Summary Notes of AS PHYSICS 终极考前冲刺班，注意看有黄色标记的部分哦~

COURSEMO | Shirley

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<tr><td rowspan="4">1 Physical quantities and units</td><td>SI base quantities （in AS）</td><td>Base quantities：
1.length
2.time
3.current
4.temperature
5.mass</td><td>Corresponding symbols：
1.L
2.t
3.I
4.T
5.M</td></tr>
<tr><td>SI base units
（in AS）</td><td>Base units：
1.meter
2.second
3.ampere
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3.A
4.K
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<tr><td>prefixes</td><td><table>
<tr><th>Prefix</th><th>Symbol</th><th>Value</th></tr>
<tr><td>pico</td><td>p</td><td>10^{-12}</td></tr>
<tr><td>nano</td><td>n</td><td>10^{-9}</td></tr>
<tr><td>micro</td><td>μ</td><td>10^{-6}</td></tr>
<tr><td>milli</td><td>m</td><td>10^{-3}</td></tr>
<tr><td>centi</td><td>c</td><td>10^{-2}</td></tr>
<tr><td>deci</td><td>d</td><td>10^{-1}</td></tr>
<tr><td>kilo</td><td>k</td><td>10^{3}</td></tr>
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<tr><td>tera</td><td>T</td><td>10^{12}</td></tr>
</table></td><td></td></tr>
<tr><td>estimates</td><td colspan="2">Notes：
● mass of a person 70 kg
● height of a person 1.5 m
● walking speed 1 ms^{-1}</td></tr>
</table>

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

		• speed of a car on the motorway $30ms^{-1}$ • volume of a can of drink 300 cm^3 • density of water 1000 kgm^{-3} • weight of an apple 1 N • typical current in domestic appliance 13 A • e.m.f. of a car battery 12 V • the mass, in kg, of a wooden metre rule (0.05 to 0.2) kg • the volume, in cm3, of a cricket ball or a tennis ball (50 to 300) cm^3 • the mass, in g, of a new pencil 1–20 g • the wavelength of ultraviolet radiation 1×10^{-8} m to 4×10^{-7} m • radius of proton or neutron ~ 10^{-15} m • radius of nucleus ~ 10^{-15} m to 10^{-14} m • radius of atom ~ 10^{-10} m size of molecule ~ 10^{-10} m to 10^{-6} m.
2 Measurement techniques	Scalars	**Defintion：** A scalar quantity is the quantity which has magnitude only
	Vectors	**Defintion：** A vector quantity is the quantity which has magnitude and direction
	Random error	**Description：** upon multiple measurements, will result in readings being scattered around the accepted value. **Notes：** • **（Description）** The effects of random errors ■ scatter in readings about the true reading
	Systematic error	**Description：** An error in readings which is repeated throughout an experiment, producing a constant absolute error or a constant percentage error.

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

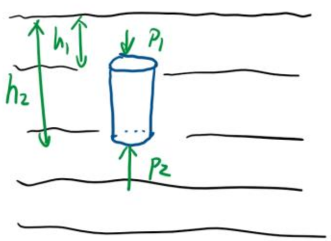
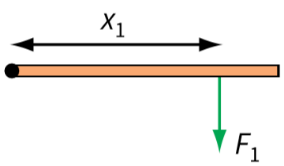
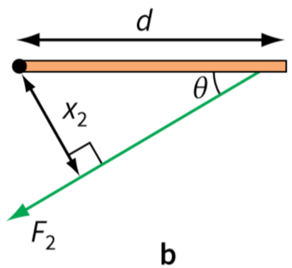
		Notes: ● **(Description)** The effects of systematic errors ■ the reading is larger or smaller than the true reading by a constant amount
	Accuracy	**Description**: Accuracy is determined by the closeness of the measurements to the true value **Notes**: ● This can be improved by reducing or eliminating systematic errors.
	precision	**Description**: Precision is determined by the range in the measurements **Notes**: ● Precision is affected by random errors. ● Distinguish between precision and accuracy: ■ precision: the size of the smallest division on the measuring instrument ■ accuracy: how close measurement value is to the true value
3 Kinematics	Distance	**Defintion**: Length of path that an object moves through
	Displacement	**Defintion**: Distance travelled in a particular direction from starting point to final point
	Speed	**Defintion**: The rate of change of distance
	Velocity	**Defintion**: The rate of change of displacement $\text{velocity} = \frac{\Delta s}{\Delta t}$
	Acceleration	**Defintion**: The rate of change of velocity $a = \frac{\Delta v}{\Delta t}$
	suvat	equation 1: $v = u + at$ equation 2: $s = \frac{(u+v)}{2} \times t$ equation 3: $s = ut + \frac{1}{2}at^2$ equation 4: $v^2 = u^2 + 2as$

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

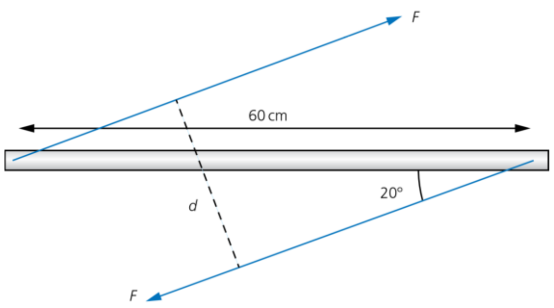
Units	Key points	Content
4 Dynamics	Newton's first law	**Description:** A body continues at rest or constant velocity unless acted upon by a resultant force **Notes:** ● Newton's first law is the special case of Newton's second law (Newton's first law follows the Newton's second law)
	mass	**Defintion:** mass is the property of a body resisting changes in motion Or mass is the quantity of matter in a body **Notes:** ● Mass is a measure of inertia
	Newton's second law	**Description:** The resultant force is equal to rate of change of momentum $F = \frac{\Delta p}{\Delta t} = \frac{mv - mu}{t}$ **Notes:** ● The equation F = ma is a special case of F = Δp Δt which only applies when the mass of the object is constant.
	Newton's third law	**Description:** Between two interactive objects, forces of action and reaction are same in magnitude but opposite in direction and in a same line **Notes:** ● Appear and disappear at the same time ● Acting on two different objects ● They are forces of the same type.
	momentum	**Defintion:** Product of mass and velocity
	impulse	**Defintion:** Change in momentum=product of force and time **P=mv**
	Conservation of momentum	**Description:** **Total momentum of a system** of bodies remains **unchanged** in any direction **before and after the collision** when there is **no resultant external force** acting on the system $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ **Notes:** ● It is base on newton's second and third law: ■ force on A by B equal and opposite to force on B by A (due to Newton's third law) ■ force is rate of change of momentum (due to Newton's second law)

