

SPM From zero **PHYSICS THERAPY** to Master!
in 3 classes

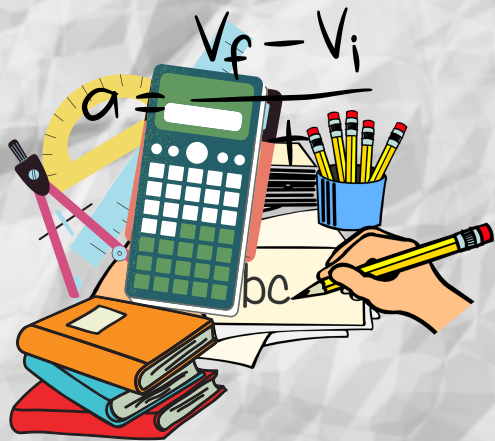
A+



TOPIK TINGKATAN 4 & TINGKATAN 5 | DWIBAHASA

NOTA RINGKAS FIZIK SPM

"Received a Platinum Award in International Summit of Innovation & Design Exposition, InSIDE 2019"



<http://www.cikguajwad.com>

Penerangan berkaitan nota di :



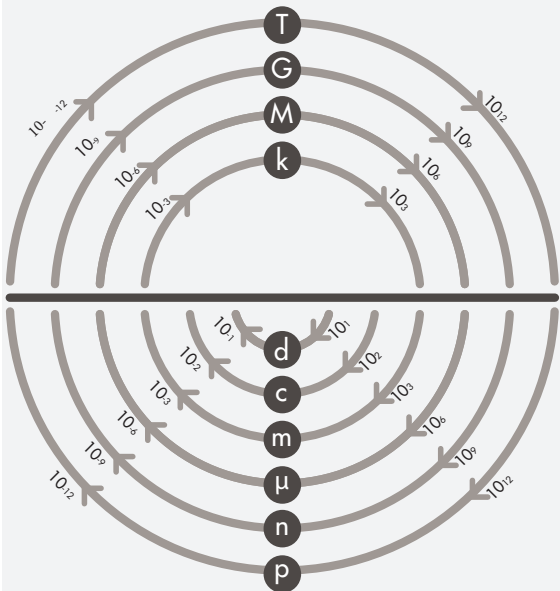
Fizik SPM Physiotherapy



PHYSICAL QUANTITY

Quantity that can be measured.

Base Quantity	Derived Quantity
Length, l (m)	Quantity that produce by (x) or (\div) or both operation of base quantity (other than 7 base quantity).
Mass, m (kg)	
Time, t (s)	
Temperature, T (K)	
Current, I (A)	
Luminous Intensity, I_v (cd)	
amount of substance, n (mol)	



CONVERSION

$100 \text{ kmh}^{-1} \rightarrow \text{ms}^{-1}$

SHIFT CONV 1 9

$100 \text{ ms}^{-1} \rightarrow \text{kmh}^{-1}$

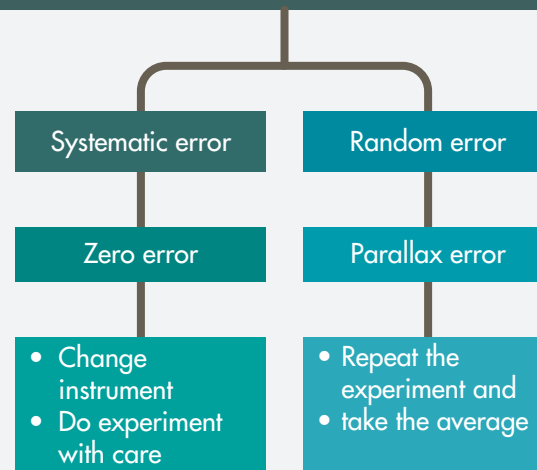
SHIFT CONV 2 0

$10 \text{ cm} \rightarrow \text{m}$
 $10 \times 10^{-2} \text{ m}$

$10 \text{ cm}^2 \rightarrow \text{m}^2$ $10 \text{ cm}^3 \rightarrow \text{m}^3$
 $10 \times 10^{-2 \times 2} \text{ m}^2$ $10 \times 10^{-2 \times 3} \text{ m}^3$

density $10 \text{ gcm}^{-3} \rightarrow \text{kgm}^{-3}$ tips: multiply with 1000

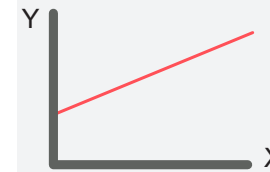
ERROR



GRAPH



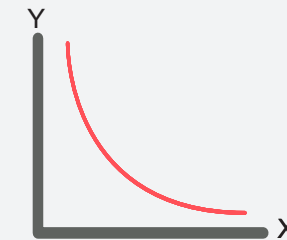
Y directly proportional to X



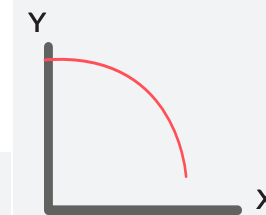
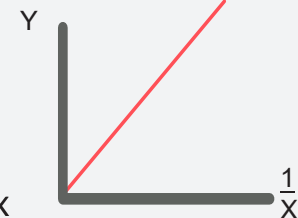
Y increase linearly with X



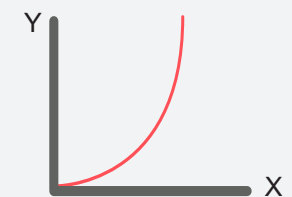
Y decrease linearly with X



Y inversely proportional to X



Y decrease with X



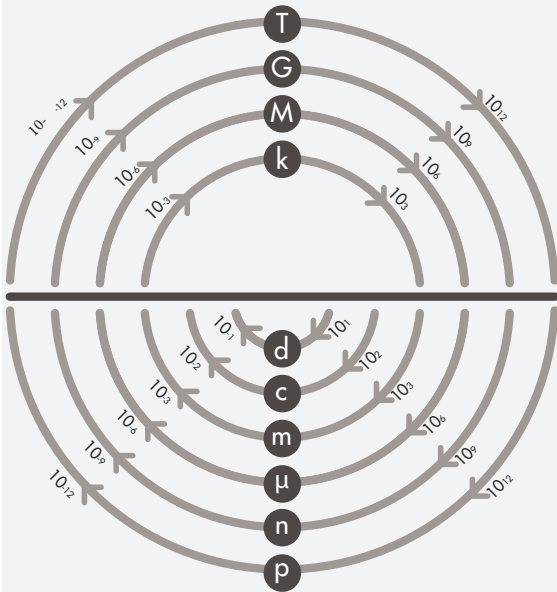
Y increase with X



KUANTITI FIZIK

Kuantiti yang boleh diukur:

Kuantiti Asas	Kuantiti Terbitan
Panjang, l (m)	Kuantiti fizik yang terhasil daripada hasil (x) atau (+) atau kedua-dua operasi keatas kuantiti asas (Selain daripada 7 kuantiti asas).
Jisim, m (kg)	
Masa, t (s)	
Suhu, T (K)	
Arus Elektrik, I (A)	
Keamatan Berluminositi, I_v (cd)	
Kuantiti bahan, n (mol)	



PENUKARAN

$100 \text{ kmh}^{-1} \rightarrow \text{ms}^{-1}$

SHIFT CONV 1 9

$100 \text{ ms}^{-1} \rightarrow \text{kmh}^{-1}$

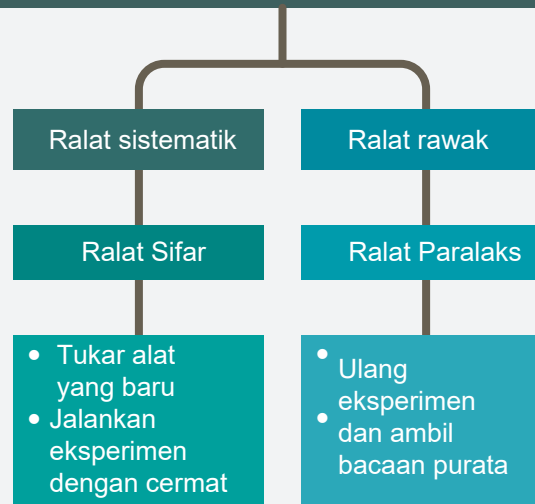
SHIFT CONV 2 0

$10 \text{ cm} \rightarrow \text{m}$
 $10 \times 10^{-2} \text{ m}$

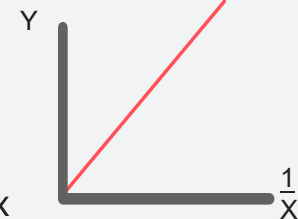
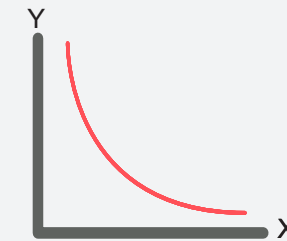
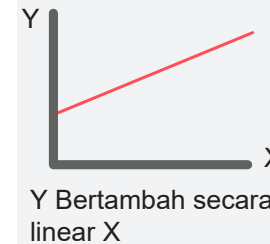
$10 \text{ cm}^2 \rightarrow \text{m}^2$ $10 \text{ cm}^3 \rightarrow \text{m}^3$
 $10 \times 10^{-2 \times 2} \text{ m}^2$ $10 \times 10^{-2 \times 3} \text{ m}^3$

density $10 \text{ gcm}^{-3} \rightarrow \text{kgm}^{-3}$ tips: darab dengan 1000

RALAT



GRAF



FORCE & MOTION (1)



SCALAR

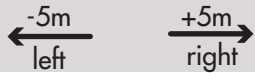
VECTOR

Distance, d

How far body travel in motion

5m

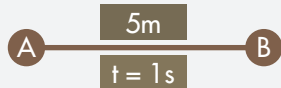
Displacement, s
 shortest path from starting point to end point



SPEED

Rate of change of distance

$$\frac{\text{Distance}}{\text{Time}} = \frac{m}{s} = ms^{-1}$$



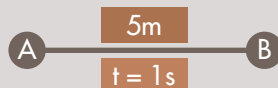
$$V_{AB} = 5ms^{-1}$$

$$V_{BA} = 5ms^{-1}$$

VELOCITY

Rate of change of displacement

$$\frac{\text{Displacement}}{\text{Time}} = \frac{m}{s} = ms^{-1}$$



$$V_{AB} = 5ms^{-1} \text{ (right)}$$

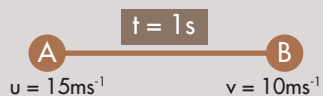
$$V_{BA} = -5ms^{-1} \text{ (left)}$$

ACCELERATION, a

Uniform a, Rate of change of velocity

$$v^2 = u^2 + 2as$$

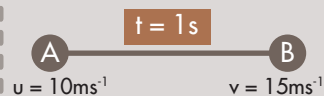
$$s = ut + \frac{1}{2} at^2$$



$$a_{AB} = \frac{10 - 15}{1} = -5ms^{-2}$$

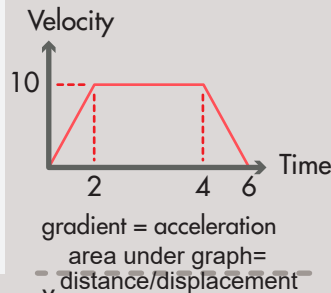
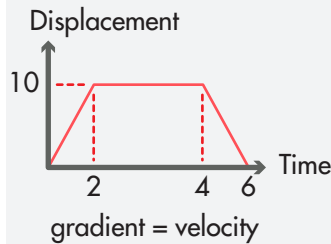
(decelerate)

if a = 0ms⁻², the object is either at rest or at constant velocity.



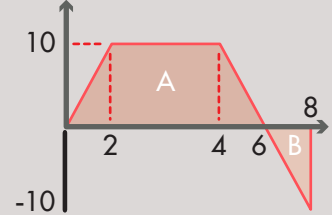
$$a_{AB} = \frac{15 - 10}{1} = 5ms^{-2}$$

(accelerate)



Distance
 Area A + Area B

Displacement
 Area A - Area B



INERTIA

Mass ▲, Inertia ▲

tendency of object to retain its state of motion.

NEWTON'S 1ST LAW

Object will remain at rest or continue with constant speed (velocity) in straight line unless an unbalance force act upon it.

MOMENTUM, p

$$p = (\text{mass})(\text{velocity})$$

$$p = mv \text{ (kgms}^{-1}\text{)}$$

product of mass and velocity of an object

Newton's 3rd Law

For every action, there is equal & opposite reaction

FORCE, F

$$F = (\text{mass})(\text{acceleration})$$

$$F = ma \text{ (Newton, N)}$$

Newton's 2nd Law

Net force directly proportional to the rate of change of momentum.

Principle Conservation of Momentum

TOTAL momentum before collision is equal to TOTAL momentum after collision.

Elastic Collision

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

Inelastic Collision

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

Explosion

$$m_1v_1 = m_2v_2$$

Impulsive Force

Rate of change of momentum

$$F = \frac{mv - mu}{t}$$

▼ time of impact, ▲ F

Unit force : Newton, N

Impulse

change of momentum

$$Ft = mv - mu$$

Ns = kgms⁻¹ (unit for momentum)

Weight, W

$$W = mg \text{ (9.81ms}^{-2}\text{)}$$

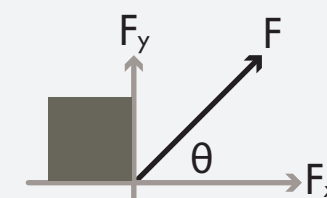
g = gravitational acceleration

BALANCE FORCE

Net force / Resultant Force

$$\Sigma F = 0$$

#at rest/
 constant velocity



$$F_x = F \cos \theta$$

$$F_y = F \sin \theta$$

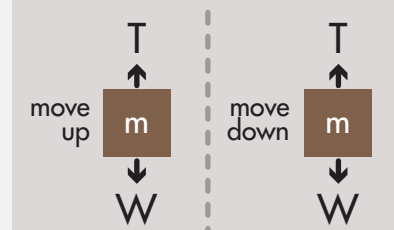
UNBALANCE FORCE

$$\Sigma F = ma$$

a = ?



$$F - f = ma$$



$$T - W = ma$$

$$W - T = ma$$

DAYA & GERAKAN (1)



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f FIZIK SPM PHYSICSTHERAPY



SKALAR

Jarak, d
jauh sesuatu jasad bergerak

5m

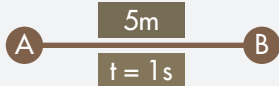
VEKTOR

Sesaran, s
jarak terpendek antara titik mula dan akhir

-5m +5m
Kiri Kanan

KELAJUAN

Kadar perubahan Jarak

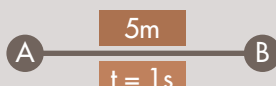
$$\frac{\text{Jarak}}{\text{Masa}} = \frac{m}{s} = ms^{-1}$$


$$V_{AB} = 5ms^{-1}$$

$$V_{BA} = 5ms^{-1}$$

HALAJU

Kadar perubahan sesaran

$$\frac{\text{Sesaran}}{\text{Masa}} = \frac{m}{s} = ms^{-1}$$


$$V_{AB} = 5ms^{-1} \text{ (kanan)}$$

$$V_{BA} = -5ms^{-1} \text{ (kiri)}$$

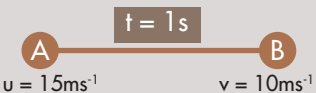
PECUTAN, a

Kadar perubahan halaju

a seragam,

$$v^2 = u^2 + 2as$$

$$s = ut + \frac{1}{2} at^2$$



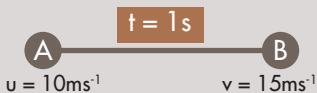
$$a_{AB} = \frac{10 - 15}{1} = -5ms^{-2}$$

(nyah-pecut)

$$a = \frac{v - u}{t}$$

$$s = \frac{1}{2} (u + v) t$$

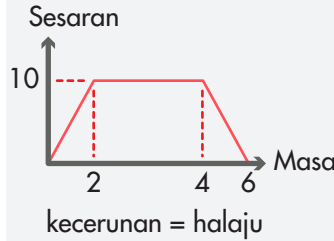
$$= ms^{-2}$$



$$a_{AB} = \frac{15 - 10}{1} = 5ms^{-2}$$

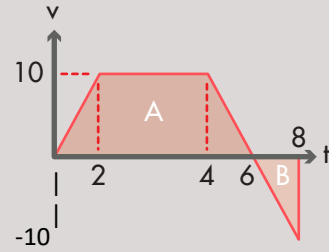
(memecut)

Jika a = 0ms⁻², objek itu sama ada tidak bergerak atau pada kelajuan seragam



Jarak
Keluasan A + Keluasan B

Sesaran
Keluasan A - Keluasan B



INERSIA

Jisim ▲, Inersia ▲

kecenderungan objek untuk mengekalkan keadaan gerakannya

HUKUM NEWTON PERTAMA

Objek akan kekal dalam keadaan pegun atau bergerak dengan halaju malar sehingga ada daya luar yang bertindak

MOMENTUM, p

$p = (\text{jisim})(\text{halaju})$
 $p = mv \text{ (kgms}^{-1}\text{)}$
hasil darab jisim dan halaju sesuatu objek

Hukum Newton ke-3

Bagi setiap tindakan, terdapat daya tindak balas yang sama pada arah bertentangan.

DAYA, F

$F = (\text{jisim})(\text{pecutan})$
 $F = ma \text{ (Newton, N)}$

Hukum Newton ke 2

Daya yg dikenakan berkadar terus dengan kadar perubahan momentum

Prinsip keabadian Momentum

JUMLAH momentum sebelum perlanggaran adalah sama dengan JUMLAH momentum selepas perlanggaran.

