



Charles Darwin

Inheritance





Inheritance

Inheritance is the process by which genetic information is passed on from parent to child
Hereditary traits can be passed down to you by your parents:



ability to roll tongue



allergy



ability to taste PTC (bitter compound)



dimples



right or left handed



attached or free earlobe



(a) Distinguish between the terms gene and allele

(b) Explain the terms dominant, recessive, codominant, homozygous, heterozygous, phenotype and genotype



Terms

Gene	<ul style="list-style-type: none">• A sequence of DNA nucleotides that stores information used to make a polypeptide• A unit of inheritance passed from parents to offspring• Each gene occupies a locus, a specific position on chromosome
Allele	<ul style="list-style-type: none">• Alleles are different forms of a gene that leads to variations in those traits• Alleles arise due to mutation• Alleles of a gene occupy the same locus on a pair of homologous chromosomes.• Individuals inherit two alleles for each gene, one from each parent.• For example, for the gene controlling eye color, there might be alleles for brown eyes and alleles for blue eyes.



Terms

Chromosome	<ul style="list-style-type: none">● Chromosome is a compact structure visible in the nucleus during cell division and it is made up of DNA● The place on the chromosome where the gene is located is called the gene locus.
Dominant	<ul style="list-style-type: none">● A dominant allele is the allele that is always expressed in the phenotype, no matter under homozygous or heterozygous condition.
Recessive	<ul style="list-style-type: none">● A recessive allele is the allele that is only expressed under homozygous recessive condition.
Codominant	<ul style="list-style-type: none">● When both alleles have an equal effect on the phenotype of the offspring.● Both alleles are expressed in the phenotype.
Homozygous	<ul style="list-style-type: none">● When organisms have two identical alleles of a particular gene. Allele can be either both dominant or both recessive.
Heterozygous	<ul style="list-style-type: none">● When organisms have two different alleles of a particular gene.
Genotype	<ul style="list-style-type: none">● The genetic makeup of an organism.● An organism's genotype is homozygous for a trait if the two alleles controlling the trait are identical, heterozygous for a trait if the alleles controlling the trait are different.
Phenotype	<ul style="list-style-type: none">● Phenotype refers to the observable, physical traits that are determined by the genotype.



(c) Predict the results of simple crosses with expected ratios of 3:1 and 1:1, using the terms homozygous, heterozygous, F1 generation and F2 generation

(d) Use genetic diagrams to solve problems involving monohybrid inheritance



Monohybrid Inheritance

Parental
Generation



F1 Generation



F2 Generation



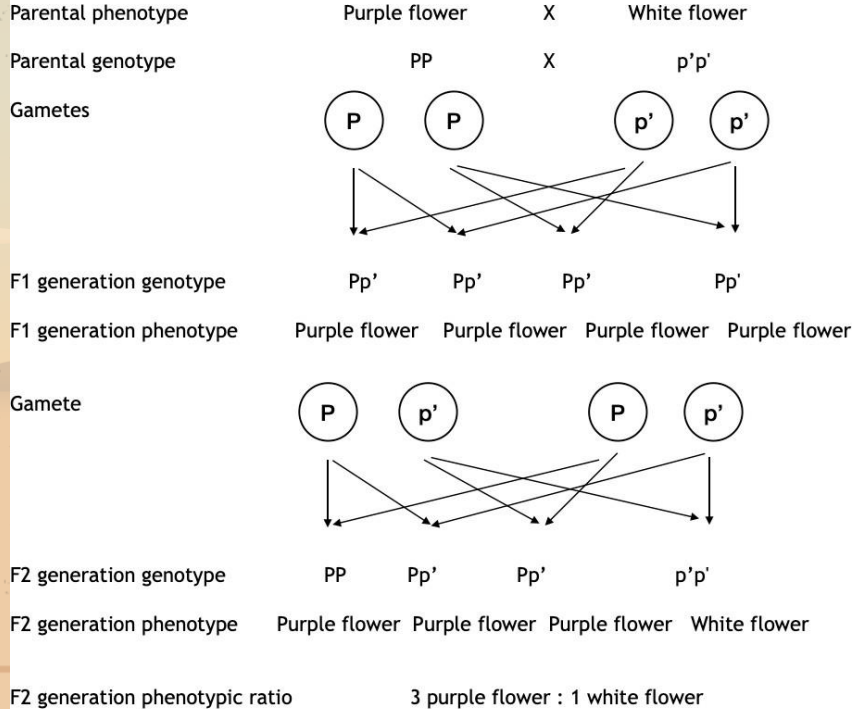
- The gene for flower colour of pea plant has two alleles: dominant **purple allele** (P) and recessive **white allele** (p')
- When a homozygous purple plants (PP) is crossed with a homozygous white plant ($p'p'$), each organism inherits one allele from the mother and one allele from the father during sexual reproduction
- The offspring generation consisted of all purple-flowered plants even though their genotype is heterozygous (Pp') as the dominant purple allele (P) is expressed over recessive white allele (p')
- Self-pollination in the F1 generation produced a F2 generation where the phenotypic ratio of purple-flowered to white-flowered plants is 3:1