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

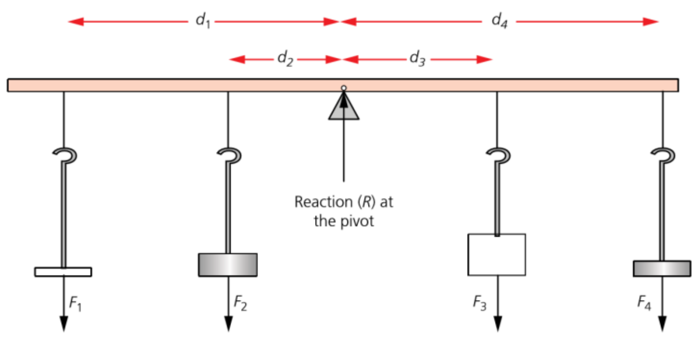
		■ and time of contact is same ■ so the change in momentum of A is equal and opposite to the change in momentum of B during the collision ● During the collision, the total momentum is also conserved
	Elastic collision	**Description:** Collision where total kinetic energy is conserved before and after the collision in a close system **Notes:** ● During the collision the total kinetic energy is not conserved ● In an elastic collision ,the **relative speed is conserved before and after the collision**
	Inelastic collision	**Description:** collision where total kinetic energy is not conserved before and after the collision in a close system
5 Forces, density and pressure	Force	**Defintion:** It is the rate of change of momentum **force = rate of change of momentum** $F = \frac{\Delta mv}{\Delta t}$
	weight	**Defintion:** Is a force on a mass causeed by gravity **W=mg** **Notes:** ● g=gravitational field strength (9.81N/kg) ● the direction of the weight is vertically downwards
	Centre of gravity	**Defintion:** The point from where **all** the weight of the body **seems** to act
	upthrust	**Description:** It is a force when an object is immersed in fluid, due to the difference in pressure on the upper surface and the lower surface **Notes:** ● **Description:** The origin of the upthrust ■ pressure changes with depth ■ the pressure on the lower surface of sphere is greater than the pressure on the upper surface of sphere

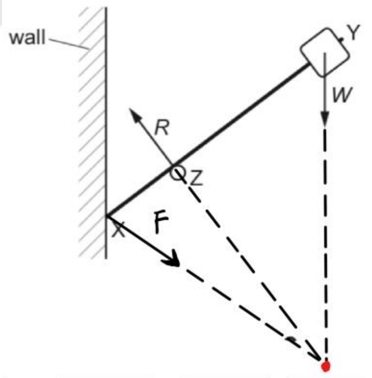
Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
5 Forces, density and pressure		 $P = \rho g h$ ρ: density of fluid h: depth below the surface $P_1 = \rho g h_1$ $P_2 = \rho g h_2$ $\Rightarrow F_1 = P_1 \cdot A$ $\Rightarrow F_2 = P_2 \cdot A$. total force by the fluid = upthrust $= F_2 - F_1$ $= \rho g h_2 \cdot A - \rho g h_1 \cdot A$ $= \rho g A (h_2 - h_1)$ $= \rho g V$		
	Fictional force	**Notes:** ● Decided by the properties of contact surface ● the magnitude of normal force. always against the relative motion		
	Viscous force	**Notes:** ● Shape, contact area, the properties of contact surface ● Relative speed ● Opposite to the relative motion		
	Air resistance	**Notes:** ● When the speed is low, air resistance is directly proportional to the speed. ● when the speed is high, air resistance is proportional to the square of speed. ● special viscous force in air		
	Moment of a force	**Defintion:** Moment of a force about a point is Product of the force and the **perpendicular** distance between the line of action of the force and the point  **a**  **b**		

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

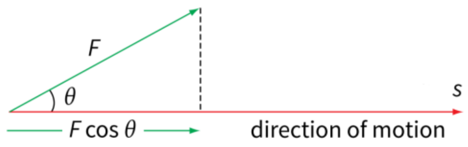
		$\text{moment} = \text{force} \times \text{distance from pivot}$ $= F_1 \times x_1$ $\text{moment of force} = F_2 d \sin\theta$ **Notes:** ● Described by two direction: clockwise and anticlockwise ● Is used to described the turning effect.
	couple	**Defintion:** Two forces acting on the same object are equal magnitude in opposite direction and separated by a distance
	Torque of a couple	**Defintion:** Product of the one of the forces and the **perpendicular** distance between two lines of action of the forces  $\textbf{torque} = \frac{F \times d}{2} \times 2 = Fd$
	Principle of moment	**Description:** For any object that is in equilibrium, the sum of the clockwise moments about a point provided by the forces acting on the object equals the sum of the anticlockwise moments about that same point.

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

<table>
<tr><td rowspan="4"></td><td></td><td>

$F_1d_1 + F_2d_2 = F_3d_3 + F_4d_4$</td></tr>
<tr><td>equilibrium</td><td>Notes:
● Description: two conditions for a system to be in equilibrium:
■ The resultant force acting on the object is zero.
■ The resultant moment is zero.
● If all forces passing through the same point（共点力）, it means that the total moment equals zero


● If all forces are in a close triangle the resultant force is zero.</td></tr>
<tr><td>density</td><td>Defintion: density = mass / volume
$\rho = \frac{m}{v}$</td></tr>
<tr><td>pressure</td><td>Defintion: Pressure is defined as the force acting per unit area normal to the force.</td></tr>
</table>

