Higher Chemistry: Unit 2 – Nature's Chemistry

Part F – Fragrances and Skin Care

Lesson 2 – Skin Care

Learning Outcomes

By the end of this lesson you should know:

1. The effect of UV light on our bodies.
2. What are "free radicals" and how are they made
3. The steps of a free radical chain reaction
4. What are "free radical scavengers" and how we use them

Success Criteria

You will have been successful in this lesson if you:

1. Read and learn the notes given

2. Watch the links provided

3. Complete questions provided

4. EXTENSION: There is a further reading section to help you gain more depth of understanding for this section. There are also suggested questions for you to try from the blue book of revision questions.

5. HOMEWORK: Details of this week's homework are at the end of this lesson

If you have any questions about the content of this lesson, you should ask your class teacher either through your class MS team or via email. The teams will be monitored through the week and someone will get back to you as soon as they can.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

Higher chemistry – systematic carbon chemistry

You may wish to have a copy of the data booklet handy for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Notes - you should either copy, print or save the notes below.

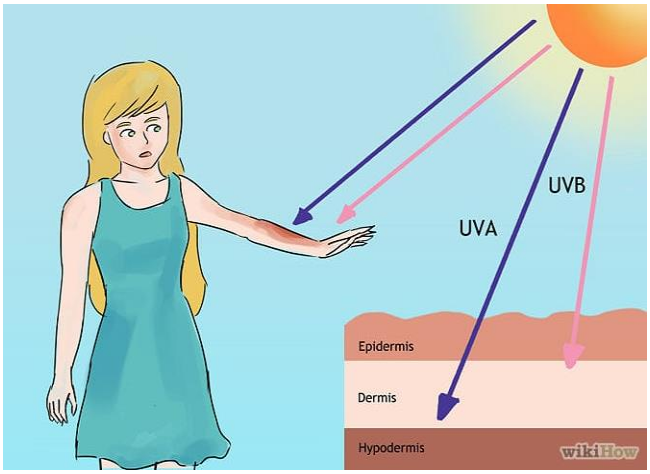
You will receive a paper copy of these notes when we return to school.

Skin Care

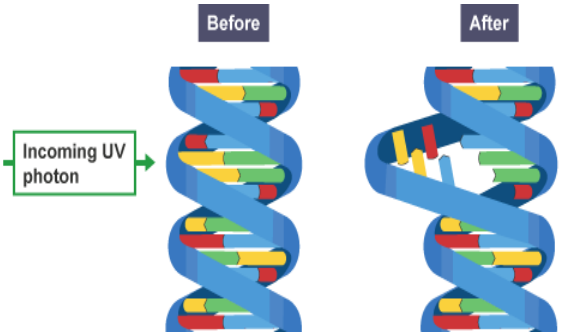
WATCH: Click the link for a recorded lesson:

PowerPoint with voice recording from Ms Hastie

UV Radiation



Ultraviolet radiation (UV) from the sun is a high energy form of light. There are three types of UV radiation, UVA, UVB and UVC.



All three forms affect the breakdown of collagen in our skin, which can lead to premature ageing. Over-exposure to UV radiation is also a major cause of numerous health problems involving the skin and eyes of humans, because UV radiation can damage the DNA in our skin cells.

WATCH - (3 mins) - UV light and its effect on us

https://www.youtube.com/watch?v=IgPNf-Td2og&feature=emb_logo

WATCH - (1 mins) - DNA damage caused by UV radiation

https://www.youtube.com/watch?v=uN82GLQYAUQ

Effect of UV radiation on molecules – Formation of Free Radicals

On a molecular level, UV light can provide enough energy to break some covalent bonds within molecules. The diagram below shows what happens to the electrons in this type of bond breaking reaction. The dots represent electrons.

Covalent bond: shared pair of electrons between two atoms.

Covalent bond breaks each atom retaining one electron from the pair. Atoms are now unstable FREE RADICALS.

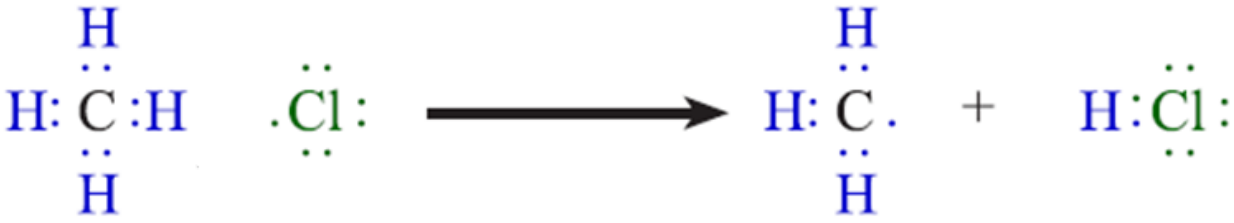
This reaction can also be represented:

Covalent bond: shown as a line between two atoms.

