Irish Independent | Independent.ie with Yeats College

Exam Brief

Thursday, 13 May, 2021

Chemistry & Biology

Your complete guide to the Higher Level papers in the Leaving Cert

Sample questions and answers

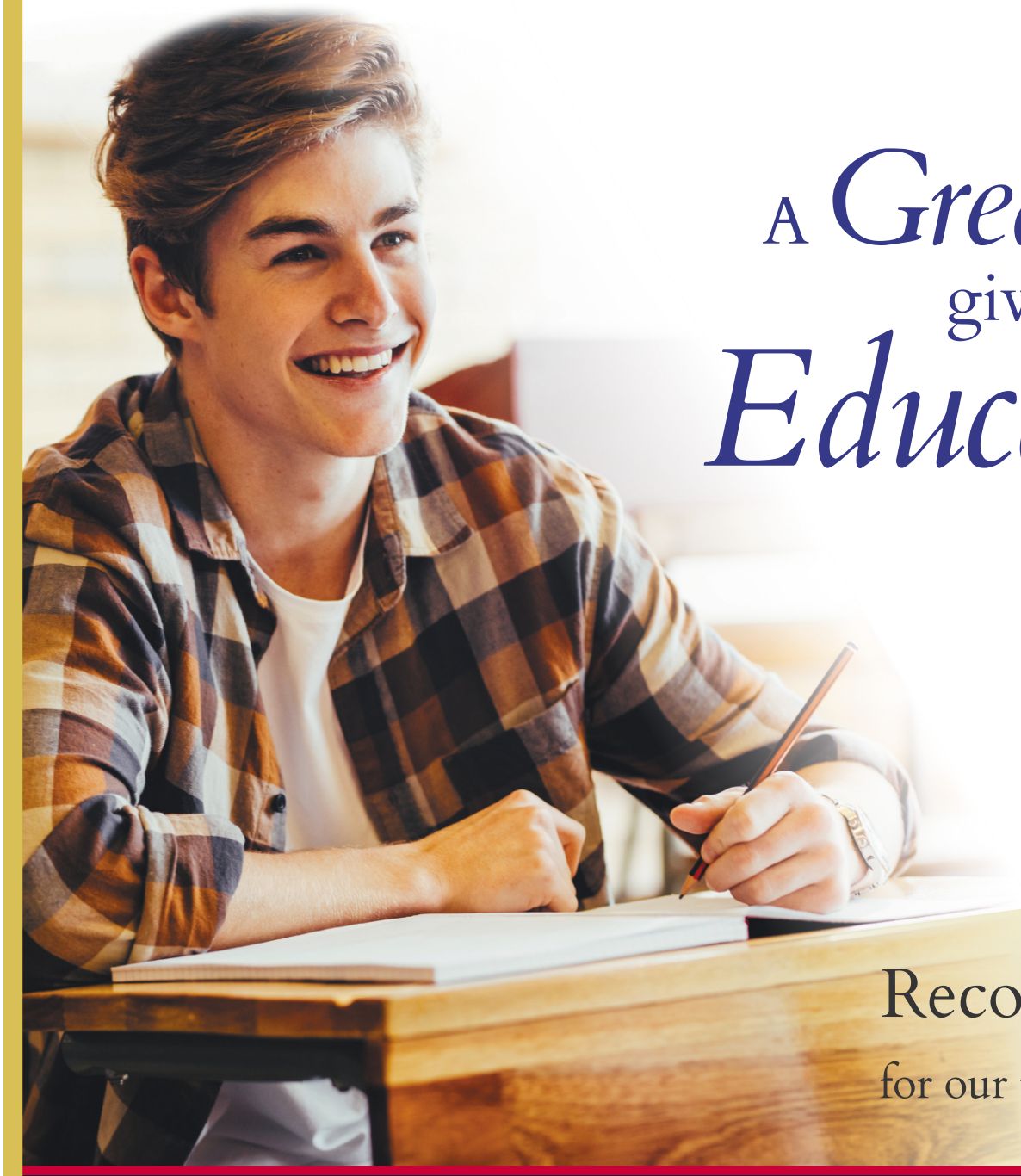
Expert advice from Yeats College

Covid-19 amendments for 2021

Yeats College has produced a podcast to help students to prepare for the Biology exam. Go to https://www.yeatscollege.ie/exam-brief-2021/

Yeats College

Masters in Educational Success



A *Great* school gives you an *Education* for *Life*

Recognised *in* Ireland
for our truly *exceptional* Results

Now Enrolling

5th Year | 6th Year | Repeat Leaving Certificate

Teaching Excellence | Uniquely motivated environment
Unrivalled results record | Flexible subject choice

Galway: 091 533500 **Waterford:** 051 304211

www.yeatscollege.ie

Precision and accuracy are the keys to success

*Yeats teacher **Dr Martina Audley McDonagh** provides advice on how to approach this year's exam to achieve the best possible result*

Chemistry is a most fascinating subject and it extends to all facets of life today. Students of chemistry get to explore the basis on which many innovations have impacted on our daily lives. In archaeology, the science of carbon dating is used regularly to establish a scientific connection with the past and to verify authenticity of historical artefacts. Other fields include forensic science, domestic fuels, plastics, paint and a myriad of other products. Even the water we drink every day has been purified by the science of chemistry.

This past year has been difficult for many students and it is important that all Leaving Cert students are up to date with the adjustments to this year's exams.

Exam Structure

Length of exam – 3 hours.
Total number of questions – 11
Three questions have internal choices, Questions 4, 10 and 11.
Number of questions to be answered – 6
Answer ANY 6 questions (for this year only!)
Length of time per question – 30 minutes (for this year only!)
Rule of thumb - 25 minutes per question leaving 30 minutes to read exam paper, pick your best questions, spend extra time if needed at a question and read over your answers.
Total marks – 300 (for this year only!)
50 marks per question.

There are **two sections** in the chemistry paper:
Section A has 3 questions and
Section B has 8 questions.

For this year only, you answer **ANY SIX** questions (it is **not** compulsory to answer questions from **Section A** this year!!)

Section A examines the **mandatory experiments**. In Section A, **Question 1** is a Volumetric Analysis question,
Question 2 is an Organic practical question and
Question 3 is from the remaining mandatory experiments.

Section B of the exam paper **has eight questions** from the remaining course material.
In this section, **Question 4** consists of 12 short questions and students must answer **eight** of these.
Question 5 is based on atomic theory.

There are at least **two Organic Chemistry** questions. Other topics normally examined in Section B include Acids, Bases, pH and Water, Chemical Equilibrium, Rates of Reaction, Radioactivity and Gas Laws.

For this year only, students are not required to cover the Option Question. However, if students have covered the Option section, then there will be an additional part in the short question, Question 4(l), and an additional part in the last question, Question 11(d), to allow students to answer on this topic.

Question 1

The following experiments are examined in **Question 1**:

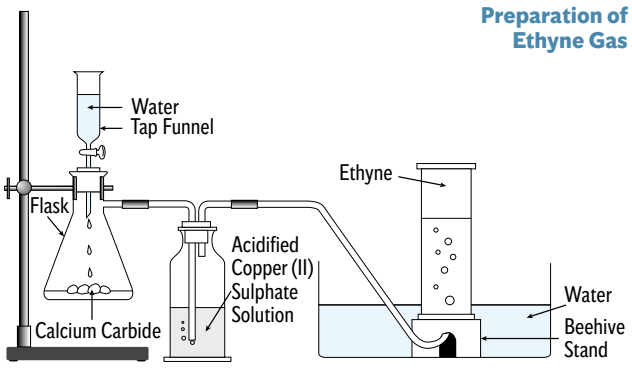
1. Preparation of standard solution of sodium carbonate (Na_2CO_3)
2. Acid – Base Titrations — HCl and Na_2CO_3,
— HCl and NaOH
3. % Ethanoic Acid in vinegar... w/v
4. % Water of Crystallisation..... "x" H_2O
5. Oxidation / Reduction (Redox) Titrations:
— $KMnO_4$ with ammonium iron (II) sulphate,
— Amount of Iron in an iron tablet,
— Iodine with $Na_2S_2O_3$
— % hyperchlorite (w\v) in a bleach.
6. Water Analysis — Total Hardness using ethylene-diaminetetraacetic acid (EDTA)
— Dissolved Oxygen .... Winkler's method.

Question 2

This is an organic experiment question. Preparation of ethene, ethyne and soap, for example, can be examined here. Students should be able to write equations for the preparation of the given substance, draw the appropriate diagrams, work out the percentage yields and know precautions and other relevant theory associated with each of the experiments.

The following is some of the information required for the preparation of ethyne gas. Calcium carbide (grey solid) reacts with water to produce ethyne gas and calcium hydroxide.

Equation: $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$



The water is added **slowly** from the tap funnel to allow for even evolution of ethyne gas. Three impurity gases **(PH_3, NH_3, H_2S)** are also given off and these impurity gases are removed by bubbling all gases through **acidified copper (II) sulphate** solution. Ethyne gas is then collected by the displacement of water.

Safety Precautions: Do not touch CaC_2 as moisture from your hands could start the reaction. Also ethyne forms an explosive mixture with air, so keep ethyne gas away from a naked flame.

Combustion: Ethyne burns with a luminous **smoky** flame with **soot** formed.

$$C_2H_2 + 2\tfrac{1}{2}\,O_2 \rightarrow 2CO_2 + H_2O$$

[Remember: Ethene burns with a luminous flame only.....
$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$]

Uses of Ethyne: Oxy aceteylene flames for welding metals. Also used for making ethanal and propanone.

Techniques like refluxing, distillation, chromatography, steam distillation and recrystallisation can also be examined. The preparation of benzoic acid from phenylmethanol by oxidation using potassium manganate (VII) solution in alkaline conditions was introduced, a few years ago, as a new experiment for this question.

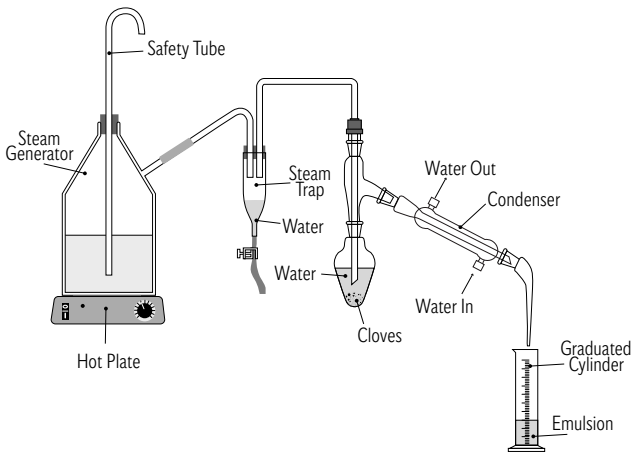
Also in the extraction of clove oil (eugenol) from cloves by steam distillation, the method of isolating the eugenol from the emulsion (liquid–liquid extraction) and the structure of eugenol must be known.

The following is some of the information required for steam distillation of clove oil.

CHEMISTRY

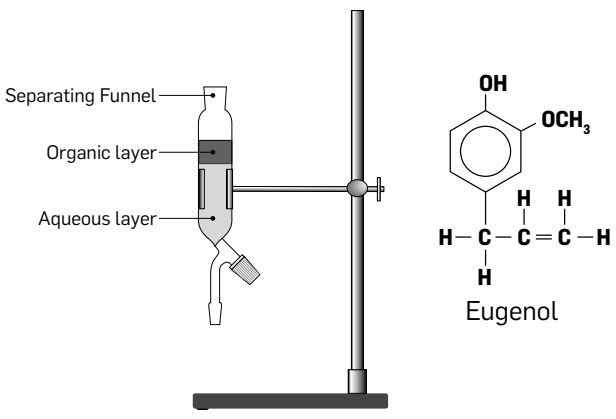
Many natural products are **isolated** for their **medicinal** purposes and/or their **fragrant oils** (perfumes).

Steam distillation isolates compounds at temperatures below their decomposition temperatures. It is carried out by bubbling steam through the material and distilling off the immiscible liquids.



Safety tube (bottom of tube well below the level of water... purpose: releases pressure, prevents explosions), steam trap (removes condensed steam), flask with whole cloves (more oil) and water, condenser, graduated cylinder (collect **milky emulsion**).

Clove oil **(eugenol)** is **isolated** from the emulsion by **liquid-liquid extraction** (solvent extraction). Cyclohexane is added to the emulsion. The cyclohexane dissolves the oil of cloves in the emulsion but does not mix with the water. The organic solution (clove oil and cyclohexane) is separated from the water using a separating funnel.....organic layer (top layer)....aqueous layer (lower layer).



Anhydrous magnesium sulfate, $MgSO_4$, is added to the cyclohexane solution (organic layer) to remove any droplets of water. The hydrated magnesium sulfate and excess magnesium sulfate are removed by filtration. The organic solvent, cyclohexane (81°C), is then allowed to evaporate (water bath) leaving the pure oil behind.

Uses of eugenol: Antiseptic properties - soaps, perfumes; flavouring food products - sausages, apple pies.

Question 3

Question 3 is from the remaining mandatory experiments.
Topics examined in this question include:
Recrystallisation, Gas Laws (relative molecular mass of a volatile liquid), Cation (positive ion) and Anion (negative ion) Tests, Rates of Reaction, Colorimetry.

Question 4

Question 4 consists of **12** short questions this year (not 11!). Students must answer **eight** of these short questions.
Each short question is allocated **6 marks** with one additional mark added to each of the first two questions for which the highest marks are awarded.

Practice is essential for this question. **All** previous Question 4s should be completed and **learned**. If a definition is asked, remember it **MUST** be word-perfect – leaving out a key word/ phrase could cause you to lose the **full** 6 marks.

An extra part is being added to this question this year **(Question 4(l))** and will be from the Option Section of the course.

Question 5

Question 5 is based on atomic theory.
Topics examined here include:

- Historical development of atomic theory including the contributions of **Dalton, Crookes, Thomson, Stoney, Millikan, Rutherford, Chadwick**
- **Bohr's theory**, Atomic Spectra, Energy Levels
- History of the Periodic Table, including the contributions of **Davy, Dobereiner, Newlands, Mendeleef, Moseley**
- **Mass Spectrometer** including its principle, five main stages of its operation and uses,
- **General trends** in Atomic Radii, Electronegativity, Ionisation Energy (don't forget the exceptions), trends within Group I , II, VII and VIII elements,
- **Shapes** of molecules using Valence Shell Electron Pair Repulsion Theory,
- **Bonding**. Octet Rule, Ionic Bond, Covalent Bond, Sigma and Pi Bonding, Intramolecular and Intermolecular Bonding, Van der Waals Forces, Dipole-Dipole Forces and Hydrogen Bonding.
- Relationship between the type of bonding present and **boiling points, Solubility** (polar / non-polar)
- **Radioactivity**. Henri Becquerel, Pierre and Marie Curie, Alpha (α), Beta (β), Gamma (γ) particles — their sources and their penetrating power, Geiger-Muller tube, nuclear reactions, half life, radioisotopes and their uses.

* * * * *

The following are some topics examined in the paper. I have placed emphasis on calculations and organic as some students have difficulty with these sections.

Moles

A **mole** is the molecular mass of a substance in grams and contains **Avogadro's number (L, $6x10^{23}$) of particles** of that substance.
Molar volume is the volume occupied by 1 mole of a gas.
At **s.t.p.** one mole of a gas occupies **22.4 litres**.
(s.t.p. is standard temperature and pressure)
Molar volume at room temperature and pressure is 24 litres.

Remember:
To convert **mass / volume / molecules back to moles** you always **divide:**
Mass → Moles ..... divide by the mass of one mole of that substance.
Volume (at s.t.p) → Moles ..... divide by the volume of 1 mole of that substance at s.t.p.
Molecules → Moles ..... divide by Avogadro's number, $6 x10^{23}$.

Question:

How many moles of carbon dioxide are there in:
(a) 110g of carbon dioxide?
(b) 1.12 L of carbon dioxide measured at s.t.p.?
(c) 1.5×10^{22} molecules of carbon dioxide?

Answer:

(a) 1 mole of $CO_2 = 12 + 2(16) = 44g$
$\Rightarrow$ number of moles = $\frac{110}{44} = 2.5$ moles
(b) 1 mole of CO_2 at s.t.p. = 22.4 L
$\Rightarrow$ number of moles = $\frac{1.12}{22.4} = 0.05$ moles
(c) 1 mole of CO_2 contains 6×10^{23} molecules
$\Rightarrow$ number of moles = $\frac{1.5 \times 10^{22}}{6 \times 10^{23}} = 0.025$ moles

If you are given **moles and** want to convert them to **mass / volume / molecules** then you **multiply:**
Moles → Mass .... multiply by molecular mass
Moles → Volume (s.t.p.) ... multiply by 22.4 L
Moles → Molecules ..... multiply by $6x10^{23}$.

Moles Exam Question: 2014 11(b)

When crystals of ammonium dichromate [$(NH_4)_2Cr_2O_7$] are heated strongly, they decompose fully, according to the following balanced equation:

$$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O$$

When 12.6g of these crystals was heated strongly, calculate:
(i) how many moles of ammonium dichromate reacted,
(ii) the mass of chromium(III) oxide (Cr_2O_3) formed,
(iii) the volume at s.t.p. of nitrogen gas evolved,
(iv) the number of molecules of water produced. How many atoms did this quantity of water contain?