Pelanggaran Kenyal

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

Pelanggaran Tidak Kenyal

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$$

Letupan

$$m_1 v_1 = m_2 v_2$$

Daya impuls

kadar perubahan momentum

$$F = \frac{mv - mu}{t}$$

▼ masa hentaman, ▲ F

Unit daya: Newton, N

Impuls

perubahan momentum

$$Ft = mv - mu$$

Ns = kgms⁻¹ (unit momentum)
Berat, W

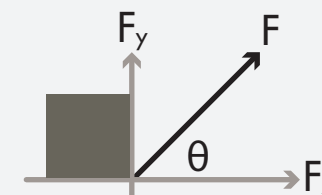
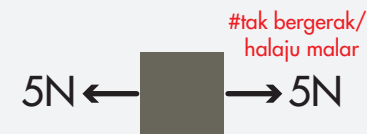
$$W = mg$$

g = pecutan graviti (9.81ms⁻²)

DAYA SEIMBANG

Daya Bersih/paduan

$$\Sigma F = 0$$



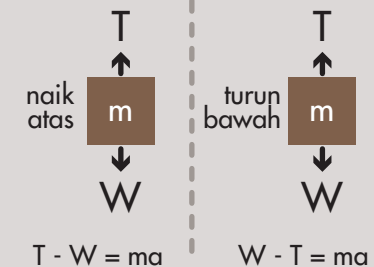
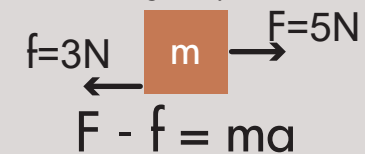
$$F_x = F \cos \theta$$

$$F_y = F \sin \theta$$

DAYA TAK SEIMBANG

$$\Sigma F = ma$$

a = ?



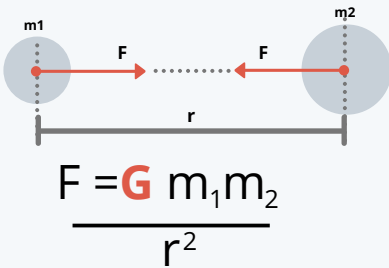
$$T - W = ma$$

$$W - T = ma$$

KEGRAVITAN



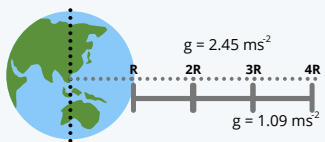
DAYA GRAVITI



F = daya graviti antara dua jasad
 m1 = jisim jasad pertama
 m2 = jisim jasad kedua
 r = jarak antara pusat jasad pertama dengan pusat jasad yang kedua
 G = pemalar kegravitian $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

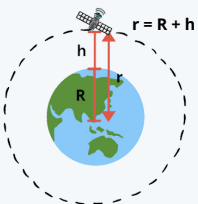
hasil darab jisim \uparrow Daya graviti, F \uparrow
 jarak antara pusat jasad, r \downarrow Daya graviti, F \uparrow
 #magnitud Daya,F antara dua objek sama

HUBUNGAN g & G



di permukaan bumi
 $g = \frac{GM}{R^2}$
 $g = 9.81 \text{ ms}^{-2}$

g = Pecutan graviti
 M = jisim bumi-- $5.97 \times 10^{24} \text{ kg}$
 R = Jejari bumi-- $6.37 \times 10^6 \text{ m}$
 G = pemalar kegravitian
 $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

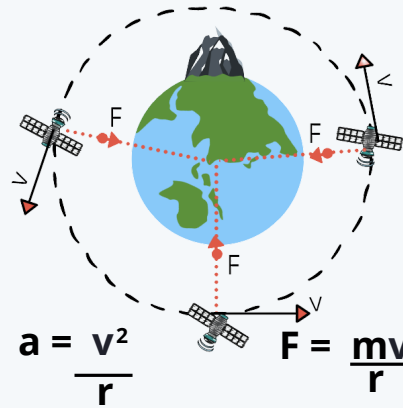


dari satu ketinggian dari permukaan bumi

$$g = \frac{GM}{(R+h)^2}$$

bila nilai h bertambah \uparrow
 nilai g akan berkurang \downarrow

DAYA MEMUSAT, F PECUTAN MEMUSAT, a

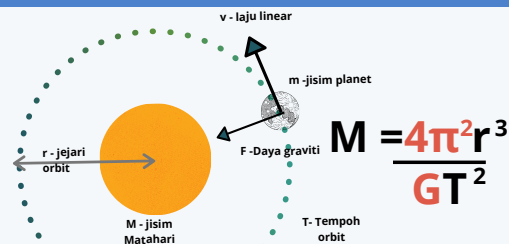


a = Pecutan memusat
 v = Laju linear satelit
 r = Jejari orbit satelit

F = Daya memusat
 m = jisim
 v = Laju linear
 r = Jejari bulatan

$v \uparrow$ mengelilingi bumi, Daya graviti ke atas pusat bumi akan bertindak sebagai daya memusat, F
 $v \downarrow$ objek jatuh semula ke bumi

RUMUS JISIM BUMI & MATAHARI



M = jisim bumi
 r = jejari orbit satelit atau bulan
 T = Tempoh peredaran bulan/ planet
 G = pemalar kegravitian $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

HUKUM KEPLER

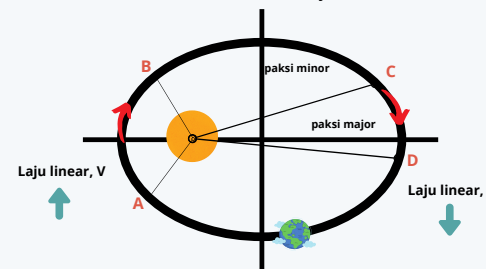
Hukum Kepler Pertama

Orbit bagi setiap planet adalah **elips** dengan matahari berada di **satu** daripada **fokusnya**

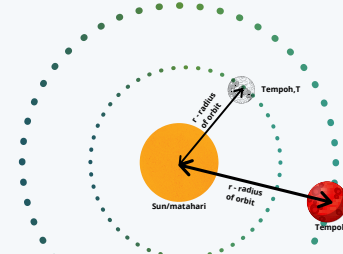
#Orbit nampak **hampir bulat** sebab panjang paksi major dan minor hampir sama

Hukum Kepler Kedua

Garis yang menyambungkan planet dengan Matahari akan mencakupi **luas yang sama** dalam **selang masa** yang sama apabila planet bergerak dalam orbitnya



Masa bergerak dari AB = masa bergerak dari CD
 Luas kawasan AB = luas kawasan CD



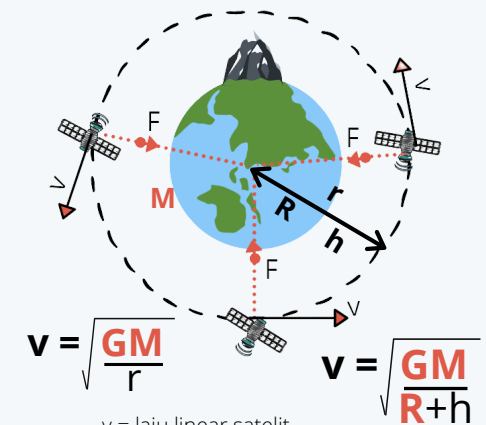
Hukum Kepler Ketiga

kuasa dua tempoh orbit planet adalah berkadar terus dengan kuasa tiga jejari orbitnya

$$T^2 = \left(\frac{4\pi^2}{GM} \right) r^3$$

$$\frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$$

LAJU LINEAR SATELIT



v = laju linear satelit
 r = jejari orbit
 # laju linear satelit cukup besar untuk bergerak dalam orbit membulat

SATELIT GEOPEGUN

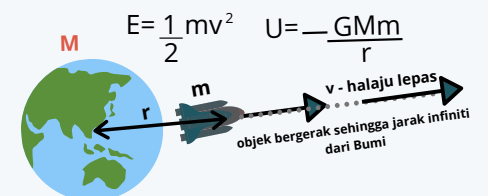
- ▶ putaran sama dgn putaran bumi.
- ▶ T = 24 jam.
- ▶ Berada di tempat yg sama dari permukaan bumi.
- ▶ satelit komunikasi (MEASAT)

BUKAN GEOPEGUN

- ▶ Putaran tidak perlu sama dgn putaran bumi
- ▶ T = < 24 jam / > 24 jam
- ▶ Berada di tempat yg berubah-ubah dari permukaan bumi
- ▶ Pengimejan Bumi, GPS, Kaji cuaca (ISS, TiungSAT, RazakSAT)

HALAJU LEPAS

Dicapai bila **tenaga kinetik minimum mengatasi tenaga keupayaan graviti**



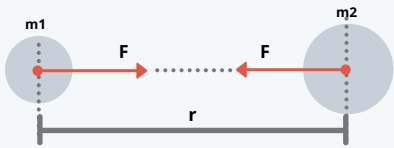
$$v = \sqrt{\frac{2GM}{r}}$$

v - halaju lepas dari bumi (jisim bumi besar, jadi halaju lepas tinggi)
 $v = 11200 \text{ ms}^{-1}$

GRAVITATION



GRAVITATIONAL FORCE

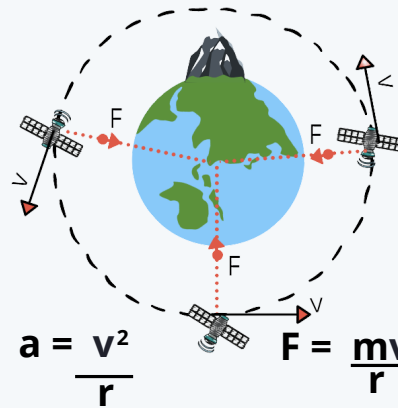


$$F = \frac{G m_1 m_2}{r^2}$$

- F = Gravitational force between two bodies
- m1 = mass of first body
- m2 = mass of second body
- r = distance between the centre of first body and the centre of the second body.
- G = Gravitational constant $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

product of mass \uparrow Gravitational force, $F \uparrow$
Distance between the centres, $r \downarrow$ Gravitational force $F \uparrow$
#magnitude of force between the two bodies is same

CENTRIPETAL FORCE, F CENTRIPETAL ACCELERATION, a



$$a = \frac{v^2}{r} \quad F = \frac{mv^2}{r}$$

- a = Centripetal acceleration
- v = Linear speed of satellite
- r = radius of the orbit
- F = Centripetal force
- m = mass
- v = Laju speed
- r = radius of circle

$v \uparrow$ circulating earth, Gravitational force acting toward the earth acts as centripetal force.

$v \downarrow$ will fall back to earth

KEPLER'S LAWS

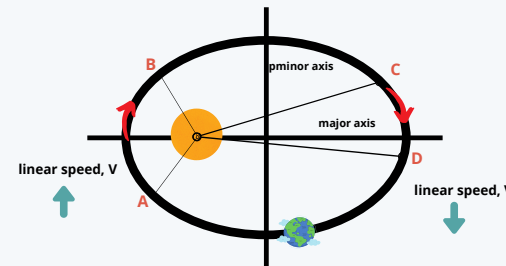
Kepler's First law

All planets move in **elliptical orbits** with the **sun** at one focus (Law of Orbit)

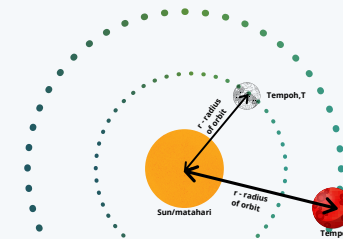
#Orbits looks **almost round** because length of major axis and minor axis almost same length

Kepler's Second Law

A line that connects a planets to the Sun sweeps out **equal areas** in **equal time** (Law of Area)



Area region AB = Area region CD
time to move from AB = time to move from CD

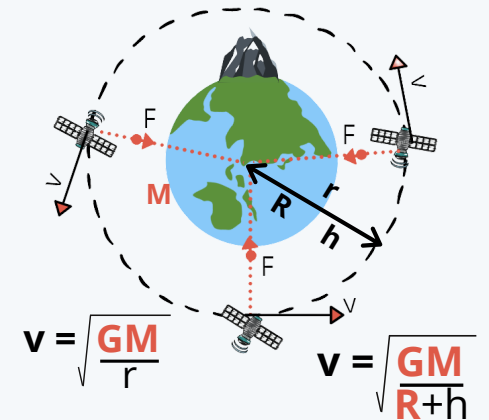


Kepler's third law

square of orbital period is directly proportional to the cube of the radius of its orbit

$$T^2 = \left(\frac{4\pi^2}{GM} \right) r^3 \quad \frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$$

LINEAR SPEED OF SATELLITE



$$v = \sqrt{\frac{GM}{r}} \quad v = \sqrt{\frac{GM}{R+h}}$$

v = linear speed of satellite
r = radius of orbit of satellite

the linear speed is high enough for the satellite to move in circular orbit around Earth

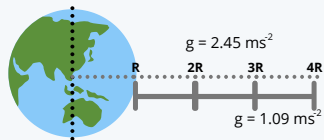
GEOSTATIONARY

- Direction of motion is same as Earth rotation
- T = 24 hours
- same geographical location
- Communication satellite (MEASAT)

NON GEOSTATIONARY

- need not be the same with direction of earth rotation.
- T = < 24 hours / > 24 hours
- Above different geographical location
- Earth imaging, GPS, weather forecast (ISS, TiungSAT, RazakSAT)

RELATIONSHIP g & G

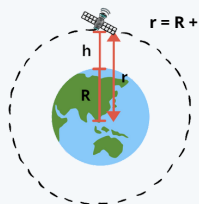


at surface of Earth

$$g = \frac{GM}{R^2}$$

$$g = 9.81 \text{ ms}^{-2}$$

- g = Gravitational acceleration
- M = mass Earth-- $5.97 \times 10^{24} \text{ kg}$
- R = Radius Earth-- $6.37 \times 10^6 \text{ m}$
- G = Gravitational constant $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

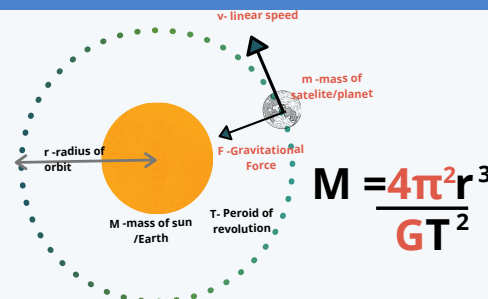


At height, h from surface of the Earth

$$g = \frac{GM}{(R+h)^2}$$

when value h increase \uparrow
value g will decrease \downarrow

MEASURE MASS EARTH OR SUN



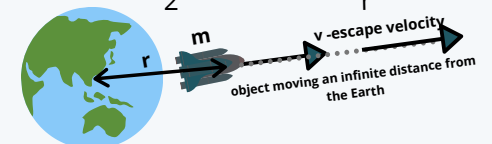
$$M = \frac{4\pi^2 r^3}{GT^2}$$

- M = Mass of Sun/ Earth
- r = radius of orbit satellite/ moon
- T = Period of revolution satellite/ moon / planet
- G = Gravitational constant $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

ESCAPE VELOCITY

Achieved when **minimum kinetic energy** able to overcome the gravitational potential energy

$$E = \frac{1}{2} mv^2 \quad U = -\frac{GMm}{r}$$



$$v = \sqrt{\frac{2GM}{r}}$$

v-escape velocity from earth (mass of earth is large)

$$v = 11200 \text{ ms}^{-1}$$

HEAT



HEAT, Q

Temperature	Heat, Q
Degree of hotness	Thermal energy transfer due to different in temperature
Kelvin, K (°C, F)	Joule, J

°C → Kelvin, K
 $\theta^{\circ}\text{C} = (\theta + 273) \text{K}$

THERMAL EQUILIBRIUM



50°C 20°C

Heat transfer in thermal contact

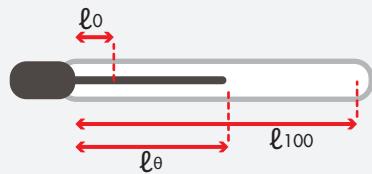


30°C 30°C

Thermal equilibrium
 #same temperature;
 net heat transfer = 0
 same heat transfer

Thermometer

Use concept of thermal equilibrium



$$\text{Temp, } \theta = \frac{l_{\theta} - l_0}{l_{100} - l_0} \times 100^{\circ}\text{C}$$

mercury? < sensitive to temperature change
 heat uniformly/non-sticky

SPECIFIC HEAT CAPACITY, C

The amount of heat/energy required by 1 kg substance to:

change its temperature by 1°C without changing state

$$Q = mc\theta$$

heat (energy) = (mass) (specific heat capacity) (temp. change)
 $J = \text{kg}(\text{Jkg}^{-1}\text{°C}^{-1})(\text{°C})$

Low c = easily heatup/cooldown

High c = hardly heatup/cooldown

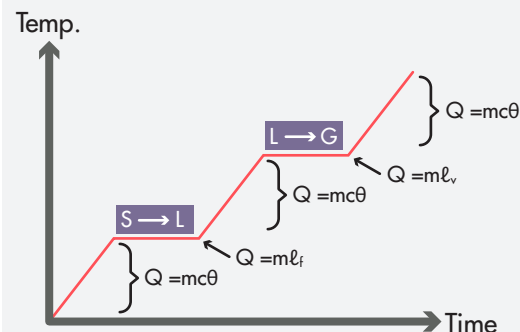
store more energy

Q is heat (energy)

if using immersion heater (electric)

$$Pt = mc\theta$$

$$Pt = m\ell$$



LATENT HEAT, \ell (SPECIFIC)

change its state from _____ to _____ at constant temperature

Latent heat fusion, ℓ_f

Latent heat vaporisation, ℓ_v



$$Q = m\ell$$

heat (energy) = (mass) (latent heat)

$$J = \text{kg}(\text{Jkg}^{-1})$$

What is quantity of heat required to change 2kg of water from 20°C to 30°C?

Temperature change. Specific heat capacity, $Q = mc\theta$

What is quantity of heat released to change 2kg of water at 0°C to ice at 0°C?