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
		$\text{pressure} = \dfrac{\text{normal force}}{\text{cross-sectional area}}$ $p = \dfrac{F}{A}$		
6 Work, energy and power	Energy	**Defintion:** Ability to do work		
	principle of conservation of energy	**Description:** Energy is conserved and energy cannot be created or destroyed. It can only be converted from one form to another.		
	Work (J)	**Defintion:** The product of force and displacement in the direction of the force.  **work done = force × displacement** **= force × displacement in the direction of the force** **work done = Fs cos θ**		
	F-d graph	**Notes:** ● The work done on an object is the area under the line in a force– displacement graph		
	Gravitational Potential Energy	**Defintion:** the energy or ability to do work of a mass that is stored due to its position in a gravitational field **gravitational potential energy change = $mg\Delta h$** **Notes:** ● Change in gpe is equal to the work done against weight		
	Kinetic Energy	**Defintion:** the energy or ability to do work of a mass/body that is stored due to its motion $\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$ $E_k = \frac{1}{2}mv^2$ **Notes:** ● The change in ke is equal to the total work done by all forces, is equal to the work done by resultant force		
	Pressure-volume graph	**Notes:** Area: Work done by gas $W = p\Delta V$		
	Heat cost by friction	**Notes:** Heat produced is equal to the work done against the frictional force		

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

<table>
<tr><td rowspan="2"></td><td>Power (W)</td><td>**Defintion:** work done per unit time

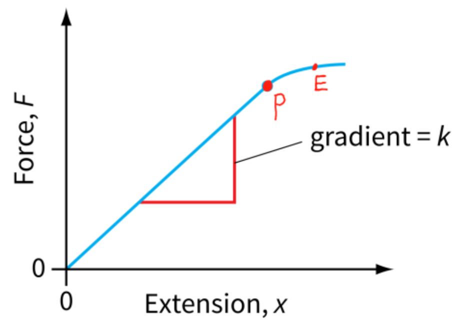
power, $P = \frac{\text{work done}}{\text{time taken}} = \frac{\Delta W}{\Delta t}$

$P = \frac{W}{t} = \frac{F \times v \times t}{t}$
and we have:
$P = F \times v$</td></tr>
<tr><td>Efficiency (%)</td><td>**Defintion:** Ratio of effective power used to total power input

efficiency = $\frac{\text{useful energy transferred in a given time}}{\text{energy supplied in that time}} \times 100\%$

Notes:
● The efficienty of electric heater is 100%</td></tr>
<tr><td rowspan="3">9
Deformati</td><td>deformation</td><td>**Description:** Change in shape cause by force in one dimension</td></tr>
<tr><td>Hooke's law</td><td>**Description:** force is proportional to extension **provided proportionality limit is not exceeded**

F=kx

Notes:
● spring constant (force per unit extension) is a measure of the stiffness of the spring</td></tr>
<tr><td>F-x</td><td>

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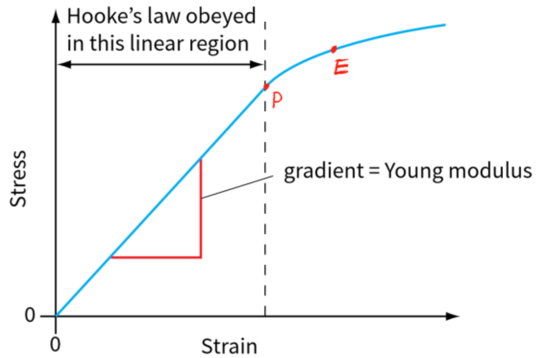
Notes:</td></tr>
</table>

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
on of solids		● Area: work done by the force ● Gradient: spring constant ● Limit of proportionality: maximum extension in the linear region ● Elastic limit: maximum elastic deformation		
	Elastic deformation	**Description:** The deformation that return to the original shape after the load is removed		
	stress	**Defintion:** Is the ratio of force to cross-sectional area $\text{tensile stress } (\sigma) = \frac{\text{force}}{\text{cross sectional area}} = \frac{F}{A}$		
	strain	**Defintion:** The ratio of extension to original length $\text{tensile strain } (\varepsilon) = \frac{\text{extension}}{\text{original length}} = \frac{\Delta L}{L}$		
	Young modulus	**Defintion:** Young modulus = stress/strain $\text{Young modulus} = \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{\sigma}{\varepsilon} = \frac{F/A}{\Delta L/L} = \frac{FL}{A\Delta L}$ **Notes:** ● It is the measure of the stiffness of the material		
	Stress stain graph	 **Notes:** ● Gradient: young modulus ● Area: strain energy per unit volume		

<table>
<tr><th>Units</th><th>Key points</th><th>Definitions or descriptions</th><th>Formulae and graphs</th><th>Notes</th></tr>
<tr><td></td><td>Elastic potential energy</td><td colspan="3">Defintion：the energy stored in a body due to its deformation</td></tr>
<tr><td rowspan="4">14 Waves</td><td>Progressive wave</td><td colspan="3">Description：transfers energy from one position to another through a material or a vacuum.
Notes：
● Property of waves: All waves can be reflected, refracted and diffracted
● （Defintion）Displacement for a progressive wave：
■ The distance in a specified direction of particle/point on wave from the equilibrium position
● （Defintion）Amplitude for a progressive wave：
■ The maximum displacement of particle on wave from the equilibrium position
● （Defintion）Wavelength for a progressive wave：
■ distance between two adjacent wavefronts
■ or the distance between two points in phase that are adjacent.
● （Defintion）Period for a progressive wave：
■ time for one complete oscillation of particle
$f = \frac{1}{T}$
● （Defintion）Frequency for a progressive wave：
■ the number of complete oscillations of particle per unit time
$v = \frac{\lambda}{T}$
$v = (\frac{1}{T}) \times \lambda$
● In a progressive wave adjacent particles are out of phase</td></tr>
<tr><td>Longitudinal waves</td><td colspan="3">Defintion： the particles of the medium vibrate parallel to the direction of
The propagation of energy</td></tr>
<tr><td>Transverse waves</td><td colspan="3">Defintion： the particles of the medium vibrate at right angles to the
direction of the propagation of energy</td></tr>
<tr><td>The intensity of a wave</td><td colspan="3">Defintion：the rate of energy transmitted (power) per unit area at right angles to the wave velocity
$\text{intensity} = \frac{\text{power}}{\text{cross-sectional area}}$</td></tr>
</table>

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

Notes:

- intensity $\propto$ $(\text{amplitude})^2$
- The intensity of a wave generally decreases as it travels along.
  - The wave may 'spread out'
  - The wave may be absorbed or scattered

Electromagnetic spectrum

Radiation	Wavelength range / m
radio waves	$>10^{6}$ to 10^{-1}
microwaves	10^{-1} to 10^{-3}
infrared	10^{-3} to 7×10^{-7}
visible	7×10^{-7} (red) to 4×10^{-7} (violet)
ultraviolet	4×10^{-7} to 10^{-8}
X-rays	10^{-8} to 10^{-13}
γ-rays	10^{-10} to 10^{-16}

Notes:

- All electromagnetic waves travel at the same speed of 3.0×10^{8} ms $^{-1}$ in a vacuum, but have different wavelengths and frequencies.
- Frequency is depending on wave source
- Wave speed depending on medium

Doppler effect:

Description: **observed frequency** is different to **source frequency** when source moves relative to observer

$$\text{observed frequency } f_o = \frac{f_s \times v}{(v \pm v_s)}$$

Principle of superposition

Description: when two or more waves meet at a point, the resultant displacement is the sum of the individual displacements.

Diffraction

Defintion: As wave pass through the slit wave spread into geometric shadow around the edge of slit.

Notes:

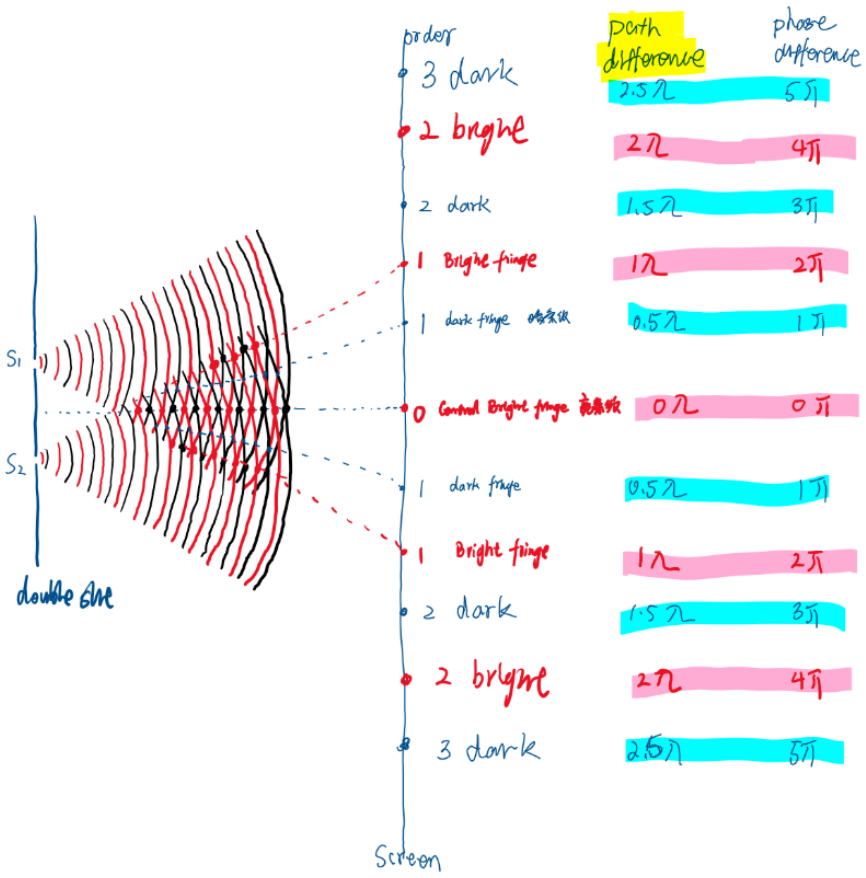
- When the gap is almost equal to the wavelength, the diffraction is most noticeable.
- The greater the ratio of gap size to wavelength, the greater the angle of diffraction, the greater the degree of diffraction.

Interference

Description: interference is the combination of the displacements of overlapping waves

Notes:

- Where two waves arrive at a point in phase with one another so that they add up, we call this effect constructive interference.

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
15 Superposition		● Where they cancel out, the effect is known as destructive interference.		
	Coherent	**Notes:** ● **Description:** coherent sources: two sources emit waves with a **constant phase difference** ● **Description:** coherent waves: **constant phase difference** between the waves		
	double-slit	**Notes:**  $$\lambda = \frac{ax}{D}$$ ● zero order maximum: ■ waves from each slit **overlap/meet/superpose** with a **zero phase difference** due to **path difference of zero**, so		

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

15

Superposition

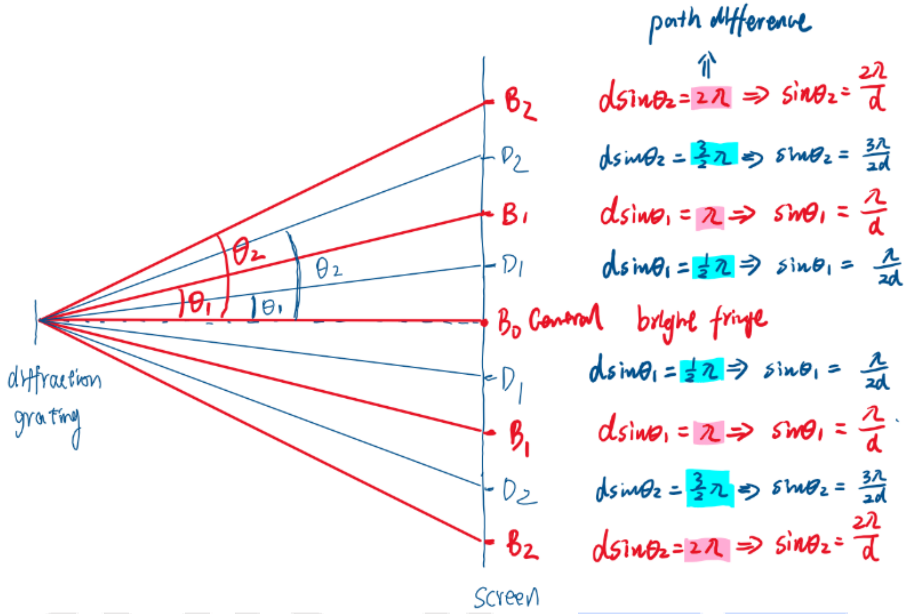
constructive interference gives bright fringe

