Some Chemistry contexts / stories

Organic Chemistry and Society

1. **Dopamine and Meth**

- Explain how dopamine works in the brain.
- Explain why methamphetamine (‘meth’) and pseudoephedrine can mimic the effect of dopamine.
- Include the organic structures of the molecules of the above substances, and state their functional groups, in your answer.
- Give one other interesting insight into this topic from your reading.

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2. **Panadol**

- What is the name of the active ingredient in Panadol? Give its structural formula and state the functional groups that it contains.
- What is the dangerous product that this substance decomposes into? Which organ does it affect?
- Why is it maybe not a great idea to take Panadol if you have a hangover?
- Give one other interesting insight into this topic from your reading.

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3. **Nicotine**

- Compare the number of deaths in the USA annually caused by a) nicotine b) alcohol c) car accidents d) illegal drug use
- Explain why nicotine is addictive.
- Give the structural formula of nicotine and state its functional groups. Which insecticide has a similar structure to nicotine?
- What do e-cigarettes contain?
- Give your opinion on whether vaping is more or less dangerous that smoking a cigarette. Justify your answer.
- Give one other interesting insight into this topic from your reading. Eg perhaps you could find the same statistics for New Zealand

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4. **Caffeine**

- State the organic structure of the molecule ‘caffeine’ and name any functional groups that it contains.
- Caffeine is the world’s most consumed psychoactive substance. Explain what ‘psychoactive’ means.
- In 1980 it was realised that caffeine is not that good for us. Soft drinks manufacturers had to justify keeping caffeine in their products. How did they do it?
- Do you think caffeine use by society should be reduced? Justify your answer.
- Give one other interesting insight into this topic from your reading.

Organic Chemistry and Society

5. **Air Pollution**

- What is the origin of the name of the ‘Blue Mountains’ in Australia?
- Turpenes are largely responsible for heat haze during summer. Give the structural formula of one example of a ‘turpene’ and state the functional groups that it contains.
- How do turpenes cause heat haze?
- How are turpenes being produced by humans?
- Why are turpenes in the atmosphere, bad for human health?
- Give one other interesting insight into this topic from your reading.

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6. **BPA**

- Give the structural formula for BPA and state the functional groups that it contains.
- What sort of products is it found in?
- Why is BPA a problem and how have nations dealt with the threat that it poses?
- Is the replacement to BPA any safer? Justify your answer.
- Give one other interesting insight into this topic from your reading.

Organic Chemistry and Society

7. **Melamine and milk powder**

- Give the structural formula of melamine and state the functional groups that it contains.
- Explain the link between melamine and milk powder that occurred in China in 2008.
- Why was melamine added to the milk powder in the first place?
- What else is melamine used for?
- Give one other interesting insight into this topic from your reading.

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8. **Nail Polish Chemistry**

- Give the structural formulae of 3 organic substances that can be found in nail polish and state the functional groups that they contain.
- Explain why these substances are used in nail polish.
- Outline any potential hazards caused to humans, by one or more of these substances
- What is ‘3-free’ nail polish and is it any good?
- Give one other interesting insight into this topic from your reading.

Organic Chemistry and Society

9. **Popcorn lung**

- Eight workers died in a popcorn factory in the USA in the year 2000. Explain how this came about.
- Provide the structural formula for the molecule ‘diacetyl’ and state the functional groups that it contains.
- What is the link between diacetyl & popcorn; and diacetyl & e-cigarettes?
- Give your newly educated opinion on the wisdom or otherwise of inhaling the buttery aroma after opening a packet of butter-flavoured popcorn.
- Give one other interesting insight into this topic from your reading.