Answer:

(i) 1 mole $(NH_4)_2Cr_2O_7 = 2(14+4)+2(52)+7(16) = 252g$

Used 12.6g $\Rightarrow$ $\frac{12.6}{252} = 0.05$ moles

(ii) 1 $(NH_4)_2Cr_2O_7 \rightarrow$ 1 Cr_4O_3
0.05 0.05 moles formed
1 mole of $Cr_2O_3 = 2(52) + 3(16) = 152g$
$\Rightarrow 0.05 \times 152 = 7.6g$ Cr_2O_3 formed.

(iii) 1 $(NH_4)_2Cr_2O_7 \rightarrow$ 1 N_2
0.05 0.05 moles evolved
1 mole of N_2 at s.t.p. = 22.4 L
$0.05 \times 22.4 = 1.12$ L

(iv) 1 $(NH_4)_2Cr_2O_7 \rightarrow$ 4 H_2O
0.05 4(0.05)
= 0.2 moles formed
1 mole of H_2O contains 6×10^{23} H_2O molecules
$\Rightarrow 0.05 \times 6 \times 10^{23} = 1.2 \times 10^{23}$ molecules
$= 3(1.2x10^{23})$ atoms.
$= 3.6 x10^{23}$ atoms.
(Every 1 molecule of H_2O contains 3 atoms).

Atom splitters, from left to right: Dr Ernest Walton, Ernest Rutherford, the 1908 Nobel prizewinner for chemistry and Dr John Cockcroft

Moles and Molarity

The **molarity (M)** of a solution is the number of moles of solute per litre of solution.
If given molarity then the number of moles is

$$\textbf{No. of Moles} = \frac{\textbf{Molarity}}{1000} \times \frac{\textbf{Volume used}}{in\ cm^3}$$

Question:

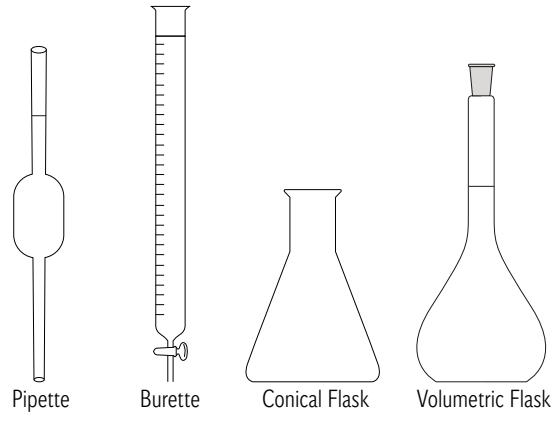
(a) Calculate the number of moles of sodium hydroxide in $25cm^3$ of 0.1 M NaOH solution.
Ans: No. of moles = $\frac{0.1}{1000} \times \frac{25}{1} = 2.5 \times 10^{-3}$

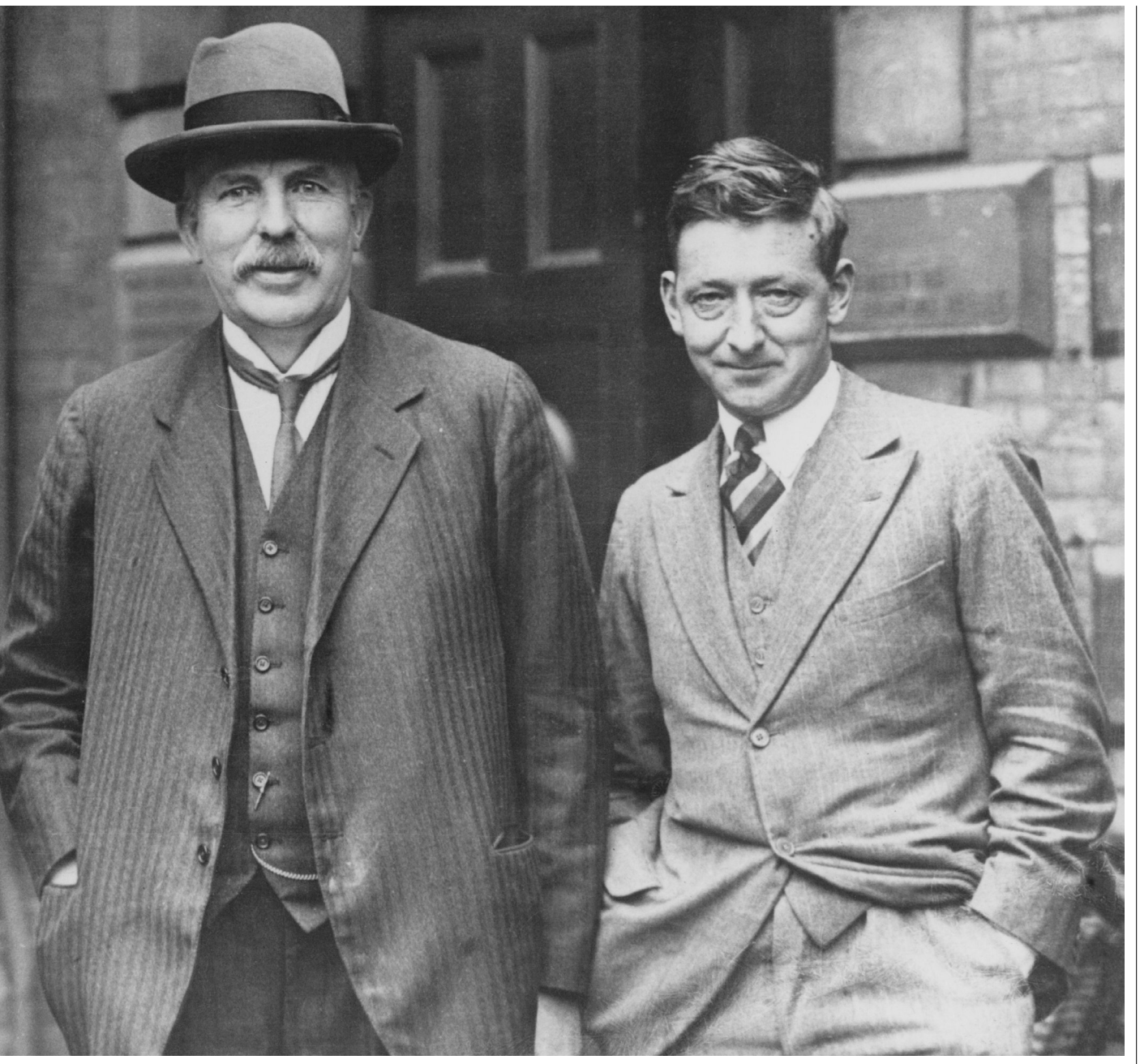
(b) Calculate the number of moles of sodium thiosulfate in $18.9cm^3$ of 0.15M $Na_2S_2O_3$.
Ans: No. of moles = $\frac{0.15}{1000} \times \frac{18.9}{1} = 2.835 \times 10^{-3}$

Volumetric Analysis — Bleach

In this question, students are examined on:
(a) General Practical Procedures
(b) Specific questions to the experiment being examined
(c) Calculations.

A - General Practical Procedures





The following are some of the general practical procedures:

1. **Burettes** and **pipettes** are washed with **deionised water** and then with the **solution** they are going to contain. The **titration flask** (conical flask) is rinsed with **deionised water only**.
2. A **pipette** is filled by drawing the solution into it by suction using a **pipette filler** (safety, hygiene). The solution is removed from a **pipette** by allowing it to run into a conical flask **under gravity**.
3. **Open** the tap of the burette before carrying out a titration to fill the **part below the tap** as this part is taken into account in burette readings.

In general, **burette** readings are always taken from the line on which the **bottom** of the **meniscus** lies (except for $KMnO_4$).

4. The **acid** is normally placed in the **burette** and the **alkali** in the **titration flask**.
5. Only use a **few drops of indicator** because indicators themselves are weak acids/bases.

B - Specific Questions to the Experiment

In the **% of hypochlorite in bleach experiment** (see right), a diluted solution of bleach is used as bleach is fairly concentrated – otherwise a large volume of sodium thiosulfate would be required. This **dilution factor** is taken into account when carrying out the calculations. The hypochlorite ion (ClO^-) is an **oxidising agent**.

This bleach experiment involves two reactions:

In the titration flask:

Acidified hypochlorite ions (ClO^-) oxidise the iodide (I^-) ions to iodine (I_2).....(colourless to red/brown).

Titration: The liberated iodine (I_2) is then titrated against sodium thiosulfate ($Na_2S_2O_3$).

In this experiment **excess KI** (I^- ions) are added to the titration flask for two reasons:

(a) to ensure **all** the ClO^- ions react completely with the I^- ions to form the maximum amount of iodine,

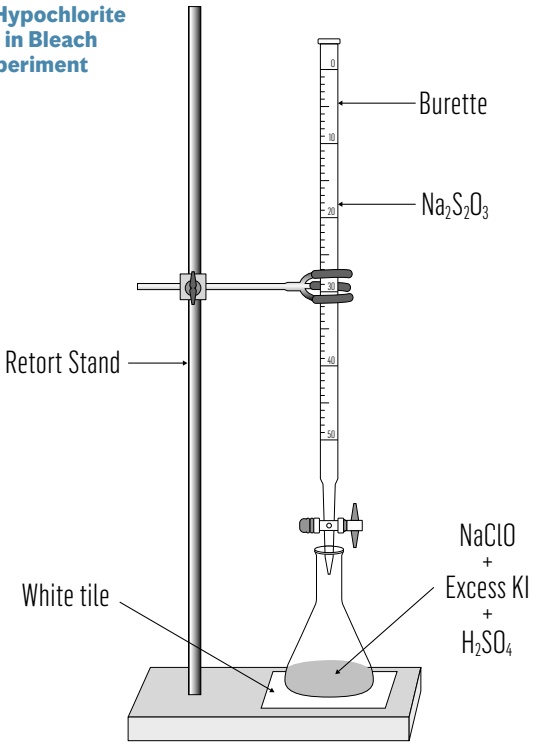
(b) the presence of the I^- ions help to keep the iodine produced in solution.

The indicator for this $Na_2S_2O_3$ and I_2 titration is **Starch**.

$$I_2 + \text{starch} \rightleftharpoons \text{blue/black complex.}$$

Remember: Do not add the indicator (starch) at the start of the titration. The indicator is added when the solution in the titration flask goes a straw-yellow colour.After the **addition** of the few drops of starch the solution in the titration flask goes blue-black (due to the presence of iodine). At the end-point the solution goes colourless.

% Hypochlorite ion in Bleach Experiment



C — Calculations

Concentration:

M (mol\L) – Molarity; moles per litre
g\L – grams per litre
%w/v – grams in 100cm³

To work out the number of moles, remember:

$$\textbf{No. of Moles} = \frac{\textbf{Molarity}}{1000} \times \frac{\textbf{Volume used}}{\textit{in } cm^3}$$

Work out the number of moles of one reagent and then by comparing the mole ratio from the balanced equation the number of moles of the other reagent can be found.

Once the molarity (moles per litre) has been worked out, multiply this answer by the molecular mass of the substance to obtain your answer in grams per litre.

Bleach Exam Question: 2011 Question 1:

A 25.0cm³ sample of the bleach was diluted to 500cm³. 25.0cm³ volume of the diluted bleach was transferred into a conical flask. Solutions of potassium iodide, KI, and sulfuric acid were added. The following reaction took place in the conical flask:

$$ClO^- + 2I^- + 2H^+ \rightarrow Cl^- + I_2 + H_2O$$

The solution in the conical flask was next titrated with a 0.10 M solution of sodium thiosulfate ($Na_2S_2O_3$). The average volume of sodium thiosulfate required was 16.1cm³.

The balanced equation for this titration is:

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$

Calculate the concentration of NaClO in moles per litre in (i) the diluted bleach, (ii) the original bleach.

(i) 16.1 cm³ of 0.1 M $Na_2S_2O_3$ reacted with 25.0 cm³ of ClO^- solution.

$$\textbf{No. of Moles} = \frac{\textbf{Molarity}}{1000} \times \frac{\textbf{Volume used}}{\textit{in } cm^3}$$

Moles of $Na_2S_2O_3$ used = $\frac{0.1}{1000} \times \frac{16.1}{1}$

$= 1.61 \times 10^{-3}$

Ratio from the two balanced equation:

$2\ S_2O_3^{2-} : 1ClO^-$ ... twice as much $S_2O_3^{2-}$ than ClO^-

⇒ No. of moles of ClO^- =

$= \frac{1.61 \times 10^{-3}}{2} = 8.05 \times 10^{-2}$ moles **in 25cm³**

=> Number of moles of ClO^- per litre

$= \frac{8.05 \times 10^{-2}}{25} \times \frac{1000}{1} =$ **0.0322 moles/L** (diluted bleach)

(ii) At start, diluted 25cm³ of bleach to 500cm³,

⇒ Diluted by a factor of 20,

⇒ Original bleach is 20 times more concentrated.

0.0322 x 20 = **0.644 moles/litre**

What was the concentration of NaClO in the original bleach (i) in grams / litre, (ii) as a % (w/v)?

(i) 1 mole NaClO = 23 + 35.5 + 16 = 74.5g

⇒ 0.644 × 74.5 = **47.978 g/litre**

(ii) % (w/v) .... is gms in a 100 cm³

47.978 g in 1000cm³

⇒ $\frac{47.978}{10} = 4.7978$ g in 100 cm³

=> **4.7978 % (w/v)**.

Rates of Reaction

The following is some of the relevant information for a Rate of Reaction question;

Definitions: **Rate of Reaction** is a change in concentration per unit time of any one reactant or product.

The **instantaneous** rate of a reaction is the change in concentration per unit time of any one reactant or product at a given moment in time.

Students should be able to describe the following experiments (and draw the appropriate diagrams):

- Monitoring the rate of production of oxygen from hydrogen peroxide using manganese dioxide as a catalyst...

$H_2O_2 \rightarrow H_2O + ½\ O_2$

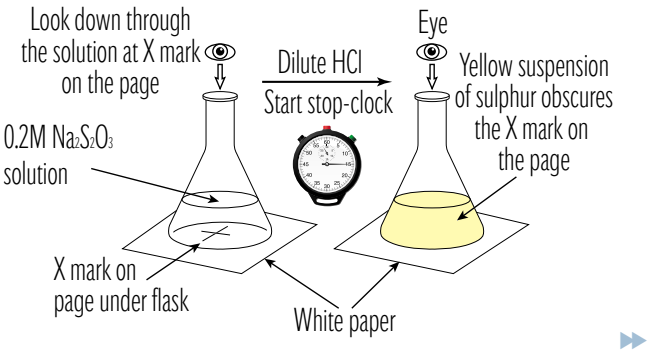
- Studying the effects on the rate of reaction of

(i) concentration, (ii) temperature, using sodium thiosulphate solution and hydrochloric acid.

$$Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O + S\downarrow$$

(... add dilute hydrochloric acid to the sodium thiosulphate, start the stop-clock and note the time taken for the mark on the white page under the flask to become invisible by the yellow precipitate of sulphur).

Effect of concentration on rate of reaction

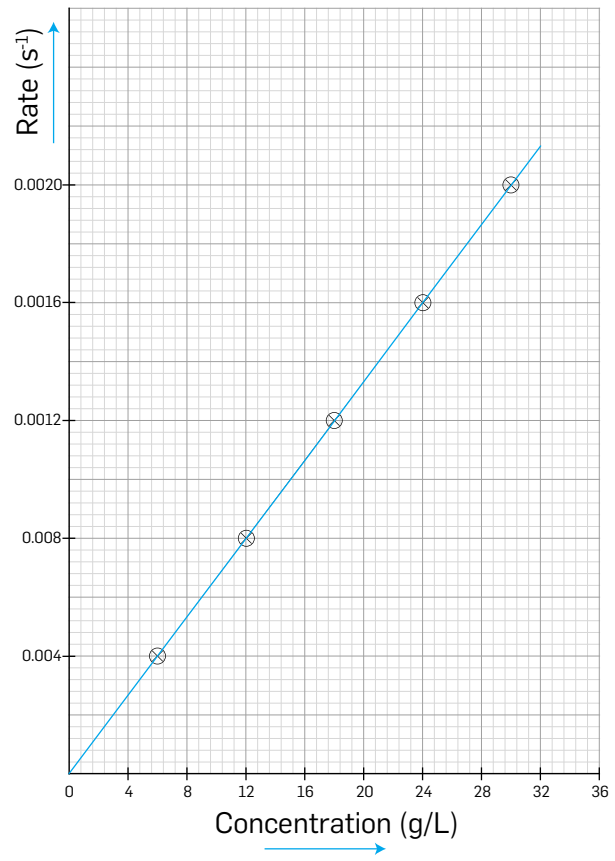


CHEMISTRY

If asked to plot a graph for a given table of results, remember the graph must be (a) on the graph page, (b) large, (c) both axes must be labelled with units, (d) points plotted accurately and (e) points joined together.

The following is the graph for reaction of sodium thiosulfate solution with hydrochloric acid in **2016 Question 3 (d)(ii):**

Rate versus Concentration of $Na_2S_2O_3$



Equilibrium

There is usually a full question or a half question on the paper on Equilibrium. The following is just some of the material examined in this question. Definitions are very important: Reversible Reaction, Chemical Equilibrium, Dynamic Equilibrium, Le Chatelier's Principle, Equilibrium Constant, Law of Chemical Equilibrium.

