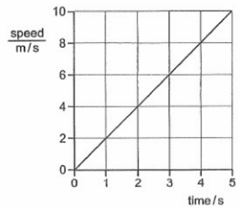
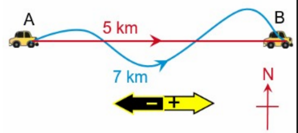
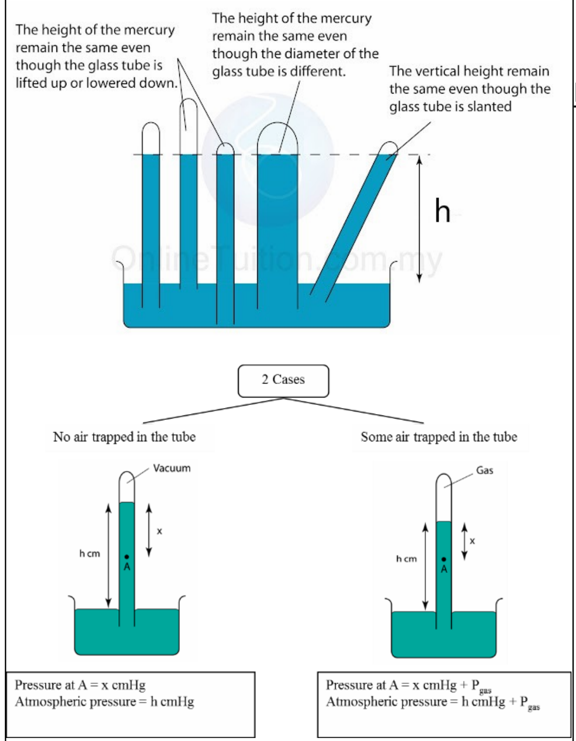
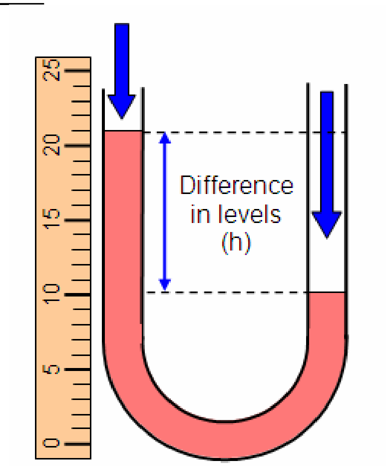
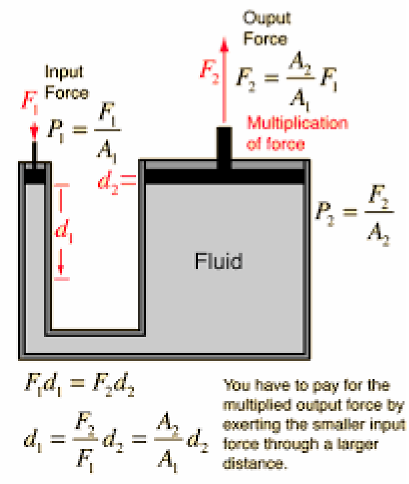
SYLLABUS 6091 PHYSICS G3 YEAR 2024 **LIST OF EQUATIONS**

NO.	EQUATION	MEANING OF SYMBOLS	Example	Solution
GENERAL PHYSICS				
1	$a = \Delta v / \Delta t$ $= (v - u) / t$	a = instantaneous acceleration in m/s^2 ; v = final velocity ; u = initial velocity ; t = time taken in s	A car accelerates uniformly from 20 m/s to 30 m/s. During this acceleration, the car travels 100m. The average speed is 25 m/s. What is the acceleration of this car? *** t = 4.0 s in this question based on formula (3) average speed.*	$= 2.5\ m/s^2$
2	Distance travelled = area under graph		The graph represents the movement of a car. How far has the car moved between 0 and 5.0 s?  	Distance travelled = area under graph = ½ x 5.0 x 10 = 25 m
3			A car takes half an hour to travel 7.0 km from A to B. What is its average speed?  	= 14 km/h
4	$F = ma$ $F_{resultant} = F_{applied} - F_{opposing}$ • **resultant** is also known as **net** • friction, air resistance are possible $F_{opposing}$	F = resultant force in N ; m = mass in kg ; a = acceleration in m/s^2	A boy pushes a box of mass 20 kg with a force of 50 N at constant speed. When the force is increased to 80N, what is the acceleration of the box?	Frictional force = 50 N Resultant force = 80 N – 50 N F = ma 80 – 50 = 20 (a) $a = 1.5\ m/s^2$

