higher nucleus
Complexity Simplified

ISSUE 1

A Level Quick Guide

Complexity Simplified

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FOREWARD

Dear Reader,

Complexity Simplified!

This is the beacon of teaching at Higher Nucleus, and advisedly, that of learning as well. Simplified means breaking down complex ideas and concepts into smaller, more manageable parts, easing understanding. This approach is really a truism yet remains a challenge in practice for many educators. At Higher Nucleus, only tutors with proven ability to simplify complex concepts are engaged to teach. For the academic year of 2022, more than 60% of the students taking General Paper, Mathematics and Chemistry achieved an A! Biology also surpassed the national distinction rate by a wide margin, with 68% attaining quality grade.

It is with the purpose of helping you understand key concepts of your subjects that this Quick Guide has been designed, providing you with useful tips and strategies to succeed. It will cover everything from exam structure to subject-specific advice, to help you feel confident and prepared on exam day. This March Issue is the inaugural issue, with many more to come.

As you embark on your GCE A-Level journey, remember that preparation is key. This Quick Guide is meant to be a quick and handy reference for you, so feel free to use it as a supplement to your existing study materials. Whether you are studying on your own or with a tutor, we hope that this Quick Guide will provide you with valuable insights and help you achieve your goals.

We wish you all the best as you prepare for the GCE A-Level exam, and we hope that this Quick Guide will be a valuable resource on your journey.

Complexity Simplified!

Sincerely,

Team Higher Nucleus

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GENERAL PAPER

Schadenfreude **noun**	**MEANING** Pleasure derived from the misfortunes of others.

POSSIBLE ESSAY QUESTION
Is it wrong to feel happy about the misfortunes of others?

What POINTS can you form to answer the Essay Question? Follow the steps!

STEPS
Use SUM
1 Scrutinise Question
2 Use Formula
3 Make Content

S

1 **SCRUTINISE** the Question
Is it wrong to feel happy about the misfortunes of others?

Judgement
- It is wrong
- It is not wrong

Event

U

2 **USE** Formula to form a Point
(a) Cause → Event ⇒ Judgement

Origin
Root
Source

Misfortunes of others

It is wrong to feel happy

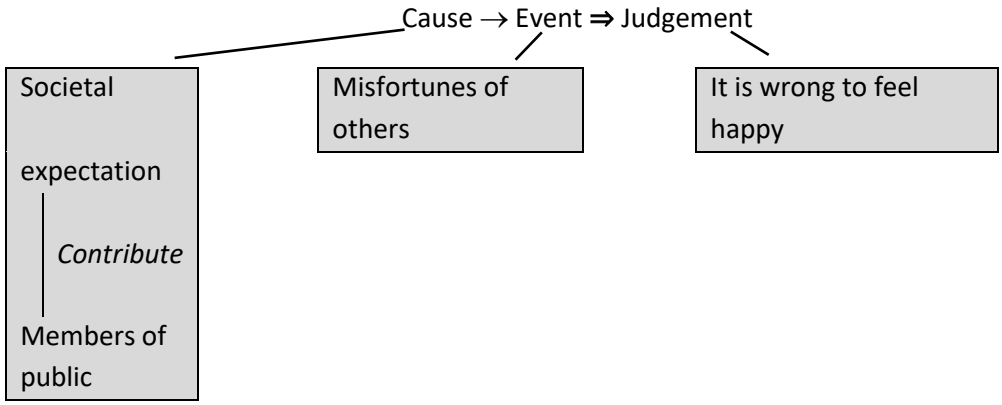
M

(b) **MAKE** Content based on STEP 2 (Using Formula)
a. Specify the Cause (Reason that leads to Event)
i. Societal expectation
ii. Etc

b. Specify a party responsible for Cause
i. One who contribute to / cement societal expectation

c. With a) and b), establish Cause → Event ⇒ Judgement
i. Societal expectation → Misfortune
One contributes to societal expectation
⇒ It is wrong to feel happy
d. Persuade with Examples

ILLUSTRATION



Possible Topic Sentence

A cause of misfortune is <u>societal expectation</u>, of which the sufferer often succumbs. Other members of society while not direct contributors of such misfortunes, are <u>indirect contributors</u>, cementing the concerned social norm. Hence, it is wrong for one to embrace schadenfreude since one, whether knowingly or otherwise, builds this cause of the sufferer.