- first order maximum
  - waves from each slit **overlap/meet/superpose** with **phase difference of 360°** due to **path difference of λ**, so constructive interference gives bright fringe

- the part played by diffraction in the production of the fringes
  - waves at each slit spread into the geometric shadow
  - then waves overlap to form fringes
- a double slit is used rather than two separate sources of light
  - waves from the double slit are coherent/have a constant phase difference
  - there is not a constant phase difference/coherence for two separate light sources

- The conditions that is required for an observable interference pattern:
  - waves must be **coherent**. (sources are connected to the same vibrator/generator)
  - the overlapping waves have **similar/same amplitude**

- The intensity of the light incident on the **double slits** is now **increased** without altering its frequency.
  - no change to fringe separation /number of fringes
  - bright fringes are brighter
  - dark fringes are unchanged
- The intensity of the light through **one of the slits** is now **reduced**.
  - same fringe separation /number of fringes
  - bright fringes are less bright
  - dark fringes are brighter
  - contrast between fringes decreases

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
	Diffraction grating	**Notes**:  $d \sin\theta = n\lambda$ ● Angle<90 degree, so maximum order of bright fringe < d/λ, total number of bright fringes observed = maximum order of bright fringe*2+1		

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

		The separation between slits is 2800 nm and the wavelength is 450 nm. How many bright frings on the screen can be observed. $d = 2800\times10^{-9} m$ $\lambda = 450\times10^{-9} m$ $\sin\theta < 1$, $\theta < 90^\circ$ $\sin\theta = \frac{n\lambda}{d} < 1$ $n < \frac{d}{\lambda} = \frac{2800\times10^{-9}}{450\times10^{-9}} = 6.2$ $n_{max} = 6$ So total number of bright fringes is 13. ($13 = 6\times2+1$) $d\sin\theta = n\lambda$ · The greater the n, the greater the θ. · $\theta < 90^\circ$, $\sin\theta < 1$
	Stationary wave	**Description:** A wave pattern produced when two progressive waves of the same frequency travelling in opposite directions combine. It is characterised by nodes and antinodes. **Notes:** ● **How the stationary wave is formed:** ■ Incident wave reflects at at fixed point/end ■ then the incident wave and reflected wave superpose to form stationary wave. ● **the conditions required for the formation of stationary waves** ■ two waves travelling at same speed in opposite directions overlap ■ waves (are same type and) have same frequency/wavelength ● **(Defintion)** Antinode of a stationary wave: ■ position where has maximum amplitude ● **(Defintion)** Node of a stationary wave: ■ position where has minimum amplitude ● In a stationary wave adjacent particles are in phase

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

	Stationary wave	Progressive wave
Wavefront	Not move but oscillation at same position	Move with the velocity of the wave.
Energy	Not transferred.	Transferred in the direction of travel of the wave
Frequency	All particles, except at the nodes, vibrate at the same frequency.	All particles vibrate at the same frequency.

	Stationary wave	Progressive wave
wavelength	Double the distance between a pair of adjacent nodes or antinodes	Distance between adjacent particles which have the same phase.
Amplitude	The amplitude varies from zero at the nodes to a maximum at the antinodes.	The amplitude is the same for all particles.
Phase difference between two particles	πm, where m is the number of nodes between the two particles.	$2\pi\, x/\lambda$, where x is the distance apart and λ is the wavelength.

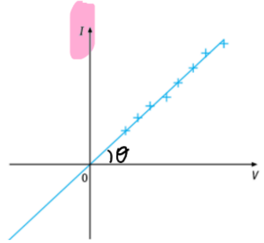
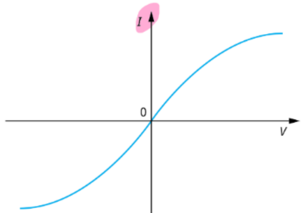
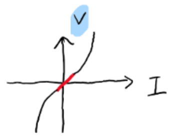
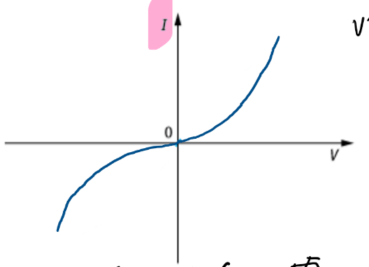
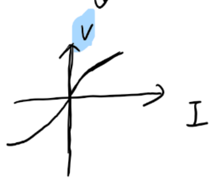
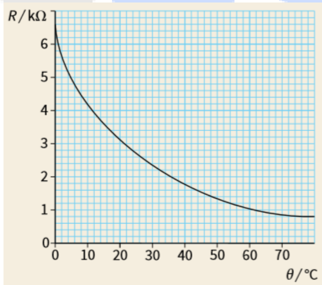
Units	Key points	Content
	Field of force	**Defintion:** A region of space where an object experiences a force by the field
	Electric field	**Defintion:** Electric field due to a charge is a region of space where another stationary charge experiences an electric force by the field
	Electric field strength	**Defintion:** force per unit **positive** charge $$E = F / q$$ E = electric field strength (N/C) F = force on test charge (N) q = size of test charge placed in the field (C) **Notes:** ● It is a vector quantity in the same direction of the force experienced by the positive charge but opposite to the direction of force on negative charge
	Electric field lines	**Defintion:** The direction of electric force acting on a small test positve charge or The path in which a free positive charge will move **Notes:** ● Field lines start **perpendicularly** from surface of positive charged object and end perpendicularly from surface of negative charged object