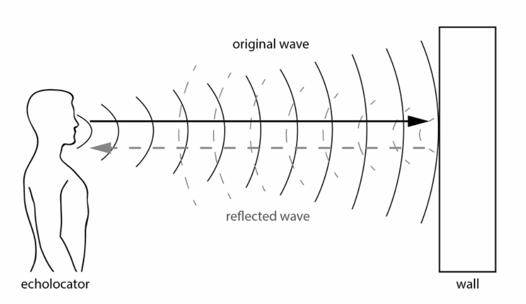
5	ρ	ρ = density in kg/m^3 ; m = mass in kg ; V = volume in m^3	Given that a wooden cube of length 8.0 cm has a mass of 500 g, calculate the density of the wood in g cm^{-3}.	ρ = 0.97656 ≈ 0.98 or 0.977 g / cm^3
6	w = mg	w = weight in N ; m = mass in kg ; g = gravitational field strength in N/kg	The acceleration of free fall on the Moon is 1.6 ms^{-2}. The acceleration of free fall on Earth is 10 ms^{-2}. A rock has a mass of 10 kg on Earth. Calculate the weight of the rock on (a) on Earth (b) on the Moon.	(a) w = mg = (10)(10) = 100 N (b) w = mg = (10)(1.6) = 16 N
7	Moment = F x d	F = force in N ; d = perpendicular distance from the line of action of F to the pivot in m	A door is hinged at its edge. A girl opens it by exerting a force of 10 N on the door handle located at the other end. Determine the moment due to the force exerted by the girl on the door.	Moment = F × d = 10 N × 1.0 m = 10 N m
8	W = F x s [use if F is constant]	W = work done in J ; F = force in N ; s = distance moved in the direction of F in m	A boy pushes a box across a rough horizontal floor. He exerts 5.0 N to move it 2.0 m. What is the work done by the 5.0 N force?	W = F × s = 5.0 x 2.0 = 10 J
9	P or P	P = power in W ; W = work done in J ; t = time in s ; E = energy converted	An engine does 60 000 J of work in ten minutes. Determine its power. ** 1 W = 1 J/s so the time must be expressed in seconds for it to be converted to Watts (W)*	P = 100 W
10	E_p = mgh	E_p = energy in gravitational potential store in J ; m = mass in kg g = 10 N/kg gravitational field strength on earth; h = vertical distance in m	A 5.0 kg box is raised 50 m from its original position. What is the gain in energy in the gravitational potential store?	E_p = mgh = (5)(10)(50) = 2500 J

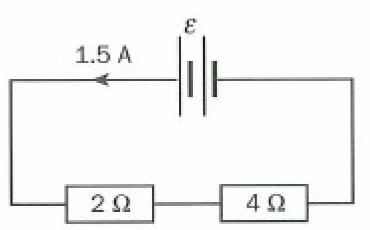
11	$E_k = \frac{1}{2} mv^2$	E_k = energy in kinetic store in J ; m = mass in kg ; v = speed in m/s	A 50 g toy car is moving at a constant speed of 2.0 m s^{-1}. Determine its energy in it kinetic store	KE = ½ mv^2 = 0.10 J
12	**Energy** **Power**		A motor with a power rating of 500 W pulls up a block of weight 20 N by 3.0 m every second. Calculate its efficiency.	E = Pt = 500 W (1s) = 500 J Work done = F x s = 20 N x (#.0 m) = 60 J = 0.12 If in percentage, % efficiency = 0.12 x 100% = 12%
13		p = pressure in Pa (or N/m^2) ; F = normal force in N ; A = area in m^2	A student of weight 800 N stands on an area of 250 x 10^{-4} m^2. Calculate the pressure exerted by her feet on the ground.	Pa or N/m^2