Water to ice (liquid → solid). Latent heat, $Q = m\ell$

What is quantity of heat required to change 2kg of ice at 0°C to water at 30°C?

State change (solid → liquid), temperature change:

$$Q_1 = mc\theta$$

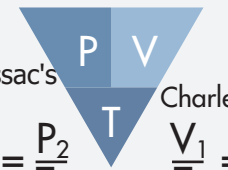
$$Q_2 = m\ell$$

$$Q_T = Q_1 + Q_2$$

GAS LAW

Boyle's Law

$$P_1V_1 = P_2V_2$$



Gay-Lussac's law
 $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Charles' Law
 $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Boyle's Law

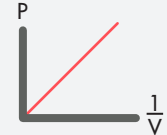
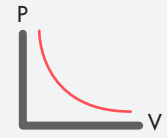
Fix mass and temp. of gas (constant temp) pressure, P of gas inversely proportional with volume, V

$$P \propto \frac{1}{V}$$

$$P = \frac{k}{V}$$

$$PV = k \text{ (constant)}$$

$$P_1V_1 = P_2V_2$$



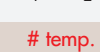
Gay-Lussac's

mass and V constant, P directly proportional with T

$$P \propto T$$

$$P = kT$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$



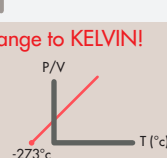
Charles'

mass and P constant, V directly proportional with T

$$V \propto T$$

$$V = kT$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$



temp. must change to KELVIN!



HABA, Q

Suhu	Haba, Q
Darjah kepanasan	Tenaga yang dipindahkan kerana perbezaan suhu
Kelvin, K (°C, F)	Joule, J

°C → Kelvin, K
θ°C = (θ + 273) K

KESEIMBANGAN TERMA



50°C 20°C

Pemindahan haba (sentuhan terma)

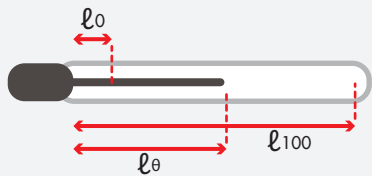


30°C 30°C

Keseimbangan terma #suhu sama; pemindahan haba bersih = 0 pemindahan haba sama

Termometer

Menggunakan konsep keseimbangan terma



$$\text{Suhu, } \theta = \frac{l_{\theta} - l_0}{l_{100} - l_0} \times 100^{\circ}\text{C}$$

merkuri? < sensitif dengan perubahan suhu memanas secara seragam/ tidak melekit

MUATAN HABA TENTU, C

Kuantiti haba/tenaga yang diperlukan oleh 1kg bahan untuk:

berubah suhu sebanyak 1°C tanpa merubah keadaan fizikal

$$Q = mc\theta$$

haba (tenaga) = (jisim) (muatan haba tentu) (perubahan suhu)

$$J = \text{kg}(\text{Jkg}^{-1}\text{ }^{\circ}\text{C}^{-1})(^{\circ}\text{C})$$

c rendah = mudah panas/sejuk

c tinggi = susah panas/sejuk

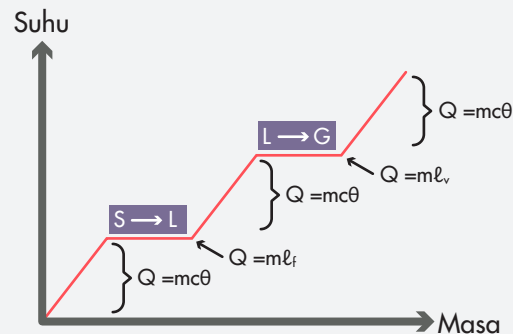
menyimpan banyak tenaga

Q adalah haba (tenaga)

jika guna pemanas rendam (elektrik)

$$Pt = mc\theta$$

$$Pt = m\ell$$



HABA PENDAM, \ell (TENTU)

berubah keadaan fizikal dari _____ kepada _____ pada suhu tetap

Haba pendam pelakuran, \ell_f

Haba pendam pengewapan, \ell_v



$$Q = m\ell$$

haba (tenaga) = (jisim) (haba pendam)

$$J = \text{kg}(\text{Jkg}^{-1})$$

Berapakah kuantiti haba yang diperlukan untuk merubah 2kg air dari 20°C ke 30°C?

Perubahan suhu. Muatan haba tentu.

$$Q = mc\theta$$

Berapakah kuantiti haba yang dilepaskan untuk merubah 2kg air pada 0°C kepada ais pada 0°C?

Air kepada ais (cecair → pepejal). Haba pendam, Q = m\ell

Berapakah kuantiti haba yang diperlukan untuk merubah 2kg ais pada 0°C kepada air pada 30°C?

Perubahan keadaan (pepejal → cecair), perubahan suhu:

$$Q_1 = mc\theta$$

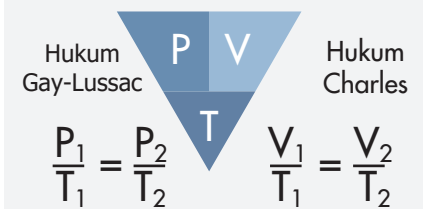
$$Q_2 = m\ell$$

$$Q_T = Q_1 + Q_2$$

HUKUM GAS

Hukum Boyle

$$P_1 V_1 = P_2 V_2$$



$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Hukum Boyle

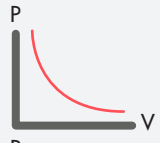
Bagi jisim gas yg tetap pada suhu gas tetap (suhu malar) tekanan, P berkadar songsang dengan isipadu, V

$$P \propto \frac{1}{V}$$

$$P = \frac{k}{V}$$

$$PV = k \text{ (malar)}$$

$$P_1 V_1 = P_2 V_2$$



Gay Lussac

jisim dan V malar

P berkadar langsung dengan T

$$P \propto T$$

$$P = kT$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Charles

Jisim dan P malar,

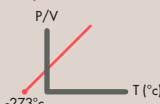
V berkadar langsung dengan T

$$V \propto T$$

$$V = kT$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

suhu mesti diubah kepada KELVIN!

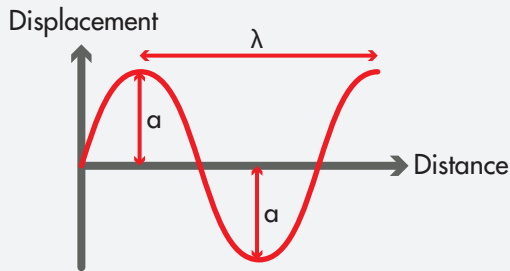
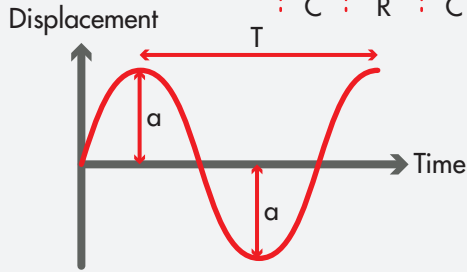


WAVE



Wave

Transverse	Longitudinal
Ex: light, water, electromagnet	Ex: sound
Can travel through vacuum	Cannot travel through vacuum (need medium: solid, liquid, gas)
particle vibrates perpendicular with the direction of wave	particle vibrate parallel



λ = wavelength (cm)

distance between 2 successive crest/trough

T = period (s) time for 1 complete oscillation

f = frequency (Hz)

number of complete oscillation in 1 seconds

a = amplitude (cm) maximum displacement

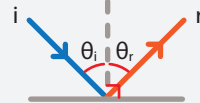
WAVE SPEED, v

unit: ms^{-1}

$$v = f\lambda$$

$$f = \frac{1}{T}$$

REFLECTION

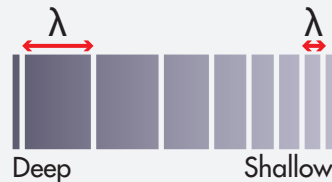


	Before	After
v	- Unchange -	- Unchange -
f	- Unchange -	- Unchange -
λ	- Unchange -	- Unchange -
	- Direction change -	- Direction change -

REFRACTION

water wave

	Deep	Shallow
v	Faster	Slower
λ	Longer	Shorter
f	- Unchange -	- Unchange -

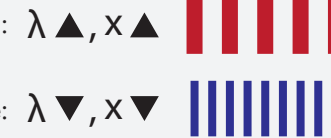
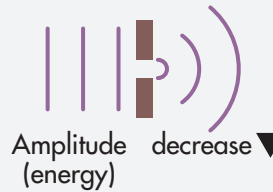


DIFFRACTION

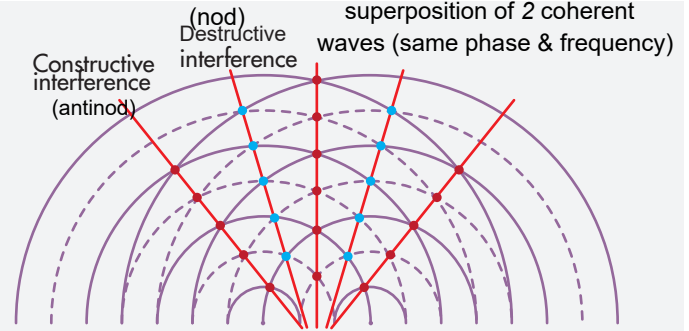
Spreading of wave as go/pass through slit/obstacle

v	- Unchange -
f	- Unchange -
λ	- Unchange -
	- Direction change -

slit/obstacle must smaller than wavelength of wave \rightarrow greater diffraction

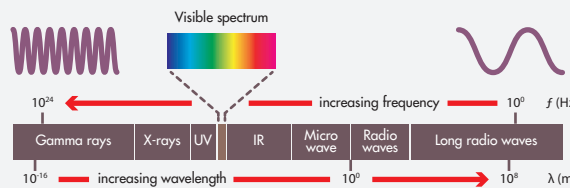


INTERFERENCE



$$\lambda = \frac{ax}{D} \quad \Delta x = \frac{D\lambda}{a}$$

ELECTROMAGNETIC WAVE SPECTRUM



- All electromagnetic waves moves with speed of light, c in vacuum.
- λ longer, frequency ∇
infrared - thermometer
ultraviolet - counterfeit money
microwaves - telecommunication

Infrasound	< 20Hz
Audible sound	20 - 20,000Hz
Ultrasound	> 20,000Hz

▲ frequency, ▲ speed

SOUND WAVE

▲ Loudness = Amplitude ▲
higher amplitude, a , louder sound

▲ Pitch = Frequency ▲
the nearer/compress the waves, higher pitch

Reflection Sound

v	= speed
D	= distance
T	= time

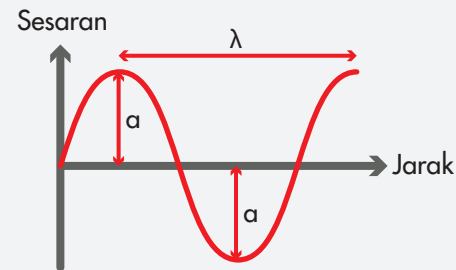
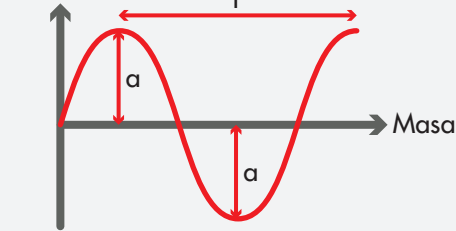
$$v = \frac{2D}{T}$$

GELOMBANG



Gelombang

Melintang	Membujur
cahaya, air, elektromagnet	bunyi
boleh melalui vakum	tidak boleh melalui vakum
jirim bergetar serenjang dgn arah gelombang	(perlu medium: pepejal, cecair, gas) jirim bergetar selari



λ = panjang gelombang (cm)

Jarak antara puncak ke puncak bersebelahan

T = tempoh (s) Masa utk 1 ayunan lengkap

f = frekuensi (Hz):

Bilangan ayunan lengkap dalam 1 saat

a = amplitud (cm): Sesaran maksimum

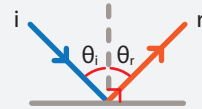
KELAJUAN GELOMBANG, V

unit: ms⁻¹

$$V = f\lambda$$

$$f = \frac{1}{T}$$

PANTULAN

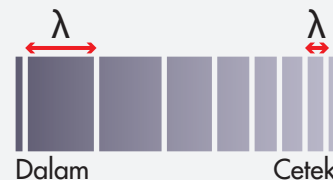


	Sebelum	Selepas
V	- Tak berubah -	- Tak berubah -
f	- Tak berubah -	- Tak berubah -
λ	- Tak berubah -	- Tak berubah -
	- Arah perambatan berubah -	- Arah perambatan berubah -

PEMBIASAN

gelombang air

	Dalam	Cetek
V	Laju	Perlahan
λ	Panjang	Pendek
f	- Tak berubah -	- Tak berubah -



PEMBELAUAN

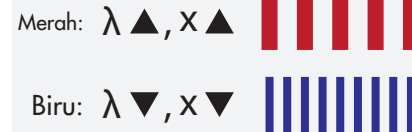
Penyebaran gelombang apabila melalui celah/halangan.

V	- Tak berubah -
f	- Tak berubah -
λ	- Tak berubah -
	- Arah berubah -

celah/halangan mesti kecil daripada panjang gelombang → lebih besar pembelauan



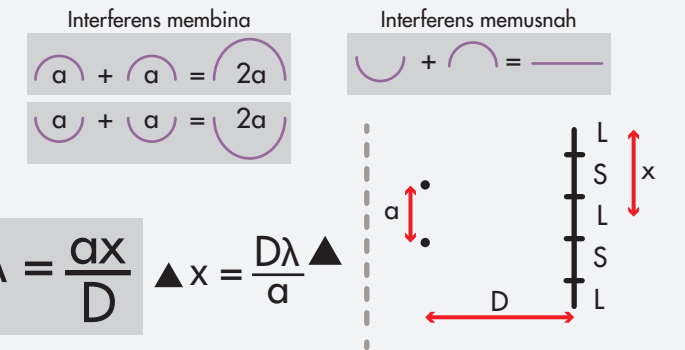
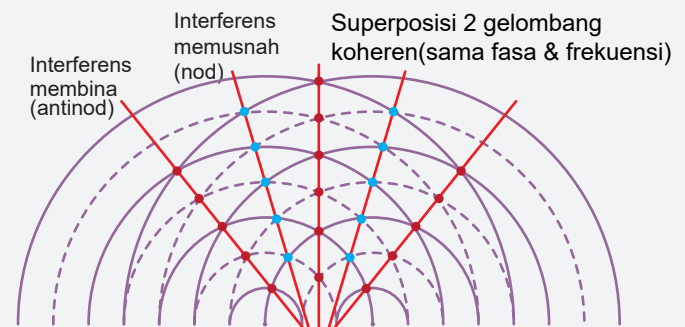
Amplitud (tenaga) Berkurang ▼



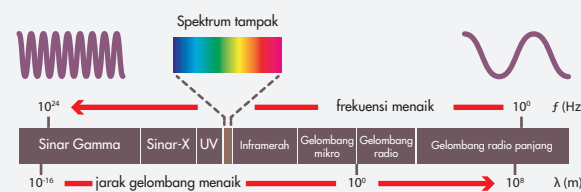
Merah: $\lambda \blacktriangle, X \blacktriangle$

Biru: $\lambda \blacktriangledown, X \blacktriangledown$

INTERFERENS



SPEKTRUM GELOMBANG ELEKTROMAGNET



- semua bergerak dgn laju cahaya, c dalam vakum
- λ panjang, frekuensi ▼
inframerah - termometer
ultraungu- cek duit palsu
mikro- telekomunikasi

Infrabunyi < 20Hz
Bunyi boleh dengar 20 - 20,000Hz
Ultrabunyi > 20,000Hz
▲ frekuensi, ▲ kelajuan

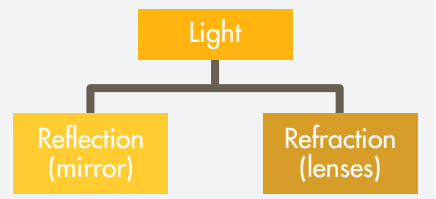
GELOMBANG BUNYI

▲Kenyaringan = Amplitud ▲ gelombang makin tinggi, makin nyaring
▲ Kelangsingan = Frekuensi ▲ Makin rapat gelombang, makin langsing

Pantulan bunyi

V = kelajuan
D = jarak
T = masa

$$V = \frac{2D}{T}$$



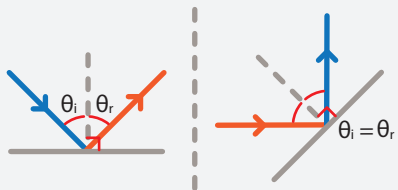
REFLECTION

Law of Reflection

incident angle = reflected angle

$$\theta_i = \theta_r$$

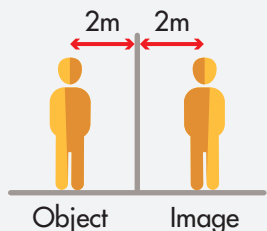
Incident ray (i), reflected ray (r), and normal line lies on the same plane.