Monohybrid Inheritance

Let P represent the allele for purple flowers

Let p' represent the allele for white flowers



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(e) Explain why observed ratios often differ from expected ratios, especially when there are small numbers of progeny





3 purple flower: 1 white flower is the expected ratios, but the actual observed ratio can be different especially when there are small numbers of progeny, because

- Fertilisation of the ova and sperms is a random event.
- Therefore the expected ratios are only based on chance and probabilities.

With small number of offspring, the observed ratios often differ from expected ratios. But, with large number of offspring (large sample size), the observed ratios will be closer to expected ratios.



(f) explain codominance and multiple alleles with reference to the inheritance of the ABO blood group phenotypes (A, B, AB, O) and the gene alleles (I^A , I^B and I^O)





Codominance

ABO blood group

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-B and Anti-A
Antigens in Red Blood Cell	 A antigen	 B antigen	 A and B antigens	None

Blood group phenotype	Homozygous Genotype	Heterozygous Genotype
A	$I^A I^A$	$I^A I^O$
B	$I^B I^B$	$I^B I^O$
AB	$I^A I^B$	
O	$I^O I^O$	

Complete dominance is when the heterozygote has the same phenotype as the dominant homozygote. In pea plant flower example, the recessive allele present in the heterozygote is masked by the dominant allele. This is because when you cross PP with pp, all the offspring in the F1 generation will have a genotype of Pp, and would therefore display purple flower phenotype.

Co-dominance is when both alleles contribute equally to the phenotype.

ABO blood group is determined by 3 alleles:

- I^A : Allele for the production of Type A antigen (Blood Group A)
- I^B : Allele for the production of type B antigen (Blood Group B)
- I^O : Allele that produces neither antigen (Blood Group O)

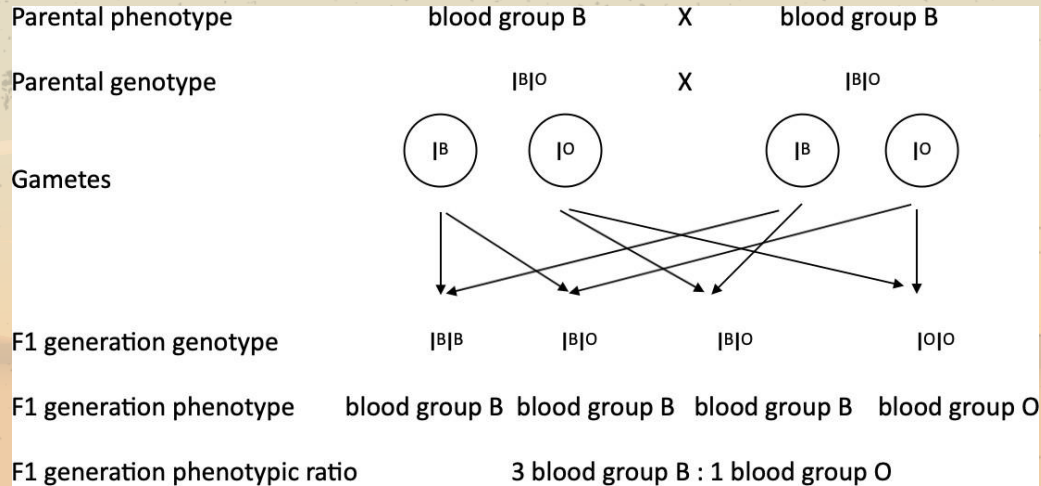
I^A and I^B are codominant, while I^O is recessive to both

