



Sec 3

Subject Combination for

Science

2022

• Compulsory: Chemistry

- Chemistry is the study of matter and energy and the interaction between them.
- It is the "central science" which connects other sciences such as biology and physics.

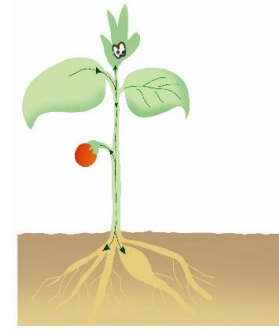
• Choice of Biology or Physics

- Consider the following:
 - Interest
 - Future courses and career
 - What are the entry requirements for JC/Polytechnic/University?
 - What are the JC subject combinations and subject prerequisites?
 - What are the Polytechnic diploma courses you are interested in?

2023 Upper Secondary Biology Content Structure

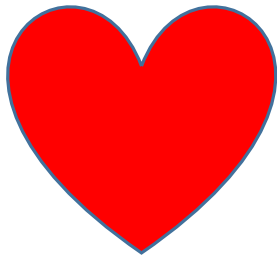
Section	Topic	O-Bio	O-Sci (Bio)	N-Sci (Bio)
Cells and Chemistry of Life	Cell Structure and Organisation	✓	✓	✓
	Movement of Substances	✓	✓	✓
	Biological Molecules	✓	✓	✓
The Human Body – Maintaining Life	Nutrition in Humans	✓	✓	✓
	Transport in Humans	✓	✓	✓
	Respiration in Humans	✓	✓	✓
	Excretion in Humans	✓		
	Homeostasis, Co-ordination and Response in Humans	✓		
	Infectious Diseases in Humans	✓	✓	✓
Living Together – Plants, Animals and Ecosystems <i>*Section name for N-Sci (Bio): Living Together – Plants and Animals</i>	Nutrition and Transport in Flowering Plants	✓	✓	✓
	Organisms and Their Environment	✓	✓	
Continuity of Life	Molecular Genetics	✓	✓	
	Reproduction (in Humans*) <i>*Topic name for O-Sci (Bio)</i>	✓	✓	
	Inheritance	✓	✓	

Choose Biology if you...

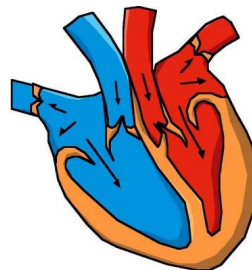


- How are substances transported in a plant?
- How does the heart pump blood through the body?

- Are keen interest in living things (plants, animals, human systems, health, nature)
- Are able to understand data and processes
- Are proficient in English Language i.e. able to describe and explain details well
- Have good observation skills
- Are able to remember and apply details / concepts to questions
- Aspire to be further your studies and have a career in these fields:
 - Life Science, Biomedical Science, Pharmaceutical Science
 - Environment
 - Education and research
 - Forensics etc



Biology



Misconception: Biology is easier than Physics because it only requires remembering of facts.

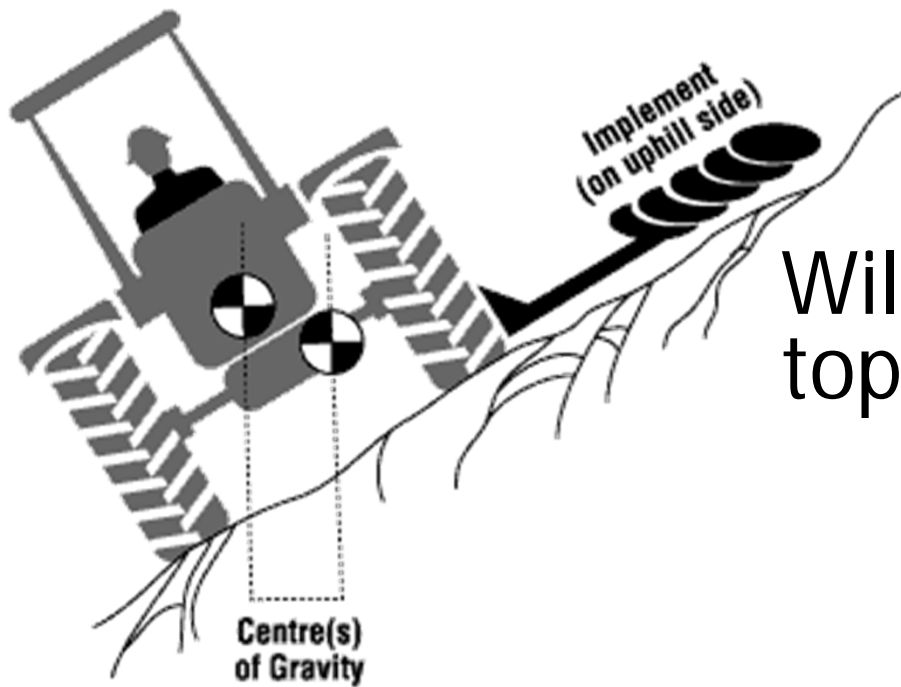
Truth: Similar to Physics, Biology also requires good understanding of concepts and applications. This understanding can be enhanced when you have keen observation skills and interest in how living organisms work.