Plane Mirror

Characteristic of image:

1. Virtual
2. Upright
3. Same size
4. Laterally inverted
5. Same distance



Convex mirror = Concave lens

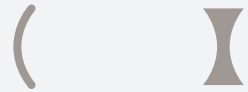
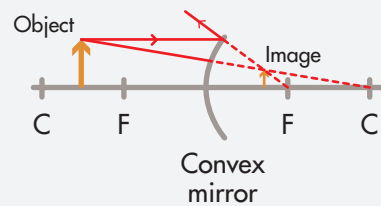


Image DO NOT depend on position of the object

1. Virtual
2. Upright
3. Diminish

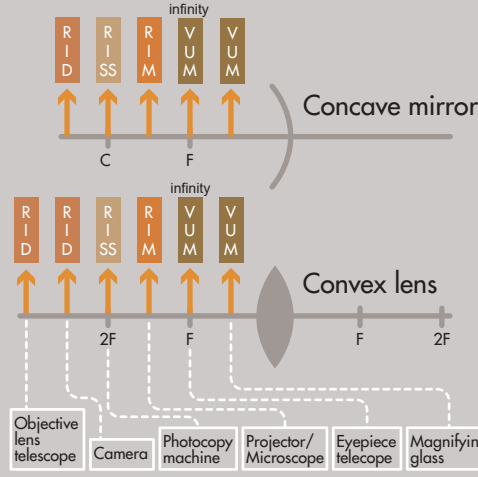


give wider view (at store, corner of road)

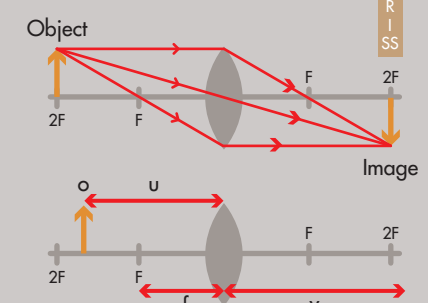
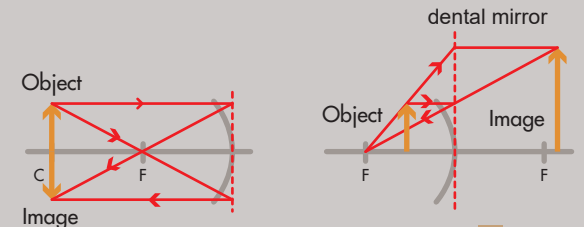
Concave mirror = Convex lens



Image DEPEND on position of the object



- V = Virtual
- U = Upright
- D = Diminish
- M = Magnified
- R = Real
- I = Inverted
- SS = Same size



u = object distance v = image distance f = focal length

Power, P = $\frac{100}{f}$ (in cm)
Diopter, D
P \blacktriangle f \blacktriangledown
Thicker lens - high power
Thinner Lens - Low power

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\text{Magnification, } m = \frac{v}{u} = \frac{h_i}{h_o}$$

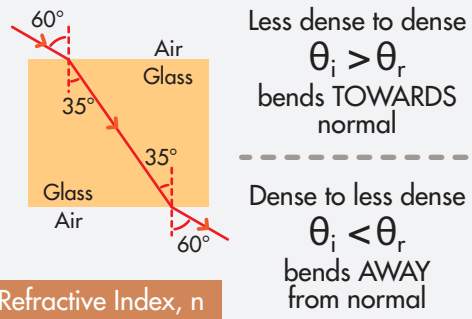


- Telescope: \blacktriangledown Power, L = f_o + f_e, \blacktriangle Power
- Microscope: \blacktriangle Power, L > f_o + f_e, \blacktriangledown Power

bigger diameter lens - more light can be refracted
Image produce : Virtual, Inverted, Magnified

REFRACTION

Bending of light when travel through different optical density.



Less dense to dense
 $\theta_i > \theta_r$
bends TOWARDS normal

Dense to less dense
 $\theta_i < \theta_r$
bends AWAY from normal

Refractive Index, n

1. NO unit!
 2. Value must be MORE > 1
- $n_{\text{vacuum}} = 1.0$ $n_{\text{air}} = 1.0029$ (1.0)
 $n_{\text{water}} = 1.33$ $n_{\text{glass/prism}} = 1.4 - 1.9$
- value of n, \uparrow density \uparrow speed of light \downarrow

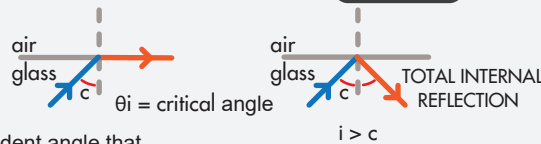
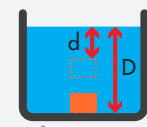
$$n = \frac{\sin i}{\sin r} \quad n_i \sin i = n_r \sin r$$

#bigger angle at TOP!

$$n = \frac{\text{speed of light in vacuum, } c}{\text{speed of light in medium}}$$

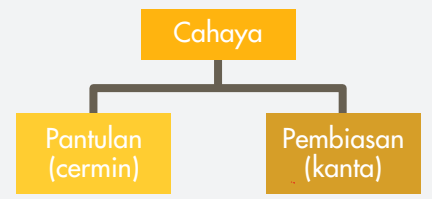
where $c = 3 \times 10^8 \text{ ms}^{-1}$

$$n = \frac{\text{real depth, } D}{\text{apparent depth, } d}$$



incident angle that produce refracted angle at 90°
RULE FOR TIR TO OCCURS
incident angle $i >$ critical angle c
light travel from denser medium to less denser medium (from higher refractive index to lower refractive index)

$$n = \frac{1}{\sin c}$$



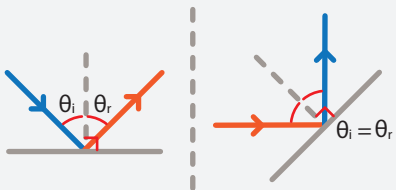
PANTULAN

Hukum Pantulan

sudut tuju = sudut pantulan

$$\theta_i = \theta_r$$

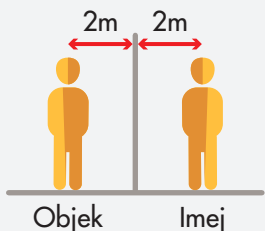
Sinar tuju (i), sinar pantulan (r), dan garis normal terletak pada satah yang sama



Cermin satah

Ciri-ciri imej:

1. Maya
2. Tegak
3. Sama saiz
4. Songsang sisi
5. Sama jarak



Cermin cembung = Kanta cekung

Imej tidak bergantung pada posisi objek
1. Maya 2. Menegak 3. Mengecil

Cermin cembung

memberikan gambaran lebih luas (di kedai, simpang jalan)

Cermin cekung = Kanta cembung

Imej bergantung pada posisi objek

infiniti

N	S	K	N	S	S	N	S	B	M	T	B	M	T	B
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Cermin cekung

Kanta cembung

Teleskop kanta objektif, Kamera, Mesin fotokopi, Projektor/Mikroskop, Kanta mata Teleskop, Kanta pembesar

M	=	Maya	N	=	Nyata
T	=	Tenagak	S	=	Songsang
K	=	Kecil	SS	=	Sama saiz
B	=	besar			

Objek, Imej, C, F, 2F

Objek, Imej, F, 2F

Objek, Imej, 2F, F, 2F

Objek, Imej, 2F, F, 2F

Objek, Imej, 2F, F, 2F

PEMBIASAN

Pembengkokan cahaya apabila melalui medium yang berbeza ketumpatan optik.

Udara, Gelas, Udara

Kurang tumpat ke tumpat
 $\theta_i > \theta_r$
membengkok mendekati normal

Tumpat ke kurang tumpat
 $\theta_i < \theta_r$
membengkok menjauhi normal

Indeks biasan, n

1. TIADA unit!
 2. Nilainya mesti melebihi > 1
- $n_{\text{vakum}} = 1.0$ $n_{\text{udara}} = 1.0029 (1.0)$
 $n_{\text{air}} = 1.33$ $n_{\text{kaca}} = 1.4 - 1.9$
 Nilai n, ↑ ketumpatan ↑ laju cahaya ↓

$$n = \frac{\sin i}{\sin r} \quad n_i \sin i = n_r \sin r$$

#sudut lebih besar berada di atas!

$$n = \frac{\text{kelajuan cahaya dalam vakum, } c}{\text{kelajuan cahaya dalam medium}}$$

$c = 3 \times 10^8 \text{ ms}^{-1}$

$$n = \frac{\text{kedalaman sebenar, } D}{\text{kedalaman ketara, } d}$$

udara, gelas, udara, gelas

$\theta_i = \text{genting}$ $i > c$

Sudut tuju yang menghasilkan sudut biasan 90°

Syarat PDP
sinar tuju $i >$ sudut genting, c
Cahaya merambat dari kawasan tumpat ke kurang tumpat (dari indeks biasan tinggi ke rendah)

$$n = \frac{1}{\sin c}$$

u = jarak objek v = jarak imej f = panjang fokus

Kuasa, $P = \frac{100}{f \text{ (cm)}}$

Diopter, D

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

Pembesaran, $m = \frac{v}{u} = \frac{h_i}{h_o}$

kanta objek 2 kanta cembung kanta mata

Teleskop	▽ Kuasa	$L = f_o + f_e$	▲ Kuasa
Mikroskop	▲ Kuasa	$L > f_o + f_e$	▽ Kuasa

diameter kanta besar - banyak cahaya boleh dibias
Imej terhasil: maya, songsang, besar

FORCE AND MOTION 2



RESULTANT FORCE

BALANCE FORCE

Net force / Resultant Force
 $\Sigma F = 0$
 $a = 0 \text{ ms}^{-2}$ #at rest/ constant velocity

 $5\text{N} \leftarrow m \rightarrow 5\text{N}$
 $5\text{N} - 5\text{N} = 0\text{N}$

stationary (hanging) move with uniform velocity or constant velocity
 $T - W = 0$
 $T = W$

UNBALANCE FORCE

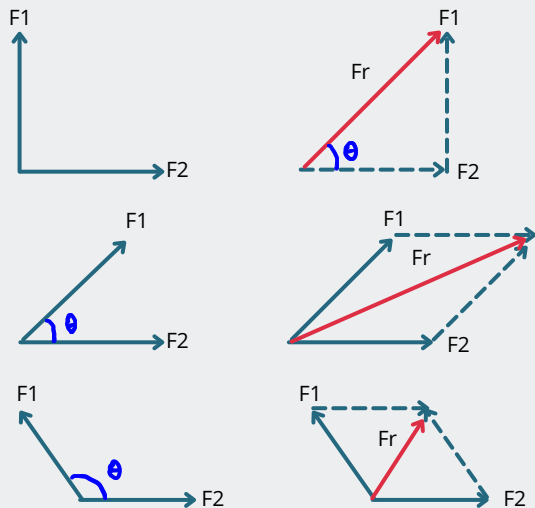
$\Sigma F = ma$
 acceleration, $a = ?$

 $f = 3\text{N} \leftarrow m \rightarrow F = 5\text{N}$
 $F - f = ma$
 $5\text{N} - 3\text{N} = 2\text{N}$

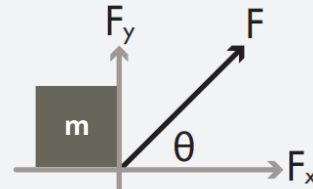
move up
 $T - W = ma$

move down
 $W - T = ma$

RESULTANT FORCE BETWEEN 2 FORCE WITH AN ANGLE

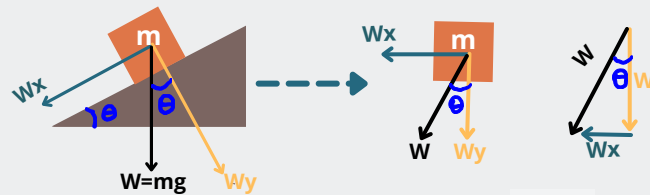


RESOLUTION OF FORCE



$$F_x = F \cos \theta$$

$$F_y = F \sin \theta$$



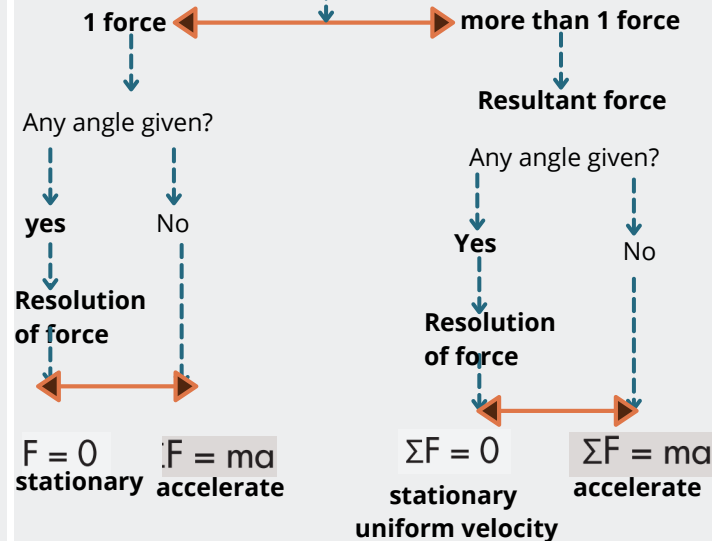
if the angle of the inclined plane in 30° , W_x is equal to half of the weight

$$W_x = W \sin \theta$$

$$W_y = W \cos \theta$$

STEP ON HOW TO SOLVE FORCE

How many force involve?



ELASTICITY

HOOKE'S LAW

Force, F applied to a spring is directly proportional to the spring extension or compression, x as long as not exceed elastic limit

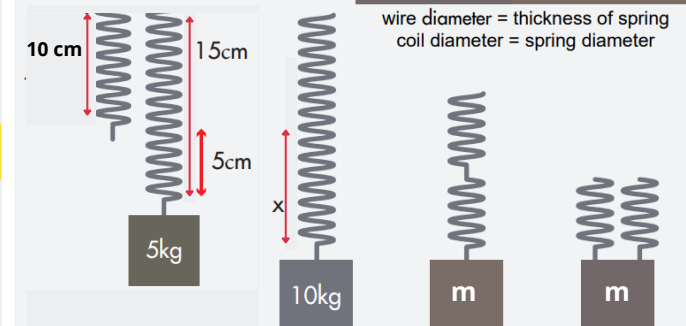
$$F = kx$$

Elasticity - ability of object to return to its original shape after force being removed

force = (spring constant)(extension/compression)

$$k = \frac{F}{x} = \frac{\text{N}}{\text{m}} = \text{Nm}^{-1}$$

Factors	Stiffer/Spring
- Length	- Shorter ▼
- wire diameter	- Greater ▲
- Type	- Steel ▲ than Copper
- Coil diameter	- Smaller ▼



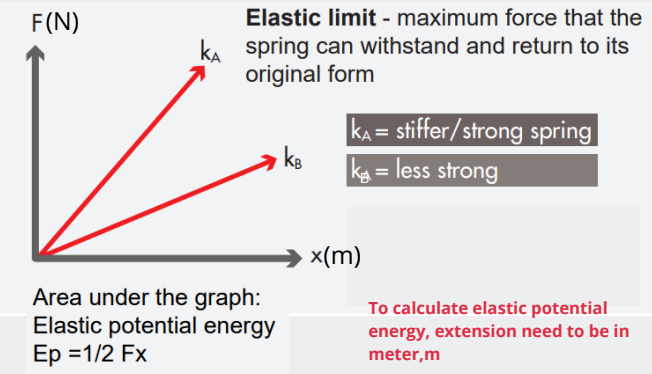
wire diameter = thickness of spring
coil diameter = spring diameter

$$k = \frac{F}{x} = \frac{5(10)}{5} = 10\text{Nm}^{-1}$$

$$x = \frac{F}{k} = \frac{10(10)}{10} = 10\text{cm}$$

extension $x = 2x$

$$x = \frac{1}{2}x$$





DAYA PADUAN

DAYA SEIMBANG

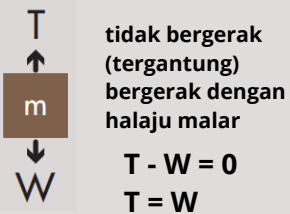
Daya Bersih/paduan

$$\Sigma F = 0$$

$a = 0 \text{ ms}^{-2}$ #tak bergerak/ halaju malar



$$5 \text{ N} - 5 \text{ N} = 0 \text{ N}$$



DAYA TAK SEIMBANG

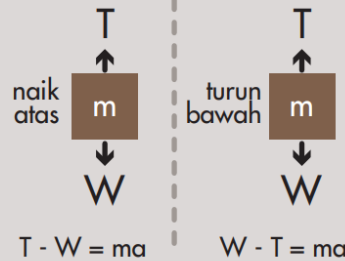
$$\Sigma F = ma$$

pecutan, $a = ?$

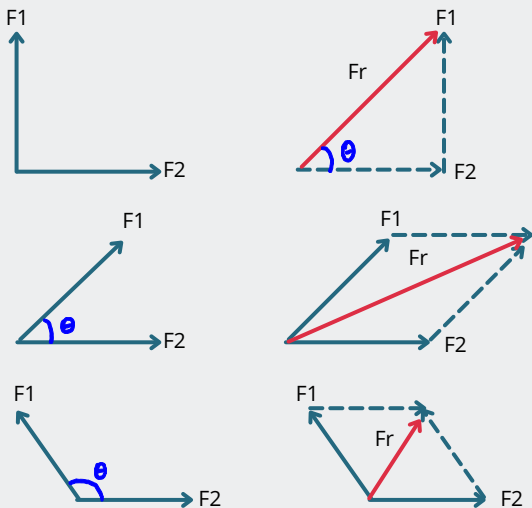


$$F - f = ma$$

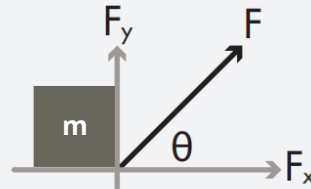
$$5 \text{ N} - 3 \text{ N} = 2 \text{ N}$$



DAYA PADUAN ANTARA 2 DAYA BERSUDUT

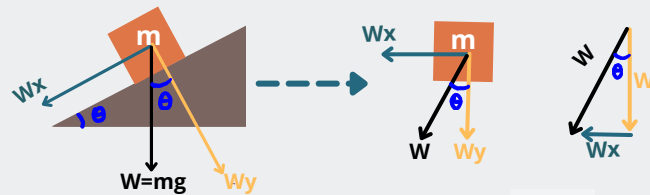


LERAIAN DAYA



$$F_x = F \cos \theta$$

$$F_y = F \sin \theta$$



#Kalau sudut 30', nilai W_x separuh dari berat objek

$$W_x = W \sin \theta$$

$$W_y = W \cos \theta$$

LANGKAH PENYELESAIAN SOALAN DAYA

Ada berapa daya terlibat?