Now, let's persuade with an EXAMPLE.

HIKIKOMORI, JAPAN

- In Japan, Hikikomori is total withdrawal from society and seeking extreme degrees of social isolation and confinement.
- One contributing factor is particularities of the educational, housing and economic systems.
- Chujo, 24, has been a hikikomori for two years. He has dreams of becoming an opera singer, but as he is the eldest son, his family wants him to join the family business. He worked in an office for a year, but it was so stressful that he suffered from stomach pain. Upset, he would act up, drawing further reprimand from his family, which would, in turn, intensify his feelings of shame.

MATHEMATICS

Graphing: Conics

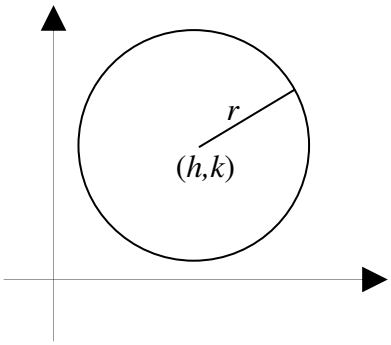
Conics are special loci representing the intersection of a plane and the surface of a cone. These are the 4 types which we need to be familiar with for H2 math.

(a) Circles

A circle, centered at (h, k), with radius r is given by the equation:

$$(x-h)^2+(y-k)^2=r^2$$

where h, k are real numbers and r is a positive real number.

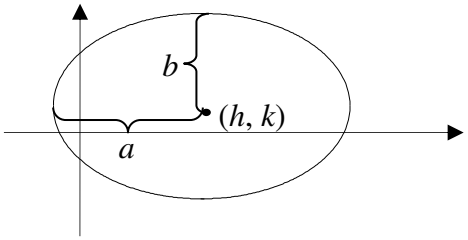


(b) Ellipses

An ellipse, centered at (h, k), with horizontal radius a and vertical radius b is given by the equation:

$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

where h, k are real numbers and a, b are positive real numbers.

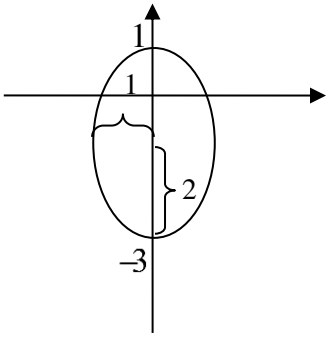


The ellipse is symmetrical about x = h and y = k
If $a = b$, then we obtain an equation of a circle.

When using the GC to sketch, we need to make y the subject of the expression.

Example: $4x^2+y^2+2y=3$ .Upon completing the square we get $4x^2+(y+1)^2=4$.

Making y the subject, we get $y=-1\pm\sqrt{4-4x^2}$.



The standard form of this ellipse is $\frac{x^2}{1^2}+\frac{(y+1)^2}{2^2}=1$.

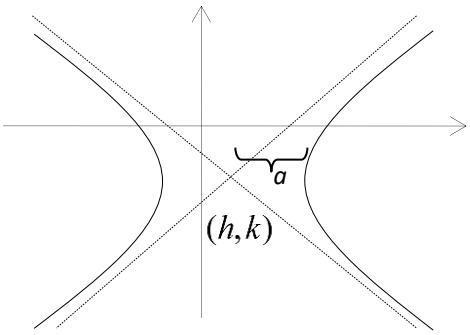
It has centre $(0,-1)$ with vertical radius 2 and horizontal radius 1.

(c) Hyperbolas

A hyperbola, centered at (h, k), where h, k are real numbers and a, b are positive real numbers, has a graph of the following equation:

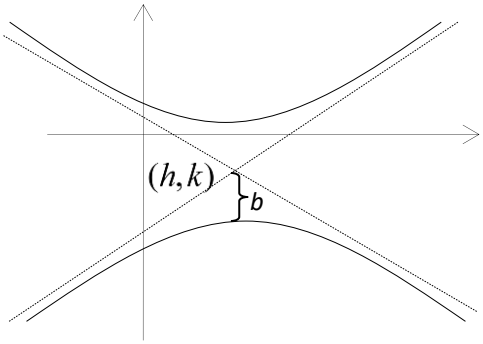
$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$$

(East-West)



$$\frac{(y-k)^2}{b^2} - \frac{(x-h)^2}{a^2} = 1$$

(North-South)



It is symmetrical about the lines $x = h$ and $y = k$.