FREE RADICALS are shown as the atom symbol with a single dot beside, representing the **unpaired electron.**

This type of bond break produces **FREE RADICALS. Free Radicals** are atoms or molecules that are **highly reactive** due to the presence of **unpaired electrons.**

Free radicals are unstable and so they react very quickly to try pair up their electron. This is done by either by pairing up with another free radical or by attacking a covalent bond to steal an electron, causing a new free radical to be formed.



Chlorine free radical attacks the methane molecule

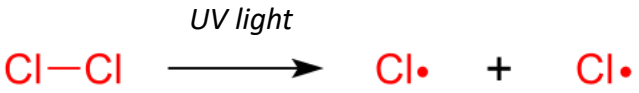
Chlorine free radical is now stable in a hydrogen chloride molecule, but has left a methyl free radical.

Free radicals can therefore cause **chain reactions**. These reactions happen in a three stage process – initiation, propagation, termination.

Free Radicals Chain Reactions

1. Initiation Step:

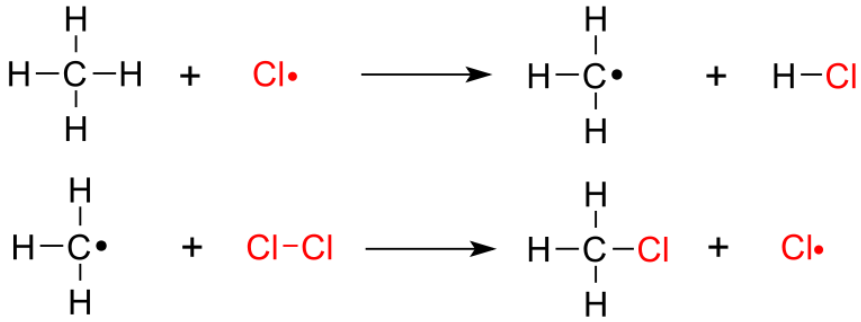
Splitting of a covalent bond, initiated by **UV radiation or sunlight.** This produces **two free radicals** each with an unpaired electron.



INITIATION: Free radicals on **RIGHT HAND SIDE** **of** equation

2. Propagation Step:

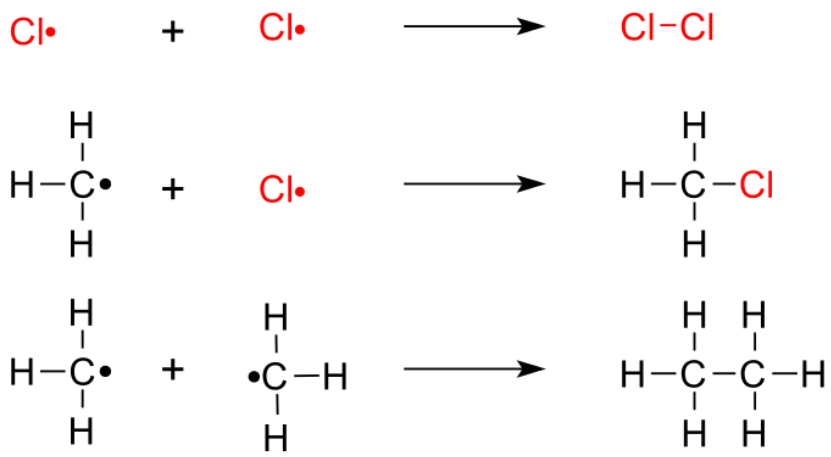
In each propagation step, one free radical enters the reaction and another free radical is generated.



PROPAGATION: Free radicals on **BOTH SIDES** **of** equation

3. Termination Step:

The chain reaction ends when two free radicals react with each other and form stable molecules. Multiple products are possible.



TERMINATION: Free radicals on **LEFT HAND SIDE** **of** equation

Protection from UV Radiation

Because of its damaging effects, we have to protect our skin from UV radiation coming from the sun (yes - even in Scotland).

Unprotected exposure to the sun is a major cause of skin cancer. This includes tanning beds, when our skin is exposed even more UV radiation than it would usually absorb from the sun.

Sun-block products prevent UV light reaching the skin, by **reflecting or absorbing UV radiation**. It therefore decreases the formation of free radicals.

WATCH - (4 mins) Sun benefit and dangers

https://www.youtube.com/watch?v=yZpEvX20gm4

WATCH - (3 mins) Your skin under UV light

https://www.youtube.com/watch?v=o9BqrSAHbTc&feature=emb_logo

Stabilising Free Radicals

Many products like cosmetics, food products and plastics contain **free radical scavengers.**

Free radical scavengers are molecules that **react with free radicals to form stable molecules** and prevent chain reactions from occurring.