1 daya Lebih dari 1 Daya

daya bertindak ada sudut?
ada tiada

Leraian daya

$F = 0$ Pegun
 $F = ma$ ada pecutan

Daya paduan

daya bertindak ada sudut?
ada tiada

Leraian daya

$\Sigma F = 0$ Pegun halaju seragam
 $\Sigma F = ma$ ada pecutan

KEKENYALAN

HUKUM HOOKE

Daya yang dikenakan pada bahan kenyal berkadar terus dengan pemanjangan atau pemampatan spring itu, x selagi tidak melebihi had kenyal

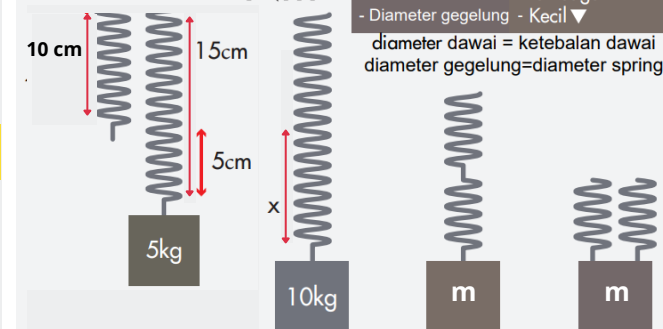
$F = kx$ **Kekenyalan** - keupayaan objek untuk kembali ke bentuk asal selepas daya dialihkan

Daya=(pemalar spring)(pemanjangan/mampatan)

$$k = \frac{F}{x} = \frac{\text{N}}{\text{m}} = \text{Nm}^{-1}$$

Faktor	spring keras
- Panjang	- Pendek ▼
- Diameter dawai	- Besar ▲
- Jenis	- Keluli ▲ berbanding Tembaga
- Diameter gegelung	- Kecil ▼

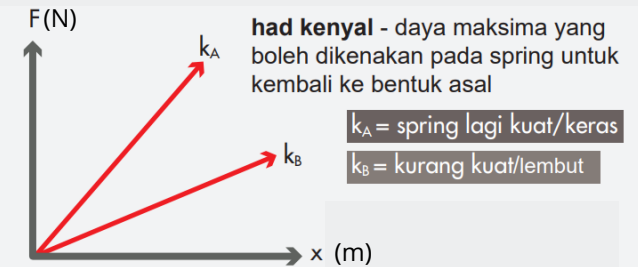
diameter dawai = ketebalan dawai
diameter gegelung=diameter spring



$$k = \frac{F}{x} = \frac{5(10)}{5} = 10 \text{ Ncm}^{-1}$$

$$x = \frac{F}{k} = \frac{10(10)}{10} = 10 \text{ cm}$$

kepanjangan $x = 2x$
 $x = \frac{1}{2} x$



luas bawah graf= tenaga keupayaan kenyal $E = 1/2 Fx$
#Nak kira tenaga keupayaan kenyal, pemajangan, x mesti dalam unit meter

PRESSURE (P)



SOLID

A force, F applied normally to the surface of an area, A

$$P = \frac{F}{A}$$

Force
Area of Contact



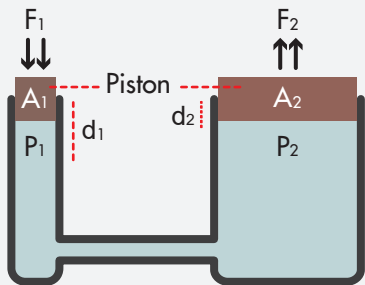
Bigger area,
 $A \uparrow P \downarrow$



Smaller area,
 $A \downarrow P \uparrow$

PASCAL'S PRINCIPLE

In enclosed system, pressure of fluid (liquid/gas) is equally distributed.



Hydraulic/Pneumatic System (jek / brek)

$$P_1 = P_2 \quad \begin{matrix} F_1 < F_2 \\ A_1 < A_2 \end{matrix} \quad F_1 d_1 = F_2 d_1$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

smaller piston, required or produce smaller force
larger piston, required or produce bigger force

the smaller the A_1 , the higher the pressure, P_1 ($P_1 = P_2$)
increase in area A_2 , the higher the force, F_2

LIQUID

$$P = h\rho g$$

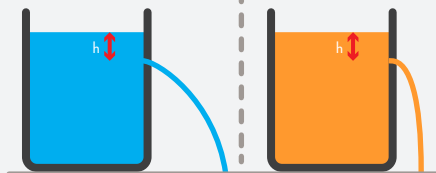
h = height/depth (m)

ρ = density (kgm^{-3})

g = gravitational acceleration (9.81ms^{-2})



$h \uparrow P \uparrow$



Water
Density \uparrow

Oil
Density \downarrow

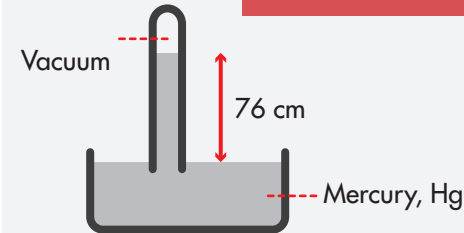
NOT DEPEND on volume and shape of the container

P ATMOSPHERE

force, F per unit area exerted against a surface by weight of air molecule above the surface

Measured by using **Barometer**

other instrument : aneroid Barometer



Why Mercury?

Opaque, \uparrow density (13600kgm^{-3})

P_{atm} in Pascal

$$P = h\rho g$$

$$= (0.76\text{m})(13600\text{kgm}^{-3})(9.81\text{ms}^{-2})$$

$$= 101396 \text{ Pa}$$

$$= 1.0 \times 10^5 \text{ Pa}$$

Altitude \uparrow , $P_{\text{atm}} \downarrow$

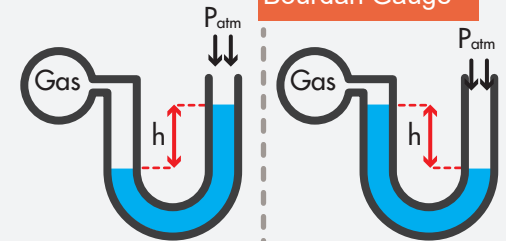
if mercury change with water, water has lower density (1000 kgm^{-3}). height of column, h will be higher (10 m)

GAS

force, F per unit area exerted by the gas particles as they collide with the wall of their container

Measured by using **Manometer**

other instrument: Bourdan Gauge



$$P_{\text{gas}} = P_{\text{atm}} + P_{\text{liq}}$$

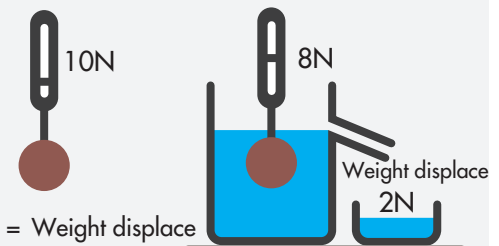
$$P_{\text{gas}} = P_{\text{atm}} - P_{\text{liq}}$$

$$P_{\text{gas}} = P_{\text{atm}} + h\rho g$$

$$P_{\text{gas}} = P_{\text{atm}} - h\rho g$$

ARCHIMEDES' PRINCIPLE

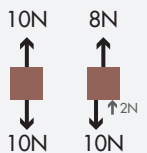
A Buoyant force, F_B on a body immersed in a fluid is equal to weight of the fluid displaced by that object



$F_B = \text{Weight displace}$
 $F_B = mg$

$$F_B = \rho Vg$$

ρ = density
 V = volume fluid displace
 g = gravitational acceleration

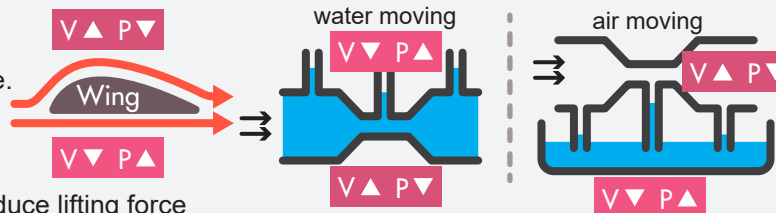


BERNOULLI'S PRINCIPLE

Pressure of moving fluid decrease as the speed of fluid increase.

$V \uparrow P \downarrow$

Pressure different produce lifting force



TEKANAN(P)



PEPEJAL

Daya normal, F yang dikenakan ke atas satu luas kawasan, A

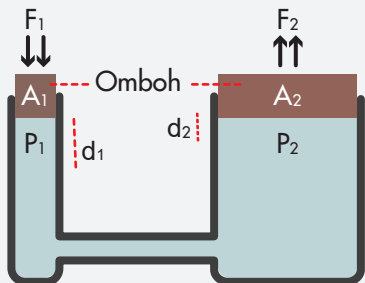
$$P = \frac{F}{A}$$

Daya
luas kwsn sentuhan



PRINSIP PASCAL

Dalam sistem tertutup, tekanan bendalir (cecair/gas) adalah sama.



Sistem Hidraulik/Pneumatik (jek, brek)

$$P_1 = P_2 \quad F_1 < F_2 \quad F_1 d_1 = F_2 d_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

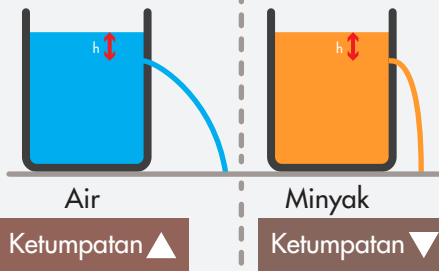
Luas omboh kecil, daya pada omboh kecil
Luas omboh besar, daya pada omboh besar

Semakin kecil A_1 , semakin tinggi tekanan, P_1 , semakin besar keluasan A_2 , semakin tinggi daya, F_2

CECAIR

$$P = h\rho g$$

h = ketinggian/kedalaman (m)
 ρ = ketumpatan (kgm^{-3})
 g = pecutan graviti (9.81ms^{-2})

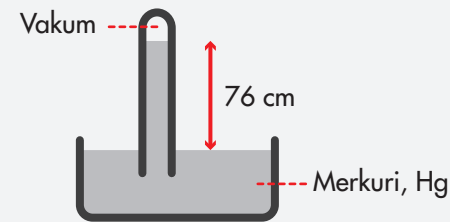


TIDAK BERGANTUNG pada isipadu dan bentuk bekas.

PATMOSFERA

Daya seunit luas yang dikenakan ke atas suatu permukaan oleh berat molekul-molekul udara di atas permukaan itu

Diukur menggunakan **Barometer**
alat lain : **Barometer Aneroid**



Kenapa Merkuri?

Legap, \triangle ketumpatan (13600kgm^{-3})

P_{atm} dalam Pascal

$$P = h\rho g$$

$$= (0.76\text{m})(13600\text{kgm}^{-3})(9.81\text{ms}^{-2})$$

$$= 101396 \text{ Pa}$$

$$= 1.0 \times 10^5 \text{ Pa}$$

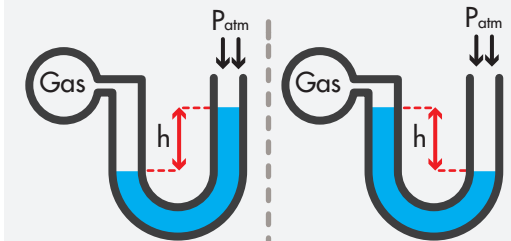
Ketinggian \triangle , P_{atm} ∇

Jika ganti merkuri dgn air, air ketumpatan rendah (1000 kgm^{-3}). ketinggian, h harus tinggi (10 meter)

GAS

Daya seunit luas yang dikenakan oleh zarah-zarah gas apabila melanggar bekas

Diukur menggunakan **Manometer**
alat lain untuk mengukur : **Tolak Bourdon**



$$P_{\text{gas}} = P_{\text{atm}} + P_{\text{cec}}$$

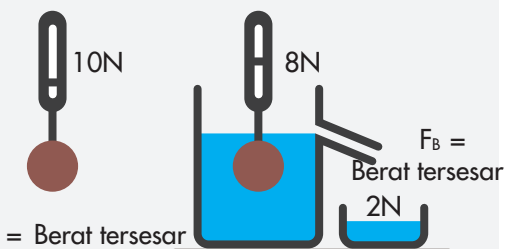
$$P_{\text{gas}} = P_{\text{atm}} - P_{\text{cec}}$$

$$P_{\text{gas}} = P_{\text{atm}} + h\rho g$$

$$P_{\text{gas}} = P_{\text{atm}} - h\rho g$$

PRINSIP ARCHIMEDES

Apabila suatu objek direndam sebahagian atau sepenuhnya, objek itu mengalami daya tujuh, F_B ke atas yang sama dengan berat bendalir tersesar

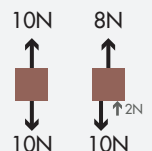


$$F_B = \text{Berat tersesar}$$

$$F_B = mg$$

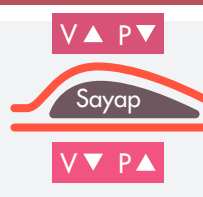
$$F_B = \rho V g$$

ρ = ketumpatan
 V = isipadu bendalir tersesar
 g = pecutan graviti

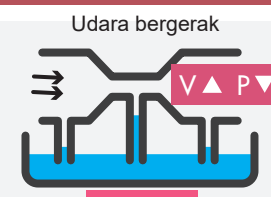
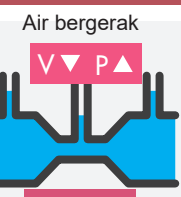


PRINSIP BERNOULLI

Tekanan bendalir bergerak berkurang apabila laju bendalir bertambah



Perbezaan tekanan menghasilkan daya angkat



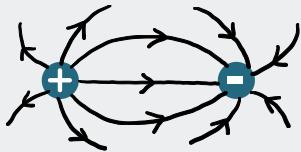


ELECTRIC FIELD STRENGTH, E

Electric force, F acting on a unit positive charge, q placed at the point

$$E = \frac{F}{q} \quad (\text{N C}^{-1})$$

$$E = \frac{V}{d} \quad (\text{V m}^{-1})$$



same/likes charge -- REPEL
Different/ unlike charge -- ATTRACT

CURRENT, I

Rate of charge, Q flow through a conductor

$$I = \frac{Q}{t} \quad \text{Cs}^{-1} \quad (\text{Ampere, A})$$

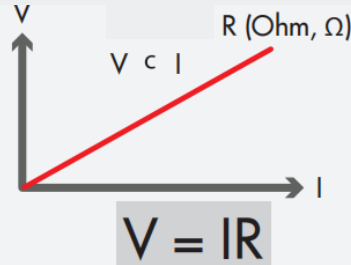
POTENTIAL DIFFERENT, V

Energy supply, E by the power source to bring a unit charge, Q

$$V = \frac{E}{Q} \quad \text{JC}^{-1} \quad \text{Volt (V)}$$

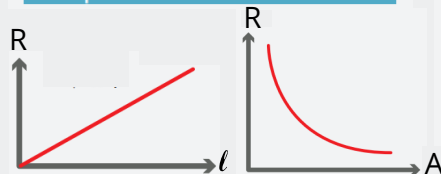
RESISTANCE, R

Ohm's Law -- V directly proportional to I (Ohmic Conductor)



Factor affecting resistance

- Length $\triangle R$
- Cross-section area/diameter $\triangle R$
- Material type (R nichrome > R constantane > R copper)
- Temperature



Resistivity, ρ

measured of conductor's ability to oppose the flow of electric current

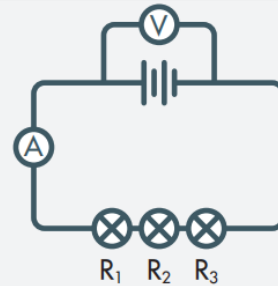
$$R = \frac{\rho l}{A} \quad \rho \text{ -- } (\Omega \text{ m})$$

application that produce heat (kettle, iron, hair dryer) -- (high resistivity)

connection wire (copper wire -- low resistivity)

SERIES & PARALLEL CIRCUIT

Series



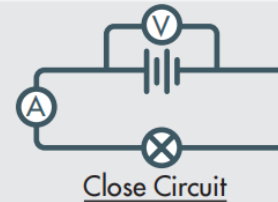
Current, I same

$$R_T = R_1 + R_2 + R_3$$

$$V_T = V_1 + V_2 + V_3$$

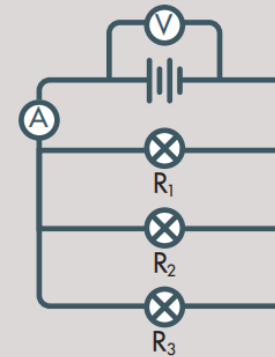
- 1.# add resistor, higher R_T
2. when R higher, V will be higher

$$R_T \triangle I \nabla$$



emf -Potential different across terminal during open circuit.
- maximum energy can be supply by power source to bring a unit charge