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

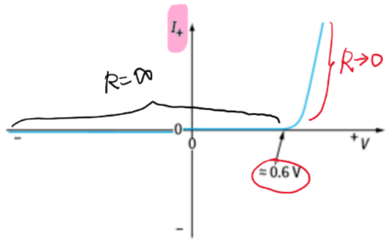
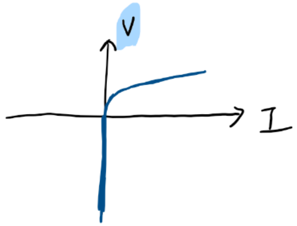
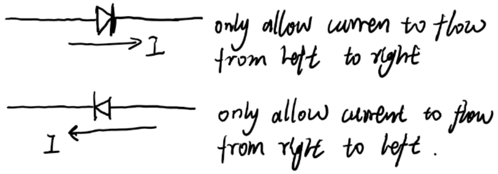
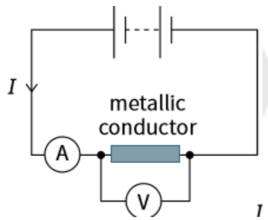
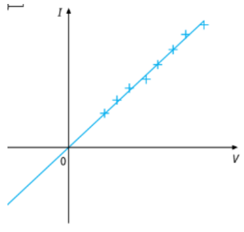
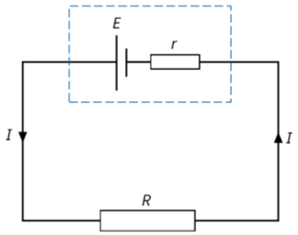
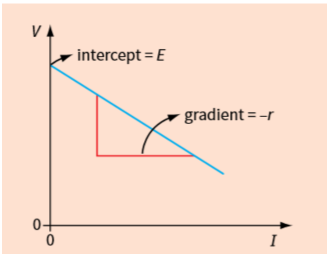
	Field strength of uniform field	**$E = V / d$** E = electric field strength (V/m) V = potential difference (voltage) between plates (V) d = distance between plates (m) **Notes:** ● The field is non-uniform near the ends of the plates
	Current	**Defintion:** Electric current is the rate of flow of electric charge carriers past a point. **I=Q/t** **Notes:** ● Direction of flow of conventional current is same as the direction of flow of positive charges, and is opposite to the direction of flow of negative charges. ● $I = nAvq$ ■ n is number density of **charge carriers(=charged particles)** ■ v is average drift velocity ■ q is the charge of a charge carrier ■ A is cross-sectional area
	Charge	**Notes:** ● **The charge on the carriers is quantised, it means charge exists only in discrete amounts** ● elementary charge e = 1.6×10^{-19} C
	Coulomb	**Defintion:** ampere second
	Potential difference	**Defintion:** Energy transferred from electrical to other forms of energy per unit charge through the two point
	Volt	**Defintion:** Joules per coulomb
	power	**Defintion:** Work done per unit time **Notes:**

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

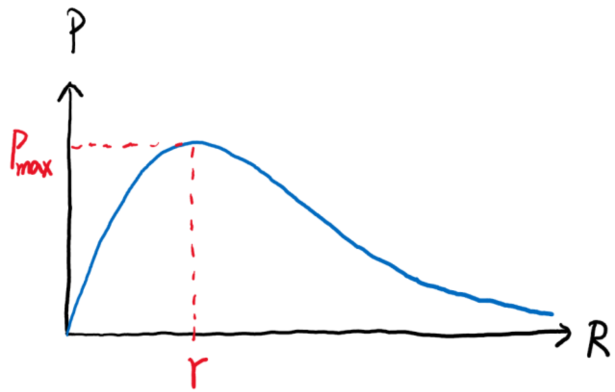
19 Current of electricity		● Electric power (**P=IV**) means the energy transferred from electrical energy to other formas of energy per unit time ● Heat power (the Joule's law) (**$P=I^2R$**): The energy transferred from electrical energy to thermal energy per unit time ● For resistor electric power equal heat power, $P=IV=I^2R$, $V=IR$
	Resistance	**Defintion:** The **ratio** of voltage across it to the current through it $$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$ $$R = \frac{V}{I}$$ **Notes:** ● Resistance of a resistor means the property that it would resist the flow of current ● Measured resistance between two points = total resistance between two points = combined resistance between two points
	Resistivity	**Defintion:** The resistivity of a material is defined by ρ= RA/L where R is resistance, L is length, A is cross-sectional area. $$R = \frac{\rho l}{A}$$ ρ = resistivity of the material l = is the length A=is the cross sectional area **Notes:** ● **Resistivity** means the property of a type of a material that could resist the flow of current
	Ohm	**Defintion:** Volt per ampere

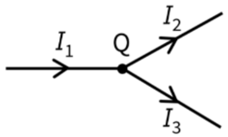
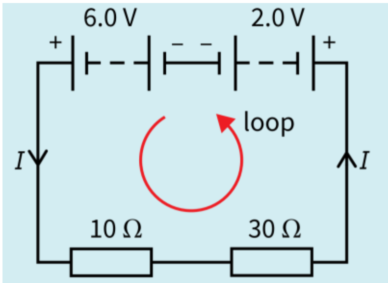
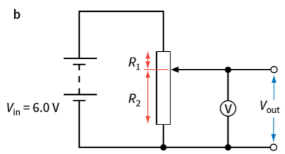
Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
	The I–V characteristic for ohmic resistor	R=constant  Eg: ohmic resistor, fixed resistor 定值电阻, metallic conductor at constant temperature		
	The I–V characteristic for a filament lamp	 filament lamp V↑ → T↑ → R↑  **Notes**: ● For very small currents and voltages, the graph is roughly a straight line.		
	The I–V characteristic for Negative temperature coefficient (NTC) thermistors	 thermistor V↑ → T↑ → R↓   **Notes**: ● the resistance of this type of thermistor decreases with increasing temperature. ● Resistance of thermistor does not decrease linearly with temperature		