The **Equilibrium Constant, K**, is a measure of how far the reaction has proceeded when equilibrium is reached.

K_c = Products / Reactants Use [ ] as [ ] = moles / litre

and whatever the number of moles of reactants / products raise it to that power.

$$N_2 + 3H_2 \leftrightharpoons 2\,NH_3$$

$$K_c = \frac{[NH_3]^2}{[N_2].[H_2]^3}$$

The value of K_c is **temperature dependent**.

- Remember: **If a system is in equilibrium, then:**
  an *increase in pressure* favours the side of a smaller number of moles,
  an *increase in temperature* favours the *endothermic* direction and
  an *increase in concentration* of 'X' favours the side that *removes* 'X'
  .... all according to Le Chatelier's principle.

- **A change in *pressure* only has an effect on the equilibrium if all the substances are gases and the number of moles of reactants is different to the number of moles of products.**
- **A *catalyst has no effect* on the position of the equilibrium.**

Students should know
- The mandatory experiment
  $Fe^{3+} + CNS^- \leftrightharpoons Fe(CNS)^{2+}$ and the effect of changing concentration and/or temperature on the position of equilibrium,
- The industrial applications of Le Chatelier's Principle (Haber Process and Contact Process) and the conditions actually used in industry –
  Haber: 500°C, 200atm, Fe catalyst,
  Contact: 450°C, above 1atm, V_2O_5 catalyst
- Be able to work out the value of K_c if given concentrations of reactants and the concentration of a reactant/product at equilibrium. Be careful of units.... set up table... initial, amount reacted (x), moles at equilibrium, moles per litre....

2016 Question 7 (c):

$$2\,SO_2 + O_2 \leftrightharpoons 2\,SO_3$$

A mixture of 96g of sulfur dioxide and 24g of oxygen was placed in a 50-litre container and reached equilibrium with sulfur trioxide at a certain temperature, according to the balanced equation above. At equilibrium, 112g of sulphur trioxide was present.

Write the equilibrium constant (K_c) expression for this reaction.

$$K_c = \frac{[SO_3]^2}{[SO_2]^2.[O_2]}$$

Calculate the value of K_c under these conditions

At start had 96g of sulfur dioxide
⇒ No. of moles of SO_2 = 96/64 = 1.5 moles
[I moles of SO_2 = 32 + 2(16) = 64g]
At start had 24g of oxygen
⇒ No. of moles of O2 = 24/32 = 0.75 moles
[I moles of O2 = 2(16) = 32g]
At equilibrium had 112g of sulfur trioxide
⇒ No. of moles of SO_3 = 112/80 = 1.4 moles
[I moles of SO_3 = 32 + 3(16) = 80g]
Set up the table....remember, at the start never have any products (SO_3 is zero).

Let **x** moles of O_2 react,
then x moles of O_2 reacts with **2x** moles of SO_2 .... (ratio 1:2 from balanced equation)
then x moles of O_2 forms **2x** moles of SO_3 .... (ratio 1:2 from balanced equation)

Remember, reactants are used up ..... **minus** x and products are made..... **plus** x

Told in question, at equilibrium, had 1.4 moles of SO_3

	$2SO_2$ +	**$O_2 \leftrightharpoons$**	**$2SO_3$**
Start	1.5	0.75	0
Reacts	-2x	-x	+2x
Equilibrium			1.4

One grid in the table is filled...
⇒ 0 + 2x = 1.4
⇒ x = 0.7
Replace x with 0.7 for SO_2 and O_2.
Also told in question, reaction was carried out in a **50-litre** container, so need to work out number of moles of reactants/

	$2SO_2$ +	**$O_2 \leftrightharpoons$**	**$2SO_3$**
Start	1.5	0.75	0
Reacts	-2x	-x	+2x
Equil.	1.5- 2(0.7) = 0.1	0.75 − 0.7 = 0.05	1.4
Equil.	$\frac{0.1}{50} = 0.002$	$\frac{0.05}{50} = 0.001$	$\frac{1.4}{50} = 0.028$

products **per litre** before the values can be inserted into the expression for K_c .... (divide by 50)

Value of K_c:

$$K_c = \frac{[SO_3]^2}{[SO_2]^2.[O_2]}$$

$$K_c = \frac{[0.028]^2}{[0.002]^2.[0.001]}$$

$K_c = 1.96 \times 10^5$

Acids / Alkali / pH / Indicators

In this section students can be examined on topics such as: Arrhenius Theory and its limitations, Bronsted-Lowry Theory of acids and bases, conjugate acids, conjugate bases, conjugate pairs, properties of acids/alkalis, "strong" and "weak", amphoteric, salt, indicators, neutralisation, pH and its limitations, pH calculations, dissociation constants and ionic product of water.

Arrhenius Theory

An **acid** is a substance that dissociates in water to produce H^+ ions.
A **base** is a substance that dissolves in water to produce OH^- ions.

Arrhenius Theory had a number of limitations:
- H_3O^+ (not H^+) that exists in aqueous solution
- the theory was restricted to aqueous solutions (solvents like ammonia and benzene were not taken into account)
- not all acid-base reactions require water.

Bronsted-Lowry Theory

Bronsted-Lowry Acid: is a proton (H^+) donor.

Bronsted-Lowry Base: is a proton (H^+) acceptor.
Conjugate Pair: two substances (acid and a base) which differ only by one proton.
Conjugate Acid: that which is formed after a base has accepted a proton.
Conjugate Base: that which is formed after an acid has donated a proton.

To find the **conjugate acid** of a species **add H^+;**
To find the **conjugate base** of a species **remove H^+ ion.**
Question: Write (i) the conjugate acid and (ii) the conjugate base of HSO_4^-.
Answer: (i) $HSO_4^- + H^+ \rightarrow H_2SO_4$
(ii) $HSO_4^- - H^+ \rightarrow SO_4^{2-}$

Salt is a compound formed when the hydrogen of an acid is replaced by a metal or ammonium ion.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Amphoteric: is a substance which can act both as an acid and a base.... H_2O.

Strong Acid/Alkali is one which **readily** donates/accepts protons — it's **fully** ionised (dissociated) in aqueous solution whereas a **weak** Acid/Base is one which **does not readily** donate/accept protons — it's **not fully** ionised (dissociated) in aqueous solution.

Concentrated/dilute refers to the amount of acid/alkali per unit volume of solution.

Students need to know which acids/alkali are strong and which are weak.
Strong Acids: Hydrochloric Acid **(HCl)**, Sulphuric Acid **(H_2SO_4)**, Nitric Acid **(HNO_3)**
Weak Acids: Ethanoic Acid **(CH_3COOH)** or any organic acid,
Strong Alkali: Sodium Hydroxide **(NaOH)**
Weak Bases: Ammonia **(NH_3)**, Sodium Carbonate **(Na_2CO_3)**

Acids can be classified as: **monoprotic** (monobasic) - HCl .... one available H^+ ion, **diprotic** (dibasic) – H_2SO_4 .... two available H^+ ions, **triprotic** (tribasic) – H_3PO_4 .... three available H^+ ions.

Indicators: substances which change colour according to the pH of the solution they are placed in. They are either weak acids or weak bases and the colour of the undissociated acid must be different from that of the anion.

Question: Explain how a named indicator works**:**
Methyl Orange **$HA \leftrightharpoons H^+ + A^-$**
Red **Yellow**
In acidic solution there is a high concentration of H^+ ions and the equilibrium is driven to the left according to Le Chatelier's

Principle and the red colour predominates.

In alkaline solution there is a high concentration of OH^- ions and these ions combine with the H^+ ions and remove the H^+ ions ($H^+ + OH^- \rightarrow H_2O$). The equilibrium is driven to the right according to Le Chatelier's Principle and the yellow colour predominates.

The intermediate colour, **orange**, is present when the undissociated acid (red) and the anion (yellow) are present equally.

Most indicators require a range of **two** pH units to show their full colour change.

Choice of indicators for titrations:

Remember the pH Titrations and the pH Curves.
Strong Acid: Strong Alkali — most indicators suitable,
Strong Acid: Weak Base — Methyl Orange,
Weak Acid:Strong Alkali — Phenolphthalein,
Weak Acid: Weak Base — titrations are **not** carried out.

Self-Ionisation of water: Pure water will conduct a tiny electric current. This is due to the fact that water dissociates slightly to form ions.
Ionic Product of Water, K_w: It's the product of the H^+ and the OH^- ion concentrations, in moles per litre, in all aqueous solutions. $K_w = [H^+].[OH^-]$
$K_w = [H^+].[OH^-] = 1 \times 10^{-14}$ mol²/ litre² **at 25°C**.
Since $H_2O \leftrightharpoons 1H^+ + 1OH^-$
then $[H^+] = [OH^-] = 1 \times 10^{-7}$ mol/litre at 25°C.
The value of **K_w is temperature-dependent** — the value of K_w increases as temperature increases
⇒ Self ionisation of water is **endothermic**.

pH

pH is minus the log to the base ten of the hydrogen ion (or hydronium ion) concentration in moles per litre.
$pH = -\log_{10}[H^+]$ or $pH = -\log_{10}[H_3O^+]$ [ ] = moles/litre.
pH is measured on a scale from 0 → 14.

Measurement of pH:

(i) pH paper — litmus paper or universal paper,
(ii) pH meter.

Limitations of the pH scale

Only works for dilute solutions; restricted to aqueous solutions; only accurate for 25°C; scale only goes from 0 → 14.

pH Calculations:

Different types of pH Calculations:
(i) Strong Acids, (ii) Strong Alkali,
(iii) Given pH
(iv) Weak Acids, (v) Weak Bases

(i) pH of Strong Acids: ....good H^+ donors ...
Calculate the pH of 0.5M solution of hydrochloric acid ...2018 Qn11 (b).

$HCl \rightarrow 1H^+ + Cl^-$
0.5 0.5
$pH = -\log_{10}[H^+]$
$pH = -\log_{10}[0.5] = 0.3$

Question: Calculate the pH of a solution of hydrochloric acid containing 2.74g of hydrochloric acid in 250cm³
2.74g HCl in 250cm³ (x 4)
⇒ 10.96g HCl in 1000cm³
1 mole HCl = 1 + 35.5 = 36.5g
$\Rightarrow \frac{10.96}{36.5} = 0.3$ moles/L = 0.3M HCl

$HCl \rightarrow 1H^+ + Cl^-$
0.3 0.3
$pH = -\log_{10}[H^+]$
$pH = -\log_{10}[0.3] = 0.523$.

(ii) pH Calculations of Strong Alkali:
Two steps....work out the pOH first and then calculate the pH.
$pOH = -\log_{10}[OH^-]$ and then
$pH = 14 - pOH$.

Question: Calculate the pH of a 0.5M NaOH solution... 2012 Qn 10(b).

$NaOH \rightarrow Na^+ + 1\,OH^-$
0.5 0.5

$pOH = -\log_{10}[OH^-]$
$pOH = -\log_{10}[0.5] = 0.301$
$pH = 14 - pOH$
$pH = 14 - 0.301 = 13.699$

(iii) pH given and asked to calculate the H^+ (or H_3O^+) concentration of the solution:
The pH of sparkling water is 5.6. Calculate the H_3O^+ ion concentration of the sparkling water (2020 Question 7(d(i)).

$pH = -\log_{10}[H^+]$
$5.6 = -\log_{10}[H^+]$
$-5.6 = \log_{10}[H^+]$
Antilog (– 5.6) = $[H^+]$
2.512×10^{-6} mol/l = $[H^+]$

(iv) pH Calculations of Weak Acids:
Dissociation Constant, **K_a,** for **weak** acids tells the **extent** to which the acid dissociates in aqueous solution.

$[H^+] = \sqrt{K_a M_{acid}}$

Calculate the pH of an aqueous 1.5×10^{-3}M solution of the indicator which has an acid dissociation constant (K_a) of 4.0×10^{-4} (2020 Question 7(e)).

$[H^+] = \sqrt{K_a M_{acid}}$
$[H^+] = \sqrt{(1.5 \times 10^{-3})(4.0 \times 10^{-4})}$
$[H^+] = 7.746 \times 10^{-4}$.
$pH = -\log_{10}[H^+]$
$pH = -\log_{10}[7.746 \times 10^{-4}] = 3.11$

(v) pH Calculations of Weak Bases:
Dissociation Constant, **K_b,** for **weak** bases tells the **extent** to which the base dissociates in aqueous solution.

$[OH^-] = \sqrt{K_b M_{base}}$

2013 Question 11(b):
Ammonium hydroxide (NH_4OH) is produced by dissolving gaseous ammonia in water. Calculate the pH of an ammonium hydroxide solution that contains 7.0 g NH_4OH per litre. The value of the base dissociation constant (K_b) for ammonium hydroxide is 1.8×10^{-5}.

Answer:

1 mole $NH_4OH = 14 + 4(1) + 16 + 1 = 35$g
$\Rightarrow \frac{7.0}{35} = 0.2$ moles/L = 0.2M NH_4OH
$[OH^-] = \sqrt{K_b M_{base}}$
$[OH^-] = \sqrt{(1.8 \times 10^{-5})(0.2)}$
$[OH^-] = 1.9 \times 10^{-3}$
$pOH = -\log_{10}[OH^-]$
$pOH = -\log_{10}[1.9 \times 10^{-3}] = 2.72$
$pH = 14 - pOH$
$pH = 14 - 2.72 = 11.28$

Water


Limescale deposits in pipes

There is usually a question on the paper on water (sometimes combined with acids, bases and pH).

Students are asked about **hardness** in water, its causes (dissolved calcium salts – **$CaSO_4$ and $Ca(HCO_3)_2$,** and to a lesser extent by the salts of **magnesium**), the **types** of hardness **(temporary and permanent)** and how they are removed, methods of softening water, advantages and disadvantages of hard water, the treatment of water for domestic use **(Screening, Flocculation, Sedimentation, Filtration, Chlorination, Flouridation and pH adjustment),**

Water Pollution, Biochemical Oxygen Demand **(B.O.D.)**, heavy metal ions **(Pb^{+2}, Hg^{+2}, Cd^{+2}),** Eutrophication **(Natural and Artificial),**

Sewage Treatment – primary **(screening...settlement),** secondary treatment **(activated sludge, oxidation, settling tank)** and tertiary treatment (removal of **Phosphates and Nitrates** (phosphates removed by precipitation by adding **$Al_2(SO_4)_3$ or $FeCl_3$ or Lime**),

Water Analysis **(pH meter, Atomic Absorption Spectrometry, Colorimetry).**

Other experiments including - the estimation of **Suspended and Dissolved Solids** in a water sample,

- **Total Hardness** of a water sample (EDTA, suitable indicator is **Eriochrome Black T**, use a **buffer solution of pH 10**. Colour change at the end-point is **wine red to blue**, total hardness is expressed as p.p.m. of $CaCO_3$),
- **Dissolved Oxygen (Winkler's Method)** in a water sample. (Add **concentrated manganese sulphate and alkaline potassium iodide** to produce a white precipitate of manganese(II) hydroxide; the dissolved oxygen in the water sample oxidises this to manganese(III) hydroxide **(brown precipitate). Concentrated sulphuric acid** is now added causing the manganese(III) hydroxide to oxidise the iodide ions to free iodine **(red/brown)** and it itself gets reduced back to manganese (II). The amount of I2 liberated can be determined by titration with standard sodium thiosulphate solution.

Overall: 1 O_2 : 2 I_2 : 4 $Na_2S_2O_3$

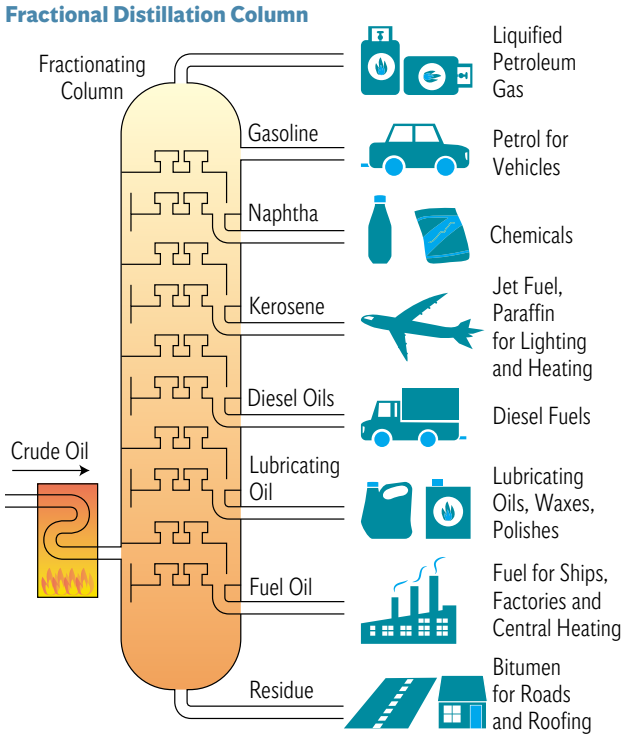
CHEMISTRY

Organic Chemistry

There are **at least** two Organic questions in Section B; one is usually based on crude oil/fractional distillation and thermochemistry, and the other question is a general organic question (functional groups, homologous series, etc).