2023 Upper Secondary Physics Content Structure

Section	Topic	O-Phy	O-Sci (Phy)	N-Sci (Phy)
Measurements	Physical Quantities, Units and Measurement	✓	✓	✓
Newtonian Mechanics	Kinematics	✓	✓	✓
	Force and Pressure	-	✓	✓
	Dynamics	✓	✓	✓
	Turning Effects of Forces	✓	✓	-
	Pressure	✓	-	-
	Energy	✓	✓	✓
Thermal Physics	Kinetic Particle Model of Matter	✓	✓	✓
	Thermal Processes	✓	✓	✓
	Thermal Properties of Matter	✓	-	-

2023 Upper Secondary Physics Content Structure

Waves	General Wave Properties	✓	✓	✓
	Electromagnetic Spectrum	✓	✓	✓
	Light	✓	✓	-
Electricity and Magnetism	Static Electricity	✓	-	-
	Current of Electricity	✓	-	-
	Electric Charge and Current of Electricity	-	✓	✓
	D.C. Circuits	✓	✓	✓
	Practical Electricity	✓	✓	✓
	Magnetism	✓	-	-
	Electromagnetism	✓	-	-
	Magnetism and Electromagnetism	-	✓	-
	Electromagnetic Induction	✓	-	-
Radioactivity	Radioactivity	✓	✓	✓



Will the tractor
topple?

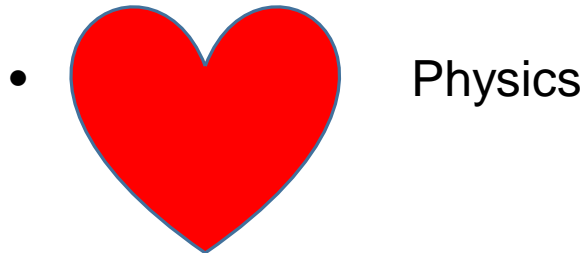
Why does his hair rise?



When will the
balloon burst?

Choose Physics if you...

- Have keen interest in physical mechanisms and how things work
- Are able to do calculations, plot and interpret formulas, graph and data
- Are able to look deeply into a problem and understand underlying concepts
- Are able to understand instructions and conduct experiments (eg heat, light, forces)
- Aspire to be further your studies and have a career in these fields:
 - Engineering and Design, Architecture
 - Computer and programming (ICT related fields)
 - Aerospace / robotics
 - Marine and Offshore, Oil and Gas industry
 - Environment, Climate & Renewable Energy
 - Telecommunications
 - Defence Sciences etc



2023 Upper Secondary Chemistry Content Structure

Section	Topic	O-Chem	O-Sci (Chem)	N-Sci (Chem)
Matter - Structures and Properties	Experimental Chemistry	✓	✓	✓
	The Particulate Nature of Matter	✓	✓	✓
	Chemical Bonding and Structure	✓	✓	✓
Chemical Reactions	Chemical Calculations	✓	✓	✓
	Acid - Base Chemistry	✓	✓	✓
	Qualitative Analysis	✓	✓	✓
	Redox Chemistry	✓	✓	
	Patterns in the Periodic Table	✓	✓	✓
	Chemical Energetics	✓	✓	
	Rate of Reactions	✓	✓	
Chemistry in a Sustainable World	Organic Chemistry	✓	✓	✓
	Maintaining Air Quality	✓	✓	✓