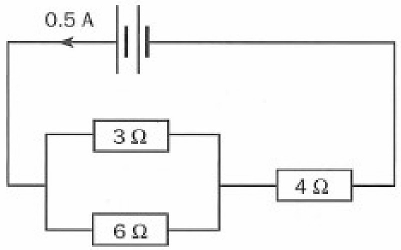
14	p = hρg <u>Barometer</u>  	p = pressure in Pa (or N/m²) ; h = height in m ; ρ = density of the liquid in kg/m³ g = gravitational field strength in N/kg <u>Manometer</u>  	Calculate the pressure on a fish 10 m below the water surface and where the atmospheric pressure above the surface is 760 mmHg. Taking that the density of water is 1000 kg/m³ g is 10 N/kg, density of mercury is 13 600 kg/m³	760 mm Hg is one atmospheric pressure which is the pressure exerted by Earth's atmosphere. It means it is the pressure equivalent to 760 mm height of mercury (Hg) Pressure due to water only: p = hρg = 10 x 1000 x 10 = 100 000 Pa Pressure due to atmosphere is p = hρg = (760/1000) x 13600 x 10 = 103, 360 Pa ≈ 103 000 Pa Total pressure = 100 000 + 103 000 = 103 000 Pa
15		= the force applied on piston 1 = the force applied on piston 2 = the area of piston 1 = the area of piston 2 <u>Hydraulic Press</u>	A force of 50 N is applied on piston 1 with an area of 0.0025 m². Piston 2 has an area of 0.25 m². Calculate the force on piston 2.	5000 N

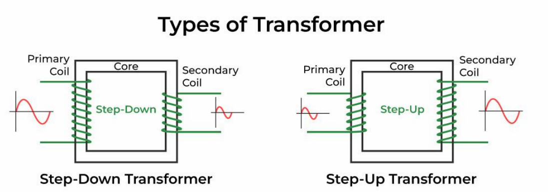
				
THERMAL				
16	Q = mcΔθ Q = CΔθ where C = mc	Q = change in internal energy by energy transfer / energy transferred by heating in J m = mass in kg c = specific heat capacity in J/kg°C or J/kgK C = mc = heat capacity J/°C or J/K Δθ = change in temperature °C or K (where Δ represents change and θ temperature)	A substance of mass 2.0 kg has specific heat capacity of 4200 J/kg°C and rose by 12 °C. Calculate the heat capacity. Calculate the rise in internal energy (by energy transfer).	C = mc = 2.0 (4200) = 8400 J/°C Q = CΔθ = 8400 (12) = 100,800 J ≈ 100 000 J (2 sf) or 101 000 J (3 sf)
17	*Q = ml* *L = ml*	Q = change in internal energy by energy transfer / energy transferred by heating in J *m* = mass in kg *l* = specific latent heat in J/kg or J/kg *L* = latent heat in J *Q* or *L* can be used with respect to the context of the question	1000 J of energy was supplied to pure ice at 0 °C of mass m to melt it fully to water at 0 °C. The latent heat of fusion is 334 J/g. Calculate the mass of ice in g that melted.	$Q = m\, l_f$ 1000 J = m (334 J/g) m = 2.994 g ≈ 3.0 g

		Additionally a subscript f and v represents fusion and vaporization respectively. E.g. l_v = the specific latent heat of vaporization		
LIGHT, WAVES and SOUND				
18		n = refractive index (from vacuum to medium); i = angle of incidence (in vacuum/air) ; r = angle of refraction (in medium)	A ray of light is incident from the water to the air at an angle of 40. The refractive index of water is 1.33. Calculate the angle of refraction.	= 1.33 sin 40° 58.7°
19		n = refractive index (from vacuum to medium); c – critical angle	Find the critical angle of the glass of refractive index 1.5.	41.8°
20		= velocity of light in vacuum (3.0×10^8 m/s); = velocity of light in the second optical medium	Calculate the speed of light in diamond of refractive index 2.4.	m/s
21	v = f λ	= speed of wave in m/s ; = frequency in Hz ; λ = wavelength in m	A bat makes a sound that is higher than the maximum audible frequency of human beings. Given that the	* max audible frequency is f = 20000 Hz

			speed of sound in air is 300 m/s. What is the maximum wavelength of the sound?	$v = f\lambda$ $300 = (20000)\lambda$ $\lambda = 0.015$ m
22		= frequency in Hz ; = period in s	The period of a waveform is 0.50 s. What is the frequency?	Hz
23	Echolocation	= speed of sound in medium = distance from the source of sound to the point of reflection e.g. wall. 	The sonar of a ship sends out a signal which is reflected and returns back to the sonar after hitting an object. The time taken between the start of the signal and when the echo is received is 40 ms. Take speed of sound in water as 1500 m/s.	40 ms = 0.040 s m
ELECTRICITY and MAGNETISM				