Organic Chemistry and Society

10. **That library smell**

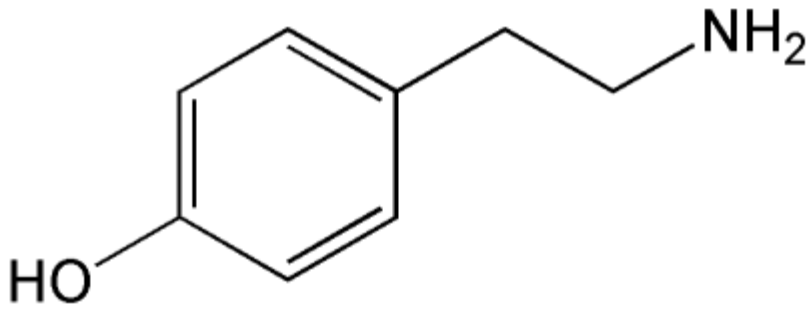
- Lignin is a complex molecule found in wood-based products such as paper. Over time it degrades and forms vanillin. Give the structural formula of vanillin and state the functional groups that it contains.
- Vanillin is partly responsible for ‘old book smell’. Name two other compounds that are also responsible for this smell.
- Explain how vanilla extract, used in cooking, is now produced.
- Explain how scientists would be able to determine whether a sample of vanilla extract could have come from actual vanilla beans as opposed to from a synthetic source.
- Give one other interesting insight into this topic from your reading.

Warm up

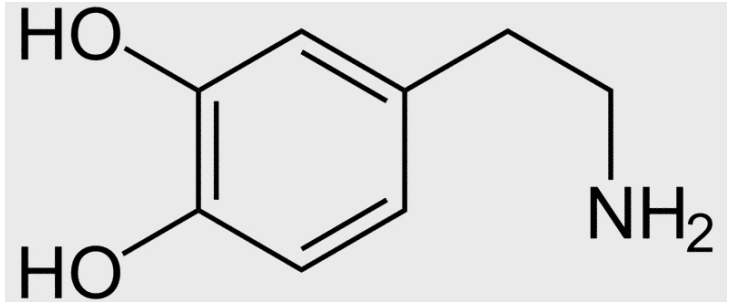
Migraines

Name the functional groups in the following molecules:

- Tyramine. Found in red wine, cheese, chocolate.



- Mimics dopamine



A drug is being developed

To treat migraines by using knowledge

Of the ***seratonin receptor***

- Canterbury Uni

A local Chemistry story: Chocolate

Wellington Chocolate Factory

Imports cocoa beans from Bourganville

Grown by James Rutana

Making Chocolate

Cocoa beans, in pod

- Ferment the beans (under 40°C)
- Dry them

Bourgainville – ‘rum & raisin flavour’

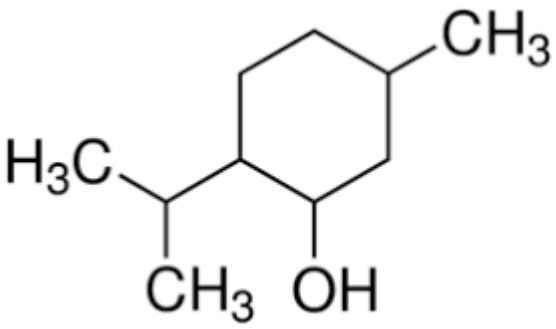
Dominican Republic – ‘raspberry jam’

-> export.

WCF – made their own trilling machine. Hired a retired ballistics engineer to build it. Started with an old grinder from India, had been used for rice.

- Grinding,72 hours per batch. WCF: 70% beans, 30% sugar
- Tempering – 50°C – 28°C – 34°C, to create ‘shine’ and ‘crack’

‘Warm up’: menthol



- Activates a nerve cell receptor TRPM8 – which is only active below 25°C.
- Menthol therefore provides a cooling sensation, is used e.g. in toothpastes, chewing gums, some lollies.
- TRPM8 receptors also found in the nose – so vapour inhalation of menthol gives a cold sensation in the nasal cavities

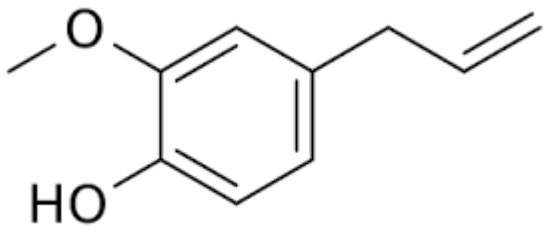
Give the structural formula of a molecule formed when menthol is reacted with

a) Br_2, Bromine water in the presence of UV light.

b) $SOCl_2$

Warm up: a spicy alcohol

Eugenol



Molecule found in a warm (spicy) taste eg cloves, bay leaves, basil, nutmeg, marijuana

What would happen if you added bromine to this molecule? Draw the organic product. (Note – it will only add one Br atom to the benzene ring, in a substitution reaction, swapping for a H)

Carboxylic acids $C_nH_{2n+1}COOH$

1. Draw the structural formulae for:

- Ethanoic acid

- Butanoic acid

- 3-methyl, 2-hexenoic acid

2. Now look up and draw the structural formula of ‘Triclosan’, one of the important antimicrobial ingredients in deodorants

3. Name the functional groups in triclosan and explain ONE reaction you could carry out to change one of the functional groups on it.