Crude Oil

Fractional Distillation Column



Fractional Distillation involves heating the crude oil and the different mixtures (fractions) are separated on the basis of their boiling points.

Fraction	Carbon Length	Uses
Refinery Gas (petroleum gas)	C_1-C_4	Domestic use-cooking, mercaptans*....LPG**
Petrol (light gasoline)	C_5-C_{10}	Petrol for cars
Naphtha	C_7-C_{10}	Manufacture of medical supplies, plastics
Kerosene (paraffin)	C_{10}-C_{14}	Fuel for lamps, stoves, aviation fuel
Diesel oil (gas oil)	C_{14}-C_{19}	Fuel for larger engines such as for trucks, buses
Lubricating oil	C_{19}-C_{35}	Prevents wear and tear of engines
Fuel oil	C_{30}-C_{40}	Fuel for ships and power plants
Bitumen	> C_{35}	Resurfacing roads (tar), roofing

* mercaptans are sulphur compounds that are added to natural gas to give an odour in the event of a leak.
** LPG - Liquid Petroleum Gas.

Knocking (Auto-ignition)

This occurs when the petrol-air mixture in the engine explodes as it is being compressed instead of the explosion being caused by the spark.

Straight-chain alkanes, like heptane, ignite very easily on compression, thereby causing knocking whereas branched-chain alkanes, like 2,2,4-trimethylpentane (iso-octane), do not tend to ignite on compression and do not auto-ignite.

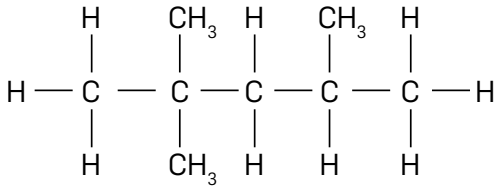
The **Octane Number** of a fuel is a measure of the tendency of the fuel to resist knocking.

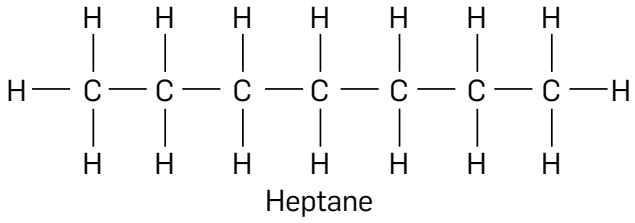
2,2,4-trimethylpentane has an octane number of **100**.
Heptane has an octane number of **0**.
Good petrol has an octane number of 97.

Research has shown that the following structural features give rise to **higher** octane numbers:
(i) the **shorter** the alkane chain,
(ii) the more **branched** the alkane chain,
(iii) **cyclic** compounds.

An "anti-knock additive", tetraethyl lead, $Pb(C_2H_5)_4$, was added to petrol to help reduce the amount of knocking. However, lead pollution from car exhausts causes environmental and health concerns as lead is toxic. Also lead poisons the catalysts in the catalytic converter.

Nowadays the octane number of petrol is increased by:
(i) **Isomerisation**
(ii) **Catalytic Cracking**





(iii) **Reforming** (Dehydrocyclisation),
(iv) **Adding Oxygenates**....Methanol, Ethanol and MTBE (methyl tertiary butyl ether).

Exam Brief *with* Yeats College — CHEMISTRY

Thermochemistry

This is a study of the heat changes which occur during chemical reactions.

Definitions for the following are very important:

Exothermic Reaction, Endothermic Reaction, Heat of Reaction, Heat of Formation, Heat of Combustion, Heat of Neutralisation, Kilogram Calorific Value, Bond Energy, Hess's Law and Law of Conservation of Energy.

Exothermic Reaction: is one in which heat is liberated. ΔH is negative.

$$C + O_2 \rightarrow CO_2 \qquad \Delta H = -393kJ$$

Endothermic Reaction: is one in which heat is taken in. ΔH is positive.

$$N_2 + O_2 \rightarrow 2NO \qquad \Delta H = +180kJ$$

ΔH represents the change in the heat content or "internal energy" or "enthalpy" of a system.

Heat of Reaction: is the heat change which occurs when a reaction takes place according to a given balanced chemical equation.

Heat of Formation: of a compound is the heat change which occurs when **one mole** of a compound is formed from its **elements** in their standard states.

Heat of Combustion: of a substance is the heat change which occurs when **one mole** of a compound is burned in **excess oxygen**.

Heat of Neutralisation: is the heat change which occurs when **one mole** of H^+ ions from an acid is **neutralised by one mole** of OH^- ions of an alkali.

Kilogram Calorific Value: of a fuel is the quantity of heat liberated when **one kilogram** of the fuel is completed burned in oxygen. (**Use**: To show the efficiencies of fuels).

Bond Energy: is the energy required to break **one mole** of covalent bonds and to separate the neutral atoms formed completely from each other. (Bond energy values are only **average** values).

Hess's Law: the heat change for a given reaction depends only on the initial and final states of the system and is independent of the path followed.

Law of Conservation of Energy: (First Law of Thermodynamics) Energy is neither created or destroyed but is converted from one form to another.

You must be able to write **equations** for the heat of **formation** and the heat of **combustion** of different substances. (Ensure you **balance** the equation).

Question: Write the equation for the heat of formation of ethanol (C_2H_5OH).

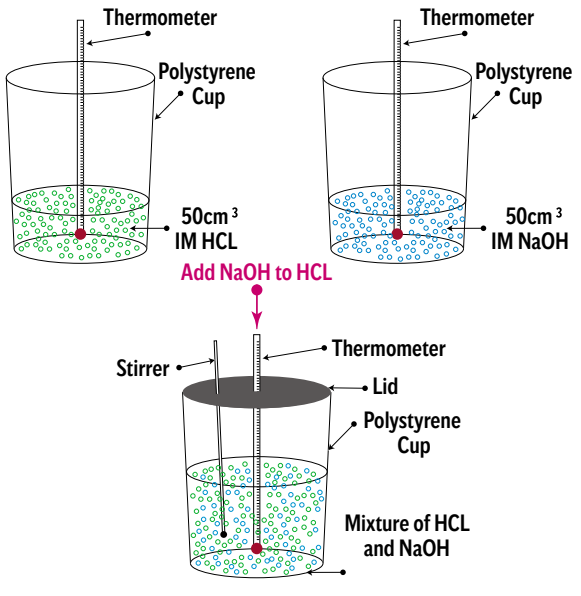
$$2C + 3H_2 + \tfrac{1}{2}O_2 \rightarrow \mathbf{1}\ C_2H_5OH$$

Question: Write the equation for the heat of combustion of ethanol (C_2H_5OH).

$$\mathbf{1}\ C_2H_5OH + 3\tfrac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$$

Heat of Combustion Values are measured using a Bomb Calorimeter whereas the **Kilogram Calorific Value** can be measured using a Bomb Calorimeter or can be found from heat of combustion values.

Heat of Neutralisation Experiment: use polystyrene cups, know procedure and precautions, and remember to use **equimolar** solutions.



Calculations: **E = m x c x (t_2 - t_1)**

t_2 – t_1 = rise in temperature of the acid/alkali mixture

c = specific heat capacity of the acid/alkali mixture

m = mass of the **acid/alkali mixture** (Kg) (density = 1)

That is the energy for the number of moles of acid/alkali neutralised, then work out the answer for **one mole**.

Remember: The Heat of Neutralisation of a **strong** acid by a **strong** alkali is almost constant at –57.2kJ/mol

$$H^+ + OH^- \rightarrow H_2O \qquad \Delta H = -57.2kJ/mol$$

The following is just some of the material examined in the general organic question:

- Draw/name **functional groups**, name members of different **homologous series** (up to 4 carbons) and their **isomers**
- Explain the relationship between the different homologous series, their **boiling points/ melting points** and their **solubility** in polar (water) and non-polar (cyclohexane) solvents
- Describe the tests to distinguish between different functional groups (eg. for **aldehydes/ketones** use dilute acidified $KMnO_4$ or Silver mirror test or Fehling's Solution), test for **unsaturation**
- Identify the **five different types of reactions**: Addition, Substitution, Elimination, Redox, Behaving as Acids
- Describe the **mechanisms for Ionic Addition and Free Radical Substitution** and the evidence for these mechanisms,

Chromatography – Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Gas Chromatography, High Performance Liquid Chromatography, Infra Red, Ultra Violet.

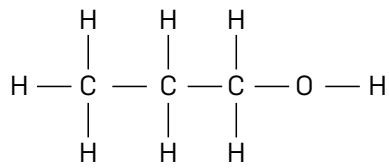
Alcohols

Alcohols form a homologous series of general formula $C_nH_{2n+1}OH$.

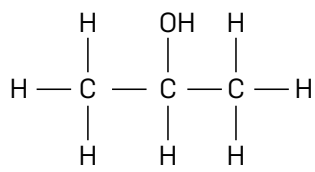
The functional group is OH.

The shape around each of the **carbon** atoms is **tetrahedral** and the **OH** group is **V-shaped**.

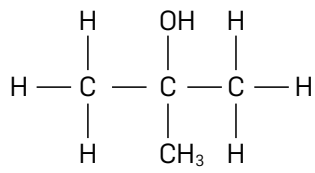
Alcohols are classified as primary, secondary and tertiary.



Propan-1-ol
Primary Alcohol



Propan-2-ol
Secondary Alcohol



2-methyl propan-2-ol
Tertiary Alcohol

Ethanol is produced by **fermentation**.

Fruit such as grapes contain sugar, **glucose**, $C_6H_{12}O_6$. When **yeast** is added, the sugar forms a solution of ethanol and carbon dioxide.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

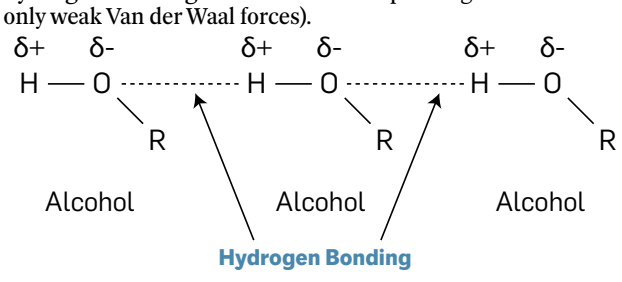
It is not possible to produce alcoholic drinks greater than about **12% v/v** by fermentation.

However fermented liquids can be distilled to produce higher alcohol concentrations **(40% v/v)**.

Ethanol is sufficiently volatile to pass from the blood to the air in the lungs, hence the use of a breathalyser test. Ethanol is oxidised to **ethanal** by the **liver**.

Uses of ethanol: alcoholic drinks, as a fuel, as a solvent.

Boiling Points: alcohols have **higher** boiling points than the corresponding alkanes. (alcohols have strong intermolecular **hydrogen bonding** whereas the corresponding alkanes have only weak Van der Waal forces).



Solubility: C1 – C3, methanol, ethanol and propan-1-ol, are completely **miscible** in water. (Solubility is due to hydrogen bonding between alcohol molecules and the water molecules)

However the **solubility** of alcohols in water **decreases** with the **length** of the carbon chain. The tendency of the OH group (polar) to make the alcohol soluble is counteracted by the insoluble alkyl portion (non-polar) of the molecule. Therefore higher alcohols have poor solubility in water but readily dissolve in non-polar solvents like cyclohexane.

Reaction of alcohols with sodium:

If a piece of sodium metal is added to ethanol, hydrogen gas is given off.

$$C_2H_5OH + Na \rightarrow C_2H_5ONa + \tfrac{1}{2}\ H_2$$

- Remember: **Alcohols can be *oxidised* to Aldehydes and Aldehydes can be easily oxidised to Acids...**

(oxidising agent – **$KMnO_4$** in **sulphuric acid** or **sodium dichromate** in **sulphuric acid**).

The colour change observed during these oxidation reactions is

$KMnO_4$: Purple (Mn^{+7}) to **Colourless** (Mn^{+2})

$Na_2Cr_2O_7$: Orange (Cr^{+6}) to **Green** (Cr^{+3}).

- ***Oxidation* of a *primary alcohol*** yields an ***aldehyde*,**
- ***Oxidation* of a *secondary alcohol*** yields a ***ketone*.**

Aldehydes are **easily oxidised** whereas ketones are not easily oxidised.

- **Preparation of an *aldehyde* — *excess alcohol*** is used.

Preparation of an *acid* — *excess oxidising agent* is used.

Fifth Years

It has been a hard year for Fifth Years — dealing with this pandemic and having to learn remotely for part of this academic year.

So, it is important that Fifth Year students get themselves organised before the summer holidays:

- Have a Chemistry folder with your notes for each section of the course covered.
- Definitions must be learned word-perfect. Write them out a number of times to help you learn them. Ask a family member to ask you them on a regular basis.
- For calculations ensure your method is clear (show all your workings) and that your units are correct.
- Be familiar with the layout of the exam paper.

Check that you are able to answer the following questions and tick the box when you can (☑)

Explain the contributions of the following scientists to chemistry?

The History of the Atom

☐ Dalton ☐ Crookes
☐ Thomson ☐ Millikan
☐ Stoney, ☐ Rutherford
☐ Chadwick

The History of the Periodic Table

☐ Davy ☐ Dobereiner
☐ Newlands, ☐ Mendeleef
☐ Moseley

Energy Levels:

☐ Define energy level, sublevel and orbital,
☐ Discuss Bohr's theory (and its limitations),
☐ Explain Atomic/Emission Spectra of hydrogen (see note 1),
☐ Write the electronic configuration of atoms/ions (see note 2),
☐ Define Aufbau Principle, Hund's Rule of Maximum Multiplicity, Pauli's Exclusion Principle,
☐ Know your flame tests and the colours observed (see note 3),
☐ Know Heisenberg's Uncertainty Principle,
☐ Explain De Broglie Wave motion,
☐ Draw Schrodinger shapes of the s and p orbitals.

Note 1: Lyman, Balmer and Pachen series of lines.

Note 2: Remember the rules: **(i)** always fill the 4s before the 3d and **(ii)** never get a $3d^4$ or a $3d^9$.....so be careful of chromium and copper!

Note 3:

Element	Colour observed in flame
Sodium	yellow
Potassium	lilac
Barium	green
Strontium	red
Copper	blue/green
Lithium	crimson

Mass Spectrometer

☐ Who invented the first mass spectrometer?
☐ Explain the principle on which the mass spectrometer works (see note 4),
☐ Name and explain the five stages in the operation of a mass spectrometer (see note 5),
☐ Where is the mass spectrometer used?
☐ Are you able to calculate the relative atomic mass if given percentage isotopes?

Note 4: Principle: positive ions separated according to their relative atomic masses when moving in a magnetic field.

Note 5: The five main stages are vaporisation, ionisation, acceleration, separation and detection.

▶▶

CHEMISTRY

Exam Brief with Yeats College

General Trends:

(i) Atomic Radii:
☐ Define atomic radius
☐ State and explain the general trends observed in atomic radii as you go across a period and down a column in the periodic table.

(ii) Ionisation Energy:
☐ Define Ionisation Energy
☐ In what units are ionisation energy values measured? (See note 6)
☐ Write an equation for first ionisation and second ionisation energy of any element X
☐ State and explain the general trends observed in ionisation energies values as you go across a period and down a column in the periodic table. (Don't forget the exceptions!).
Note 6: Units are kilojoules per mole, $kJmol^{-1}$.

(iii) Electronegativity:
☐ Define Electronegativity,
☐ On what scale are electronegativity values measured on (see note 7)?
☐ State and explain the general trends observed in electronegativity values as you go across a period and down a column in the periodic table
☐ Give uses of electronegativity values.
Note 7: Electronegativity values are measured using the Pauling Scale.

Bonding

☐ Define Octet Rule,
☐ Define Ionic bond, Covalent bond, Polar covalent bond, Dative bond,
☐ Draw (using dot and crosses) an example of an ionic bond, covalent bond and a dative bond,
☐ Distinguish between Sigma and Pi bonding in terms of molecular orbitals (see note 8)
☐ Distinguish between Intramolecular and Intermolecular Bonding (see note 9)
☐ Define and explain the following types of intermolecular forces: Van der Waals Forces, Dipole-Dipole Forces and Hydrogen Bonding (see note 10)
☐ Explain the relationship between the type of bonding present and boiling points (see note 11)
☐ Explain the solubility of different substances in polar / non-polar solvents.
Note 8: A Sigma (σ) bond is a covalent bond formed by the head-on overlap of any two atomic orbitals whereas Pi (π) bonds are formed by the 'sideways overlap' of two p orbitals
Note 9: Intramolecular bonding is bonding within *a* molecule; intermolecular bonding is bonding *between* molecules.
Note 10: Hydrogen bonding only occurs when Hydrogen is bonded to N, F or O.
Note 11: In H_2O hydrogen bonding occurs between the water molecules. This is a strong intermolecular force, thus causing water to have a high boiling point (100^0C).