24		= electric current in A; = electric charge in C; = time in s	Find the current when 10 C of charge flows through a resistor in 8.0 s.	A
25		= potential difference, or = electromotive force (e.m.f.); = energy in J; = electric charge in C	A lamp is connected to a battery in a circuit. The lamp gives off 12 J of energy when a charge of 5.0 C passes through it. What is the e.m.f. of the battery?	V
26		= resistance of a wire in Ω; = length of wire in m; 1.0 = resistivity of material in Ω m; = cross-sectional area in m^2	The resistance of a wire of length m and cross-sectional area 4.0×10^{-8} m^2 is found to be 2.0 Ω. What is the resistivity of the material?	= 8.0×10^{-8} Ω m
27	(for ohmic conductors)	= p.d. in V; = current in A; = resistance in Ω	A resistor is connected to a battery. It allows a current of 0.30 A to pass through it. The potential difference across the resistor is 4.0 V. What is the resistance R?	Ω or 13 Ω
28	**Series circuit** **Parallel circuit**	= combined effective resistance = resistance of each individual resistor where represents each resistor	(a) Find the total resistance.  (b) Find the combined	(a) Ω **(b) Step 1** For the parallel part of the circuit only

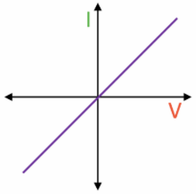
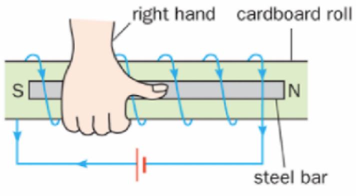
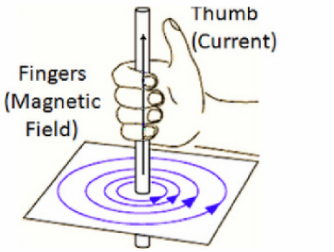
			resistance. 	**Step 2** For the whole circuit after solving the parallel Ω
29		= electrical power in W; = voltage in V; = current in A; = resistance in Ω; = electrical energy in J; = time in s (or h if calculating for cost of electricity)	A torchlight consists of a light bulb and a 5.0 V battery. A current of 0.30 A passes through the bulb. (a) Calculate the electrical power of the bulb. (b) Calculate the electrical energy supplied to the bulb in 30 minutes. (c) Calculate the cost of using the same bulb for 30 mins if one unit of electricity costs $0.20.	(a) W (b) 0 J If energy is calculated in Joules, the time must be in seconds (c) 1 unit of electricity means 1 kWh of electricity. Cost = $0.20 x 0.00075 kWh = $0.00015 When calculating cost of electricity, energy is express in kWh if not the number of

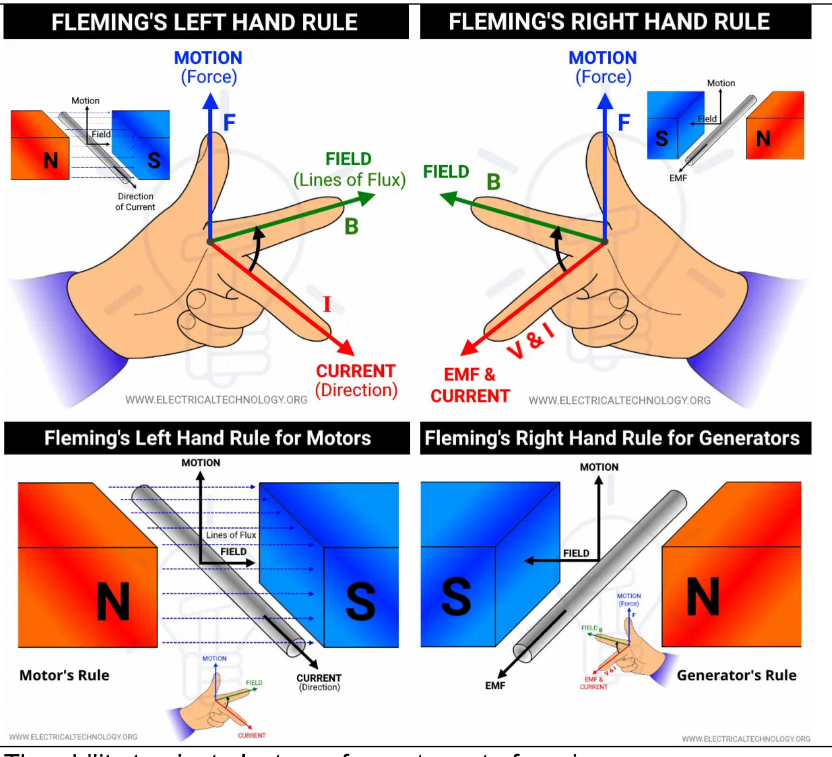
				Joules will be too large for easy reading. 1 kWh = 3,600,000 J This will make a typical electrical bill difficult to read if expressed in Joules
30		= p.d. at primary coil = p.d. at secondary coil = number of turns at primary coil = number of turns at secondary coil = current at primary coil = current at secondary coil 	In a step-up transformer, the input voltage is 50 V and the output voltage is 100 V. If the number of turns in the secondary coil is 20 turns, determine the number of turns in the primary coil if the transformer is 100% efficient.	turns