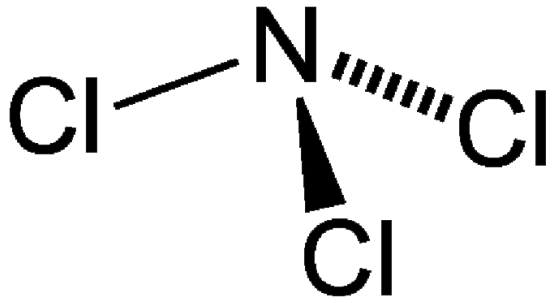
Non-organic contexts

Mt. Ruapehu

- Changes to sulfate and chloride concentration tell us about the thermal activity of the crater lake
- https://www.stuff.co.nz/national/123776685/ruapehus-crater-lake-heating-up-tremors-continue

Trichloramine

Draw the Lewis diagram for NCl3, given its shape shown here.



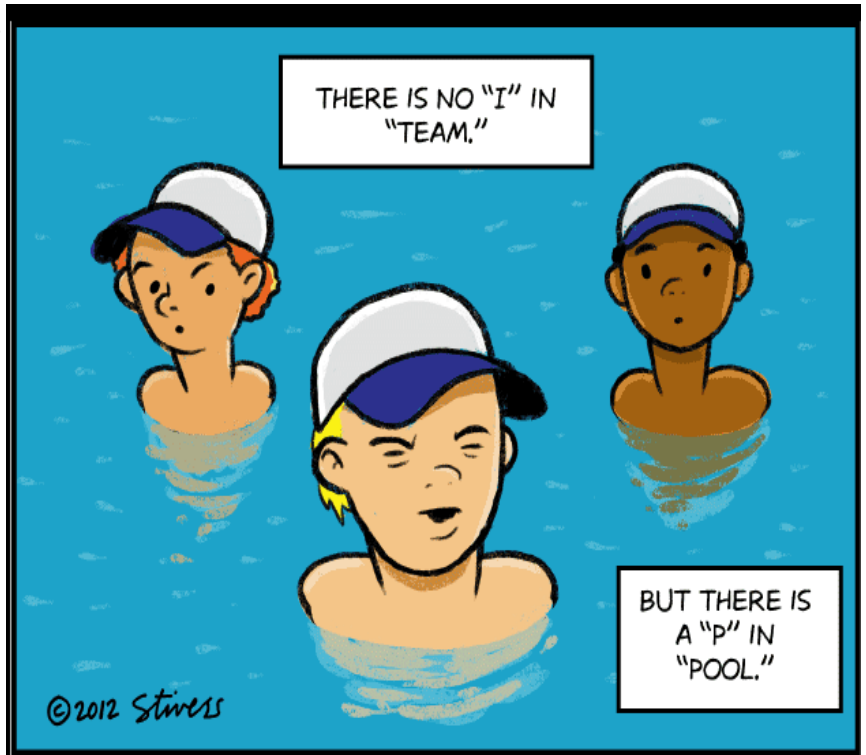
Explain its shape.

……

Don't pee in the pool

This molecule forms when Cl_2, Chlorine, which is used to sterilise pools, reacts with urea, found in urine.

It is much more responsible for the 'chlorine' smell of swimming pools than the chlorine itself.