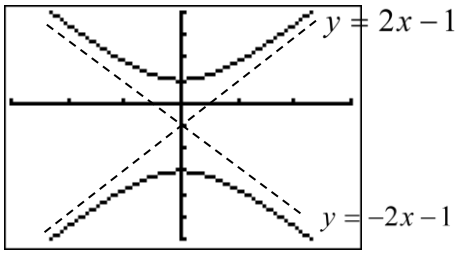
The equations of the asymptotes are $y - k = \pm\frac{b}{a}(x-h)$ ⟶

1. convert the '1' into a '0'
2. make *y* the subject

Example:

$-4x^2 + y^2 + 2y = 3$. Upon completing the square, we get $-4x^2 + (y+1)^2 = 4$.

Making *y* the subject, we get $y = -1 \pm \sqrt{4 + 4x^2}$.



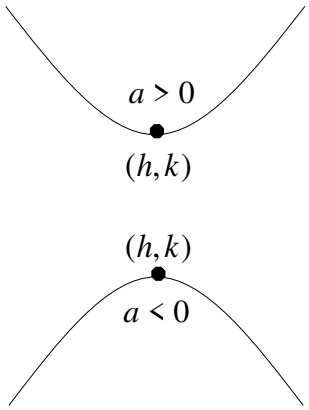
The standard form of this hyperbola is $\frac{(y+1)^2}{2^2} - \frac{x^2}{1} = 1$.

The asymptotes are $y + 1 = \pm\frac{2}{1}x \rightarrow y = 2x - 1$ and $y = -2x - 1$

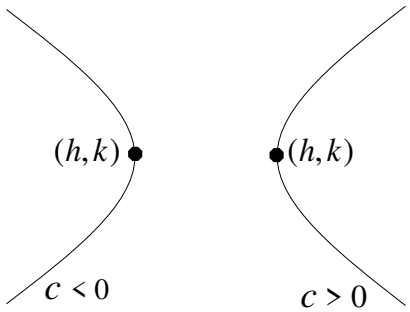
(d) Parabolas

A parabola, with vertex at (h, k), where h, k are real numbers has a graph of the following shape:

$y = a(x-h)^2 + k$



$x = c(y-k)^2 + h$



Identifying type of conic

To differentiate between the 4 conics above (when not in standard form), we just compare the coefficients of x^2 and y^2.

Coefficients of x^2 and y^2	**Conic**
Same sign and value	Circle
Same sign, different value	Ellipse
Different sign	Hyperbola
y^2 exists but x^2 does not	C or inverted C-shape Parabola
x^2 exists but y^2 does not	U or inverted U-shape Parabola

For e.g., observe the equations below:

1. $4x^2 + 9y^2 - 18y = 36$
2. $x^2 - k^2 y^2 + 2k^2 y = 2k^2, k \in \square$

We can tell that equation (1) is an ellipse. Equation (2) is a hyperbola, even though the value of k is not known since 1 and $-k^2$ have different signs.

CHEMISTRY

Chemical Bonding Summary 2023

1. Interatomic Bonds

(I) Ionic Bonds

- Ionic bond is the electrostatic force of attraction between two oppositely charged ions (cations and anions).
- Ionic bond strength is proportional to lattice energy (L.E).

  $|\text{L.E}| \ \alpha \ \frac{q_+ q_-}{r_+ + r_-}$ where q_+ is charge of the cation while q_- is the charge of the anion while $r_+ + r_-$ is the inter-ionic distance between the anion and the cation.

(II) Covalent Bonds

- Covalent bond is the electrostatic attraction between the nuclei of each bonding atom for the shared pair of electrons.
- Three factors affecting the strength of covalent bonds are:
  - Bond order (No. of covalent bonds formed)
  - Bond length or Degree of overlap
  - Bond polarity

(III) Intermediate bonds

- Covalent bond with ionic character: Arises due to difference in electronegativity between two atoms. E.g., HCl
- Ionic bond with covalent character: Arises due to distortion of the electron cloud of the anion by the cation and the extent of distortion depends on (i) the charge density (charge / ionic radius) of the cation and (ii) the ionic radius of the anion.