LIST OF DEFINITIONS

NO.	PHYSICAL QUANTITY	DEFINTION / MEANING
1	Scalar	are physical quantities that have only magnitude.
2	Vector	are physical quantities that have both magnitude and direction.
3	Speed	is the rate of change of distance. OR The distance travelled per unit time.
4	Velocity	is the rate of change in displacement
5	Acceleration	is the rate of change of velocity.
6	Constant Acceleration	is a constant rate of change of velocity
7	Acceleration of free fall	Is a constant and is about 10 m/s^2 (or 9.8 m/s^2)
8	Displacement	is the distance moved in a specified direction.
9	Mass	is a measure of the amount of matter in the body.
10	Weight	Is the gravitational force acting on an object that has mass
11	Gravitational field	Is a region in which a mass experiences a force due to gravitational attraction.
12	Gravitational field strength, *g*	Gravitational force per unit mass placed at that point
13	Density	is the mass per unit volume OR = mass / volume
14	Pressure	Is the force per unit area. OR = force / area
15	Force	= mass x acceleration
16	Moment of a force (about the pivot) OR turning effect of a force	is the product of the force and its perpendicular distance from the line of action of the force to the pivot. OR = force x perpendicular distance from the pivot
17	Centre of gravity	Of an object is an imaginary point where the entire weight of the object seems to act. (no need to define in exam)
18	Stability	Of an object is a measure of its ability to return to its original position. [it is based on the angle of tilt] (no need to define for exam)
19	Energy in kinetic Store	is the energy possessed by an object because of its motion.
20	Energy in gravitational potential store	is the energy which a body possesses because of its raised height relative to the Earth.
21	Work done (by a constant force on an object)	Is the product of the force and the distance moved by the object in the direction of the force. OR = force x distance moved in the direction of the force

22	Power	Is the rate of work done OR energy transferred per unit time OR = work done / time taken = energy transfer / time taken
23	Rise in temperature	Is the increase in average kinetic energy of all the particles in the body.
24	Internal energy	Is an energy store that is made up of the total kinetic energy associated with the random motion of the particles and the total potential energy between the particles in the system.
25	Evaporation	is the process in which more energetic surface molecules escape from the surface of a liquid.
26	Conduction	Is a process of energy transfer where energy is transferred through the passing on of vibrational motion from one particle to another.
27	Convection	Is a process of energy transfer by means of convection currents of a fluid (liquid or gas), due to a difference in density.
28	Radiation (i) (ii) (iii)	Is the process of energy transfer by electromagnetic waves. It does not require a medium. Transfer to and from body is affected by surface colour and texture surface temperature surface area
29	Melting point	of a substance is fixed temperature at which the substance changes from the solid to liquid state.
30	Boiling point	of a substance is a fixed temperature at which the substance changes from the liquid to gaseous state.
31	Heat capacity	of an object is the change of its internal energy per unit change in its temperature.
32	Specific heat capacity	of a material is the change of its internal energy per unit mass for each unit change in its temperature.
33	Latent heat	is the energy released or absorbed to change the state of a substance at constant temperature.
34	Specific latent heat	Is the amount of energy transferred per unit mass of a substance to change between the solid and liquid states at constant temperature.
35	Wavefront	is the imaginary line joining all adjacent point on on the wave that are in phase.
36	Frequency	is the number of waves generated in one second.
37	Wavelength	is the shortest distance between 2 points on the wave which are in phase. OR Is the shortest distance between two successive crests or troughs.
38	Period	is the time taken for a particle to complete one oscillation.
39	Amplitude	is the maximum displacement of oscillating particles from its rest position.
40	Wave speed	Is the distance travelled by the wave per unit time.
41	Transverse wave	Has a direction of vibration that is perpendicular to the direction of wave travel.
42	Longitudinal wave	Has a direction of vibration that is parallel to the direction of wave travel.
43	Refractive index	is the ratio of velocity of light in vacuum to the velocity of light in medium.
44	Principal focus/focal point, F	Is the point on the principal axis where all rays parallel to the principal axis meet after passing through the lens.
45	Focal length, f	is the distance between the principal focus and the optical centre of the lens where the principal focus is where all rays parallel to the principal axis meet after passing through the lens.
46	Critical angle	Is defined as the angle of incidence in an optically denser medium for which the angle of refraction in the less dense medium is 90°.