Chewing gum…

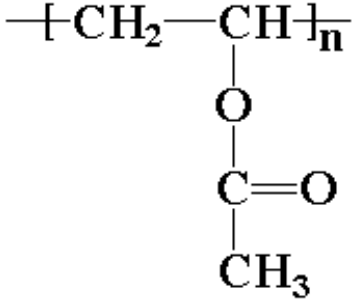
Used to come from a **sapodilla tree**. – grows in Mexico (also Thailand, Phillipines, Florida and other warm climates)

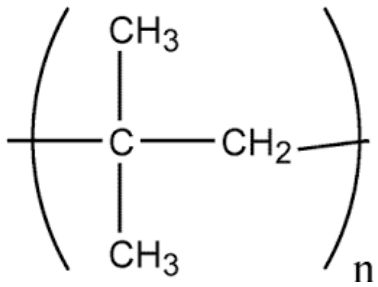
Legend has it – General Antonio Lopez de Santa Anna, President of Mexico in 1869 was exiled to America, took with him a sample of chicle, a latex gum derived from the sapodilla tree. He gave the sample to Thomas Adams who created the first modern gums – Tutti Frutti and Black Jack licorice.

Chewing gum…

Contains

polyvinyl acetate …and .. polyisobutylene.. now derived from crude oil





- Chewing gum consists of (very) long covalent molecules. What sort of forces exist between molecules within chewing gum?
- Chewing gum stuck in hair can be removed reasonably easily using peanut butter or cooking oil. Explain why.
- Chewing gum does not stick well to glass or aluminium cans. Why not?

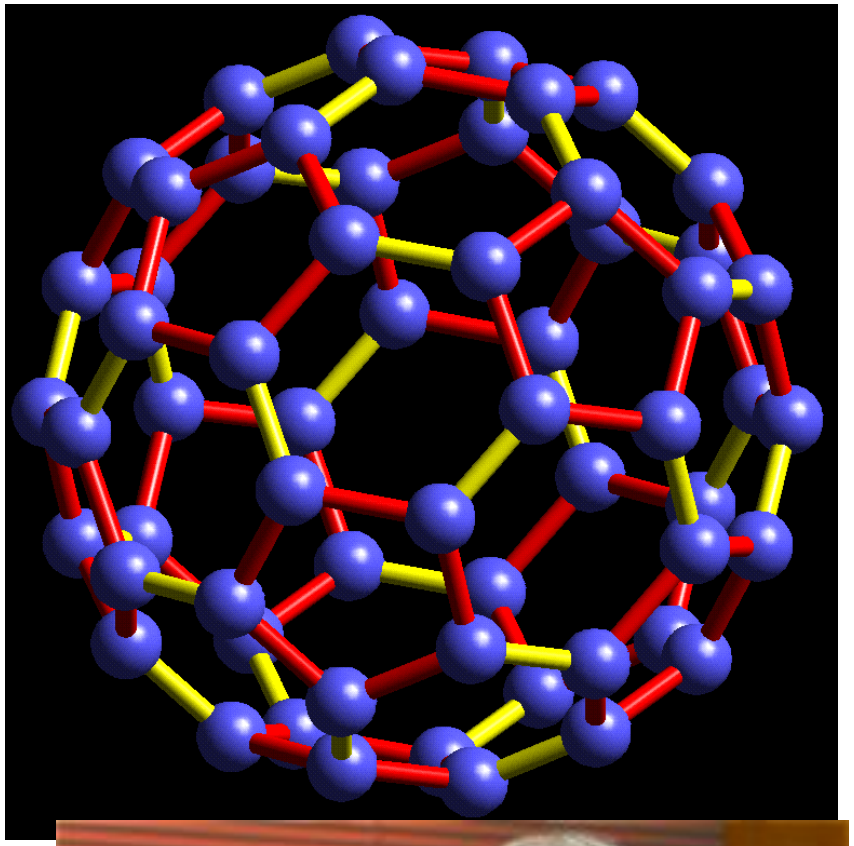
Buckyball!