Acids, Bases and Neutralisation

☐ Define Arrhenius Theory and state its limitations
☐ Define Bronsted-Lowry Theory of acids and bases
☐ Define conjugate acids, conjugate bases, conjugate pairs
☐ Write conjugate acid / conjugate base of a given species (see note 12)
☐ Distinguish between "strong" and "weak"
☐ Define neutralisation and give examples of neutralisation reactions
☐ State the properties of Acid/Alkali and give examples of where they are used
☐ Give examples of strong acids / alkali and weak acids / bases (see note 13).
Note 12: To find the conjugate acid of a species add H^+;
To find the conjugate base of a species remove H^+ ion.
Note 13: Strong Acids: HCl, H_2SO_4 and HNO_3
Weak Acids: CH_3COOH or any organic acid,
Strong Alkali: NaOH,
Weak Bases: NH_3 and Na_2CO_3.

Indicators:

☐ Define the term indicator
☐ Explain how a named indicator works
☐ Explain pH Titrations and know the pH Curves of different acid/base titrations
☐ Name the indicator used for the different types of titrations (see note 14).
Note 14: Indicators used in different titrations:
Strong Acid: Strong Alkali — **most** indicators suitable
Strong Acid: Weak Base — **Methyl Orange**
Weak Acid: Strong Alkali — **Phenolphthalein**
Weak Acid: Weak Base — titrations not carried out.

pH

☐ Define pH
☐ State two ways to measure pH (see note 15)
☐ Give limitations of the pH scale
☐ pH Calculations of Strong Acids
☐ pH Calculations of Strong Alkali (see note 16)
☐ Calculations if given pH and asked to work out the H^+ concentration of the solution
☐ pH Calculations involving weak acids (K_a) (see note 17)
☐ pH Calculations involving weak bases (K_b).
Note 15: pH can be measured using (i) pH paper (ii) pH meter.
Note 16: Question:
Calculate the pH of a 0.1M NaOH solution.

$$NaOH \rightarrow Na^+ + 1\ OH^-$$
$$0.1 \qquad\qquad 0.1$$
$$pOH = -\log_{10}[OH^-]$$
$$pOH = -\log_{10}[0.1]$$
$$pOH = 1$$
$$pH = 14 - pOH$$
$$pH = 14 - 1$$
$$pH = 13$$

Note 17: $[H^+] = \sqrt{K_a M_{acid}}$

K_a = Acid dissociation constant.
M_{acid} = Concentration of the acid in moles/litre.

Question: Calculate the pH of a 0.8M solution of Ethanoic Acid whose $K_a = 1.8 \times 10^{-5}$.

$$[H^+] = \sqrt{K_a M_{acid}}$$
$$[H^+] = \sqrt{(1.8 \times 10^{-5})(0.8)}$$
$$[H^+] = 0.0038$$
$$pH = -\log_{10}[H^+]$$
$$pH = -\log_{10}[0.0038]$$
$$pH = 2.42$$

Volumetric Analysis

☐ Explain general volumetric practical procedures: preparing a pipette, a burette, a conical flask for a titration, measuring and diluting a given solution
☐ Know the specific questions for each type of volumetric experiment (see note 18)
☐ Practise the different types of calculations (see note 19).
Note 18: The indicator used for % Ethanoic Acid in vinegar titration is phenolphthalein. The colour change observed at the end-point is pink to colourless.
Note 19: If given molarity then the number of moles is:

$$\text{No. of Moles} = \frac{\text{Molarity}}{1000} \times \frac{\text{Volume used}}{in\ cm^3}$$

Once the molarity (moles per litre) has been worked out, multiply this answer by the molecular mass of the substance to obtain your answer in grams per litre.

Advice for this year's Chemistry exam

Revising for the exam

- Do flash cards for each topic including key phrases, diagrams etc.
- Definitions must be learned word-perfect.
- When you finish revising a topic, take a blank page and complete an exam question in the allocated time and check your answers.
- Go through all the past exam papers for each topic and be extremely familiar with the way the marks were awarded for each question.

In the exam

- Read the **entire** exam paper; resist the temptation to start writing.
- Choose your **SIX** questions from **ANY** part of the paper.
- For each of your chosen questions – **read the question carefully**, (highlight any keywords) and ensure you answer **all** parts. Remember only answer what is asked, do not waffle! Always look to the **marks** awarded for each part of the question in order to know the amount of **detail** required.
- Remember your exam script is scanned so write your answers in **blue or black pen** only. Use **pencil for graphs and diagrams** only. Start each question on a new page and write the question number in the box at the top of each page. Write your answers in the spaces provided and use the left-hand column to label each part. Graph paper is provided within the answer book.
- Start with your **best** question as this will boost your confidence.
- Remember your answers must be **precise**. For calculations ensure your method is clear (show all your workings) and that your units are correct. Graphs must be drawn on graph paper with labelled axes (with units).

Finally, best of luck to all students in their Chemistry exam in June. *Martina*

Doing what comes naturally

*Yeats College teacher **Katrina Davitt** provides a step-by-step guide through the Biology exam as well as advice on techniques and sample answers*

In what has been a challenging academic year the changes to the Biology exam 2021 will provide reassurance and a boost in confidence for all students as June approaches. This Exam Brief will guide you through those changes and provide you with ideas on how to focus your revision and refine your exam technique over the next few weeks.

The extra questions on this year's paper will ensure that students will have enough choice on the day – all you have to do is make sure you are as prepared as you can be.

It is vital that students can recall important information from each topic and understand the meaning of keywords and definitions. When revising a chapter, start with learning keywords and their meaning i.e. **mitochondria** is where **respiration** occurs in the **cell**. Then learn the definitions within that chapter i.e. **aerobic respiration is the release of energy from food in the presence of oxygen**. Once you have the keywords and definitions you can then start to expand that knowledge.

Students that achieve a high grade can interpret exam questions and provide the relevant information in their answers. The only way to accomplish this is to practise exam questions. When you feel like you know a topic you must then try the related exam questions. Anything you are unable to answer you must revise again and then try the exam question again. Learning requires repetition.

Exam Layout

The exam is three hours in length and the paper is worth a total of 290 marks.

The exam is divided into three sections:

Sections	Questions to be answered	Marks per question	Marks in total
A	4 out of 7	20	80
B	1 out of 3	30	30
C	3 out of 7	60	180

Syllabus

Unit 1	The Study of Life	Characteristics of life, scientific method, food and ecology
Unit 2	The Cell	Cell structure, diversity and division, diffusion and osmosis, enzymes, photosynthesis, respiration and genetics
Unit 3	The Organism	Classification, Monera, Protista and fungi, human and plant biology

Each section contains extra questions this year, but the basic layout of the exam will remain the same and will contain topics from each unit:

Section A (Questions 1-7)

- Minimum of two questions from Unit 1
- Minimum of two questions from Unit 2
- Minimum of two questions from Unit 3
- Remember this year you need to answer **four questions from Section A**

Section B (Questions 8-10)

Question 8 of the exam will be based on unit one and subunits 2.1 and 2.5.

The experiments that could be asked this year for Question 8 are as follows:

Ecology
- Using a key
- Ecology collection
- Quantitative study of an ecosystem
- Measuring abiotic factors in ecology

Food
- Food tests

Cell Structure
- Use of a microscope.
- To examine a plant or animal cell using a microscope

Genetics
- To isolate DNA from a plant tissue

Question 9 of the exam will be based on subunit 2.2

The experiments that could be asked this year for Question 9 are as follows:

Enzymes
- pH and enzyme activity
- Temperature and enzyme activity
- Heat denaturation and enzyme activity
- Enzyme immobilisation and application

Osmosis
- To demonstrate osmosis

Photosynthesis
- Effect of light intensity or carbon dioxide concentration on photosynthesis

Respiration
- To prepare and show the production of alcohol by yeast.

Question 10 of the exam will be based on unit three experiments.

The experiments that could be asked this year for Question 10 are as follows:

Plant Biology
- To prepare and examine a TS of a dicot stem.
- To investigate the effects of IAA on plant tissue
- To investigate the effects of water, oxygen and temperature on germination
- To use starch agar/skimmed milk plates to show digestive action during germination.

Human Biology
- To dissect, display and identify the parts of the heart
- To investigate the effects of exercise on breathing rate **or** pulse rate

Fungi
- To investigate the growth of leaf yeast

Remember this year you need to answer **one question from section B**.

Section C (Questions 11-17)

- Minimum of one question from Unit 1
- Minimum of two questions from Unit 2
- Minimum of three questions from Unit 3
- Remember this year you need to answer **three questions from Section C**.

▶▶

BIOLOGY

Exam Brief with Yeats College

Study Tips

Definitions

- Write out all definitions per topic.
- Test yourself regularly taking 15-20 minutes per day to write the definitions and compare to your notes, correcting any mistakes.

Experiments

- Once you understand a topic, i.e. enzymes, take the time to read through the experiment(s) linked to that topic.
- Take note of what you are trying to show by carrying out the experiment, i.e. the effect of pH on enzyme activity
- Make the link between the theory and the reason for doing the experiment.
- Draw and label clearly all the key equipment that will be used, followed by bullet points explaining how you set up the apparatus.
- It is important to note that most of the experiments will have several constants that remain the same throughout and one variable.
- The variable is something that is changed in the experiment, i.e. the pH is the variable, the temperature will be constant. We only change one variable, so we can prove that the result we see is due to the thing we changed.
- Most experiments on the course include a **control** which **acts as a comparison** and is used to verify the result of the variable.
- Once you have revised an experiment you must practise the related exam questions; anything you cannot answer, revise again.

Topics

- It is important that you study the shorter topics covered in Unit 2 in detail, i.e. cell structure/diversity/division, diffusion and osmosis as these will link to all the other topics on the course.
- When revising complex topics such a genetics, respiration and photosynthesis, break them down into smaller sections, i.e. aerobic respiration contains two stages. Learn stage I first and be clear on the process/products and when you have grasped the concept begin to study stage II.
- At the end of revising each topic, practise the relevant exam questions to reinforce what you know and to highlight which parts need more work.
- All exams require a certain level of confidence, always focus on the positives and look at how much you can answer due to your hard work and consistency. If you still have a lot to learn set your goal and use this as your motivation

Exam Tips

Timing

- You must set out a timing plan before you go into the exam, this ensures that you will have enough time to read through your questions and answers carefully.
- This year you still have three hours to complete the exam but fewer questions to answer. It is essential you use this time wisely.
- Do not rush through the questions and leave the exam early.
- Take time to re-read the question asked and the answers you have given.
- Use this extra time to your advantage, this is your chance to show off your learning and you won't have this opportunity again.

Reading exam questions

- Write the topic next to the exam question in order to push your thinking in the right direction.
- Highlight keywords from the question such as explain, distinguish, outline etc.
- If your mind goes blank jot down a few key points from the topic that you can remember, and this will help trigger your memory.
- Do not dwell too long on a question, if the answer doesn't materialise move on and return to it again.

Answering exam questions

- Section A and B answers are written on the exam paper.
- Section C answers are written in a separate exam booklet.
- Answer booklets are now scanned for online corrections

→ A black/blue biro must be used to answer all questions
→ Answers for Section A and B should be written in the space provided
→ Answers for Section C must remain within the page boarders
→ Diagrams should be drawn using pencil and must be at least half a page in size
→ A biro should be used to label all diagrams

Prepare yourself before you go into the exam

- Make sure you have eaten and are well hydrated.
- Use the bathroom beforehand. If nerves are an issue, talk to someone who will understand and help you relax.

Section A: Short Questions (1–7)

- Each question carries 20 marks.
- If time allows you can attempt to answer more questions and you will be marked out of your best four.
- All answers should be written clearly on the exam paper.
- Do not waffle, answers should be concise and to the point.
- Remember, a wrong answer will cancel a right answer in this section.
- Section A will contain a minimum of two questions from each unit.
- Experiments can be included as part of the short questions, i.e., food tests.

Key Exam Techniques for Section A

- Write the topic next to each question.
- Read each question carefully, picking out the keywords, i.e. name, state, define etc.
- Answers should not exceed the amount of space given.
- If given an unlabelled diagram, label it before you read the question to trigger your memory.
- If given a graph, highlight the axes and interpret the information given on the graph, before you begin answering the question.

Below is a selection of sample questions and answers from Section A

2018 Question 1 (5x4 marks)

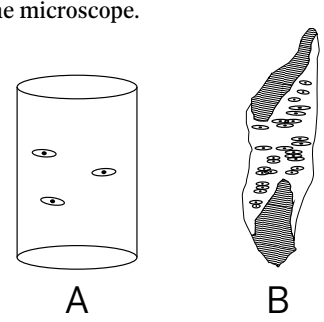
Answer any *five* of the following parts (a) to (f)
(a) Give the two main reasons why living organisms require food.
1. Source of energy or respiration
2. Growth/repair of cells
(b) What is a polysaccharide?
A carbohydrate with many sugar units
(c) Name the main structural polysaccharide in plants.
Cellulose
(d) Describe the composition of a triglyceride molecule.
Glycerol and three fatty acids
(e) Give a structural role of lipids in the human body.
Found in cell membranes
(f) Name a test or give the chemicals used to demonstrate the presence of a protein in a food sample.
Biuret test

2011 Question 2

Use your knowledge of mitosis to answer the following questions:
(a) What is the role of mitosis in single celled organisms?
Reproduction (3)
(b) What medical term is used for the group of disorders in which certain cells lose normal control of mitosis?
Cancer (3)
(c) Suggest a possible cause of one of the group disorders referred to in (b).
UV light/smoking/alcohol/radiation etc. (3)
(d) Name the stage of mitosis in which the chromosomes are located at the equator of the cell and before they begin to separate.
Metaphase(3)
(e) To what are the chromosomes attached in the stage of mitosis referred to in (d).
Spindle fibres (3)
(f) Towards the end of mitosis, in what type of cell does a cell plate form?
Plant cell (3)
(g) Give one way in which mitosis differs from meiosis.
Mitosis produces two identical daughter cells (2)

2007 Question 6

The diagrams represent two forms of a vascular plant tissue, as seen under the microscope.



(a) Name this vascular tissue.
Xylem (2)
(b) Identify the two forms of this tissue:
A: Vessel B: Tracheid (2x6)
(c) The walls of A and B are reinforced with a hard material. Name this material.
Lignin (2)
(d) Where precisely is this vascular tissue found in the stem of a young dicotyledonous plant?
In the vascular bundle/next to the phloem (2)
(e) Name another vascular tissue
Phloem (2)

Section B: Mandatory Experiment Questions (8–10)

- Each question carries 30 marks.
- If time allows you can attempt to answer more than one question and you will be awarded the highest marks.
- All answers should be written clearly on the exam paper.
- Divided into part (a) and part (b):
  → Part (a) is based on the theory linked to the mandatory experiment.
  → Part (b) is based on the method, results and control used in the experiment.
- It is essential you cover your chosen mandatory experiments in detail.
- You will need a clear understanding of the scientific method with focus being on:
  → A control being used as a comparison.
  → What is the variable in each experiment and why we do only change one part of an experiment?
  → What are the constant factors in each experiment?
  → Definitions for hypothesis, theory and principle/law.
  → Limitations to the scientific method.

Below is a selection of sample questions and answers from Section B.

2008 Question 8

Growth regulators in plants can promote growth or inhibit growth.
(a) Give an example of each of the following:
(i) A growth regulator that promotes growth
Auxin or IAA (3)
(ii) A growth regulator that inhibits growth
Auxin or IAA or ethylene or abscisic acid (3)
(b) In the course of your studies you investigated the effect of a growth regulator on plant tissue. Answer the following questions in relation to that investigation.
(i) Name the plant you used
Cress seeds (3)
(ii) Describe how you carried out the investigation
- Made a stock solution of IAA
- Carried out a serial dilution of IAA, so that the IAA concentration is decreasing in each of the seven petri dishes.
- Set up a control with just water in the petri dish.
- Line the cress seeds along graph paper in the lid of each dish and cover each with a different IAA concentration
- Seal and incubate plates on their side for 2-3 days(4 x 3)

(iii) Give a safety precaution that you took when carrying out the investigation.
Wear gloves/safety goggles/lab coat (3)
(iv) State the results that you obtained
Control: Some growth is seen due to IAA being present naturally in the cress seeds
Experiment: Some dishes show root or shoot growth or no growth depending on the concentration. IAA may cause cell elongation or inhibition in roots or shoots. (2 x 3)

2011 Question 9

(a) (i) How are the two strands of the DNA molecule joined together?
Hydrogen bonds(3)
(ii) What is 'junk' DNA?
Non-coding DNA/DNA that has not got a known function (3)

(b) Answer the following questions by referring to the procedures that you used to isolate DNA from a plant tissue.
(i) Having obtained a plant tissue, e.g. onion,
1. What was the first procedure that you followed?
Chop the onion with a knife/scalpel (3)
2. What was the reason for that procedure?
To increase the surface area of the onion (3)
(ii) Washing-up liquid is then used in the isolation. Give a reason for its use.
To break down the cell membranes and release the DNA (3)
(iii) Salt (sodium chloride) is also used in the isolation. Give a reason for its use.
To clump the DNA together (3)
(iv) 1. What is protease?
An enzyme that breaks down protein (3)
2. Why is a protease necessary when isolating DNA?
DNA is combined with proteins so they must be broken down so the DNA can be isolated (3)
(v) The final stage of the isolation involves the use of freezer-cold ethanol.
1. Describe how it is used.
Poured slowly down the side of the test-tube (3)
2. For what purpose is it used?
To remove water from the DNA so it can float and be isolated (3)

Section C: Long Questions (11–17)

- Questions 11 – 17 are worth 60 marks each:

(a) is 9 marks
(b) is 24 marks
(c) is 27 marks

- Questions 16 and 17 are divided into four sections, (a)(b)(c) and (d), each is worth 30 marks.
- You must answer two out of the four in questions 16 and 17.
- In this section we will see:

1 question from Unit 1 (usually ecology).
2 questions from Unit 2 (usually genetics and a mixture of respiration, photosynthesis and enzymes).
3 questions from Unit 3 (human and plant biology and classification including Monera, Fungi and Protista).