- For $I^A I^B$ genotype, both antigen A and antigen B are expressed since they are codominant and each of the alleles produces its own antigen. Both alleles contribute to the phenotype, which is blood group AB.
- For $I^A I^O$ and $I^B I^O$ genotype, I^O is recessive to I^A and I^B thus, the phenotype is blood group A and B respectively.



Codominance

ABO blood group example



Parents with blood group B can produce offsprings with blood group O

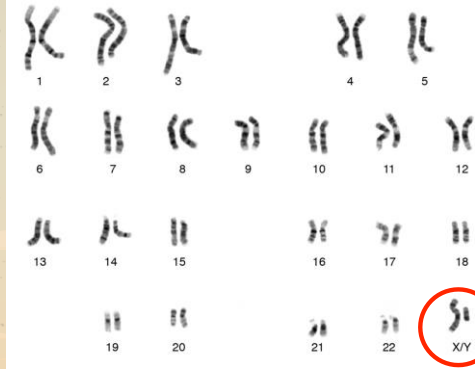


(g) describe the determination of sex in humans - XX and XY chromosomes



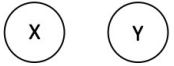
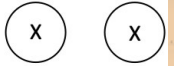


Sex determination



- A human cell has 23 pairs of chromosomes and the last pair is the sex chromosomes
- In humans, sex is determined by sex chromosomes.
- Human sex chromosomes are the X chromosome and the Y chromosome.
- X chromosome is much larger than the Y chromosome.
- Human males have one X chromosome and one Y chromosome (XY genotype)
- Human females have two X chromosomes (XX genotype)

Example of sex determination cross:
equal probability of a male or female offspring

Parental phenotype	Male	X	Female	
Parental genotype	XY	X	XX	
Gametes				
F1 generation genotype	XX	XY	XX	XY
F1 generation phenotype	Female	Male	Female	Male
F1 generation phenotypic ratio	1 Female : 1 Male : 1 Female : 1 Male			



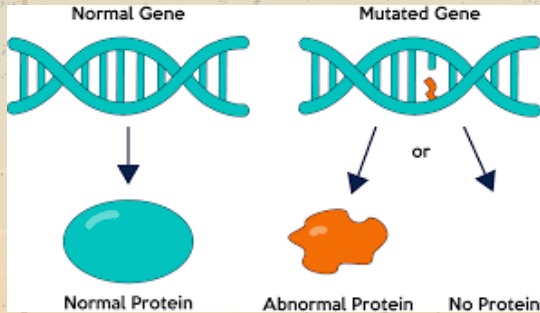
(h) describe mutation as a change in the sequence of a gene such as in sickle cell anaemia, or in the chromosome number, such as the 47 chromosomes in the condition known as Down syndrome

(i) name ionising radiation (e.g. X-ray) and chemical mutagens as factors which may increase the rate of mutation





Mutation



1. Mutation is a random change in the :

- 1) structure/ sequence of a gene (gene mutation)
- 2) chromosome number

1. Mutations that take place in body cells other than gametes are called somatic mutations, which will not be passed on to the next generation

1. Mutation is spontaneous and can occur during replication of DNA

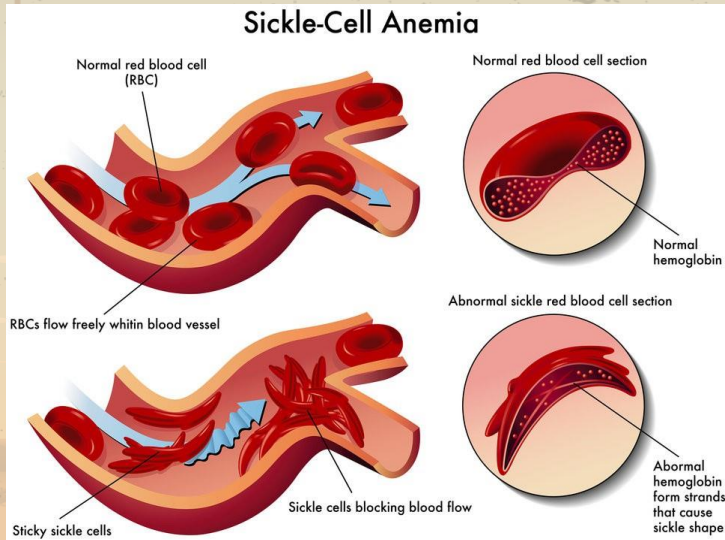
1. Mutagen increase the rate of mutation