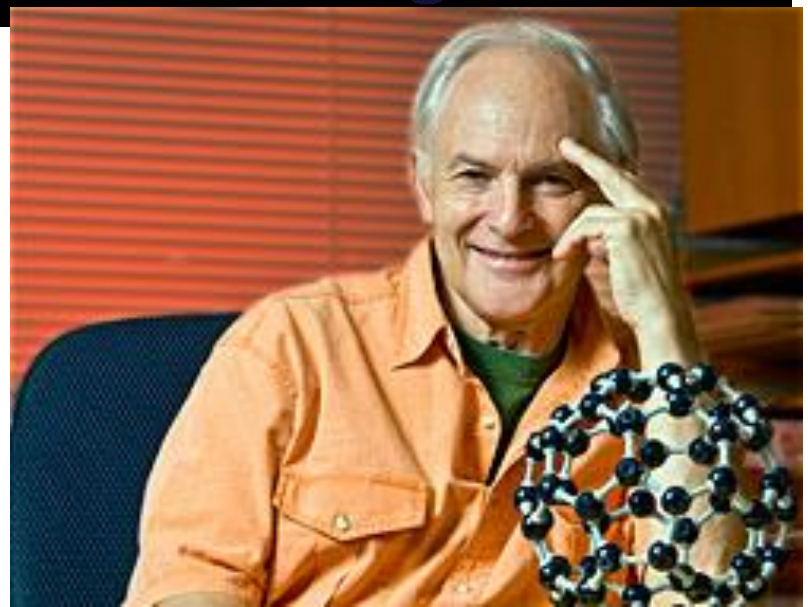
- Another pure form of carbon, C_{60}
- 1996 Nobel prize in Chemistry
- http://nobelprizes.com/nobel/
- - naturally occuring in soot
- - Harry Kroto dropped a large spanner into the mass spectrometer when working on the buckyball. Was dangled upside down inside it to retrieve it.

- http://en.wikipedia.org/wiki/Fullerene

- Also: carbon nanotubes

- Uses – electronics industry





Ammonium nitrate explosion

clip

This deadly explosion happened on 5th August 2020 in Beirut, Lebanon. It was possibly the largest peace-time explosion ever recorded.

Use oxidation numbers to work out what was oxidised and what was reduced in this explosion.

$2NH_4NO_3 \rightarrow 2N_2 + O_2 + 4H_2O$

……

Given the extreme heat involved, nitrogen and oxygen reacted together:

$$N_2 + O_2 \longrightarrow NO$$

The nitric oxide very quickly reacts with more oxygen to form **nitrogen dioxide.**

$$NO + O_2 \longrightarrow NO_2$$

Both of the nitrogen compounds are known collectively as nitrogen oxides or NO_x.

The Rio Olympics Diving Pool Saga

Several tonnes of hydrogen peroxide was added to the diving pool at the Rio Olympics by mistake. The result (after a while) was a green appearance of the water.

The two half equations occurring were:

H_2O_2 -> O_2

OCl^- -> Cl^-

Complete the half equations and write a fully balanced ionic equation for the reaction occurring.

Full equation:

Any thoughts on what might have caused the green colouration? (It took a while to form)

Equilibrium Systems

Balance Agri – Nutrients urea plant, Kapuni, Taranaki

Some chemistry background to fertilizers……

Ammonia synthesis

Ammonia is synthesised from hydrogen (from natural gas) and nitrogen (from the air). Natural gas contains some sulfurous compounds which damage the catalysts used in this process. These are removed by reacting them with zinc oxide, e.g.

$$ZnO + H_2S \rightarrow ZnS + H_2O$$

The methane from the natural gas is then converted to hydrogen:

$$CH_4 + H_2O \leftrightarrows 3H_2 + CO$$

$$CH_4 + 2H_2O \leftrightarrows 4H_2 + CO_2$$

$$CO + H_2O \leftrightarrows H_2 + CO_2$$

Air is mixed in with the gas stream to give a hydrogen:nitrogen ratio of 3:1.

Water, carbon monoxide and carbon dioxide (all of which poison the iron catalyst used in the ammonia synthesis) are removed. The carbon monoxide is converted to carbon dioxide for use in urea production, and the carbon dioxide removed:

$$CO + H_2O \leftrightarrows CO_2 + H_2$$

The remaining traces of CO and CO_2 are converted to methane and then the gases cooled until the water becomes liquid and can be easily removed.

