

NOTE: It's important to have a general gist of these everyday compounds, but you are not expected to memorise every single detail about them!

Space for Personal Notes

Let's look at a question together!

Question 26 Walkthrough.

Many sportswear brands use *polyester* (a synthetic fabric made from organic compounds) to make clothing such as athletic shirts, leggings, and jackets.

Polyester is produced through a chemical reaction between ethylene glycol ($C_2H_6O_2$) and terephthalic acid ($C_8H_6O_4$), both of which are organic compounds derived from petroleum.

Polyester is widely used in clothing because it is strong, lightweight, dries quickly, and doesn't wrinkle easily. However, there are concerns about its environmental impact because polyester is made from petroleum (a non-renewable resource), and it releases tiny plastic fibres (microplastics) when washed.

a. Explain **two** benefits of using polyester fabrics in sportswear for society.

b. Polyester clothing is made from plastic-like materials. When these clothes are washed in a washing machine, tiny pieces of plastic, called *microplastics*, can break off and go down the drain. These tiny plastic fibres are so small that they can pass through water filters and enter rivers, lakes, and even drinking water supplies.

Based on this information, what is a possible health concern related to polyester clothing?

A. The dyes in polyester clothes instantly cause skin burns.

B. The microplastics released from polyester clothes might enter the food chain and be swallowed by humans.

C. Polyester releases toxic gases every time it is worn.

D. Polyester directly causes lung infections when worn.

c. Polyester is made from non-renewable resources like petroleum (crude oil). In addition, when polyester clothing is thrown away, it does not break down easily in landfills or in the environment. Tiny plastic fibres can also enter oceans, affecting marine animals.

Based on this information, what is a likely environmental problem caused by the use or disposal of polyester clothing?

A. Polyester clothing helps clean the air as it breaks down.

B. Polyester clothing quickly biodegrades in landfills, reducing waste.

C. Polyester is made from renewable plant materials, so it is eco-friendly.

D. Polyester contributes to plastic pollution because it does not break down easily and releases microplastics into the environment.

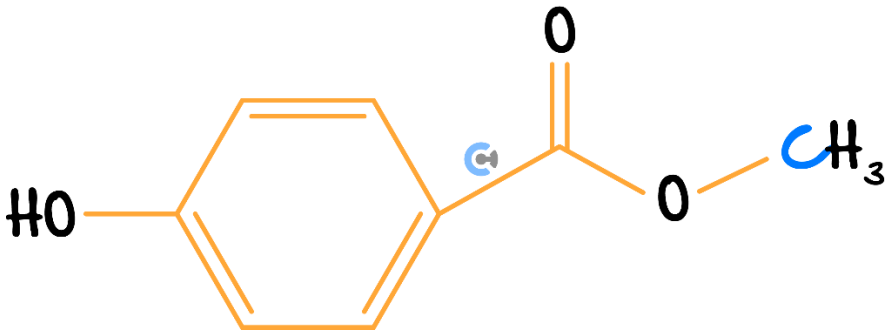
Your turn!

Question 27

Many shampoos, lotions, and makeup products contain *parabens*, a group of chemical preservatives. Preservatives prevent products from becoming mouldy or growing bacteria, making them last longer and safer to use.
Parabens are a type of *ester* - a molecule formed when an alcohol reacts with an acid. In parabens, a molecule called *p-hydroxybenzoic acid* reacts with an alcohol (like methanol or propanol) to make the ester. The part of the molecule called the *ester functional group* has the formula –COO–.
Although parabens are useful, some studies have raised concerns that they might interfere with hormones in humans and affect wildlife when washed into rivers and oceans.

a. The diagram below shows a simplified paraben molecule.

Circle or label the *ester functional group* in the molecule.



b. Give **two** reasons why parabens are used in cosmetics.

c. Parabens are a type of chemical used in cosmetics to prevent bacteria and mould from growing. Some scientists are concerned that parabens are *structurally similar* to certain hormones in the human body, like estrogen (a hormone involved in growth and development).