1. Examples of mutagens:

- Ionising radiation: Ultraviolet radiation, x rays, gamma rays
- Chemical mutagens: such as benzene, ethidium bromide



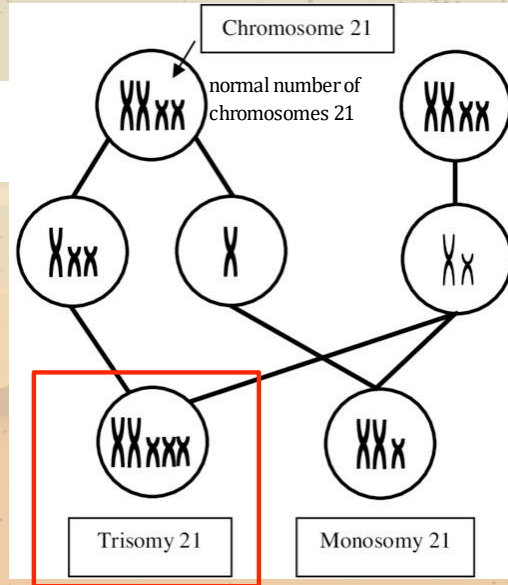
Gene mutation



- Sickle-cell anaemia is caused by a change in the sequence of nucleotides coding for the protein, haemoglobin
- It is a recessive condition, which means mutated allele only express in a homozygous recessive condition
- Heterozygous individual with one normal allele, one mutated allele are healthy but are carriers
- Normal red blood cells are flexible and can change their shape in order to pass through capillaries.
- Mutated gene produces Haemoglobin S (HbS) that tend to clump together, which result in sickle-shaped red blood cells that can block capillaries
- When oxygen concentration in the blood drops, the red blood cells become sickle-shaped and this lowers their surface area to volume ratio for diffusion of oxygen.
- Hence, they cannot transport oxygen as effectively as the normal red blood cells.
- In summary: changes in the sequence of nucleotides impacts the structure of proteins and consequently, the function of the protein



Chromosomal mutation



- Down syndrome is a condition caused by a chromosome mutation during meiosis (gamete production)
- The gamete has 2 copies of chromosome 21, thus upon fertilisation, the zygote inherits 3 copies of chromosome 21 and a total of 47 chromosomes
- This mutation is present in all body cells due to mitosis during zygote development.
- This chromosome mutation is far more likely to occur during ovum production than during sperm production.
- Women above 30 have a higher risk of carrying babies with Down syndrome.

down syndrome is also known as trisomy 21



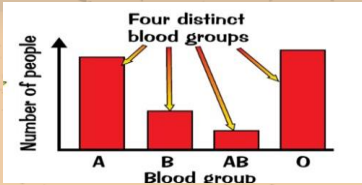
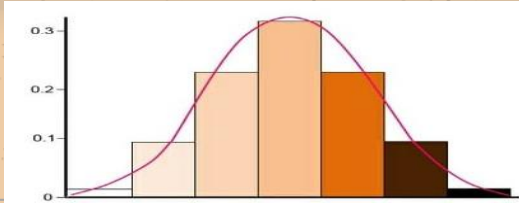
(j) distinguish between continuous and discontinuous variation and give examples of each





Variation

Variations are differences in traits between individuals of the same species.