Antioxidants are excellent free radical scavengers as they give away electrons while they are being oxidised. Another reason why a healthy diet with plenty of fruit and vegetables is essential to good health and a long life.

WATCH - (3 mins) TWIG – **The Dark side of oxygen**
https://www.twigscotland.com/film/the-dark-side-of-oxygen-986/

SUMMARY

Skin care

1. Ultraviolet (UV) radiation is a high-energy form of light, present in sunlight.
2. UV light can provide sufficient energy to break bonds within molecules.
3. This causes sunburn and accelerates ageing of the skin.
4. Sun-block products prevent UV light reaching the skin.
5. When UV light breaks bonds, free radicals are formed.
6. Free radicals are atoms or molecules that are highly reactive due to the presence of unpaired electrons.
7. Free radical chain reactions include the following steps: initiation, propagation and termination.
8. Equations can be written for reactions involving free radicals.
9. An equation involving free radicals can be recognised as representing an initiation, propagation or termination step.
10. Free radical scavengers are molecules that react with free radicals to form stable molecules and prevent chain reactions from occurring.
11. Free radical scavengers are added to many products including cosmetics, food products and plastics.

Learning Outcomes

You should now know:

5. The effect of UV light on our bodies.
6. What are "free radicals" and how are they made
7. The steps of a free radical chain reaction
8. What are "free radical scavengers" and how we use them

Further Reading

To learn more about proteins, try the following online resources:

BBC Bitesize: https://www.bbc.co.uk/bitesize/guides/zbwtbdm/revision/1

Read pages 1 and 2 and ***TRY THE TEST***

Scholar: Log in through GLOW

Higher Chemistry → Nature's chemistry → 11. Skin Care

Read through the exercises and ***TRY THE END TOPIC TEST***

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher → Unit 2: Nature's Chemistry → Skin Care

Check your understanding – Answers the questions below in you class jotter

2.19 Skin Care

1. Skin ageing and cancers can be caused by exposure to sunlight.

a) What type of radiation is present in sunlight?
b) How does this radiation affect the molecules in our skin?

2. The Earth has a protective layer around it in space, known as the ozone layer. In the past it was damaged when ozone molecules (O_3) reacted with chlorine free radicals:

$$Cl\bullet + O_3 \longrightarrow ClO\bullet + O_2$$

a) What is a free radical?
b) Identify the above reaction as initiation, propagation or termination.

3. The reaction between alkanes and bromine proceeds through free radical chain reactions. Some of the steps that can occur in the reaction between bromine and ethane are shown below:

i. $Br_2 \rightarrow 2Br\bullet$
ii. $C_2H_6 + Br\bullet \rightarrow C_2H_5\bullet + HBr$
iii. $C_2H_5\bullet + Br_2 \rightarrow C_2H_5Br + Br\bullet$
iv. $C_2H_5\bullet + Br\bullet \rightarrow C_2H_5Br$

a) Classify each type of reaction.
b) Another termination step results in the formation of **butane**. Write an equation for this step.
c) The following is a possible initiation step for the reaction:

$$C_2H_6 \rightarrow C_2H_5\bullet + H\bullet$$

Suggest why this step does not occur whereas step i(above) does, when the mixture of bromine and ethane is exposed to UV light.
Use page 10 of the data booklet to help.

4. People in the UK spend approximately £1.15 billion on facial skincare. Two important chemicals found in face creams are sun blocks and free radical scavengers.

a) How does sun block protect our skin?
b) What is a free radical scavenger?
c) What other substances have free radical scavengers added to them?

ANSWERS TO EXERCISES WILL BE POSTED ON WEDNESDAY FOR YOU TO CHECK YOUR WORK

EXTENSION WORK

Use the online learning link above if you would like to extend your knowledge of detergents and emulsions. For more practise questions for proteins, use your Revision Questions for Higher Chemistry "Blue book"

Free radicals page 65 Q1-6

HOMEWORK

You should now complete "**Homework 6 – Fragrances and Skin Care**" in your homework jotter, or the back of your class jotter if you don't have your homework jotter at home with you.

Take a picture of your homework answers and submitted them to your class teacher by **1pm on Friday 26th February.** Your teacher will let you know how to submit this and will give you feedback on this homework.

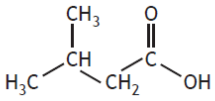
A copy of the homework is on the next pages.

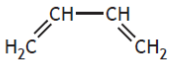
Homework 6 – Fragrances and Skin Care

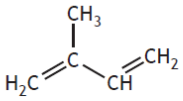
1. Which of the following is a termination step in a free radical chain reaction?