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

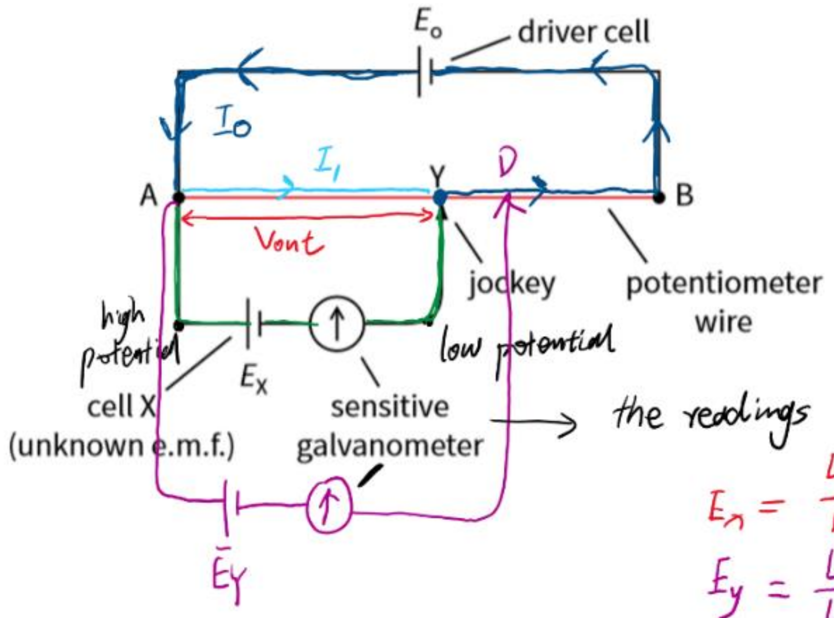
	The I–V characteristic for a diode	 **Notes:** ● Describe the I–V characteristic ■ zero current for one direction –ve V up to a few tenths of volt +ve V (resistance is infinite/very high) ■ straight line with positive or increasing gradient +ve V (resistance decreases as V increases)
	The ohm's law	**Description:** The current through a resistor is directly proportional to the voltage across it when the physical condition are constant  **Notes:** ● Graph is a straight line which passes through the origin.
	e.m.f	**Defintion:** The energy transformed from other forms to electrical energy per unit charge driven around a complete circuit **Notes:** ● **Defintion:** electromotive force (e.m.f.) of a cell: ■ The energy transformed from chemical to electrical energy per unit charge driven around a complete circuit
	complete Circuit	therefore, $\varepsilon = IR + Ir$ becomes: $\varepsilon = V + Ir$ (as $V = IR$) or $V = \varepsilon - Ir$ 

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

20 D.C. circuits		**Notes:** ● In a V-I graph, y-intercept is E, gradient is negative r. ● The graph is a straight line. ● V=terminal p.d. = total external p.d. ● Ir=lost volts
	Power in complete Circuit	**Notes:** ● P=IE: Total input power of the supply ● $P=IV=I^2R$: Output power by the supply Power dissipated in the external circuit ● $P=I^2r$: Power dissipated due to internal resistance ● **For the whole complete circuit:** $IE= IV+ I^2r$ I=E/ (R+r) ● **Efficiency of the battery** = IV/ IE=V/ E
	Output power by the supply – external resistance graph	 **Notes:** ● When R=r, output power is maximum, V=Ir=1/2E, Efficiency of the battery = IV/ IE=V/ E=50%
	Kirchhoff's first law	**Description:** The sum of currents entering a junction is equal to the sum of currents leaving this junction

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes
20 D.C. circuits		 $I_1 = I_2 + I_3$ **Notes:** ● It is based on the **conservation of charge**		
	Kirchhoff's second law	**Description:** The sum of e.m.f.s is equal to the sum of the p.d.s around a closed circuit  sum of e.m.f.s = 6.0 V − 2.0 V = 4.0 V sum of p.d.s = (I× 10) + (I × 30) = 40 I 4.0 = 40 I and so I = 0.1 A **Notes:** ● It is based on the **conservation of energy**		
	Potential divider	 $V_{out} = (\frac{R_2}{R_1 + R_2}) \times V_{in}$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ **Notes:** ● Vin is constant ● If R1 increases, Vout decreases ● If R2 increases, Vout increases		

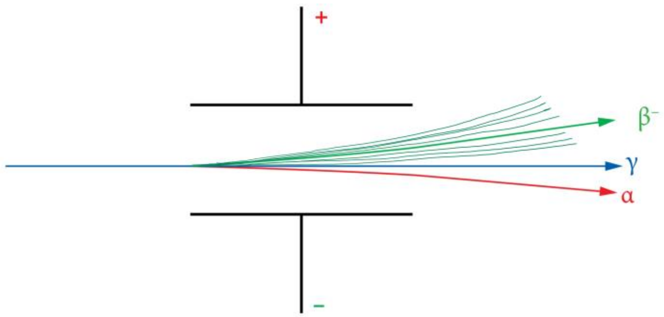
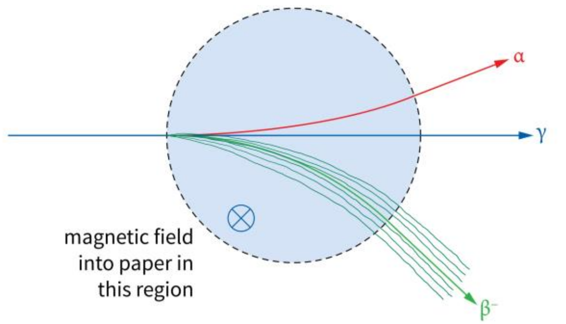
Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

	Potentiometers	 the readings on the two galvanometers are both zero $E_x = \frac{L_{AY}}{L_{AB}} \cdot E_0$ $E_y = \frac{L_{AD}}{L_{AB}} \cdot E_0$ $\Rightarrow \frac{E_x}{E_y} = \frac{L_{AY}}{L_{AD}}$ **Notes**: ● When the potentiometer is balanced: ■ The galvanometer gives zero deflection, showing that there is no current through it. ■ The potential difference across the length of wire AY is equal to the e.m.f. of cell X. ● **$E_x = V_{AY}$ (I=0, lost volts = Ir = 0)**
	Rutherford's Experiment	● **Observations 1**: The vast majority of α-particles passed through the foil with very little or no deviation from their original path. ■ **Explanation 1**: **most of the atom is empty space**. ● **Observations 2**: An extremely small number of particles were deflected through an angle greater than 90°. ■ **Explanation 2**: ◆ **the majority of mass in very small nucleus** ◆ **the nucleus has positive charge.**
26	Notation	nucleon number / proton number element symbol $^{A}_{Z}X$ **Notes**: ● The Proton (Atomic) Number is the number of Protons and Electrons unless it is an ion. (Protons = Electrons)