Parallel

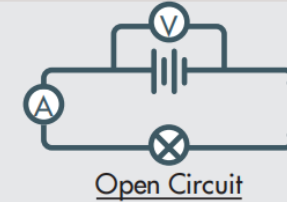


Voltage, V same

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

- 1.# rearrange to get R
2. add resistor, lower value R_T

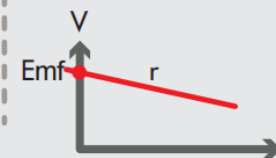
$$R_T \nabla I \triangle$$



$$\text{emf, } \mathcal{E} = V + Ir$$

$$\text{emf, } \mathcal{E} = I(R+r)$$

emf-electromotive force
r = internal resistance



ELECTRICAL ENERGY

unit: Joule, J

$$E = VQ$$

$$Q = It$$

$$E = VIt$$

$$V = IR$$

$$E = I^2Rt$$

$$E = Pt$$

$$I = \frac{V}{R}$$

$$E = \frac{V^2}{R}t$$

Electrical Bill \rightarrow Calculate Energy $E=Pt$
Calculated in unit kWh

POWER, P

unit: Watt, W

Rate of energy being transferred or lost

$$P = \frac{E}{t}$$

$$P = \frac{VI}{t}$$

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

EFFICIENCY

$$\frac{\text{Power output}}{\text{Power Input}} \times 100\%$$

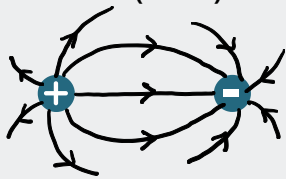
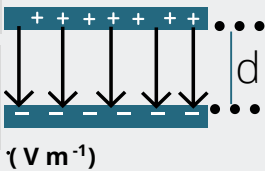


KEKUATAN MEDAN ELEKTRIK, E

Daya elektrik, F yang bertindak ke atas seunit cas positif, q yang terletak pada titik itu

$$E = \frac{F}{q} \quad (\text{N C}^{-1})$$

$$E = \frac{V}{d} \quad (\text{V m}^{-1})$$



cas yang sama -- MENOLAK
Cas berlainan -- MENARIK

ARUS, I

kadar pengaliran cas, Q melalui konduktor

$$I = \frac{Q}{t} \quad \text{Cs}^{-1} \quad (\text{Ampere, A})$$

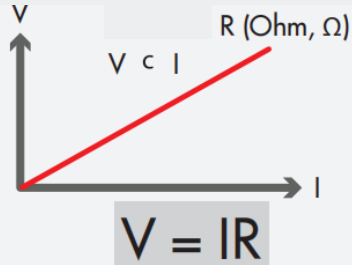
BEZA KEUPAYAAN, V

Tenaga, E dibekalkan oleh sumber kuasa untuk membawa satu unit cas, Q

$$V = \frac{E}{Q} \quad \text{JC}^{-1} \quad (\text{Voltan, V})$$

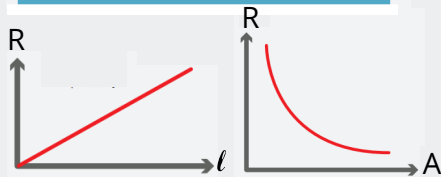
RINTANGAN, R

Hukum Ohm-- V berkadar terus dengan I (Konduktor Ohm)



Faktor mempengaruhi rintangan

- Panjang $\triangle R \triangle$
- Ketebalan/diameter $\triangle R \nabla$
- Jenis bahan (R nikrom > R konstantan > R kuprum)
- Suhu



Kerintangan, ρ

ukuran bagi keupayaan konduktor untuk menentang pengaliran arus elektrik

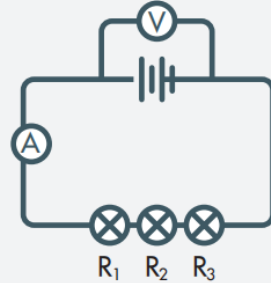
$$R = \frac{\rho l}{A} \quad \rho \text{ -- } (\Omega \text{ m})$$

Aplikasi yang menghasilkan suhu (seterika, pengering rambut, cerek) -- **(kerintangan tinggi)**

Wayar penyambung (**wayar kuprum** -- kerintangan rendah)

LITAR SESIRI / SELARI

Sesiri



Arus, I sama

$$R_T = R_1 + R_2 + R_3$$

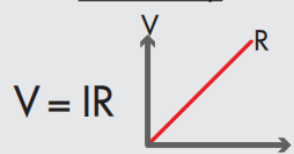
$$V_T = V_1 + V_2 + V_3$$

1. # tambah perintang, tinggi R_T
2. bila nilai R besar, nilai V besar

$$R_T \triangle I \nabla$$

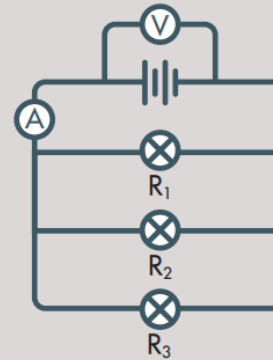


Litar Tertutup



dge - Beza keupayaan terminal apabila litar terbuka. Tenaga/kerja maksima yang boleh dibekalkan untuk membawa seunit cas

Selari



Voltan, V sama

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

1. # susun semula utk dapat R.
2. tambah perintang, rendah R_T

$$R_T \nabla I \triangle$$



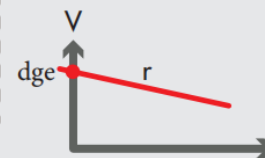
Litar Terbuka

$$\text{dge, } \mathcal{E} = V + Ir$$

$$\text{dge, } \mathcal{E} = I(R+r)$$

dge = daya gerak

r = rintangan dalam



TENAGA ELEKTRIK

unit: Joule, J

$$E = VQ$$

$$E = Pt$$

$$Q = It$$

$$E = VIt$$

$$I = \frac{V}{R}$$

$$V = IR$$

$$E = \frac{V^2}{R} t$$

$$E = I^2 R t$$

Bill elektrik \rightarrow kira tenaga $E=Pt$

Dikira dalam unit kWh

KUASA, P

unit: Watt, W

kadar tenaga elektrik yang dipindah atau dilesapkan

$$P = \frac{E}{t}$$

$$P = I^2 R$$

$$P = \frac{VI}{t}$$

$$P = VI$$

$$P = \frac{V^2}{R}$$

KECEKAPAN

$$\frac{\text{kuasa Output}}{\text{kuasa input}} \times 100\%$$

ELECTROMAGNETISM

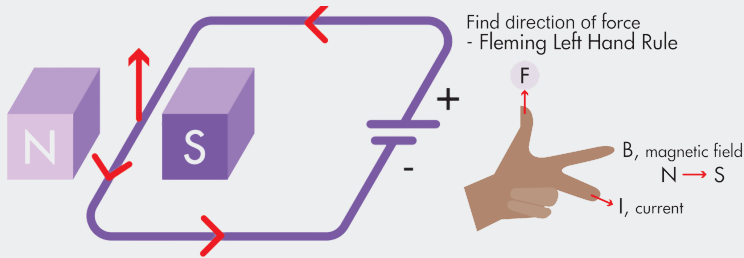


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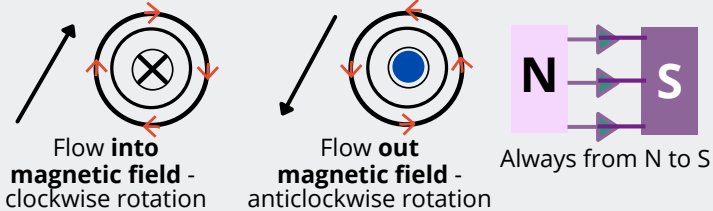
f FIZIK SPM PHYSICSTHERAPY



MAGNETIC FORCE ON CURRENT CARRYING CONDUCTOR IN MAGNETIC FIELD

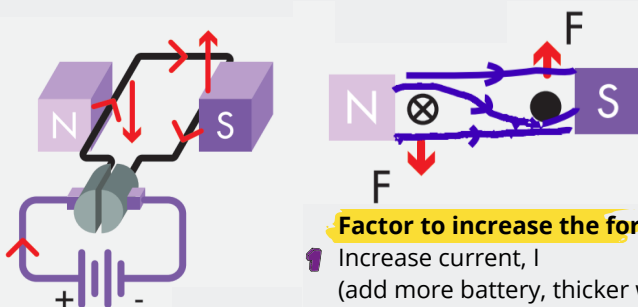


Magnetic field for current carrying conductor and magnet



Catapult field

Resultant magnetic field produced by the interaction of between the magnetic field produce by current carrying conductor and magnetic field from a permanent magnet



DC motor

Coil of wire carrying current in between magnet

Factor to increase the force

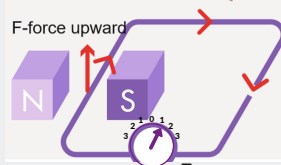
- 1 Increase current, I (add more battery, thicker wire)
- 2 number of turn
- 3 stronger magnet \rightarrow stronger magnetic field

Change direction of motor rotation or force on wire

- 1 Change position of battery
- 2 Change polarity of magnet

ELECTROMAGNETIC INDUCTION

production of an induced e.m.f. in a conductor when there is relative motion between the conductor and a magnetic field or when the conductor is in a changing magnetic field



Faraday's Law - MAGNITUDE of induce e.m.f /current directly proportional to the rate of cutting magnetic flux

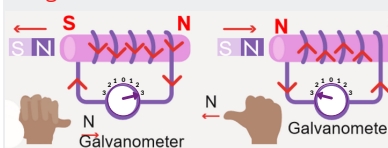


Factor to increase the magnitude

- 1 Increase speed of relative motion / rate of cutting magnetic field
- 2 Number of turn of solenoid
- 3 stronger magnet \rightarrow stronger magnetic field

#deflection of galvanometer -- direction of electron flow

Lenz law- DIRECTION of induced current always flows opposes the change of magnetic flux that causes it.

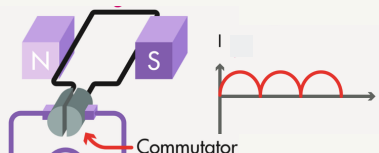


Change direction deflection of galvanometer

- 1 Change pole of magnet
- 2 Change direction of cutting magnetic flux

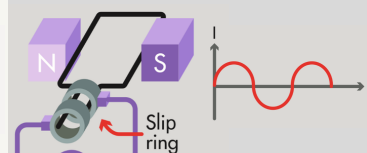
GENERATOR

DC GENERATOR



- 1 current, I flow in 1 direction
- 2 Cannot pass through capacitor

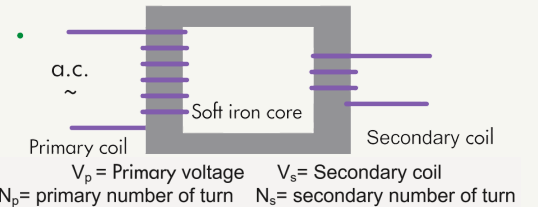
AC GENERATOR



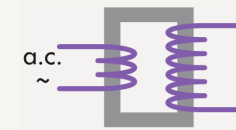
- 1 current, I change direction after certain period
- 2 Can pass through capacitor
- 3 Voltage can be increase or decrease by a transformer

TRANSFORMER

Can increase or decrease the AC Voltage. Work base on electromagnetic induction (secondary coil).



STEP UP



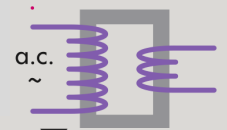
▲ AC voltage

$$N_s > N_p$$

$$V_s > V_p$$

$$I_s < I_p$$

STEP DOWN



▼ AC voltage

$$N_s < N_p$$

$$V_s < V_p$$

$$I_s > I_p$$

Ideal transformer : No power lost or energy lost

$$P_p = P_s \quad V_p I_p = V_s I_s$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

#Reality, power / energy is lost

cause of energy lost

way to reduce lost

Resistance of coils

Use thicker copper wire. resistance will be lower

Eddy currents

Laminated iron core

Magnetization of core Hysteresis

Used soft iron insulated core.

Magnetic flux leakage

Secondary coil wound on the primary coil

KEELEKTROMAGNETAN

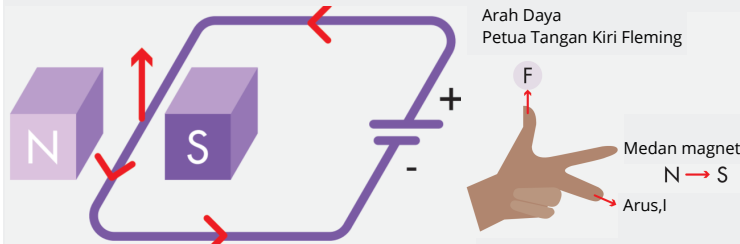


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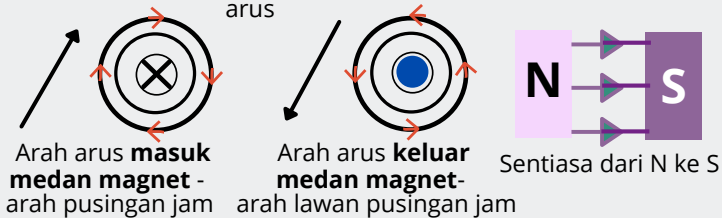
f FIZIK SPM PHYSICSTHERAPY



DAYA KE ATAS KONDUKTOR PEMBAWA ARUS DALAM SUATU MEDAN MAGNET

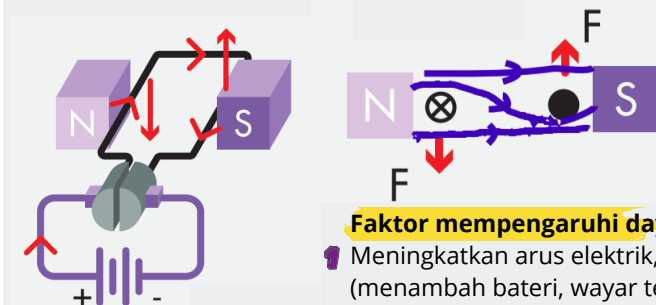


Medan magnet bagi konduktor pembawa arus



Medan lastik

Medan magnet paduan yang dihasilkan oleh interaksi antara medan magnet daripada konduktor pembawa arus dengan medan magnet daripada magnet kekal



Motor AT

gegelung wayar membawa arus mengalir diantara dua magnet berlainan kutub.

Faktor mempengaruhi daya

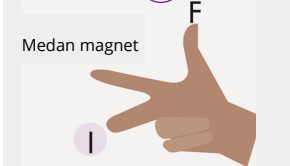
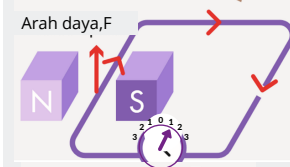
- 1 Meningkatkan arus elektrik, I (menambah bateri, wayar tebal)
- 2 Bilangan lilitan
- 3 Magnet kuat--> Medan magnet yang kuat

Menukar arah pusingan motor dan arah daya pada wayar

- 1 Menukar kedudukan sel kering
- 2 Menukar kedudukan kutub magnet

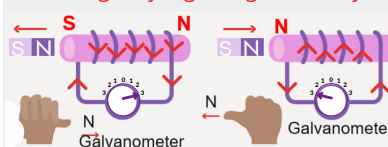
ARUHAN ELEKTROMAGNET

Penghasilan d.g.e. aruhan merentasi suatu konduktor apabila terdapat gerakan relatif antara konduktor itu dengan suatu medan magnet atau apabila konduktor berada di dalam medan magnet yang berubah.

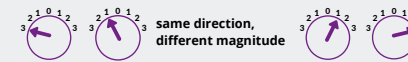


#pemesongan jarum galvanometer-- arah gerakan elektron

Lenz law- ARAH arus aruhan mengalir pada arah yang menentang perubahan fluks magnet yang menghasilkannya.



Hukum Faraday - MAGNITUD d.g.e teraruh berkadar terus dengan kadar pemotongan fluks magnet.