(IV) Metallic Bonds

- The **metallic bond** is the electrostatic attraction between positive ions of the atoms and the mobile sea of delocalised electrons.
- **Factors affecting Strength of Metallic Bonds**
  - Number of valence electrons contributed by each atom.
  - Charge density (charge / ionic radius) of the cations

2. Intermolecular Forces of Attraction

(I) Instantaneous dipole-induced dipole interactions (id-id): This is the predominant intermolecular forces between **non–polar molecules**.

Factors affecting Strength of temporary dipole-dipole interactions

– **Size** of the electron cloud: The greater the electron cloud size, the easier it gets distorted, the stronger is the id-id formed between the molecules.

– **Shape** of molecule (if the electron cloud size is the same): Straight chain molecules have a larger surface area and hence form stronger id-id than their branched chain isomers.

(II) Permanent dipole-dipole interactions: This is the predominant intermolecular forces between **polar molecules**.

Summary on how to determine if a molecule is polar / non-polar

(a) Hydrocarbons (molecules containing C and H only) and molecules containing identical atoms are non-polar (e.g., C_2H_6, Br_2, S_8)

(b) When there is 2–6 bond pairs around the central atom (zero lone pairs) and all terminal atoms are the same, the molecule is non-polar (e.g., CO_2, BF_3, CCl_4, PCl_5, SF_6), meaning, if one terminal atom is different, the molecule is polar (e.g., $CHCl_3$, CH_2Cl_2)

(c) If the molecule has one lone pair of electrons around the central atom, it will be polar. E.g., NH_3, SF_4.

(d) If there are two lone pairs and above around the central atom, you would need to determine where the lone pairs are located and check if the bond pairs' dipoles cancel out.

(III) Hydrogen Bonding

- **Conditions required for Hydrogen Bonding:**

Condition 1:

Protonic H in H–F, N–H and O–H bonds:

Condition 2:

A highly electronegative atom (F, O or N) in the neighboring molecule with at least 1 lone pair:

- **Factors that affect Strength of H-bonding**

– Extensiveness of H–bonds

– Polarity of H–X bond (X = F, O or N)

BIOLOGY

DNA REPLICATION VS TRANSCRIPTION VS TRANSLATION

Feature	DNA Replication	Transcription	Translation
Location	**Nucleus** **Mitochondrion** **Chloroplast**	**Nucleus**	**Cytoplasm (ribosomes)** (Free ribosomes & ribosomes attached on the RER membrane)
Initiation site	**Origin of replication (Ori)**	**Promoter**	**Start codon AUG on the mature mRNA**
Termination site	Telomeres at both ends of the DNA molecule	Termination sequence	Stop codon on the mature mRNA (UAA, UAG, UGA)
Monomers	**Free deoxyribonucleotides** / deoxyribonucleoside triphosphates	**Free ribonucleotides** / ribonucleoside triphosphates	**Amino acids**
Bonds formed between monomers	**Phosphodiester bond**	**Phosphodiester bond**	**Peptide bond**
Template strand used	Both DNA strands of the double-stranded parental DNA molecule	DNA template strand of a gene	Mature mRNA
Product formed	2 genetically identical **DNA** molecules	**RNA** (E.g., mRNA, rRNA, tRNA etc.)	**Polypeptide**
Destination of Product	Remains in the nucleus or mitochondria or chloroplast (Nucleoid region for prokaryotes)	Cytoplasm	Cytoplasm, nucleus, embedded on membranes, secreted out of the cell
Enzymes involved in forming bonds between monomers	**DNA polymerase III and I**	**RNA Polymerase**	**Peptidyl transferase** (a ribozyme within large ribosomal subunit)
Direction of reading the template strand	**3' to 5'**	**3' to 5'**	**5' to 3'**
Direction of synthesis	**5' to 3'**	**5' to 3'**	**N to C terminus**

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GP *– "Mr Lim's lessons are practical with effective mnemonics, simplified writing methods and equal coverage of paper 1 and 2."*

Lucas Wong, RI 2022

Math *– "I have always found JC Math tough. This all changed after joining Mr Chia's class. I improved from S to A!"*

Durga, VJC 2022

Bio *- Mr Alex is an energetic and passionate tutor. I wouldn't have achieved A without his dedication and commitment.*

David Leong, ACJC 2022

Chem *- Mr Low's notes are clear and concise, summarized straight to the point! Very useful!*

Jolyn Tan, RI 2022