The nitrogen and hydrogen are then reacted at high temperature and pressure using an iron catalyst to form ammonia:

$$N_2 + 3H_2 \leftrightarrows 2NH_3$$

Urea synthesis

Urea is made from ammonia and carbon dioxide. The ammonia and carbon dioxide are fed into the reactor at high pressure and temperature, and the urea is formed in a two step reaction

$$2NH_3 + CO_2 \leftrightarrows NH_2COONH_4 \text{ (ammonium carbamate)}$$

$$NH_2COONH_4 \leftrightarrows H_2O + NH_2CONH_2 \text{ (urea)}$$

Facts about ammonia, NH_3

- 500 million tonnes of NH_3 are produced each year using the Haber Process
- This process sustains 1/3 of the world's population
- Without it, more than 2 billion people would be dead, from starvation
- Economic output - $200billion dollars per year worldwide
- This process uses 5% of the world's natural gas production

$$2N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Nitrogen Hydrogen Ammonia

Fritz Haber -The man behind the story

- 1918 Nobel Chemistry prize for synthesis of NH_3 from its elements.
- Provided replacement for limited supply of Chilean nitrate fertilisers.
- NH_3 is also used to produce the nitric acid required for explosives, so the new self sufficiency probably delayed the end of WWI.
- Before WWI he developed an insecticide called Zyklon A which was later modified to gas millions of Jews in WWII.
- He developed mustard gas which was first used at Ypres in 1915.
- In 1915 his wife Clara, also a PhD chemist committed suicide – apparently distressed at Fritz's enthusiasm for poisonous gases.
- Ironically this German nationalist and patriot was forced to flee Germany in 1933 because of his Jewish ancestry.

Application of pH

- Changing pH of the world's oceans

For 300 million years, the pH of the oceans has been stable at around 8.2.

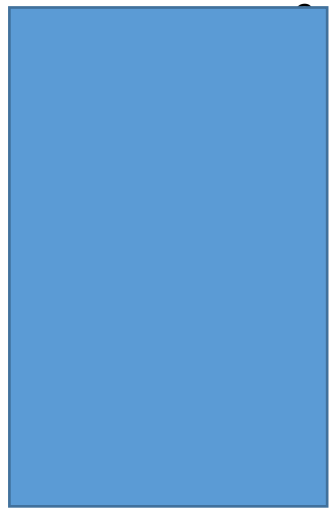
Today it is 8.1 Calculate the % increase in concentration of acid in the ocean.

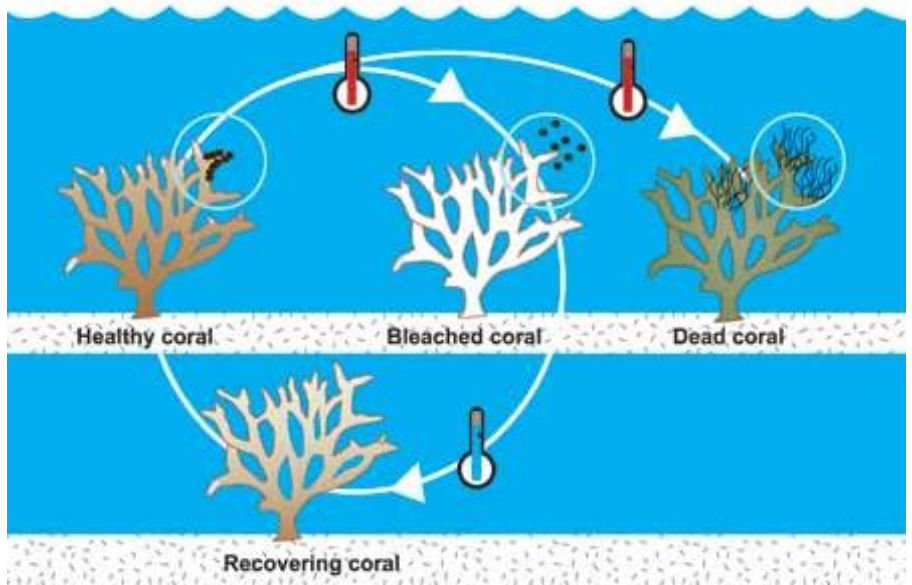
Answer: At pH 8.2, $[H_3O^+]$ = _____ $molL^{-1}$.

At pH 8.1, $[H_3O^+]$ = _____ $molL^{-1}$.

% change = _____ x 100

= _____ %




Healthy coral
Bleached coral
Dead coral
Recovering coral