47	Total internal reflection	Is the complete reflection of a light ray in an optically denser medium at the boundary with an optically less dense medium.
48	Electric current	Is the rate of flow of electric charge OR = charge / time
49	Electromotive force	Is the work done by the source in driving a unit charge around a complete circuit OR = work done / charge. Through a complete circuit.
50	Potential difference	Is the work done per unit charge in driving charges through the component. OR = work done / charge. Through a component.
51	Resistance	Is the ratio of the potential difference V across it to the current I flowing through it. OR = potential difference / current
52	Ohmic conductor	Ohmic Conductor 
53	How temperature affects resistance	Resistance increases as temperature increases.
54	NTC thermistors	Resistance decreases as temperature increases.
55	NTC Light Dependent Resistor (LDR)	Resistance decreases as light intensity increases.
56	Live wire	Usually brown. It is at high voltage and carries the current.
57	Neutral wire	Blue. Zero voltage. Provides the return path for the current to close the circuit.
58	Earth wire	Green and yellow. It is a safety wire that earths appliances with a metal casing to protect the user.
59	Right Hand Grip Rule	**Current carrying solenoid**  **Current carrying straight wire** 

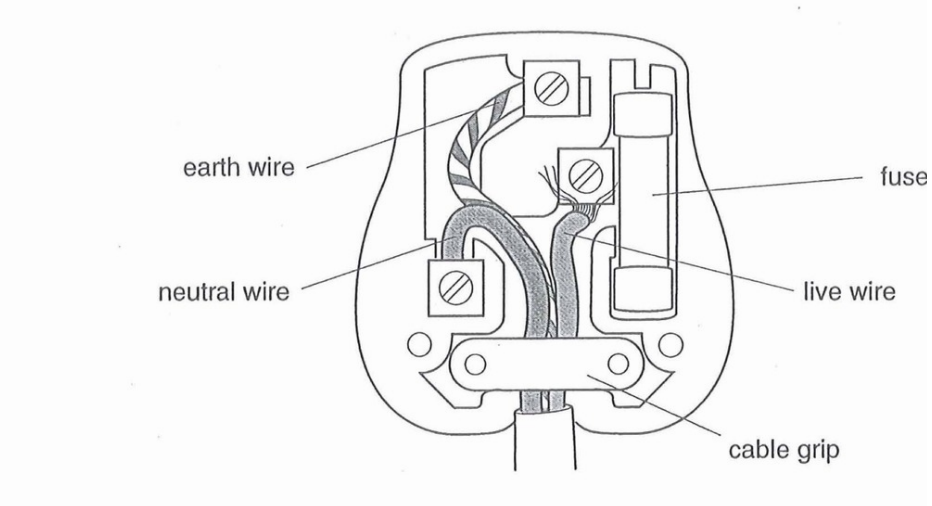
60	Fleming's Left Hand Rule And Fleming's Right Hand Rule	
61	Ionising Effect	The ability to eject electrons from atoms to form ions.