Faktor meningkatkan magnitud

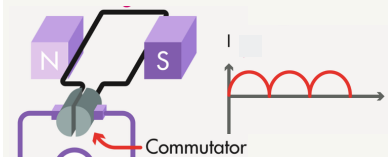
- 1 menambah laju gerakan relatif/ kadar pemotongan fluks magnet
- 2 Bilangan lilitan solenoid
- 3 Magnet lebih kuat--> menambah kekuatan medan magnet

Menukar arah pemesongan jarum galvanometer

- 1 Tukar kekutuban magnet
- 2 Menukar arah pemotongan fluks magnet

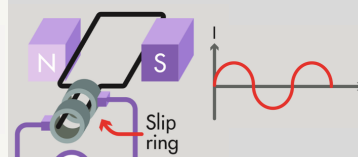
PENJANA

PENJANA A.T



- 1 Arus, I mengalir dalam 1 arah
- 2 Tidak boleh merentasi kapasitor

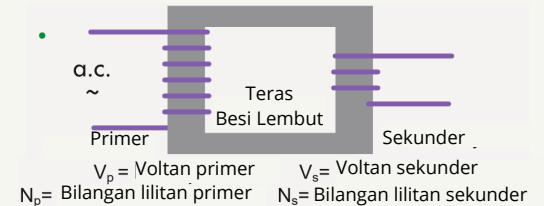
PENJANA A.U



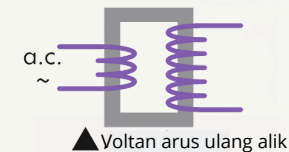
- 1 Arus, I menukar arah aliran selepas suatu tempoh.
- 2 Boleh melalui kapasitor
- 3 voltan boleh ditingkatkan dan direndahkan menggunakan transformer

TRANSFORMER

Boleh meningkatkan dan mengurangkan Voltan A.U Berfungsi berdasarkan konsep Aruhan elektromagnet



INJAK NAIK

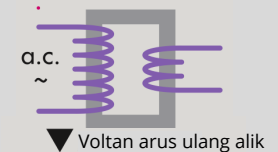


$$N_s > N_p$$

$$V_s > V_p$$

$$I_s < I_p$$

INJAK TURUN



$$N_s < N_p$$

$$V_s < V_p$$

$$I_s > I_p$$

Transformer unggul : **Tiada kehilangan kuasa/tenaga**

$$P_p = P_s \quad V_p I_p = V_s I_s$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Realiti tenaga/kuasa hilang

Punca kehilangan tenaga

Cara mengurangkan kehilangan tenaga

Ritangan gegelung

Gunakan wayar yang tebal, ritangan menjadi rendah

Arus pusar

Teras besi lembut berlamina

Pemagnetan teras Histeresis

Guna teras besi lembut

Kebocoran flux magnet

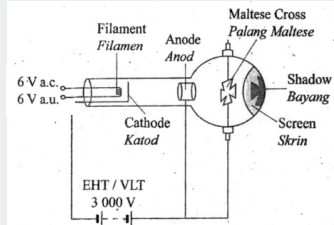
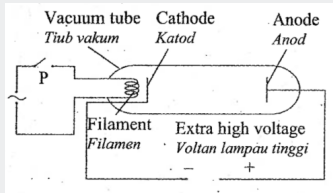
Gegelung sekunder dililit di atas gegelung primer



ELECTRONS

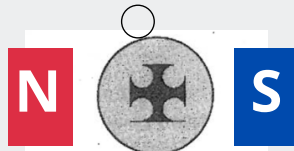
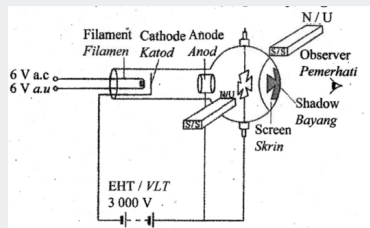
Thermionic emission

The emission of free electrons from surface of heated metal.
electron beam = cathode ray

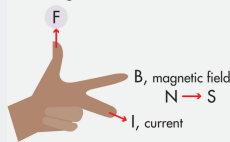


Characteristic of cathode ray

1. Negatively charge electron
2. travel in straight line and cast sharp shadow
3. Can be deflected by electric field and magnetic field
(Determine the deflection of shadow- Fleming Left hand rule)
4. possess momentum and kinetic energy



shadow deflected downward



$$eV = \frac{1}{2} mv^2$$

Electric potential energy = eV (J)

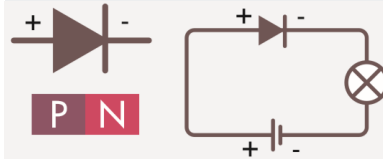
$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m = 9.11 \times 10^{-31} \text{ kg}$$

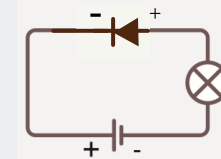
v = velocity of electron beam (ms⁻¹)

V = Potential difference, Volt (V)

DIODE



Forward biased - Current, I can flow through diode
smaller depletion layer
Holes & electrons will be pull across the PN junction



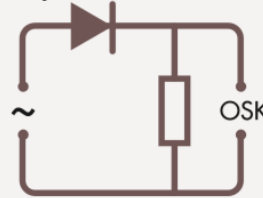
Reverse biased - Current, I cannot flow through diode
Bigger depletion layer
Holes & electrons will be pull away from PN junction

RECTIFICATION

Process converting and alternating current into direct current

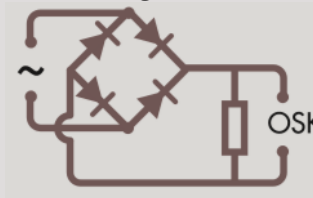
HALF - WAVE

only used 1 diode



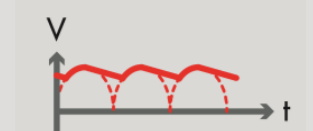
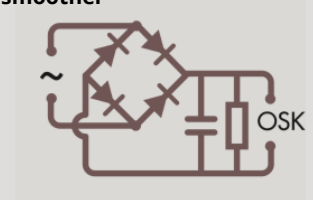
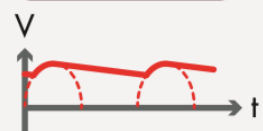
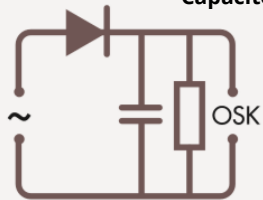
FULL - WAVE

4 diode - bridge rectifier



RECTIFICATION CIRCUIT + CAPACITOR

Capacitor - current smoother



TRANSISTOR



N P N



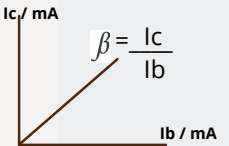
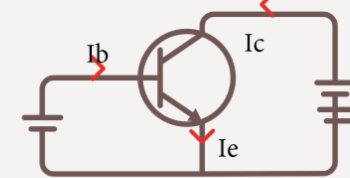
P N P

$$I_E = I_B + I_C$$

$$I_B < I_C < I_E$$

CURRENT AMPLIFIER

Amplification factor (No unit)



Transistor turn on when **Base current, Ib** flow

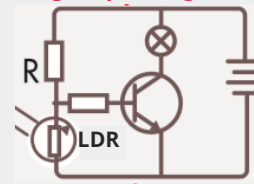
AUTOMATIC SWITCH

-LDR - Light Dependent resistor

Resistance depend on intensity of light

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

light up during dark

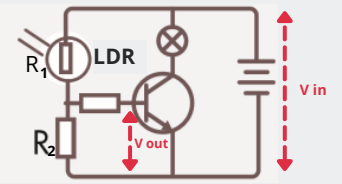


#LDR bottom

Resistance of LDR is **high** during **dark**

Current flow through the base of transistor
Transistor turn on the bulb lights up

light up during bright

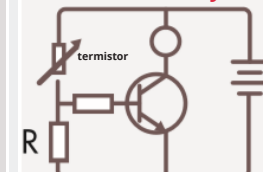


#LDR at the top

Resistance of LDR is **low** during **bright**

Current flow through the base of transistor
Transistor turn on the bulb lights up

Thermistor - Resistance change with surrounding temperature
#thermistor always at the top



Resistance of thermistor low when surrounding temperature high.

Current flow through the base of transistor. Transistor turn on, the bell ring

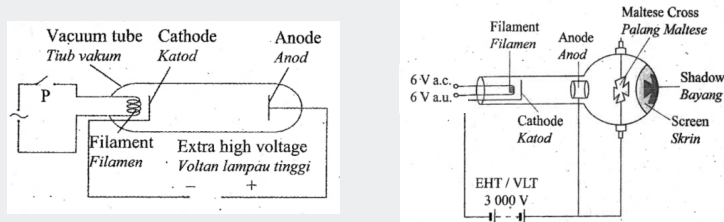


ELEKTRON

Pancaran termion

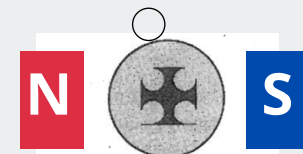
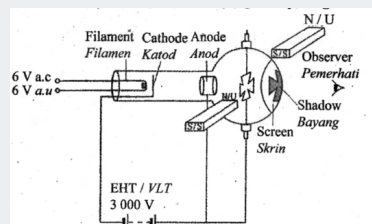
Pemancaran elektron bebas daripada permukaan logam yang dipanaskan.

Alur elektron = Sinar katod

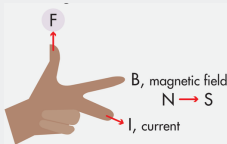


Ciri-ciri sinar katod

1. Elektron bercas negatif
2. Bergerak lurus dan menghasilkan bayang-bayang tajam
3. Terpesong dengan medan elektrik dan medan magnet. (tentukan arah pemasangan bayang-bayang-- Peraturan tangan kiri Fleming)
4. Mempunyai momentum dan tenaga kinetik



bayang-bayang terpesong ke bawah



$$eV = \frac{1}{2} mv^2$$

Tenaga Keupayaan Elektrik = eV (J)

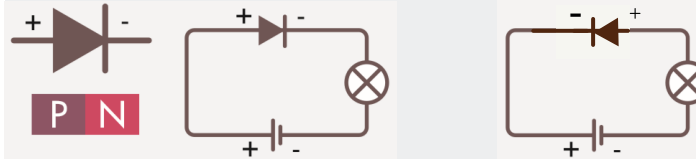
$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m = 9.11 \times 10^{-31} \text{ kg}$$

v = halaju alur elektron (ms⁻¹)

V = Beza keupayaan/ Volt (V)

DIOD



Pincang hadapan - arus, I boleh mengalir merentasi diod
Lapisan susutan kecil
Lohong dan elektron ditarik merentasi simpang PN

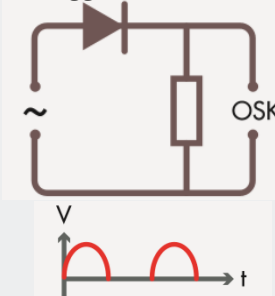
Pincang songsang- arus, I tidak boleh mengalir merentasi diod.
Lapisan susutan besar
Lohong dan elektron ditarik menjauhi simpang PN

REKTIKIFIKASI

Proses penukaran Arus ulang-alik kepada arus terus

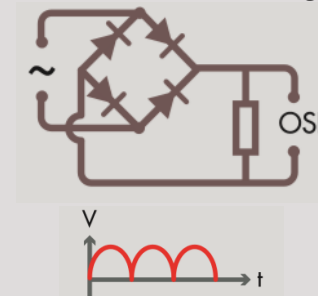
GELOMBANG SEPARUH

Menggunakan 1 diod



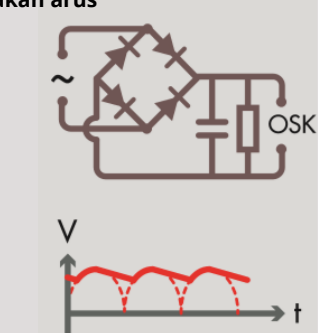
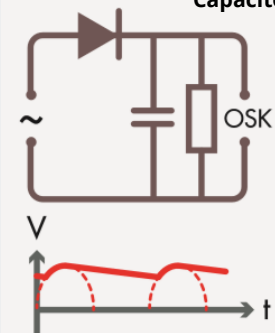
GELOMBANG PENUH

4 diod - rektifier tetimbang

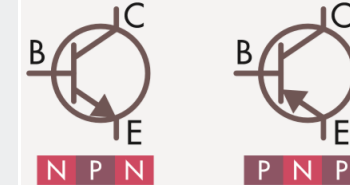


LITAR REKTIKIFIKASI +CAPACITOR

Capacitor - meratakan arus



TRANSISTOR

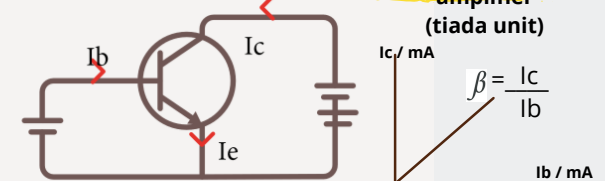


$$I_E = I_B + I_C$$

$$I_B < I_C < I_E$$

AMPLIFIER ARUS

faktor penggandaan amplifier (tiada unit)



transistor berfungsi apabila ada arus tapak, I_b

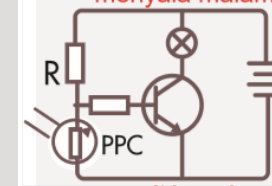
SUIS AUTOMATIK

PPC -Perintang Peka Cahaya

Rintangan berubah dengan keamatan cahaya

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

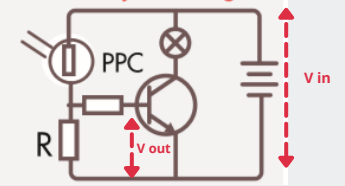
menyala malam



#PPC di bawah

Rintangan PPC tinggi pada waktu gelap
Arus mengalir melalui tapak Transistor
Transistor dihidupkan
lampu menyala

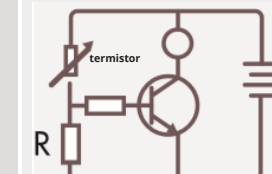
menyala siang



#PPC di atas

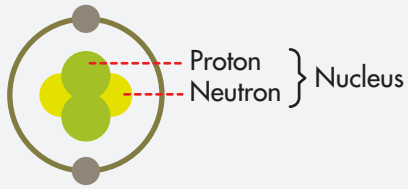
Rintangan PPC rendah pada waktu cerah
Arus mengalir melalui tapak Transistor
Transistor dihidupkan
lampu menyala

Termistor -Rintangan berubah dengan suhu persekitaran
#termistor sentiasa di atas



Rintangan termistor rendah bila suhu persekitaran tinggi
Arus mengalir melalui tapak Transistor.
Transistor dihidupkan
loceng berbunyi

NUCLEAR PHYSICS



Nucleon --- 4
Proton --- 2 **He**

ISOTOPE

Element which has SAME proton number but DIFFERENT nucleon number in the nucleus.

same chemical properties, different physical properties



RADIOACTIVITY

SPONTANEOUS disintegration of unstable nucleus to become more stable by emitting radioactive emission (α , β , γ).

	α	β	γ
Nature	${}^4_2\text{He} (+)$	${}^0_{-1}\text{e} (-)$	Elektromagnetic wave
Ionizing power	Strong	Weak	Weakest
Penetrating power	Weakest (paper)	Weak (aluminium)	Strong (lead)

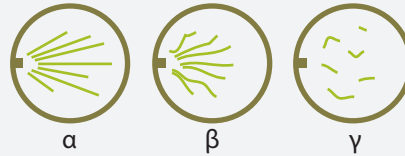
RADIOISOTOPE

Isotope of an unstable nucleus

Detector of nuclear radiation

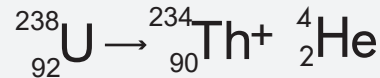
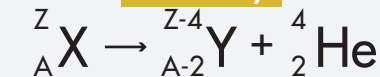
	α	β	γ
GM Tube	✓	✓	✓
Cloud Chamber	✓	✓	✓
Spark Counter	✓	✗	✗
Fim Batch	✓	✓	✓

Cloud Chamber

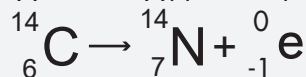
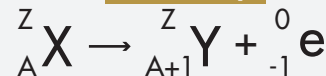


based on ionizing power

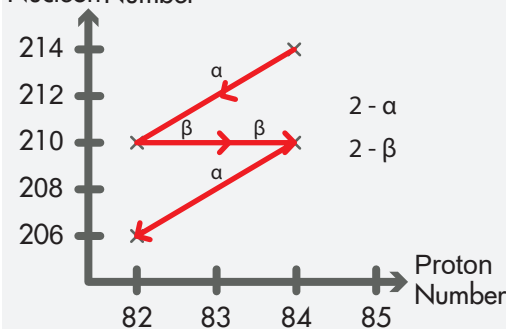
α -Decay



β -Decay



Nucleon Number

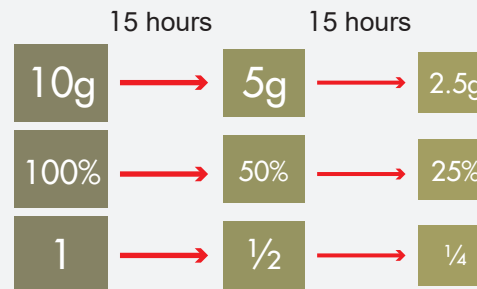
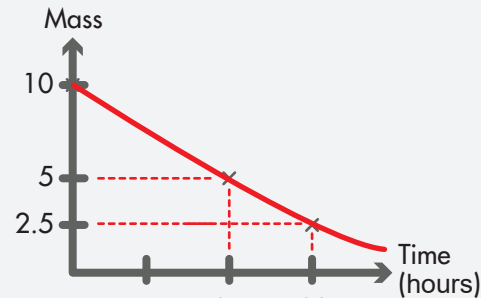


HALF-LIFE, $T_{1/2}$

Time taken for a number of undecayed radioactive element to reduce to half of its original value.

Sodium, Na-24

Initial mass = 10g
Half Life, $T_{1/2}$ = 15 hours



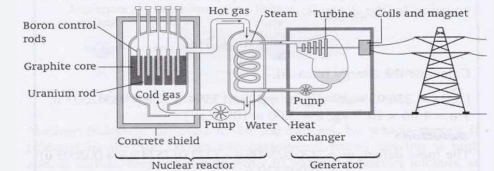
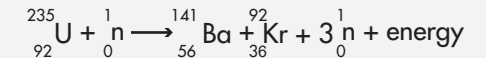
Archeology	Carbon-14 ($T_{1/2}$ =5730 years)
Paper thickness	β source
Leakage in pipe	β source (Sodium-24)
Blood cloth	Sodium-24
Sterilization	Cobalt-60
Tracer in plant study	Phosphorus-32
Preserve food	Cobalt-60

NUCLEAR REACTION

Atomic energy released during nuclear reaction

Fission

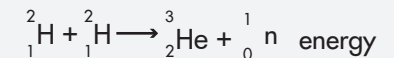
- Splitting heavy nucleus into two small nuclei with release of energy.
- Bombarded by neutron.



boron control rods-absorb neutron
Graphite moderator- slow down fast moving neutron

Fussion

- Combination of two small nuclei into one big nucleus with release of energy (heat).
- Thermonuclear reaction.(reaction at sun)



NUCLEAR ENERGY

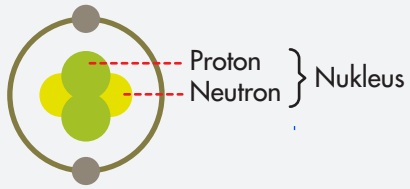
$$E = mc^2$$

m = mass defect (kg)

c = speed of light
($3 \times 10^8 \text{ ms}^{-1}$)

conversion from a.mu to kg (multiply(X))

$$1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg}$$

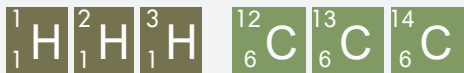


Nukleon --- 4
Proton --- 2 **He**

ISOTOP

atom -atom bagi satu unsur yang mempunyai no. proton yang SAMA tetapi no. nukleon yang berbeza

sama ciri-ciri kimia, tetapi berbeza ciri-ciri fizikal.