	Discontinuous variation	Continuous variation
Phenotype	Few clear-cut phenotypes with no intermediate	Range of phenotypes.
Environment influence	Rarely affected by environmental conditions	Greatly affected by environmental conditions.
Genes	Controlled by one or few genes	Controlled by many genes
Additive effect	Not present	The effect of many genes add together and contribute the phenotype
Graph	Discrete groups 	Normal distribution 
Examples	Blood groups, eyelid, flower colour in pea plant	Height, skin colour, weight, intelligence



(k) State that variation and competition lead to differential survival of, and reproduction by, those organisms best fitted to the environment

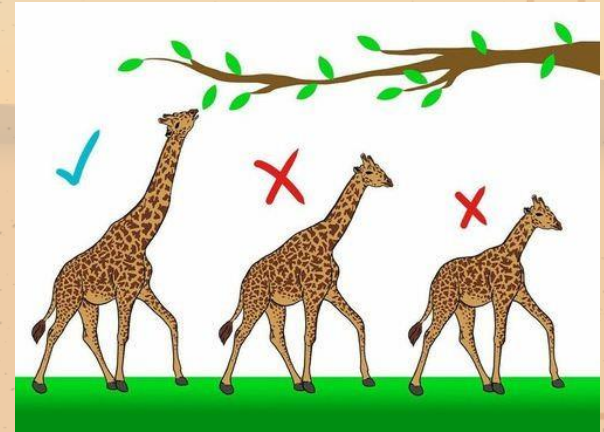
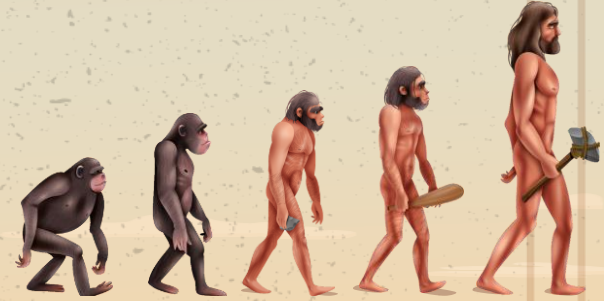
(l) give examples of environmental factors that act as forces of natural selection

(m) explain the role of natural selection as a possible mechanism for evolution which is a gradual change in the inheritable characteristics of a population over time



Natural selection

1. There are variation among individuals within the population such as giraffe with short and long neck. This is due to **environmental factors that act as forces of natural selection**: variation in climate, predation pressure, food availability, diseases and pathogens, geographic features, competition for resources
2. This therefore leads to **natural selection**, where individuals traits that are favoured by the environment / adapted to their environment are more likely to survive and reproduce and pass down their favourable alleles to their offspring
3. Overtime, offspring with favourable alleles and traits would increase in proportion
4. This leads to **evolution**: the gradual change in allele frequency in a population over generations. This could give rise to a new species.



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07

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Our efforts to go out of our way to support our students were captured by local new publications.

OVERMUGGED was SG first tuition center to host **large scale mock exam!**

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TODAY
June 16 at 5:49 PM · 🌐

One Primary 6 student who is sitting mock exams told TODAY: "I feel stress didn't do any exams all the way until prelims and PSLE... I'll be unfamiliar w/ environment and I cannot concentrate."



TODAYONLINE.COM
Hundreds sign up for tuition centre mock exams costing up to \$1000, scrapping of all mid-year school exams

👍❤️😬 53

👍 Like




P6 and Sec 4 students flock to tuition centres for mock exams after scrapping of school midterms

Wong Shying
The Straits Times

Vulcan Post
12h · 🌐

Overmugged launched a tuition subscription plan for 'O' Levels subjects to make education more affordable and accessible, and has achieved a six-figure revenue in its first year.



VULCANPOST.COM
OVERMUGGED: This 28-year-old built S'pore's first online tuition subscription service

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With midterms scrapped, students take mock exams at tuition centres



Many in Primary 6 and Secondary 4 seek to build experience ahead of national exams

Wong Shying
The Straits Times

Students are flocking to tuition centres for mock exams ahead of national exams after the scrapping of school midterms. The centres offer a more familiar environment and provide a chance for students to practice their skills in a real exam setting.

Overmugged, a tuition subscription service, has seen a surge in sign-ups for its 'O' Level mock exams. The service provides a comprehensive package of materials and support for students preparing for their national exams.