LAWS AND PRINCIPLES

NO.	NAME OF LAW	STATEMENT
1	Newton's First Law of Motion ***Not required to state***	Every object will continue in its state of rest or uniform motion in a straight line unless a resultant force acts to change its state.
2	Newton's Second Law of Motion ***Not required to state***	When a resultant force acts on an object of constant mass, the object will accelerate and move in the direction of the resultant force. The product of the mass and acceleration of the object is equal to the resultant force.
3	Newton's Third Law of Motion ***Not required to state***	For every action, there is an equal and opposite reaction, and these forces act on mutually opposite bodies.
4	Principle of moments	When an object is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot.
5	Principle of Conservation of Energy	Energy cannot be created or destroyed. Energy can be transferred from one store to another. The total energy of an isolated system is constant.
6	Laws of reflection	1. The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane. 2. The angle of incidence is equal to the angle of reflection.
7	Laws of refraction	1. The incident ray, the refracted ray and the normal all lie in the same plane. 2. For two particular media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.
8	Laws of electrostatics	Like charges repel; unlike charges attract.
9	Laws of magnetism	Like poles repel; unlike poles attract.

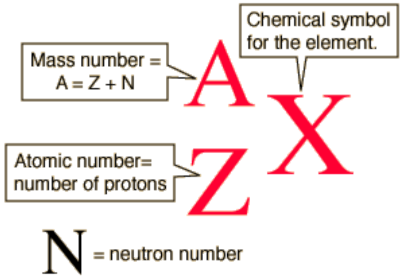
SELECTED KEY FACTS

NO.	Topic	STATEMENT
1	Sound	Sound travel fastest in solids and slowest in gases. A medium is required to pass through. Frequency is directly related to pitch. The higher the frequency, the higher the pitch. Amplitude is directly related to loudness. The higher the amplitude the louder the sound.
2	Electromagnetic Waves	L **L**ongest wavelength **L**owest Frequency typical uses of the following regions of the electromagnetic spectrum: (i) radio waves (e.g. radio and television communication, astronomy and RFID tags) (ii) microwaves (e.g. mobile (cell) phones, microwave oven and satellite television) (iii) infrared (e.g. infra-red remote controllers, intruder alarms and thermal imaging) (iv) visible light (e.g. photography, optical fibres in medicine and telecommunications) (v) ultraviolet (e.g. sunbeds, bank note authentication and disinfecting water) (vi) X-rays (e.g. medical radiology, security screening and industrial defect detection) (vii) gamma (γ) rays (e.g. sterilising food, detection of cancer and its treatment) Shortest wavelength Highest Frequency High energy electromagnetic waves can have heating and ionizing effect which can cause cell mutation and death due to over-exposure
3	Static Electricity	Field lines start from positive to negative and must be drawn with arrows. Field lines do not cross and will enter and exit the poles at right angles. Field line density shows the strength of the electric field where the denser the field lines within a region, the greater the electric field strength
4	Current Electricity	Electron flow direction is opposite of current flow. The actual flow of charges is by electron flow.
5	D.C. Circuits	Ammeters are placed in series Voltmeter are placed in parallel
6	Practical Electricity	The correct fuse rating must be slightly bigger than the working current.

		The fuse is always connected to the live wire and it is first component of the circuit from the live terminal. Hazards of using electricity includes overheating causing damage to appliance or electrical fire, and electric shocks that can lead to death. Earthing links to the casing of the appliance when the casing is metallic. The earth wire is a low resistance wire; at low potential. The earth wire is a safety device **Compare:** The neutral wire which is also a low resistance wire at low potential but it functions as a return path for the circuit. Double insulation gives an additional layer of insulating covering to the conductive parts of the appliance including having a non-conductive casing.  Circuit breakers can be reset and works on the principle of electromagnetism. Circuit breakers fuse and switches are connected to the live wire.
	3.	
7	Magnetism 3.	Field lines start from N to S and must be drawn with arrows. Field lines do not cross and will enter and exit the poles at right angles. Field line density shows the strength of the magnetic field where the denser the field lines within a region, the greater the magnetic field strength
8	Radioactivity	**Atomic (proton) number Z**

Nucleon (mass) number A

Nuclide Notation



α-particle (alpha particle) consists of 2 protons and 2 neutrons.
Positively charged
Charge of +2
Highest ionizing effect
Least penetrating – can be stopped by a piece of paper

β-particle (beta particle) is a fast-moving electron
Negatively charged
Charge of -1
Medium ionizing effect
Medium penetrating ability – can be stopped by few mm thick of aluminium

γ-ray (gamma ray) is an electromagnetic radiation
No charge
Lowest ionizing effect
Highest penetrative ability – pass through most materials readily; few cm thick lead and few metres thick concrete
Count rate