- All answers for this section must go into your answer booklet which is handed up with your exam paper containing your section A and B answers.

Key Exam Techniques Section C

- Read all of section C carefully in order to determine which questions you will answer.
- Write the topic next to each question.
- Read the question carefully and highlight the key words.
- Make sure you are labelling your answers carefully as you go i.e. 1(a)(i)
- Long questions do not mean you need to provide long answers:
  → Use bullet points.
  → Keep answers concise and to the point.
  → Do not write paragraphs as you are more likely to make mistakes.
  → Start each question on a new page.
  → Give yourself plenty of space between each part of a question so you can go back and make any changes.
  → Do not correct any mistakes using tippex or scribbling, one line through the incorrect answer is enough i.e. ~~mitosis~~.
- You can be asked to draw diagrams in this section:
  → Diagrams should be drawn clearly in pencil.
  → Use at least half a page for diagrams so you can label them clearly.
  → Use a biro to include as many labels as possible.
  → Only include a diagram if they specifically ask for one in the question.
  → If using a diagram to help explain your answer, you must include bullet points in your answer as well to ensure full marks.

Topic 1: Respiration

Definition: Aerobic respiration is the release of energy (ATP) from food in the presence of oxygen

Balanced Chemical Equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

Respiration is divided into two stages:

Energy Carriers:

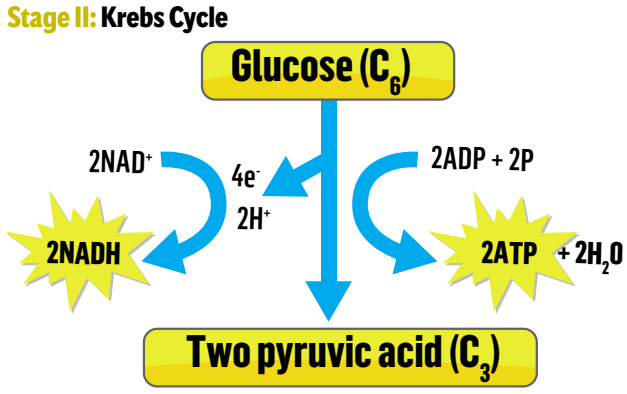
	Full Name	Role
ADP	**A**denosine **Di****P**hosphate	**Low energy** molecule found in all cells that can gain energy to form **ATP**
ATP	**A**denosine **Tri****P**hosphate	**High energy** molecule. Carries and transfers energy to where it is needed in the cell
NAD$^+$	**N**icotinamide **A**denine **Di**nucleotide	Low energy molecule Gains two high energy electrons **($2e^-$)** and a hydrogen proton **(H^+)** to form **NADH**
NADH	**N**icotinamide **A**denine **Di**nucleotide **H**ydrogen	High energy molecule Transfers electrons **($2e^-$)** and hydrogen protons **(H^+)** into the **electron transport system**

I. Glycolysis and II. Krebs cycle
Respiration is required to form a large amount of ATP (catabolic reaction), which can then be used by the cell as a source of energy.

Stage I: Glycolysis

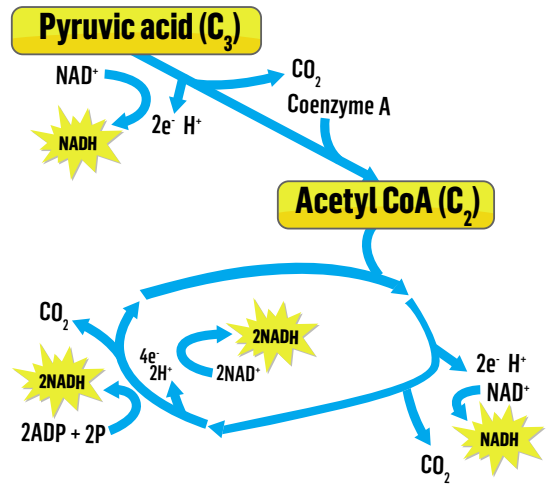
Location: Cytosol (cytoplasm without any cell organelles)
Anaerobic: No oxygen required
Energy: Small amount of energy (ATP) produced
Glucose (C_6) is broken down into two compounds containing **three carbons**, each known as **pyruvic acid (pyruvate) (C_3)**
As the bonds between the carbons are broken, **high energy electrons** and **hydrogen protons** are released.
High energy electrons and a **hydrogen proton** are captured by **NAD$^+$** to form **NADH**, which transfers them to the **electron transport system**.
Two molecules of **ADP** are converted to two molecules of **ATP**, which **carries energy** to where it is needed in the cell.

Stage II: Krebs Cycle



Stage II begins when pyruvic acid enters the mitochondria
Location: Mitochondria (matrix)
Aerobic: Oxygen required
Energy: Large amount of energy (ATP) produced
Pyruvic acid (C_3) enters the mitochondria and is converted into a two-carbon molecule (acetyl-CoA) (C_2) with release of carbon dioxide.
High-energy electrons and hydrogen protons are released forming NADH.
CoA (C_2) enters the Krebs cycle where it is broken down into carbon dioxide, high energy electrons and hydrogen protons which join NAD$^+$ to form NADH.
At one point in the cycle ADP is converted to ATP

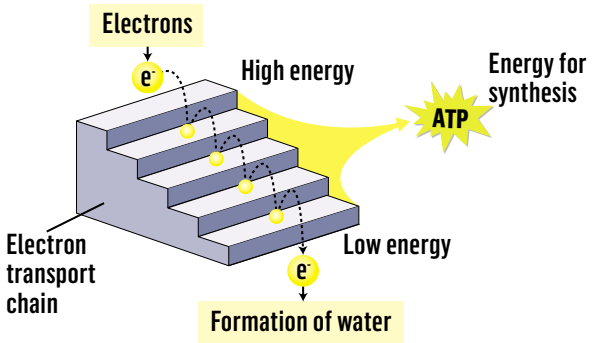
Electron Transport System



NADH enters the **electron transport system**, where it is broken down to form **NAD$^+$** and **H$^+$** and **2 high-energy electrons**.
The high-energy electrons move through the **electron transport system** and **lose their energy** as they move.
The energy released in picked up by **ADP** to form **ATP**.
At the end of the system the **two low energy electrons** join with **oxygen** and two **hydrogen protons** to form **water**

$$2e^- + 2H^+ + \tfrac{1}{2}\,O_2 \rightarrow H_2O$$

Oxygen is the last **electron acceptor**



2016 Question 11 (c)

Answer the following questions from your knowledge of respiration.
(i) Name the 3-carbon molecule that is an intermediate compound in both aerobic an anaerobic respiration.
Pyruvic acid/pyruvate (3)
(ii) What name is given to the biochemical pathway by which this intermediate compound is produced?
Glycolysis (3)
(iii) What happens to the intermediate compound referred to in (i) above when oxygen is available and used in the breakdown of glucose?
Pyruvate enters the mitochondria in the presence of oxygen. (3)
In your answer refer to 1. Krebs Cycle 2. Electron transport system
1. Krebs Cycle

- Pyruvate is broken down into the two-carbon compound acetyl CoA
- Acetyl CoA enters Krebs cycle where it is fully broken down.
- Energy is released and combines with ADP + P to form ATP.
- High-energy electrons and H$^+$ are released and combine with NAD$^+$ to form NADH.
- CO_2 is released.

2. Electron transport system

- NADH enters the electron transport system and breaks down to NAD$^+$ + H$^+$ + 2e$^-$
- The high energy electrons move through the system, losing their energy as they move.
- This energy is used to form large amounts of ATP.
- The low energy electrons combine with H$^+$ and ½ O_2 to form water (H_2O) *(3 x 3)*

(iv) What is produced from the intermediate compound referred to in (i) above when oxygen is not available?
1. In muscle?
Lactic acid (3)
2. In yeast?
Ethanol and carbon dioxide (3)

BIOLOGY

Topic 2: Photosynthesis

Photosynthesis is the way in which plants make their own food (glucose) using light energy from the sun.

Plants are known as **autotrophic** as they make their own food.

Heterotrophic organisms take in food from an outside source.

Balanced Chemical Equation:

$$6CO_2 + 6H_2O \xrightarrow{\text{Light, Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Energy Carriers

	Full Name	Role
$NADP^+$	**N**icotinamide **A**denine **D**inucleotide **P**hosphate	**Low energy molecule** Can also gain two high energy **electrons ($2e^-$)** and a **hydrogen proton (H^+)** to become **NADPH**
NADPH	**N**icotinamide **A**denine **D**inucleotide **P**hosphate and **H**ydrogen	**High energy molecule**. Transfers **electrons ($2e^-$)** and **hydrogen protons (H^+)** into the **dark stage**

Note: Remember link the **P** in $NADP^+$ and NAD**P**H to **P**hotosynthesis

Photosynthesis is divided into two stages
1. The light stage 2. The dark stage

Photosynthesis will use the large amount of energy stored in ATP and in the high energy electrons to make glucose (anabolic reaction).

Stage 1: Light Stage/Light Dependent Stage (requires light)
Location: The chloroplast (membranes containing chlorophyll)

Occurs due to the movement of **electrons**.
Reactions are not controlled by **enzymes**.
Events in the **light stage** include:
1. Light is absorbed
2. Light energy is transferred to electrons
3. High-energy electrons enter either:
- The cyclic pathway (Electron pathway 1)
- The non-cyclic pathway (Electron pathway 2)

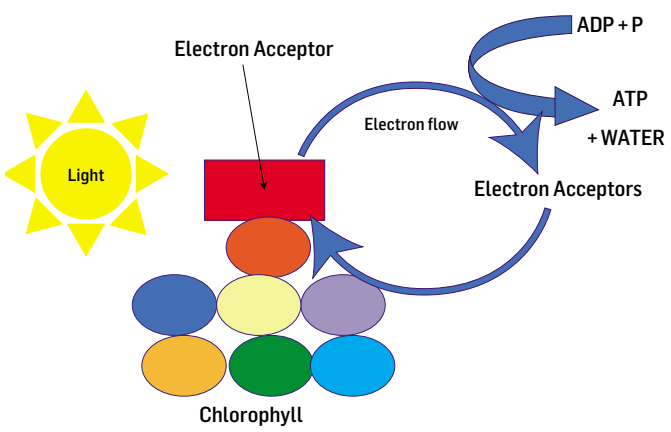
Pathway I: Cyclic Pathway

The **cyclic pathway** is made up of **electron acceptors**.

The **high-energy electrons** leave the **electron. acceptor** and move along the **electron acceptor pathway**.

As they move, the **high-energy electrons** lose their **energy** which is picked up by **ADP** to form **ATP**.

The **electrons** return to the **reaction centre chlorophyll** having lost their energy.



Pathway II: Non-Cyclic Pathway

Two high-energy electrons pass from the **electron acceptor** into the **pathway**.

These **high-energy electrons** lose some **energy** which is used to form **ATP**.

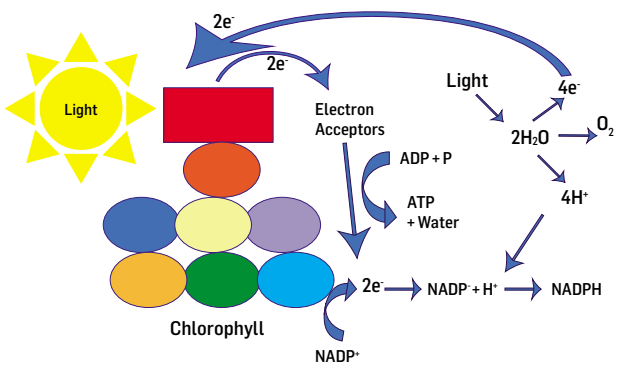
The **two high-energy electrons** join with **$NADP^+$** to form **$NADP^-$** (electrons are negatively charged)

Two water molecules (H_2O) are **split** using light **energy (photolysis)**.

Products of **water splitting**:
Four **hydrogen protons ($4H^+$)**
- Some are stored in a pool of **protons**
- **One hydrogen proton H^+** is attracted to the **$NADP^-$** to form **NADPH**

Four electrons ($4e^-$)
- **Two** of these **electrons** are **returned** to the **chlorophyll reaction centre**

Oxygen
- The **oxygen** produced **diffuses** out of the **chloroplast**.
- Some is used in **respiration**.



Stage 2: The Dark Stage/Light Independent Stage (does not require light)
Location: Chloroplasts (Stroma)
Controlled by **enzymes**
Dark stage is affected by temperature.

Enzymes can become **denatured** above or below the **optimum temperature**.
(20 – 30°C)

Carbon dioxide (provides the carbon to make glucose) **diffuses** into the **chloroplast**.

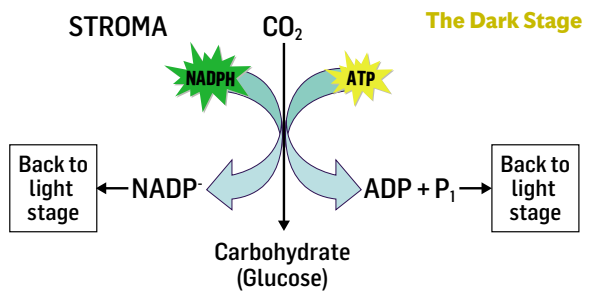
NADPH and **ATP** enter the **stroma** in the **chloroplast**.

NADPH breaks down releasing **hydrogen ions H+ and electrons.**

ATP releases its energy forming **ADP**.

This **energy** is used to combine **carbon dioxide, hydrogen protons (H+) and electrons to form glucose**.

ADP and NADP+ are reused in the **light stage**.



2006 Question 11(a)(b)

(a)
(i) What is the primary role of chlorophyll in photosynthesis?
Traps light energy from the sun (3)
(ii) Write an equation to summarise photosynthesis

$$6CO_2 + 6H_2O \rightarrow 6O_2 + C_6H_{12}O_6 \quad (6)$$

(b) The second stage of photosynthesis is called the dark stage or light-independent stage.
(i) Why is the dark stage given the alternative name of the light-independent stage?
It does not use/need light (3)
(ii) Name a gas that is essential for the dark stage
Carbon dioxide (3)
(iii) Two products of the light stage are vital for the dark stage. Name each of them.
NADPH and ATP (2x3)
(iv) State the precise role in the dark stage of each of the substances that you named in (iii)
NADPH: Supplies hydrogen protons and high-energy electrons to the dark stage (3)
ATP: Supplies energy to make glucose (3)
(v) To what group of biomolecules do the main products of the dark stage belong?
Carbohydrates/monosaccharide's (6)

Topic 3: Genetics (Crosses)

Definitions:
Alleles are different forms of the same gene.
A dominant allele prevents a recessive allele from working.
- Always represented by a capital letter
- The **dominant allele** will determine the **characteristic of the offspring**, i.e. what the offspring will look like.

A recessive allele will not work if a dominant allele is present.
- Always represented by a lower-case letter
- The recessive allele will only determine the characteristic of the offspring if there are two recessive alleles present.

Genotype means the genetic make-up of an organism, i.e. which genes are present.
- At the end of each cross you will have to list all the possible genotypes

Phenotype means the physical characteristic of the organism.
- The **genotype** will determine the **phenotype**.
- At the end of each **cross** you will have to list the matching **phenotypes** for each **genotype**.

Progeny is the offspring produced (Also known as the **F1 offspring**).
Homozygous means that the two alleles on a chromosome are the same.
- The **alleles** will either both be **dominant**, i.e. BB or **recessive**, i.e. bb.

Heterozygous means that the two alleles on a chromosome are different.
- The alleles will have a **dominant** and a **recessive allele**, i.e. Bb.

There are a number of genetic crosses covered on the course, including: monohybrid crosses (using one characteristic only), dihybrid crosses (using two characteristics), incomplete dominance (two characteristics but the offspring has a phenotype that is half-way between the parents), linkage and sex-linked crosses.

Sex Determination Crosses

Sex Chromosomes

Female sex chromosome is XX (One X is inherited from the mother and the other from the father).
Male sex chromosome is XY (X is inherited from the mother and Y is inherited from the father).
The sex of the offspring is determined by the father.
- The mother's eggs can only carry the X chromosome
- The father's sperm can either carry an X or a Y chromosome
- The offspring is determined by which sperm, an X or a Y, fertilizes the female egg

There is an equal, 50:50 chance of the offspring being a female or a male.