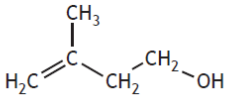
A $Cl_2 \rightarrow Cl\bullet + Cl\bullet$
B $CH_3\bullet + Cl\bullet \rightarrow CH_3Cl$
C $CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$
D $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$

2. The structure of isoprene is

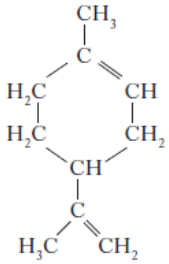
A 

C 

B 

D 

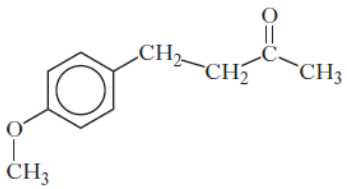
3. Limonene is one of the terpene molecules responsible for the flavour of lemons.



How many isoprene units are used in the production of one limonene molecule?

A 1
B 2
C 3
D 4

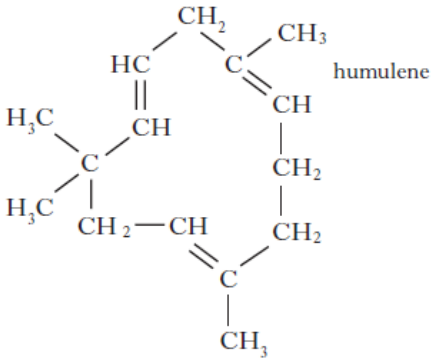
4. A compound with the following structure is used in perfumes to help provide a sweet, fruity fragrance.



This compound could be classified as

A an aldehyde
B a carboxylic acid
C an ester
D a ketone.

5. Humulene is a terpene which contributes to the aroma of beer.



How many isoprene units were used to form a humulene molecule?

A 2
B 3
C 4
D 5

6. Which statement is not true about free-radical scavengers?

A They remove grease and sweat from clothes.
B They are present in many cosmetic products.
C They are added to food products and plastics.
D They react with free radicals to form stable molecules and prevent chain reactions.

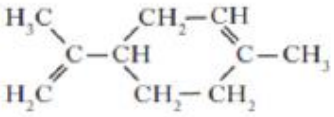
7. Which of the following is **not** a step in a free radical chain reaction?

A Activation
B Initiation
C Propagation
D Termination

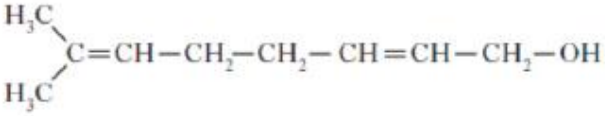
8. Which of the following is **not** true for an essential oil?

A They are widely used in cleaning products.
B They contain aroma compounds.
C They contain volatile compounds.
D They are water soluble.

9. Two typical compounds that are present in many perfumes are shown.



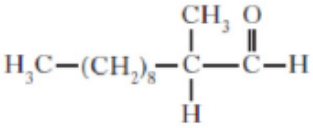
$C_{10}H_{16}$
limonene



$C_9H_{16}O$
geraniol

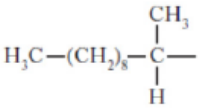
(a) Why does geraniol evaporate more slowly than limonene? (1)

(b) The structure of one of the first synthetic scents used in perfumes is shown.



Name the family of carbonyl compounds to which this synthetic scent belongs. (1)

(c) Copy and complete the structure below to show the product formed when this scent is oxidised.



(1)

(d) Suggest a reagent which could be used to oxidise geraniol. (1)

(e) Suggest what effect the oxidation would have on the effect of the scent of the molecule. (1)

10. Carbon monoxide gas is produced as a result of the incomplete combustion of fuels. The amount of carbon monoxide in the atmosphere is controlled by a series of free radical reactions.

(a) What is meant by the term *free radical*? (1)

(b) Why do free radicals form in the atmosphere? (1)

(c) The equation below shows one of the steps in the free radical chain reaction which controls the level of carbon monoxide.

$$CO + HO\bullet \rightarrow CO_2 + H\bullet$$

What term describes this type of step in the free radical chain reaction? (1)

(d) Carbon monoxide can be used to produce the gas tricarbon dioxide, C_3O_2, a substance used to bind dyes to natural fur. Draw a structural formula for tricarbon dioxide. (1)

11. Esters and terpenes have been used for thousands of years to create fragrances.

Traces of liquid were discovered in a perfume bottle that belonged to Queen Hatshepsut, ruler of Egypt, over 3500 years ago. Egyptian perfumes were made by dissolving plant extracts containing pleasant-smelling terpenes and esters in an edible oil. A little ethanol and water may also have been added.

Using your knowledge of chemistry, comment on the possible smell(s) when such a bottle is opened after being stored for thousands of years. (3)

Total = 20