Parents are also seeking out these services to help their children stay on track and build confidence before the big day. The mock exams are designed to mirror the format and difficulty of the actual national exams, giving students a valuable experience.

Overmugged's approach is gaining traction, with many parents praising the company's commitment to quality and student success. The service's focus on providing a supportive and structured learning environment is a key factor in its popularity.

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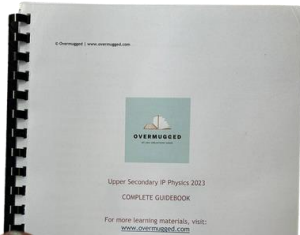
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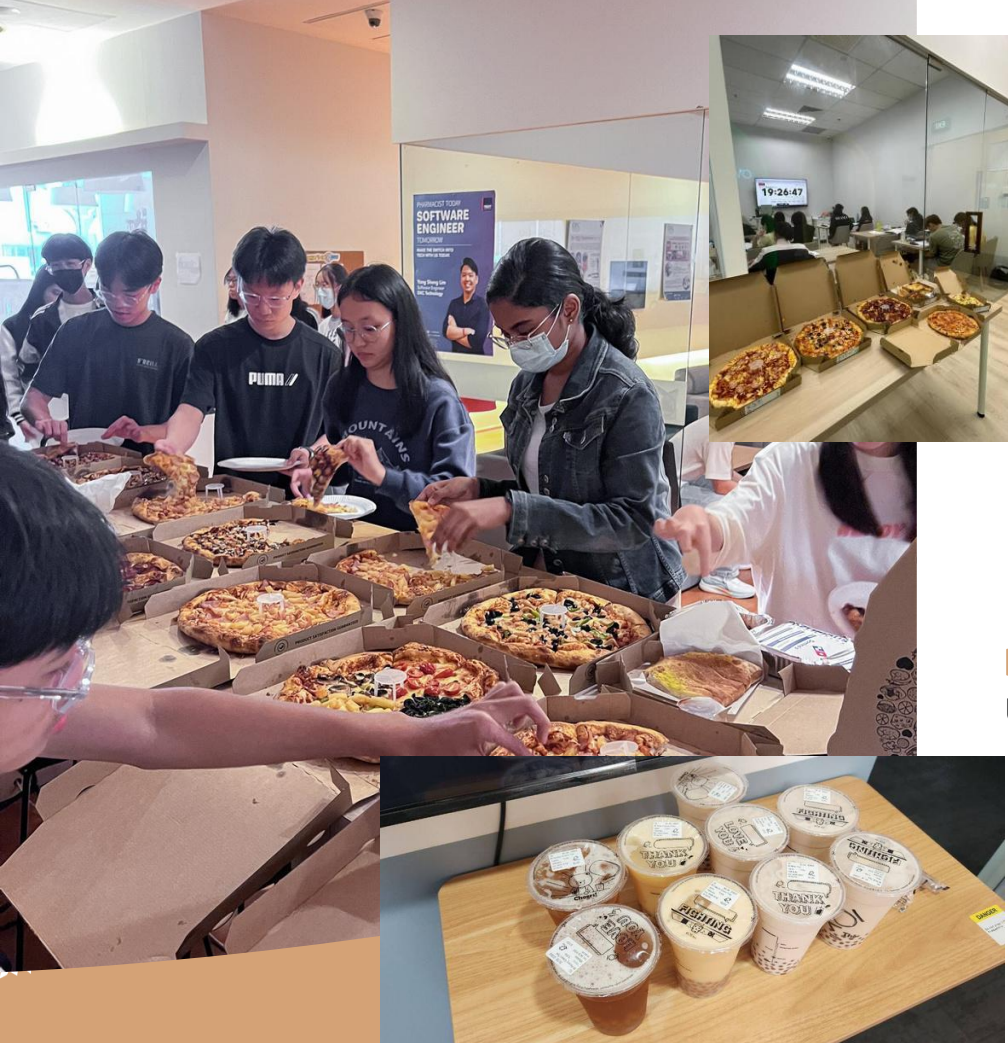
TOPIC: KINEMATICS			
Type	Definition	Formula	Remarks
Linear Motion	Object that is moving in a straight line. 1-D motion	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$	<ul style="list-style-type: none"> Motion can be represented (upwards or right) or -ve (down or left) sign. Equations can only be used if acceleration is constant.
2-D Motion	Object that is moving in a plane; trajectory (s and v directions)	Horizontal motion (acceleration = 0) $v_x = u_x$ $s_x = u_x t$	<ul style="list-style-type: none"> Acceleration always act down Parabola will fall and go parabolic if resistance is negligible
	Acceleration is experienced in both axes. Vertical and horizontal motion are independent of each other	Vertical motion (uniform vertical acceleration = g) $v_y = u_y + at$ $s_y = u_y t + \frac{1}{2}at^2$ $v_y^2 = u_y^2 + 2as$	
3 Vectors (vector motion)	Analyse the horizontal and vertical motion separately	For a vector \vec{v} pointing at an angle θ from the horizontal: $v_x = v \cos(\theta)$ (horizontal) $v_y = v \sin(\theta)$ (vertical) $v = \sqrt{v_x^2 + v_y^2}$ $\tan \theta = \frac{v_y}{v_x} = \tan^{-1} \left(\frac{v_y}{v_x} \right)$	