Sex Determination Cross

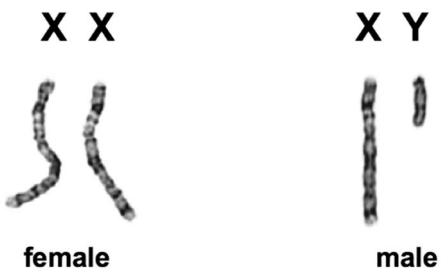
Parents: XX x XY
Gametes: X X X Y

Punnett Square:

	X	Y
X	**XX**	**XY**
X	**XX**	**XY**

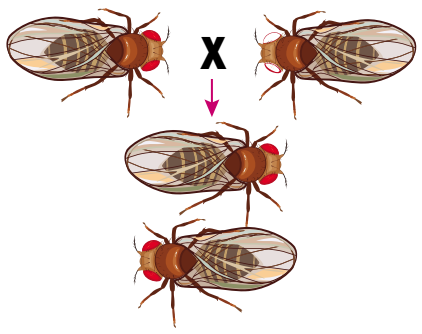
Genotypes: 50% XY and 50% XX
Phenotypes: 50% Male and 50% Female
Ratio: 1:1
The **X chromosome** carries a large number of **genes**.

The **Y chromosome** carries very few **genes** (it is a lot shorter than the female X chromosome).



Sex Linkage

Sex linkage means that a characteristic is controlled by a gene on the X chromosome.
In **sex-linked** characteristics the male is more likely to suffer.
These **sex-linked characteristics** include:
- Colour blindness
- Haemophilia
- Duchenne muscular dystrophy
- Eye colour in the *Drosophilia* fly (red eyes is a female trait and white eyes is a male trait, *see graphic, above right*).



All F1 offspring have red eyes

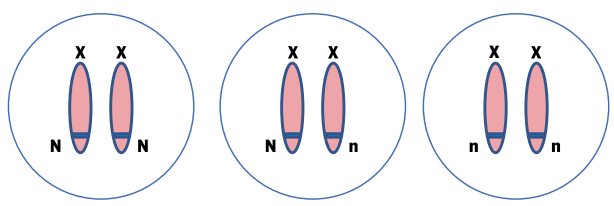
All of the above **sex-linked characteristics** are controlled by **genes** located on the **X chromosome**.
They are controlled by the **X chromosome** as there is no corresponding gene on the **Y chromosome**.

Sex Linkage Crosses

Colour-blindness
Normal individuals can detect red, green and blue light which is reflected on the **retina** at the back of the eye.
Allele for normal vision is N dominant.
A person who is colour-blind cannot tell red from green.
Allele for colour blind is n recessive.
The **gene** for colour vision is located on the **X chromosome**.

Females
Females can have three **genotypes**:
- Normal vision NN **(homozygous dominant)**
- Normal vision **Nn (heterozygous)**
- Colour blind **nn (homozygous recessive)**.

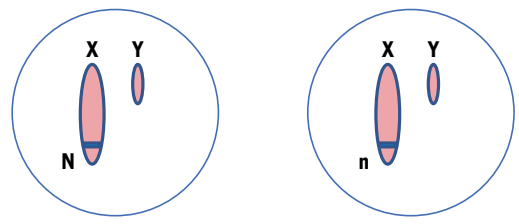
For a female to be colour blind she must inherit **two recessive alleles**, one from each parent.
Remember a female is XX.



Homozygous Dominant Normal XN XN | **Heterozygous Normal XN Xn** | **Homozygous Recessive Colour Blind Xn Xn**

It is rare to have two **recessive alleles**, there is a 0.2% chance of a female in Ireland being colour-blind.

Males
Males are XY.
Males only have **one allele** for colour vision located on the **X chromosome**.
They do not have a corresponding **allele** for colour vision on the **Y chromosome**.
Males only have to **inherit one recessive allele** on the **X chromosome** to be colour-blind.



Normal Vision Male XN Y- | **Colour-Blind Male Xn Y-**

Males are more than likely to be colour-blind than females (approx 8%).

Sex-Linked Cross

The gene for haemophilia is located on an X chromosome. Normal blood clotting (N) is dominant over haemophilia (n).
Show the genotypes and phenotypes of the offspring of the cross between a mother who is a carrier and a father who is normal for the trait.

Parents: XN Xn x XN Y-
Gametes: XN Xn x XN Y-

	XN	Y-
XN	**XNXN**	**XNY-**
Xn	**XNXn**	**XnY-**

Genotypes	Phenotypes
25% XNXN	Normal female
25% XNY–	Normal male
25% XNXn,	Carrier female
25% XnY–	Male haemophiliac

BIOLOGY

2005 Question 10(c)

(iii) Red-green colour blindness is a sex (X)-linked condition. Normal red-green vision results from the possession of a dominant allele (C). In each of the following cases give the genotypes of the mother and of the father.

1. A family in which one daughter is red-green colour blind and one daughter has normal colour vision.

Daughter = colour-blind
Genotype: XcXc

Daughter = Normal vision
Genotype XC Xc

	Xc	Y-
XC	XCXc	XCY-
Xc	XcXc	XcY-

Mother Genotype: XC Xc (3)
Father Genotype: Xc Y- (3)

2. A family in which all the sons are red-green colour blind, and all the daughters are carriers (heterozygous).(12)

Sons = colour-blind
Genotype: Xc Y-

Daughters = carriers
Genotype: XC Xc

	XC	Y-
Xc	XCXc	XcY-
Xc	XCXc	XcY-

Mother Genotype: XcXc (3)
Father Genotype: XC Y- (3)

Monohybrid Crosses

Are used to determine the possible **genotypes** and **phenotypes** of the **offspring** when studying **one characteristic**, i.e. Hair colour

Parents can be:
- **Homozygous dominant or recessive**
- **Heterozygous**

Each square in a four-square **Punnett square** represents a 25% probability.

Offspring:
- Two **homozygous parents** will form a **ratio of 1:0**
- Two **heterozygous parents** will form **a ratio of 3:1**
- One **homozygous** and one **heterozygous parent** will form **a ratio of 1:1.**

Both parents are homozygous

Alleles: Brown = B (dominant)
Black = b (recessive)
Parents: BB x bb
Gametes: B B b b

Gametes	b	b
B	Bb	Bb
B	Bb	Bb

Genotypes: 100% Bb
Phenotypes: 100% Brown
Ratio: 1:0

Both parents are heterozygous

Alleles: Brown = B (dominant)
Black = b (recessive)
Parents: Bb x Bb
Gametes: B b B b

Gametes	B	b
B	BB	Bb
b	Bb	bb

Genotypes: **Phenotypes:**
BB Brown (25%)
Bb Brown (50%)
bb Black (25%)
Ratio of phenotypes: Brown: black = 3: 1

One parent is homozygous recessive and one parent is heterozygous

Alleles: Brown = B (dominant)
Black = b (recessive)
Parents: Bb x bb
Gametes: B b b b

Gametes	b	b
B	Bb	Bb
b	bb	bb

Genotypes **Phenotypes:**
Bb Brown 50%
bb Black 50%
Ratio of phenotypes: Brown: black = 1 : 1

Dihybrid Crosses

Are used to determine the possible **genotypes** and **phenotypes** of the **offspring** when studying **two characteristics**, i.e. Colour and height

Parents can be:
- **Homozygous dominant or recessive**
- **Heterozygous**

You must remember to show **both characteristics** in the parents' **genotype**.

Gametes:
- **Homozygous** parents will only produce one type of **gamete**.
- **Heterozygous** parents will produce four different types of **gamete**.

Both parents are homozygous (One dominant and one recessive)

Alleles: Tall: T Green: G
Small: t Yellow: g
Parents: TTGG x tt gg
Gametes: TG x tg
(All four gametes will be the same for each parent, we only need to use one as you will be repeating yourself otherwise)

Gametes	tg
TG	TtGg

Genotypes **Phenotypes:**
100% TtGg Tall and Green

Both parents are heterozygous:

Alleles: Tall: T Green: G
Small: t Yellow: g
Parents: Tt Gg x Tt Gg

In each parent:

Link the 1st letter to 3rd and then the 4th

Link the 2nd letter to 3rd and then the 4th

Gametes: TG Tg TG Tg
tG tg tG tg

Punnett Square:

Gametes	TG	Tg	tG	tg
TG	TTGG	TTGg	TtGG	TtGg
Tg	TTGg	TTgg	TtGg	Ttgg
tG	TtGG	TtGg	ttGG	ttGg
tg	TtGg	Ttgg	ttGg	ttgg

Genotypes **Phenotypes:**
TTGG x1 Tall and Green
TTGg x2 Tall and Green
TtGG x2 Tall and Green
TtGg x4 Tall and Green
TTgg x 1 Tall and Yellow
Ttgg x2 Tall and Yellow
ttGG x 1 Small and Green
ttGg x2 Small and Green
ttgg x1 Small and Yellow

F1 Genotype Ratio: 9:3:3:1
F1 Phenotype Ratio: 9 tall and green
3 tall and yellow
3 small and green
1 small and yellow

One parent is homozygous dominant and the other is heterozygous

Alleles: Tall: T Green: G
Small: s Yellow: g
Parents: Tt Gg x TT GG

In each parent:

Link the 1st letter to 3rd and then the 4th

Link the 2nd letter to 3rd and then the 4th

Gametes: TG Tg TG Tg
tG tg tG tg

Punnett Square:

Gametes	TG	Tg	TG	Tg
TG	TTGG	TTGg	TTGG	TTGg
tG	TtGG	TtGg	TtGG	TtGg
TG	TTGG	TTGg	TTGG	TTGg
tG	TtGG	TtGg	TtGG	TtGg

(All four gametes will be the same for the homozygous parent, we only need to use one as you will be repeating yourself otherwise)

Punnett Square:

Gametes	TG
TG	TTGG
Tg	TTGg
tG	TtGG
tg	TtGg

Genotypes: **Phenotypes:**
TTGG Tall and Green
TTGg Tall and Green
TtGG Tall and Green
TtGg Tall and Green
Ratio: 1:1:1:1

Incomplete Dominance

Incomplete dominance means that neither allele is dominant or recessive, both alleles work when present in the heterozygous genotype to produce an intermediate phenotype.

You will always be able to spot an incomplete dominance question in the exam because it will either be clearly stated, or the genotype/phenotype of the offspring will be given, and it will be half- way between the two parents.

Examples of Incomplete Dominance

Snapdragon plants: One parent has a red flower, the other a white flower and the offspring has a pink flower.

Shorthorn cattle: One parent has a red coat, the other has a white coat and the offspring has a roan coat (patches of red and white).

Both parents are heterozygous

(Incomplete dominance = roan coat)
Alleles: R = Red r = white
Parents: Rr x Rr
Gametes: R r R r

Gametes	R	r
R	RR	Rr
r	Rr	rr

Genotypes: **Phenotypes:**
RR 25% Red
Rr 50% Roan
rr 25% White
Ratio = 1:2:1

2008 Question 11 (a) (b)

(a) Explain the following terms which are used in genetics: homozygous, recessive, phenotype

Homozygous: Two alleles are the same (3)
Recessive: Will not work if a dominant allele is present (3)
Phenotype: The physical characteristic due to the genotype (3)

(b) In the fruit fly, *Drosophilia*, the allele for the grey body (G) is dominant to the allele for ebony body (g) and the allele for long wings (L) is dominant to the allele for vestigial wings (l). These two pairs of alleles are located on different chromosome pairs.

(i) Determine all the possible genotypes and phenotypes of the progeny of the following cross: grey body, long wings (heterozygous for both) X ebony body, vestigial wings

Grey: G Long wing: L
Ebony: g Vestigial wing: l
Parent 1: Grey body and long wings heterozygous: GgLl
Parent 2: Ebony body and vestigial wing: ggll
Parents: GgLl x ggll
Gametes: GL Gl x gl
gL gl

Gametes	gl
GL	GgLl
Gl	Ggll
gL	ggLl
gl	ggll

Genotype: **Phenotype:**
GgLl (3) Grey & long wings(3)
Ggll (3) Grey & vestigial wings(3)
ggLl (3) Ebony & long wings(3)

Ecology

Some questions in Ecology require students to read and answer questions based on graphs. The graph given will be based on any ecology-related topic but can sometimes see an overlap between other topics on the course. For students to achieve full marks they must be able to combine their common knowledge with their ability to take information from a graph and the knowledge they have gained from their ecology studies.

When given a question like this:

Check to see what information has been given on the graph

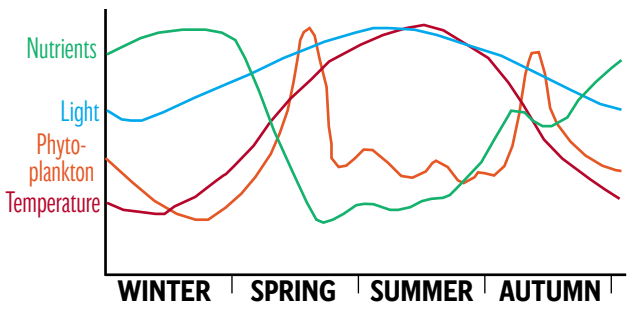
- Are the axes labelled?
- Are there one or more curves given on the graph?
- What is the relationship between the curves if there are two or more present?
- How would you describe the curves, i.e. is the curve increasing and then decreasing?

After studying the graphs given, read the questions and highlight keywords.

Some of the questions will be directly related to the graph, others will be based on your Ecology theory.

2014 Question 15(a)

Phytoplankton is the collective term covering the small photosynthetic organisms which are part of aquatic ecosystems. The solid line in the graph below shows the fluctuation in phytoplankton numbers in a lake over a 12-month period. The broken lines show the variations over that period in temperature, light and nutrient levels.



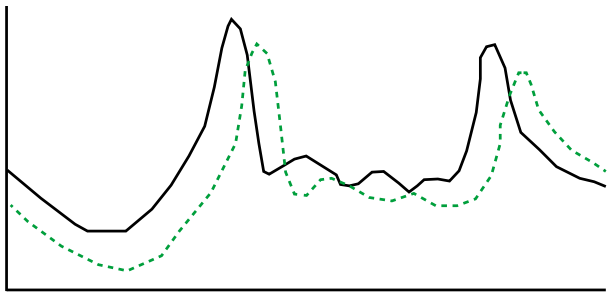
(i) What does the graph tell you about the phytoplankton population?
Phytoplankton numbers decrease in winter, increase in spring, decrease during the summer and increase again in autumn. (2x3)

(ii) Why do you think the nutrient levels are high in the winter and then drop sharply in spring?
Phytoplankton use the nutrients, so as phytoplankton numbers increase in spring and autumn the level of nutrients decreases. (3 x 3)

(iii) Give an example of an inorganic nutrient, necessary for phytoplankton growth, that you would expect to find in lake water.

Nitrates (3)

(iv) Zooplankton is the collective term for the small animals present in the lake. Copy the graph for phytoplankton into your answer book and then, on the same axes and using a dashed (--) line show how the number of zooplankton would vary over the 12-month period. Briefly explain the graph you have drawn.



Things to look for in the graph

- Zooplankton numbers lower than phytoplankton
- Rise and fall of curve similar to phytoplankton
- Zooplankton curve shifted to the right
- Zooplankton indicated with a dashed line and label the axes

(4 x 2)

Explain graph:

- As phytoplankton numbers increase, zooplankton numbers increase as there is more food available.
- As phytoplankton numbers decrease, zooplankton numbers decrease as they move elsewhere to find food.
- As phytoplankton numbers increase, zooplankton return to the area.
- The time lag is due to the zooplankton adjusting to the change in numbers. (2 x 2)

(v) Other than the affect on the zooplankton, suggest why the phytoplankton population drops in late autumn. Low temperature/low light (4)


A hawk having a mouse for lunch is just one part of an interlinked food chain

Ecosystem study

The first thing you must be able to do is **name** your ecosystem, i.e. grassland, seashore, woodland etc.

You then need to be able to draw a food chain/food web containing at least four trophic levels, using organisms from your studied ecosystem.

A grazing food chain is a sequence of organisms in which one is eaten by the next member of the chain.

A **food chain** always begins with a **producer**, i.e. plants

Producers are organisms that carry out photosynthesis.

Next in the **food chain** are the **consumers**:

Primary consumers	Feed on **producers** **Herbivores** **Decomposers**
Secondary consumers	Animals that feed on **primary consumers** **Carnivores/Omnivores** Scavengers
Tertiary consumers	Feed on **secondary consumers** (top of the food chain) **Carnivores/omnivores**

Herbivores	Carnivores	Omnivores
Eat plants	Eat meat	Eat plants and meat
Cows, sheep, caterpillar, goats, humans etc.	Dogs, cats, foxes, humans etc.	Humans, pigs, badgers etc.

A trophic level is a feeding stage in a food chain

1st	2nd	3rd	4th
Producers	**Primary Consumers**	**Secondary Consumers**	**Tertiary Consumers**

Note: This food chain can be used for a grassland or woodland ecosystem study

Questions based on food chains include:

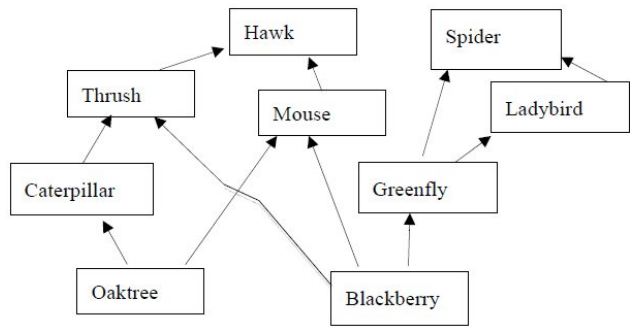
Why are food chains short in length?

There is a large loss of energy between trophic levels/there is a small amount of energy transferred between trophic levels.