KERADIOAKTIFAN

Proses pereputan spontan nukleus yang tidak stabil dengan memancarkan sinaran radioaktif (α, β, γ) untuk menjadi nukleus lebih stabil.

Pancaran radioaktif (α, β, γ)

	α	β	γ
Semulajadi	${}^4_2\text{He} (+)$	${}^0_{-1}\text{e} (-)$	Gelombang elektromagnet
Kuasa pengionan	Kuat	Sederhana	Lemah
Kuasa penembusan	Paling lemah (kertas)	Sederhana (aluminium)	Kuat (plumbum)

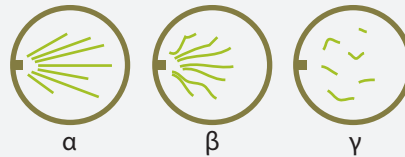
RADIOISOTOP

Isotope nukleus yang tidak stabil

Pengesanan sinaran radioaktif

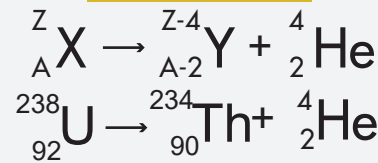
	α	β	γ
Tiub GM	✓	✓	✓
Kebuk awan	✓	✓	✓
Pembilang bunga api	✓	✗	✗
Lencana filem	✓	✓	✓

Kebuk Awan

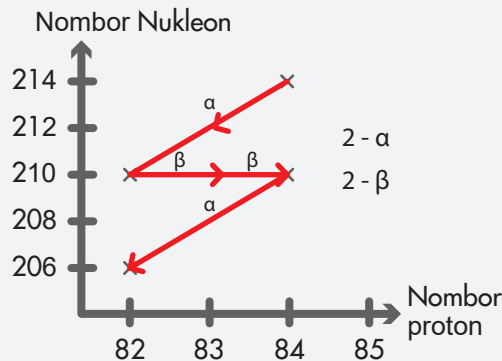
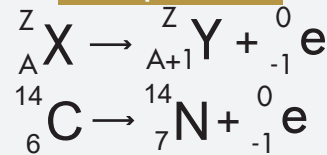


bergantung pada kuasa pengionan

Pereputan α



Pereputan β

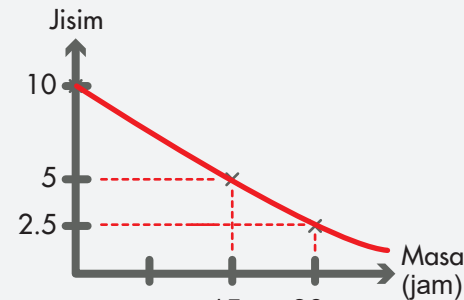


SEPARUH HAYAT, $T_{1/2}$

masa yang diambil untuk bilangan nukleus yang belum mereput berkurang menjadi separuh daripada nilai asalnya

Natrium-24,

Jisim asal = 10g
Separuh hayat, $T_{1/2} = 15$ jam



10g	→	5g	→	2.5g
100%	→	50%	→	25%
1	→	1/2	→	1/4

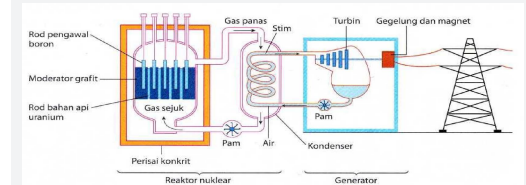
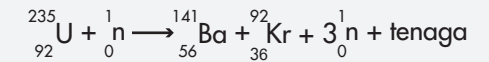
Arkeologi	Karbon-14 ($H_{1/2}=5730$ tahun)
Ketebalan kertas	sumber β
Kebocoran paip	sumber β (Natrium-24)
Darah pada pakaian	Natrium-24
Pensterilan penyurih dalam kajian tumbuhan	Kobalt-60
Mengawet makanan	Fosforus-32
	Kobalt-60

TINDAKBALAS NUKLEAR

tenaga atom yang dibebaskan semasa tindak balas nuklear

Pembelahan

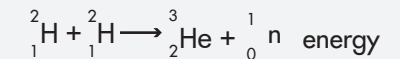
- Pemecahan satu nukleus berat kepada dua nukleus baharu yang lebih ringan. Dibedil oleh neutron.



Rod pengawal boron-Menyerap neutron
Graphite moderator- memperlambatkan neutron

Pelakuran

- Gabungan dua nukleus ringan menjadi satu nukleus lebih berat yang menghasilkan tenaga (haba).
- Tindakbalas termonuklear.(matahari)



NUCLEAR ENERGY

$$E = mc^2$$

$m = \text{cacat jisim (kg)}$ $c = \text{laju cahaya } (3 \times 10^8 \text{ ms}^{-1})$

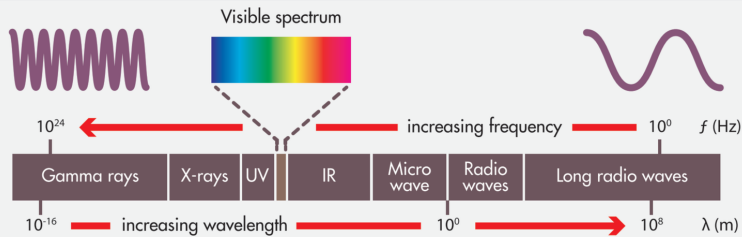
tukar dari a.m.u kepada kg (darab (X))

$$1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg}$$

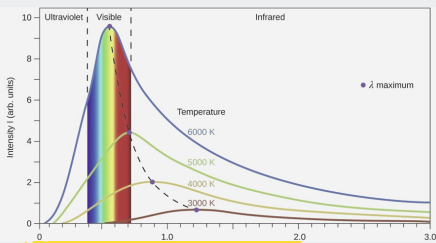


QUANTUM THEORY OF LIGHT

LIGHT → **WAVE PARTICLE DUALITY**
has properties of **particles** and **waves**
(electromagnetic spectrum, light, electrons, protons, neutrons)



BLACK BODY ideal body that absorb all electromagnetic radiation. emit electromagnetic radiation determined by its temperature



higher temperature → Higher intensity. Peak intensity at shorter wavelength. higher frequency.
Blue light -- higher frequency
higher light intensity, higher light energy emits.

QUANTUM OF ENERGY → Higher frequency, higher energy
Discrete light energy packet (photon) and not a continuous energy

$$E = hf$$

$$E = \frac{hc}{\lambda}$$

$$c = \lambda f$$

E = Photon energy (J)
h = Planck's Constant
 6.63×10^{-34} J s
f = frequency of light waves (s⁻¹)(Hz)
c = speed of light (ms⁻¹)
 3×10^8 ms⁻¹

De Broglie's Hypothesis ----> **wave particle Duality**
Particle have wave properties

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

= wavelength (m)
p = momentum of particle (kgms⁻¹)
m = mass of particle (kg)
v = velocity of particle (ms⁻¹)

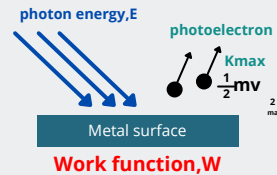
Photon Power, P

$$P = nhf = \frac{nhc}{\lambda}$$

P = Photon power, (W)
n = number of photon emitted per second (s⁻¹)

Photon power high, number of photon emitted high
Photon energy depend on frequency of light used, not power

PHOTOELECTRIC EFFECT



Electrons (photoelectrons) emitted from the metal-sensitive surfaces (cathodes) when illuminated by a beam of light at a certain frequency.

W Minimum energy required to produce photoelectric effect

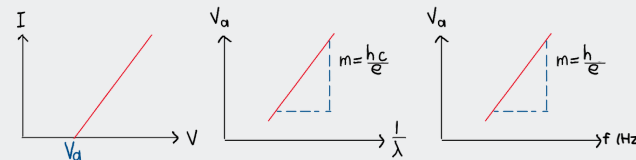
$$W = hf_0$$

$$W = \frac{hc}{\lambda_0}$$

λ_0 maximum wavelength to produce photoelectric effect

λ_0 threshold wavelength
 f_0 threshold frequency

finding Planck's constant, h from the gradient of the graph



Activation Voltage, Va - V intercept from graph I against V
gradient, m of graph Va against $1/\lambda$
c = speed of light (3×10^8 ms⁻¹)
 $e = 1.60 \times 10^{-19}$ C

CHARACTERISTIC OF PHOTOELECTRIC EFFECT

- higher frequency of photon (light), the higher kinetic energy of photoelectron emitted.
- Threshold frequency, fo** - minimum frequency required to produce a photoelectric effect on metal.
- The kinetic energy of photoelectrons does not depend on the intensity of light.
- Photoelectrons are emitted instantaneously when a metal surface is illuminated by light

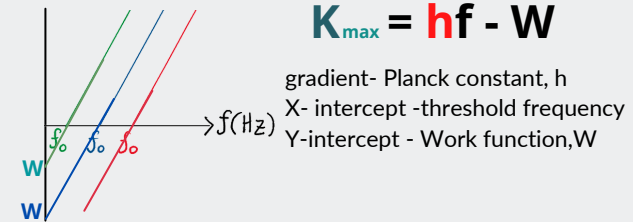
EINSTEIN'S PHOTOELECTRIC EFFECT

$$E = W + K_{max}$$

maximum kinetic energy of photoelectron

- $E < W$ ✗ photoelectric effect
- $E = W$ ✓ Photoelectric effect ✗ kinetic energy
- $E > W$ ✓ Photoelectric effect ✓ kinetic energy

frequency of light (photon) = threshold frequency, fo of metal, photoelectron emitted with Kinetic energy = 0 J
 K_{max}

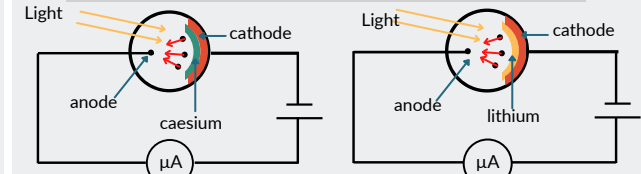


$$K_{max} = hf - W$$

gradient- Planck constant, h
X- intercept - threshold frequency
Y-intercept - Work function, W

different metals have different threshold frequency, fo,

Photoelectric current in Photocell circuit



Ceasium	Lithium
W = 2.14 eV	W = 2.50 eV
$f_0 = 5.16 \times 10^{14}$ Hz	$f_0 = 6.03 \times 10^{14}$ Hz
$\lambda_0 = 579$ nm	$\lambda_0 = 496$ nm

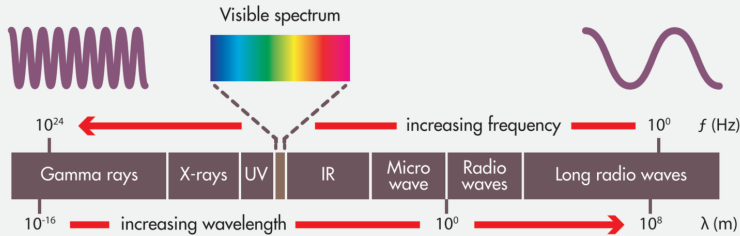
APPLICATIONS OF PHOTOELECTRIC

- Solar cells
- Light detector of automatic door
- Image sensor
- ISS Solar panel



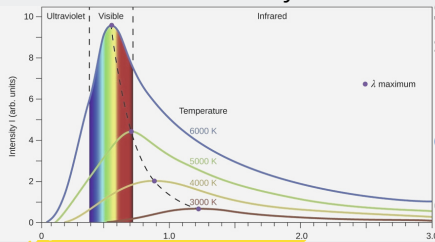
TEORI KUANTUM CAHAYA

CAHAYA → **KEDUALAN GELOMBANG ZARAH** mempunyai sifat-sifat **zarah** dan **gelombang** (gelombang elektromagnet, cahaya, elektron, proton, neutron)



JASAD HITAM

Jasad unggul yang berupaya menyerap semua sinaran elektromagnet yang jatuh padanya. mengeluarkan sinaran termal bergantung pada suhunya



Suhu tinggi → Keamatan sinaran tinggi. Keamatan tinggi bila panjang gelombang pendek. Frekuensi tinggi. **cahaya biru** -- frekuensi tinggi, keamatan cahaya tinggi, tenaga cahaya tinggi.

KUANTUM TENAGA

→ frekuensi **tinggi**, tenaga **tinggi**

Paket tenaga yang diskrit (foton) dan bukan tenaga selanjur

$$E = hf$$

$$E = \frac{hc}{\lambda}$$

$$c = \lambda f$$

E = Tenaga Foton (J)
 h = Pemalar Planck $6.63 \times 10^{-34} \text{ J s}$
 f = Frekuensi gelombang cahaya (s^{-1})(Hz)
 c = laju cahaya dalam vakum (ms^{-1})
 $3 \times 10^8 \text{ ms}^{-1}$

Hipotesis De Broglie ----> **KEDUALAN GELOMBANG ZARAH** zarah mempunyai sifat gelombang

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

= panjang gelombang (m)
 p = momentum zarah (kgms^{-1})
 m = jisim zarah (kg)
 v = halaju zarah (ms^{-1})

Kuasa Foton, P

$$P = nhf = \frac{nhc}{\lambda}$$

P = Kuasa Foton, (W)
 n = bilangan foton dipancarkan per saat (s^{-1})

Kuasa foton tinggi, bilangan foton dipancarkan tinggi. Tenaga foton bergantung pada frekuensi cahaya, bukan kuasa.

KESAN FOTOELEKTRIK



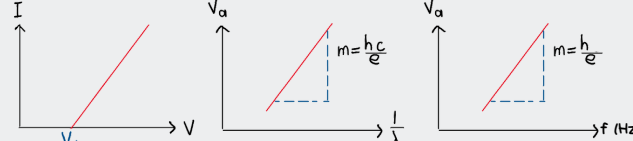
Elektron (Fotoelektron) keluar dari permukaan logam sensitif (katod) apabila alur cahaya dipancarkan pada frekuensi tertentu.

W Tenaga minimum yg diperlukan untuk menghasilkan kesan fotoelektrik

$$W = hf_0 \quad W = \frac{hc}{\lambda_0}$$

λ_0 panjang gelombang ambang
 f_0 frekuensi ambang

Menentukan Pemalar Planck, h dari kecerunan graf



Voltan Pengaktifan, Va - pintasan V dari graf I melawan V kecerunan, m dari graf Va melawan $1/\lambda$
 c = laju cahaya dalam vakum ($3 \times 10^8 \text{ ms}^{-1}$)
 e = $1.60 \times 10^{-19} \text{ C}$

CIRI-CIRI KESAN FOTOELEKTRIK

- 1 Semakin tinggi frekuensi foton cahaya, Semakin tinggi tenaga kinetik fotoelektron.
- 2 **Frequency ambang, fo** - frekuensi minimum diperlukan untuk menghasilkan kesan fotoelektrik dari logam.
- 3 Tenaga kinetik fotoelektron tidak bergantung kepada keamatan cahaya.
- 4 Photoelektron dipancar secara serta merta apabila permukaan logam disinari dengan cahaya

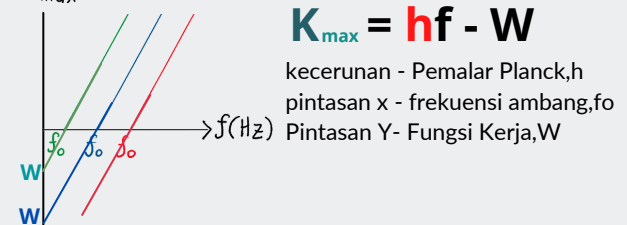
TEORI FOTOELEKTRIK EINSTEIN

$$E = W + K_{max}$$

tenaga kinetik maximum fotoelektron

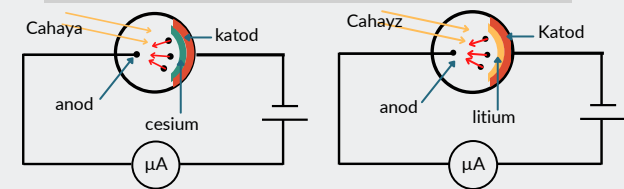
$E < W$ ✗ kesan fotoelektrik
 $E = W$ ✓ kelas fotoelektrik ✗ tenaga kinetik
 $E > W$ ✓ kelas fotoelektrik ✓ tenaga kinetik

frekuensi cahaya (foton) = frekuensi ambang, fo logam, fotoelektron dikeluarkan dengan tenaga kinetik = 0 J
 K_{max}



logam yang berbeza, **frekuensi ambang, fo** berbeza,

Arus fotoelektrik dalam sebuah litar sel foto



Cesium	Litium
$W = 2.14 \text{ eV}$	$W = 2.50 \text{ eV}$
$f_0 = 5.16 \times 10^{14} \text{ Hz}$	$f_0 = 6.03 \times 10^{14} \text{ Hz}$
$\lambda_0 = 579 \text{ nm}$	$\lambda_0 = 496 \text{ nm}$

APLIKASI KESAN FOTOELEKTRIK

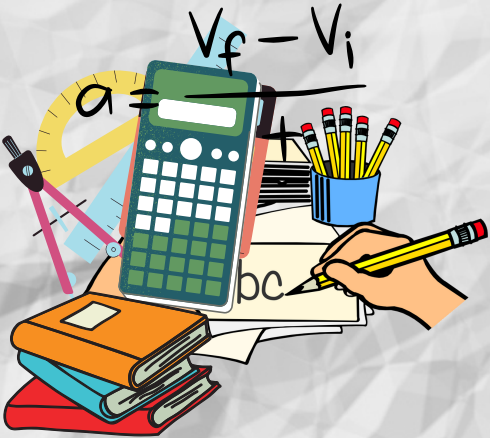
- 1 Sel suria
- 2 Pengesan cahaya pintu automatik
- 3 Pengesan imej
- 4 Panel suria ISS

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