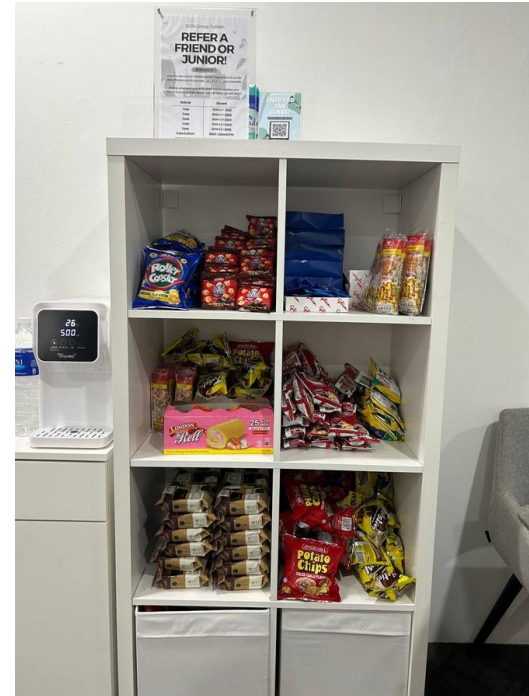
ELEMENTARY MATHEMATICS			
Question Paper	Duration: 45	Formulae	Remarks
Date: 3 March 2023 Candidates answer on separate writing paper.	it reached in a time t $u_y = 0$	$s^2 = (u \sin \theta)^2 - 2gh$ $\therefore H = \frac{u^2 \sin^2 \theta}{2g}$	With air resistance, <ul style="list-style-type: none"> Drag force acts in the same direction as the weight of object. Net acceleration $>> g$ Maximum height reached lower.
READ THESE INSTRUCTIONS FIRST Answer all questions. A scientific calculator is permitted for this section. You are expected to use a scientific calculator to evaluate lengthy numerical expressions, if the degree of accuracy is not specified in the question, use 4 for the answer to your calculation. Give answers to 3 significant figures. Give answers to degrees to one decimal place. For a question your observation score of 4 or 5, unless the question requires the answer to be in terms of π . Your names will be listed above each question for your benefit and records.	$v_y = u \sin \theta - gt$ $t_{up} = \frac{u \sin \theta}{g}$	$v_y = u \sin \theta - gt$ $t_{up} = \frac{u \sin \theta}{g}$	With air resistance, <ul style="list-style-type: none"> Drag force acts in the same direction as the weight of object. Net acceleration $>> g$ Final vertical speed smaller than vertical speed. Average speed upwards $>$



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(every 3 months).**

ACADEMIC YEAR

TERM 1: NOV – JAN

Topical Recaps

Key highlight: Christmas Party

TERM 2: FEB – APR

Topical Mastery

Key highlight: March Holiday Cohesion Program

TERM 3: MAY – JUL

Prelim/EOY Preparation

Key highlight: Mock Prelim/EOY

TERM 4: AUG – OCT

'O' Levels / 'A' Levels Preparation

Key highlight: Mock Exams, Science Practical Assessment





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