For Express students

- Choice of

- Combined Science (1 subject)**

- Science (Chemistry, Biology) OR Science (Chemistry, Physics)

OR

- Pure Science (2 or 3 subjects)**

- Pure Chemistry and Pure Biology

- OR: Pure Chemistry and Pure Physics

- OR: Pure Chemistry, Pure Physics and Pure Biology

Meet the selection
criteria

$\geq 65\%$ in overall results
in Math AND Science

Recommended for
students who are
performing well in Lower
Sec Science

Pure Sciences

Strong ability in
analyzing problems

Understand and apply
scientific concepts well

Hardworking, resilient
and willing to learn at a
faster pace

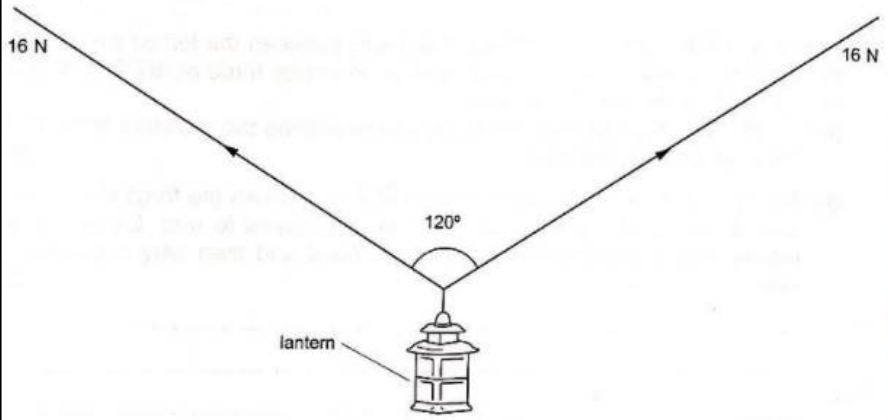
	Combined Science		Pure Science		
Number of periods per week	Phy/Chem 4+4	Chem/Bio 4+4	Physics 6	Chemistry 6	Biology 6
	8	8	Double pure science: 12		
			Triple pure science: 18		
Syllabus	Lesser topics, lesser depth		More topics, greater depth		

	Combined Science	Pure Science
Assessment (‘O’ Level Practical Exam)	Less demanding October 1 h 30 min	More demanding October 1 h 50 min for <u>each</u> pure Phy/Chem/Bio
Assessment (‘O’ Level Written Exam)	MCQ 1 h Structured / Free response 1 h 15 min	MCQ 1 h for each pure Phy/Chem/Bio Structured / Free response 1 h 45 min for <u>each</u> pure Phy/Chem/Bio

FAQ: How are questions examined in 'O' Level Combined Science and Pure Science different?

- 'O' Level Science (Physics) question on Forces (vector diagrams)
- Requires students to:
 - complete diagram on figure provided
 - prompted to write scale that is used
 - units are given on answer line
 - diagram is less complex

5. The figure shows a lantern that is held up by two wires. The tension in each wire is 16 N and the angle between the wires is 120° .



On the figure, draw a vector diagram to scale in order to determine the weight of the lantern. State the scale used.

scale: 1 cm represents

weight = N [4]

- 'O' Level Pure Physics question on Forces (vector diagrams)
- Requires students to:
 - draw from scratch
 - state scale without being told
 - write units
 - indicate direction
 - angles are more complicated

2 Fig. 2.1 shows a stone supported by two strings that hang from a rod.

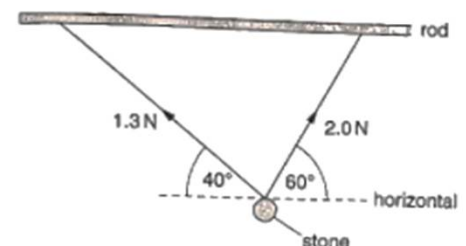


Fig. 2.1

The tensions in the two strings are 1.3 N and 2.0 N.

(a) In the space below, draw a labelled diagram to show the resultant of the two tensions.