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

<table>
<tr><td rowspan="3">Particle and nuclear physics</td><td></td><td>● The Nucleon (Mass) Number is the number of Protons + Number of Neutrons.</td></tr>
<tr><td>Isotope</td><td>Defintion：are the nuclei which have same number of protons but different number of nucleons (or neutrons)</td></tr>
<tr><td>Radiation from radioactive substances</td><td>
<table>
<tr><th>property</th><th>α-particle</th><th>β-particle</th><th>γ-radiation</th></tr>
<tr><td>mass</td><td>4 u</td><td>about u/2000</td><td>0</td></tr>
<tr><td>charge</td><td>$+2e$</td><td>$-e$ or $+e$</td><td>0</td></tr>
<tr><td>nature</td><td>helium nucleus
(2 protons + 2 neutrons)</td><td>negative or positive electron</td><td>short-wavelength electromagnetic waves</td></tr>
<tr><td>speed</td><td>up to 0.05c</td><td>more than 0.99c</td><td>c</td></tr>
<tr><td>penetrating power</td><td>few cm of air</td><td>few mm of aluminium</td><td>few cm of lead</td></tr>
<tr><td>relative ionising power</td><td>10^4</td><td>10^2</td><td>1</td></tr>
<tr><td>affects photographic film?</td><td>yes</td><td>yes</td><td>yes</td></tr>
<tr><td>deflected by electric, magnetic fields?</td><td>yes, see Figure 26.3</td><td>yes, see Figure 26.3</td><td>no</td></tr>
</table>
</td></tr>
</table>

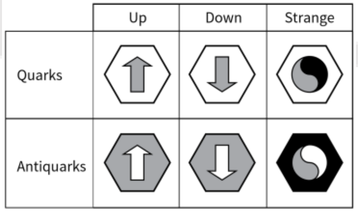
Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

26 Particle and nuclear physics		 **Figure 16.15** An electric field can be used to separate α-, β^-- and γ- radiations. (The deflection of the α-radiation has been greatly exaggerated here.)  **Figure 16.16** A magnetic field may also be used to separate α-, β^-- and γ- radiations. The deflection of the α-radiation has been greatly exaggerated here. **Notes:** ● β-particles has a continuous range of energies, rather than discrete values of energy. ● β-particles will follow the different paths inside the electric field.
	specific charge	**Notes:** ● The greater the ratio of charge to mass, the more the deflection of particle in electric field or magnetic field
	Nuclear process	**Notes:** ● nuclear processes ■ nuclear fusion: two light nuclei join together into a massive nucleus ■ nuclear fission: a massive nucleus split apart into two light nuclei ■ radioactive decay: a unstable nucleus changes into a more stabe nucleus emitting α^-, β^- and γ-radiations ● **Conservation in a nuclear process** ■ Proton number is conserved ■ Nucleon number is conserved ■ charge is conserved ■ Momentum is conserved ■ Mass-energy is conserved ● The decrease in mass transfer into energy in forms of **kinetic energy of product particles** or **gamma radiation**

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

<table>
<tr><td rowspan="6">26
Particle
and
nuclear
physics</td><td>Fundamental particle</td><td>Defintion：Particle that have no internal structure</td></tr>
<tr><td>Hadron</td><td>Defintion：Particle that consist by quarks
Notes：
● Two tpyes of hadrons
■ Meson (consist two quarks)
■ Baryon (consist three quarks)
◆ Proton (uud)、Neutron（udd)
● not a fundamental particle</td></tr>
<tr><td>Lepton</td><td>Defintion：Particle that consist by non-quark
Notes：
● Lepton
■ Electron、Neutrino
● strong force not act on leptons
● all leptons are fundamental particles</td></tr>
<tr><td>quark</td><td>

flavour	charge	strangeness
up (u)	$+\frac{2}{3}$	0
down (d)	$-\frac{1}{3}$	0
strange (s)	$-\frac{1}{3}$	−1



</td></tr>
<tr><td>beta plus decay</td><td>Notes：
● proton number of the nucleus decrease,
● up quark change to down quark
● (electron) neutrino also emitted</td></tr>
<tr><td>beta minus decay</td><td>Notes：
● proton number of the nucleus increase,
● down quark change to up quark
● (electron) antineutrino also emitted
● similarity between a β^+ particle and a β^- particle
■ same (rest) mass
■ equal (magnitude of) charge</td></tr>
</table>

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes

		● **difference between a β^+ particle and a β^- particle** ■ opposite (sign of) charge ■ one is matter and one is antimatteror one is an electron and one is an antielectron
	strong interaction (force)	**Notes**: ● nucleus is form by the strong force between nucleons ● nucleon（protron and neutron）is form by the strong force between quarks
	weak interaction （force）	**Notes**: ● beta decay due to weak force between quarks

matter

hadrons 强子 (are the particles which are formed by quarks)
can feel strong force

mesons 介子
(are particles which are formed by two quarks)

baryons 重子
(are particles which are formed by three quarks)

Eg: proton : $u\,u\,d \Rightarrow +\frac{2}{3}e+\frac{2}{3}e-\frac{1}{3}e=+e$
neutron : $u\,d\,d \Rightarrow +\frac{2}{3}e-\frac{1}{3}e-\frac{1}{3}e=0$
anti proton : $\bar{u}\,\bar{u}\,\bar{d} \Rightarrow -\frac{2}{3}e-\frac{2}{3}e+\frac{1}{3}e=-e$
anti neutron : $\bar{u}\,\bar{d}\,\bar{d} \Rightarrow -\frac{2}{3}e+\frac{1}{3}e+\frac{1}{3}e=0$

leptons 轻子
(are particles which have no quarks)
weak interaction between quarks, giving rise to **β decay**

Eg: electrons
antielectrons
neutrino
antineutrino

quarks :

up quark	$+\frac{2}{3}e$	u
down quark	$-\frac{1}{3}e$	d
strange quark	$-\frac{1}{3}e$	s
anti-up quark	$-\frac{2}{3}e$	$\bar{u}$
anti-down quark	$+\frac{1}{3}e$	$\bar{d}$
anti-strange quark	$+\frac{1}{3}e$	$\bar{s}$

* strange particle is the particle consists strange quarks or anti-strange quarks, and they have strangeness. (奇异性)

Units	Key points	Definitions or descriptions	Formulae and graphs	Notes