Based on this information, what might be a possible health concern related to the use of parabens in cosmetics?

A. Parabens can cause instant allergic reactions in all users.

B. Parabens may copy or interfere with natural hormones like estrogen in the body.

C. Parabens directly damage human DNA when applied to the skin.

D. Parabens can cause burns on contact with the skin.

d. Parabens can enter rivers, lakes, and oceans when products like shampoo or lotion are washed down the drain. Scientists are concerned because some aquatic animals (like fish or frogs) rely on delicate hormone systems to control their growth and reproduction.

Based on this information, what is a possible environmental issue caused by parabens in waterways?

A. Parabens prevent the growth of algae, improving water quality.

B. Parabens break down instantly in water, so they have no effect.

C. Parabens may interfere with hormone systems in aquatic animals, affecting their growth or reproduction.

D. Parabens help fish develop faster, improving populations in rivers and lakes.

Space for Personal Notes

Contour Check

Learning Objective: [2.8.1] Identify & explain how physical properties of branched/unbranched alkanes, haloalkanes, alkenes, alcohols, esters, & carboxylic acids compare

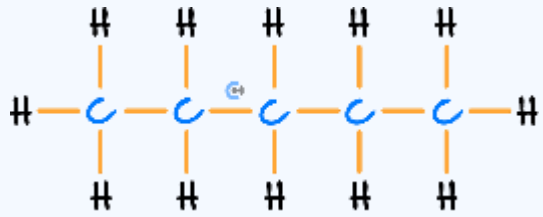
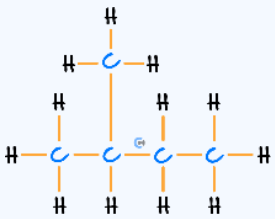
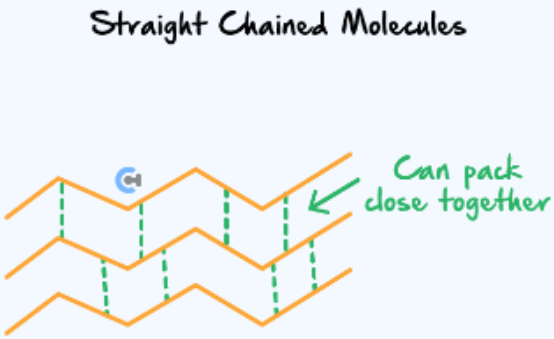
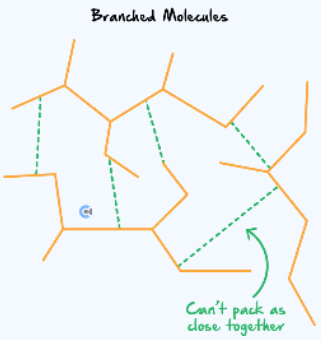
Key Takeaways

- Strength of Intermolecular Bonds:

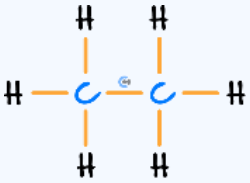
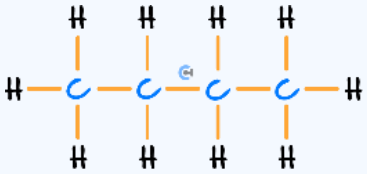
Weakest	Medium	Strongest

- Sample Response: Melting/Boiling Point
  - Explain why substance X has stronger intermolecular bonding.
  - More _____ required to _____ intermolecular bonds.
  - Leads to [higher] / [lower] melting point.