Determine the size of the resultant force and the direction between the resultant force and the horizontal.

resultant force =

direction = [3]

(b) State the weight of the stone.

weight = [1]

'O' Level Science (Physics) question on D.C Circuits

- 6 A resistor of resistance 8Ω and a resistor of resistance 2Ω are connected in series with a 12V battery. A resistor of resistance 6Ω is connected in parallel with the two resistors, as shown in Fig. 6.

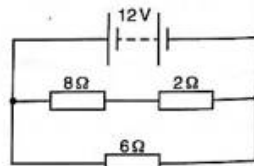


Fig. 6

Calculate

- (a) the combined resistance of all the resistors in the circuit,

combined resistance = Ω [2]

- (b) the current in the resistor of resistance 8Ω ,

current = A [2]

- (c) the power dissipated in the resistor of resistance 6Ω ,

power = W [2]

- (d) the charge flowing through the battery in 10 minutes.

charge = C [2]
(2016 P2A Q8)

For Pure Physics, there will be

- more electrical components to learn such as LDR, thermistors and diodes
- more explanation required
- more complex calculations

'O' Level Pure Physics question on D.C Circuits

- 3 Fig. 3 is a circuit diagram. The circuit uses a light-dependent resistor (LDR) and a fixed resistor of resistance $8.0\text{k}\Omega$.

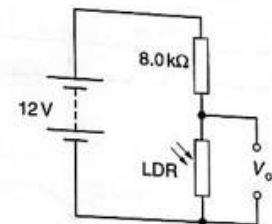


Fig. 3

The LDR has a resistance of 600Ω in bright light.

- (a) Calculate the output voltage V_{out} when the LDR is in bright light.

V_{out} = [2]

- (b) In dim light, V_{out} is 8.0V . For this level of brightness, determine

- (i) the voltage across the fixed resistor,

voltage =

- (ii) the resistance of the LDR.

resistance = [2]

- (c) The output voltage V_{out} is connected to an electronic switch and lamp. The lamp switches on when V_{out} is larger than 8.0V .

The positions of the LDR and the fixed resistor are swapped. Describe and explain the operation of the new device as the level of light falls.

..... [2]
.....
(2016 P2A Q7)

FAQ: How are questions examined in 'O' Level Combined Science and Pure Science different?

Fig. 4 shows the external features of the human heart and some of its blood vessels.

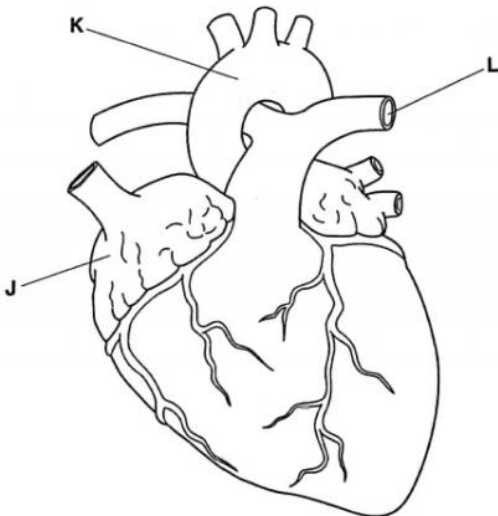


Fig. 4

(a) Name the structures J, K and L, as shown in Fig. 4.

J

K

L

[3]

(b) Place an X on Fig. 4 to show a blood vessel that becomes blocked (occluded) when an individual suffers from coronary heart disease.

[1]

(c) List four possible causes of coronary heart disease.

1.

2.

3.

4.

[4]

(d) Complete the Table to show one function of a red blood cell and one function of a white blood cell.

Table

blood cell	function
red blood cell	
white blood cell	

[2]

(2017 P4A Q3)

- 'O' Level Science (Biology) question on Transport in Humans
- More straightforward, requires mainly recall and less application

(a) Fig. 7.1 shows an external view of an organ found in the circulatory system.

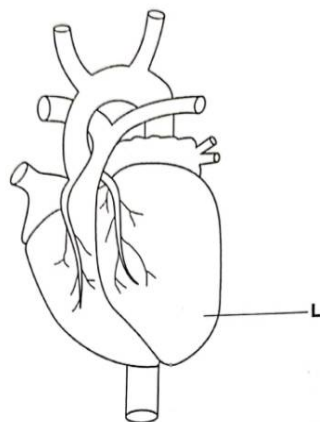


Fig. 7.1

State the name and function of the tissue that makes up the part labelled L.

name

function

[2]

(b) Fig. 7.2 shows the changes in the heart rate over a 19 minute period.