Why are there usually only four trophic levels in a food chain?

The top consumer is a carnivore, it would require too much energy to catch and kill it.

A food web is a group of interlinked food chains



Note: This food web can be used for a grassland or woodland ecosystem study

When constructing a food web, the producers should be at the bottom of the web, followed by the primary consumers (herbivores), then the secondary consumers (herbivore/omnivore). The top of the food web is the tertiary consumer (carnivore).

You must also be able to list five fauna and five fauna from your ecosystem study

The term flora refers to the plants found in an ecosystem.

The term fauna refers to animals found in an ecosystem.

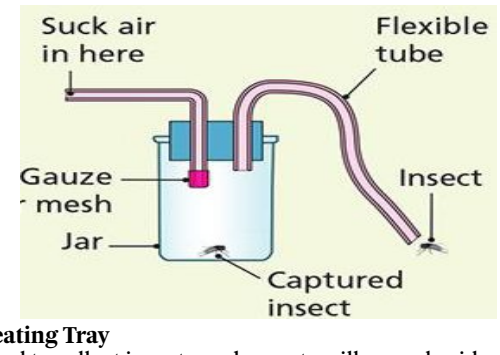
Some years the question will focus on the collection and identification of fauna in your ecosystem study.

Below is a list of apparatus commonly used, make sure you can name them and describe how they are used.

Apparatus to Capture Animals

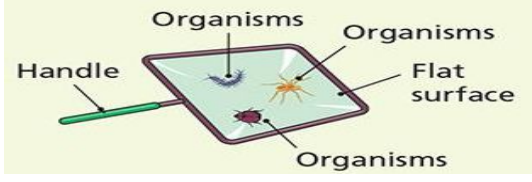
1. Pooter

- Used to collect insects.
- You place the open tube next to the insect.
- Suck air through the tube covered with the wire gauze.
- The insect is captured in the container for identification.



2. Beating Tray

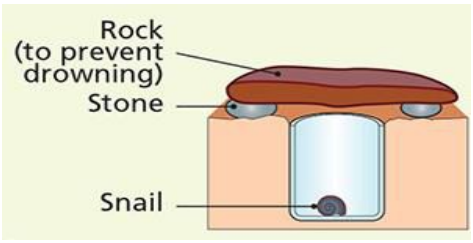
- Used to collect insects such as caterpillars and spiders.
- Place the tray under a bush or tree.
- Shake the bush or tree to collect the insects.



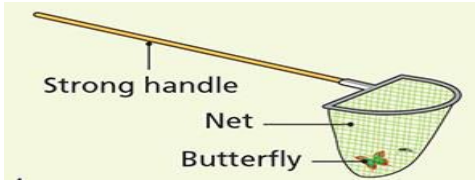
BIOLOGY

Exam Brief with Yeats College

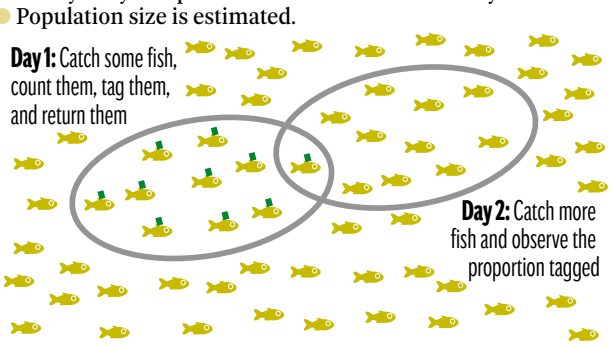
3. Pitfall Trap
- Used to collect crawling insects such as snails and beetles.
- Place a jar into the ground and cover to stop rain entering.
- Leave overnight.



4. Sweep Net
- Used to collect flying insects such as butterflies.
- Sweep the net over bushes/through the air.



5. Capture-recapture method
- Used to capture a number of animals from the same species.
- The animals caught on day one are marked for identification and released again.
- On day two you capture more fish and note how many are marked.
- Population size is estimated.



Important note: If you are asked to name an animal and describe how you observed it, the type of animal named must match the method, i.e. you can use a pooter to catch and identify a ladybird but you cannot use it to catch and identify a rabbit.

2018 Question 10(c)

(i) Describe the steps you would take to estimate the size of a population of a particular animal species in the ecosystem you have studied. (21 marks)

Answer for a slow-moving animal, i.e. snail
- Animal name
- Set up a transect line at random.
- At each point of the transect line place a grid quadrat.
- Using a key identify the animal present.
- Count the number present and record.
- Repeat at each point on the transect line and calculate the population.

Answer for a fast-moving animal i.e. rabbit
- Animal name
- Capture a number of animals from a certain area using a humane trap.
- Tag/mark the animal and release.
- After a time, return to the same area and catch a number of animals.
- Record how many are tagged and how many are not tagged.
- Calculate the population.

Some years the question will focus on the quantitative study of plants

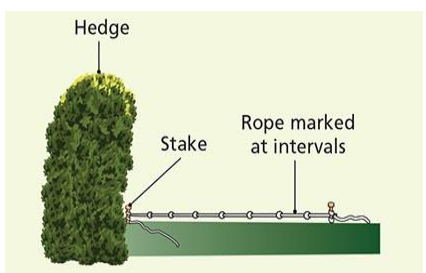
Note: This method is also suitable for calculating the population of slow-moving animals

Qualitative study records the presence or absence of something.

Quantitative study records the number of organism's present.

Apparatus used in a Quantitative Study

1. Line Transect
- This is a rope that has **markers** at certain intervals, i.e. every metre.



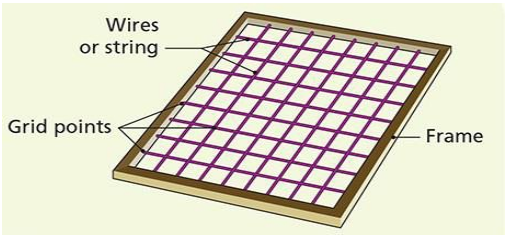
- The **transect** begins at a hedgerow and is spread out into a field, it must be placed at random to avoid bias.
- Plants or animals that are found touching the line/where the quadrat is placed are **recorded**.
- A **key** is used to **identify** the plant/animal.

2. Quadrat

A square that is made of wood or metal that can be used in two ways
- It can be thrown **randomly** in a field and plants/animals **identified**.
- It can be placed along a **line transect** at each **marker** to **identify** the plants and animals present

Quadrat limitations
- Can only be used to **identify** small plant species, i.e. grasses and flowers
- Cannot be used to **identify** fast-moving animals

3. Grid Quadrat
- A square that is divided into smaller **grids**.
- The amount of each plant **species** in each grid in the **quadrat** is counted.
- This provides an **estimation** for the entire area.



2016 Question 10(b)

(b) (i) In the case of a named ecosystem, explain how you carried out the following:

3. A quantitative study of a named plant species. In your answer explain how you ensured that the sample was random.
- Ecosystem: Name, i.e. grassland/ woodland/seashore
- Named plant species: Must match your named ecosystem
- Set up a transect line at random.
- At each point of the transect line place a grid quadrat.
- Using a key identify the plant present.
- Count the number present and record on a table.
- Repeat at each point on the transect line and calculate the number present.

Plants and animals that are found living in a particular ecosystem are there because they have adapted to the area and can survive here.

There are two types of adaptations — structural and behavioral.

You need to pick two animals from your ecosystem, a predator and a prey, and have a structural and behavioral adaptation for each.

Example: A fox (Grass/woodland)

Structural	Has good eyesight for hunting in the dark
Behavioral	Hunts at night as there is a better chance of catching prey

You need to pick two plants from your ecosystem and have a structural and behavioral adaptation for each.

Example: A dandelion (Grass/woodland)

Structural	Has yellow flowers to attract insects for pollination
Behavioral	Grows towards the light for photosynthesis

The final part of your ecosystem study is to measure abiotic factors.

Abiotic factors are non-living factors.

We must measure three abiotic factors in our ecosystem study

1. Light Intensity

Apparatus: A light meter

We will use a light meter at each marker along the transect line.

Results:
- Light intensity will be decreased nearest the hedge, i.e. the hedge provides shade.
- There will be fewer plants growing near the hedge.
- Light intensity will increase as we move away from the hedge.
- There will be more plants growing in the field as there is increased light for photosynthesis.

2. pH

Apparatus: pH meter

We will place a pH meter in the soil at each marker along the transect line.

Results:
- pH may vary along the transect line
- The pH of the soil determines the types of plants growing in an area.

3. Temperature (soil or air)

Apparatus: A thermometer

We will place a thermometer in the soil at each marker along the transect line.

We will also take an air temperature at each marker as well.

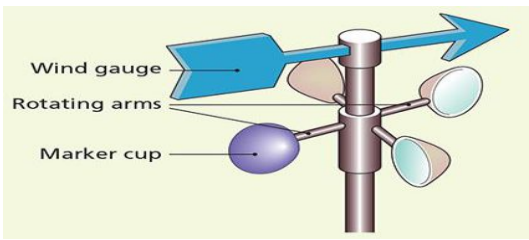
Results:
- Air and soil temperature may vary along the transect line
- The temperature in both the soil and the air determines the types of plants growing in an area

4. Wind

Apparatus: Wind gauge

We will hold up the wind gauge at each marker along the transect line.

Results: The direction and strength of the wind can affect the plants growing in an area



Safety Hazards in an Ecosystem Study
- Broken glass in the grass
- Animals that can bite/scratch
- Slipping on wet grass/mud
- Fallen branches etc.

Sources of Error in an Ecosystem Study

Error	Source of Error
Human	Mistakes in identification/using the key Over or underestimating numbers of plants/animals present
Changing Conditions	Weather Pollution Buildings
Accidental Discovery	Species may be discovered by accident Animals may hide during study Some animals only come out at night
Sample Size	A single habitat may not be large enough to represent an entire ecosystem
Random Sampling	All sampling done in the study must be random to avoid bias Bias is where samples could be chosen in order to favor a particular result

2016 Question 10

(a)(i) What is the precise meaning of the term niche as used by ecologists?

The role of an organism in an ecosystem (3)

Exam Brief *with* Yeats College

BIOLOGY

(ii) From your investigations of a named ecosystem, give one example of each:
1. A safety hazard:
Wet grass/broken glass etc. (3)
2. A source of error
Misidentification/miscalculating etc. (3)
(b) In the course of your studies you carried out an investigation of an ecosystem.
(i) In the case of this named ecosystem, explain how you carried out each of the following
1. Collection of fauna using a named method
Name an animal from your ecosystem and the collection method for the animal you have named (these must match)
i.e. pitfall trap/beating tray/pooter/capture-recapture method/ slow-moving animal using transect and grid quadrat (3)
2. Identification of collected fauna
Using a key (3)
3. A quantitative study of a named plant species. In your answer explain how you ensured the sample was random.
(i) Named plant species: Must match your named ecosystem
- **Set up a transect line at random**
- **At each point of the transect line place a grid quadrat**
- **Using a key, identify the plant present**
- **Count the number present and record on a table**
- **Repeat at each point on the transect line and calculate the number present**

(ii) Why is it essential to use a random sampling technique?
To prevent bias (3)
(iii) Suggest two abiotic factors that could affect the distribution of the named plant species
pH/air temperature/soil temperature/wind etc. (2 x 3)
(iv) State one way in which human activity can have an impact on your named ecosystem.
Pollution/conservation (3)
(c) A typical grazing food chain, consisting of four trophic levels, is shown below. Each letter represents a different species.

A → B → C → D

(i) What is meant by the term trophic level
The feeding stage in a food chain(3)
(ii) Explain why food chains are generally short
A small amount of energy is transferred between levels/a large amount of energy is lost between energy levels (3)
(iii) Which letter represents the secondary consumer?
C (3)
(iv) Give a possible reason why the population of C may decline naturally.
Disease/predation/lack of food/migration (3)
(v) Suggest a possible consequence for the population of A if the population of C was significantly reduced. Explain your answer.
Population of A will fall (3)
Explain: If population C decreases, population B will increase and the primary consumer will feed on A the producers causing a decrease
(vi) Suggest how members of species D might respond, if the population of C was significantly reduced.
Might switch their food source/migrate to find food (3)
(vii) A food web is a series of interconnected food chains. Suggest how it may be possible for the secondary consumer, in the food chain above, to be a primary consumer in another food chain
The animal could be an omnivore (3)

Thank you for taking the time to read this Exam Brief. I would like to wish all students sitting exams in June the absolute best of luck and well wishes for the future.
Katrina

Advice for Fifth Years

The message I would like to get across to Fifth Years who are finishing school in a few weeks and preparing to enter their Leaving Cert year is, there is plenty of time — time to catch up on topics not covered, time to learn, time to revise — so there really is no need to stress at this stage.

It is important you focus on the positives and the goals you have achieved. Know that you have done your best under the most extreme circumstances.

You can use the time over your summer break to prepare for the Leaving Cert year ahead.

When it comes to preparing for Biology, all of the advice provided in this *Exam Brief* can be applied to your revision and refining your exam technique.

When we look at the breakdown of exam questions each year, we can focus on key topics that appear regularly on the paper.

Syllabus

Unit 1	The Study of Life	Characteristics of life, scientific method, food and ecology
Unit 2	The Cell	Cell structure, diversity and division, diffusion and osmosis, enzymes, photosynthesis, respiration and genetics
Unit 3	The Organism	Classification, Monera, Protista and fungi, human and plant biology

Exam Layout

The exam is three hours in length and the paper is worth a total of 400 marks.

The exam is divided into three sections.

Sections	Questions to be answered	Marks per question	Marks in total
A	5 out of 6	20	100
B	2 out of 3	30	60
C	4 out of 6	60	240

Each section will contain topics from each unit:

Section A

- Two questions from Unit 1
- Two questions from Unit 2
- Two questions from Unit 3

In this section you must answer five questions, four of which will be from Units 1 and 2 (outlined above).

This means if you study these two units in detail and practise related exam questions for each topic you will be able to answer 80% of Section A

Use the following table as a checklist for each chapter in unit one and unit two:

Topic	In Class	Revised	Exam papers
Scientific method			
Food			
Ecology			
Ecosystem study			
Higher Ecology			
Cell Structure			
Cell Diversity			
Cell Division			
Diffusion and Osmosis			
Enzymes			
Respiration			
Photosynthesis			
DNA & RNA			
Genetic Crosses			
Variation and Evolution			
Genetic Engineering			

If you did not cover all these chapters this year, don't worry and focus your energy and revision on the topics you have covered.

Section B

- Three questions based on the 28 mandatory experiments.
- In this section you must answer two questions out of three.
- Nineteen of the mandatory experiments are covered in Units 1 and 2.

Highlight which experiments from these units you covered in class this year. Have you revised these experiments and tried some exam questions?

- Food tests (including test for starch, reducing sugar,proteins and lipids)
- To use simple keys to identify any flora and fauna
- Using apparatus to collect plants and animals
- To carry out a quantitative survey of plants
- To carry out a quantitative survey of animals
- To investigate three abiotic factors
- To be familiar with a light microscope
- To prepare and examine plant cells
- To prepare and examine animal cells
- To investigate the effect of pH on enzyme activity
- To investigate the effect of temperature on enzyme activity
- To prepare an immobilised enzyme and examine its application
- To examine the effect of heat denaturation on an enzyme
- To investigate the influence of light intensity/carbon dioxide concentration on the rate of photosynthesis
- To prepare and show the production of alcohol using yeast.
- To demonstrate osmosis

Again, don't worry if you haven't covered all these experiments this year. The important thing is to focus on what you have covered and work on getting those parts into the long-term memory for next year.

Section C

- One question from Unit 1
- Two questions from Unit 2
- Three questions from Unit 3

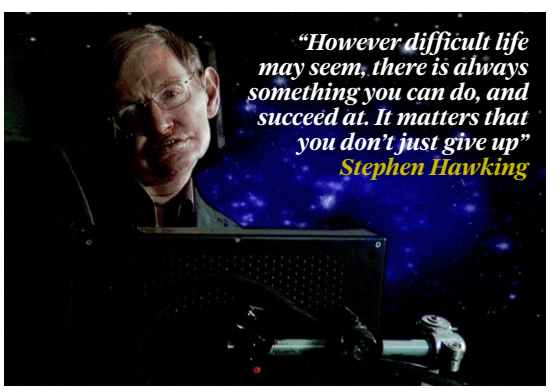
In this section you must answer four questions out of six and three of these questions will be based on topics from Units 1 and 2.

By revising the topics outlined above for Sections A and B you will have covered enough to answer three questions (75%) in section C.

You will then have plenty of choice in the exam when you include the Unit 3 topics as well.

Stay confident in your ability and don't worry if there is room for improvement. Don't aim for perfection, aim for progress.

Well done on all your efforts this year and have a restful and safe summer. *Katrina*



YEATS COLLEGE

Masters in Educational Success

When *your* *Education* matters

Our *core* belief is that
exceptional teaching
in a uniquely *motivated* environment
will always embrace the student.

Recognised in Ireland for our truly Exceptional Results.

Now Enrolling

5th Year | 6th Year | Repeat Leaving Certificate

Teaching Excellence | Uniquely motivated environment
Unrivalled results record | Flexible subject choice

Galway: 091 533500 **Waterford:** 051 304211

www.yeatscollege.ie