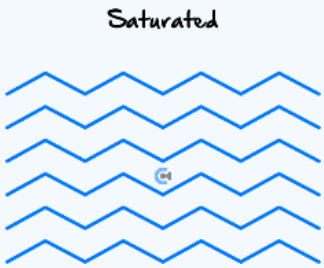
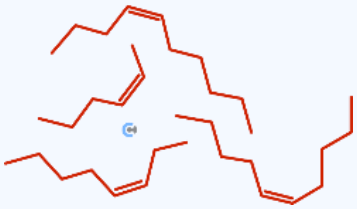
- Branching:

Pentane	Methylbutane
	
	
[Stronger] / [Weaker] intermolecular bonds.	[Stronger] / [Weaker] intermolecular bonds.

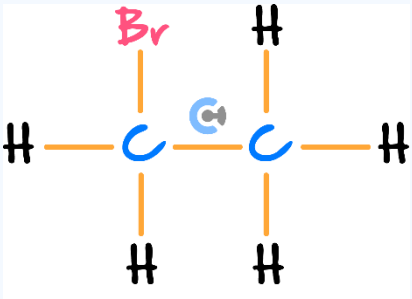
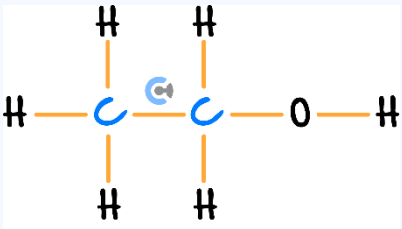
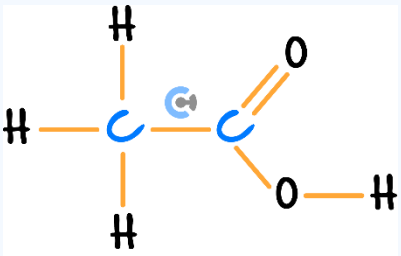
- Size of Molecule:

Ethane	Butane
	
[Stronger] / [Weaker] Dispersion Forces.	[Stronger] / [Weaker] Dispersion Forces.
[Higher] / [Lower] Melting Point.	[Higher] / [Lower] Melting Point.

- Double Bonds:

Alkanes	Alkenes
Saturated 	Unsaturated 
[Stronger] / [Weaker] intermolecular bonds.	[Stronger] / [Weaker] intermolecular bonds.

- Functional Groups:

Haloalkanes	Hydroxyl	Carboxyl
		

☐ Learning Objective: [2.8.2] Identify & explain renewable & non-renewable sources of organic matter & their impacts on society, & the limitations of renewable feedstocks

Study Design

"Plant-based biomass as an alternative renewable source of organic chemicals (for example, solvents, pharmaceuticals, adhesives, dyes and paints) traditionally derived from fossil fuels."

Key Takeaways

- ☐ Renewable Definition: Can be replaced by _____ within a _____.
- ☐ Circular Economy: Resources are _____.
- ☐ Linear Economy: Resources are _____.

Example	Limitation
Biomass	Food shortages, deforestation, habitat destruction.
Plant-based paracetamol	Expensive.
High-strength glue	Unable to source from biofuels.
Specific coloured dyes (e.g. Indigo)	Requires additives from petrochemicals (crude oil).
Harvesting of saffron	Worker exploitation.

☐ Learning Objective: [2.8.3] Apply sources of organic matter to identify real-life compounds used in society

Study Design

"Materials and products used in everyday life that are made from organic compounds (for example, synthetic fabrics, foods, natural medicines, pesticides, cosmetics, organic solvents, car parts, artificial hearts), the benefits of those products for society, and the health and/or environmental hazards they pose."

Key Takeaways

- ☐ Organic compounds are everywhere in modern life.
- ☐ Polar vs Non-Polar solvents help in _____ substances.
- ☐ Aspartame:
  - **Sweetness of Aspartame:** _____ sweeter than natural sugars.
  - **Energy Output of Aspartame:** [Higher] / [Lower] / [Same] as natural sugars.
  - **Amount of Aspartame Used:** Much _____ needed for the same sweetness.
  - **Effect on Energy Content:** [Higher] / [Lower] energy content as [more] / [less] aspartame is added.
- ☐ Polymers from organic compounds shape modern materials.

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