It also shows the volume of blood pumped out of the left ventricle.

From 2 minutes to 7 minutes the person was exercising.

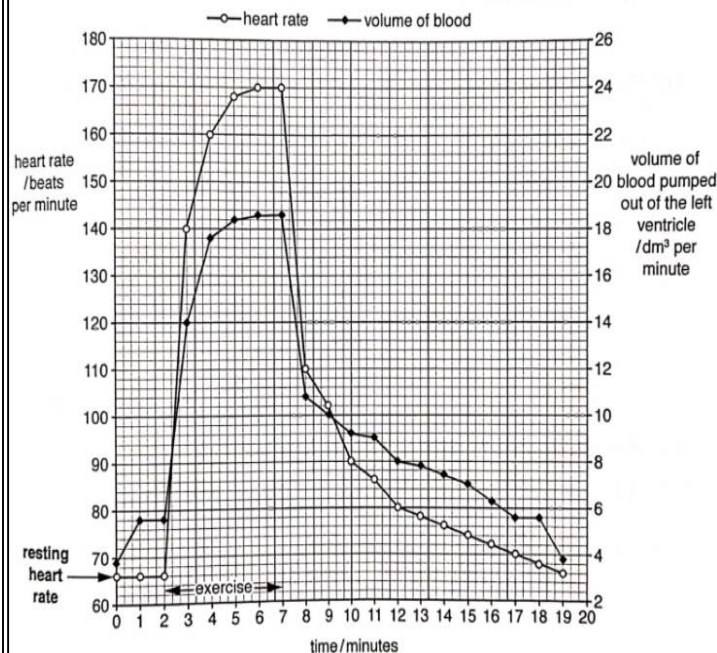


Fig. 7.2

(i) State the volume of blood pumped out of the left ventricle at the start of the exercise.

..... dm³ per minute [1]

(ii) Use Fig. 7.2 to determine how long it took for the heart rate to return to its resting rate after exercise had finished.

..... minutes [1]

(iii) Calculate the percentage increase in heart rate that occurs between 2 minutes and 5 minutes on Fig. 7.2.

Give your answer to the nearest whole number.

Show your working.

..... % [3]

(iv) With reference to Fig. 7.2 describe the changes in heart rate during exercise.

Use data from Fig. 7.2 to support your answer.

..... [3]

[Total: 10]

- 'O' Level Pure Biology question on Transport in Humans
- More demanding
- Requires very good knowledge with understanding to solve problems
- Requires very good handling & interpretation of graphs, information
- Involves calculations

FAQ: How are questions examined in 'O' Level Combined Science and Pure Science different?

1 A complex compound, serpentine, is formed in the Earth's crust from fayalite, Fe_2SiO_4 . In the first stage of its formation hydrogen is released.

This reaction is highly exothermic and could be adapted to produce hydrogen quickly on an enormous scale.

(a) Define the term *exothermic*. [1]

.....

(b) The burning of hydrogen is a source of clean energy. The burning of fossil fuels is not a source of clean energy.

Suggest the meaning of the term *clean energy*.

.....

..... [2]

(2016 P3A Q6a,b)

- 'O' Level Science (Chemistry) question on Energy Changes
- Much more straightforward, requires mainly recall

B7 Choosing and using de-icers

In some countries, winter temperatures fall below 0°C and ice forms on roads. This causes accidents because vehicles slide on the slippery surface. De-icers are mixtures of chemical compounds that are spread on the roads to melt the ice.

The most commonly used de-icer is sodium chloride. It is used because it is very inexpensive. Calcium chloride is also used in smaller areas such as paths and car parks.

Effect of the mass of de-icer used

A scientist wanted to find out if mixtures containing a higher mass of de-icer have lower freezing points. She made solutions by adding different masses of sodium chloride to 100 cm^3 samples of water at room temperature. She then measured the freezing point of each solution. She repeated the experiment with different masses of calcium chloride. Tables 7.1 and 7.2 show her results.

Table 7.1

mass of sodium chloride added/g	freezing point/ $^{\circ}\text{C}$
10	-8
20	-20
30	-15
40	does not fully dissolve

Table 7.2

mass of calcium chloride added/g	freezing point/ $^{\circ}\text{C}$
10	-9
20	-20
30	-45
40	+12

More about the chemistry of de-icers

The surface of ice has a very thin layer of water. The de-icer dissolves in this water and lowers its freezing point. This stops the water from freezing.

Some de-icers dissolve exothermically. This helps to melt the solid ice under the layer of water and allows the de-icer to work deeper in the ice.

The enthalpy change that happens during dissolving is the enthalpy change of solution, ΔH_{sol} .

During very cold conditions, there may be very little liquid water for the de-icer to dissolve in. Some de-icers attract water vapour from the air and can use this to form a solution on the surface of the ice. De-icers that act in this way are known as hygroscopic.

Table 3 shows some information about some commonly used de-icers.

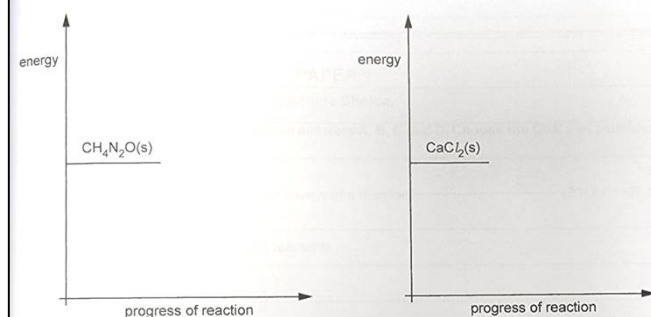
Table 3

compound	lowest effective temperature* / $^{\circ}\text{C}$	ΔH_{sol} in kJ/mol	hygroscopic	other information
NaCl	-7	+3.9	no	speeds up corrosion of metals, harmful to plants
CaCl_2	-32	-82.9	yes	speeds up corrosion of metals, harmful to plants
MgCl_2	-18	-155	yes	speeds up corrosion of metals, harmful to plants
KCl	-4	+17.2	no	speeds up corrosion of metals, harmful to plants
$\text{CH}_4\text{N}_2\text{O}$ (urea)	-4	+15.0	no	low toxicity

*temperature at which water freezes in the presence of de-icer

- Use the data to estimate the number of moles of sodium chloride that dissolve in 1 dm^3 of water. [1]
- What are the similarities and differences in the results of the scientist's experiment for sodium chloride and calcium chloride? [1]
- Some of the de-icers are effective at much lower temperatures than others. Identify **two** factors that determine which de-icers are more effective at very low temperatures. Explain your answer. [3]

- (d) (i) Complete the energy level diagrams to show the products and energy changes of solution when urea, $\text{CH}_4\text{N}_2\text{O}$, and calcium chloride, CaCl_2 , dissolve in water.



- (ii) Suggest one benefit of using urea rather than calcium chloride as a de-icer. [1]
- (e) Some of the de-icers are harmful to plants. This is because they contain a very high concentration of a particular ion. Which ion in these de-icers is most likely to be harmful to plants at high concentrations? Explain your reasoning. [1]

(2020 P2B Q7)

- 'O' Level Pure Chemistry question on Energy Changes
- Unfamiliar/new context with a lot of information to understand
- Requires very good knowledge with understanding to solve problems
- Requires very good handling & interpretation of graphs & data

FAQ

- If I take combined science instead of pure science, can I enter JC?

'O' Level Subject Prerequisites (This is an example only. Students will need to check information from the specific JC that they are interested in.)

JC Subject	H1	H2 (higher level)
Biology	Pass either as 'O' Level Combined Science OR Pure Science	B3 for Pure Science OR A2 for Combined Science
Chemistry		
Physics		

'O' Level results of Student A	'O' Level results of Student B
A1 in Combined Sci (Phy/Chem)	C5 in Pure Phy & B4 in Pure Chem
Obtained grade 2 for each of all other subjects. L1R5 = 11	Obtained grade 2 for each of all other subjects. L1R5 = 17
Enters JC of preferred choice	Unable to enter JC of preferred choice with L1R5 cut-off point of 15 for Science stream
Eligible to take JC H1 and H2 Physics	Eligible to take JC H1 Physics

FAQ

- Can I change subject combination after allocation?
- **Consider very carefully** before making your selection as changing of subject combination may not be possible