Heery's Zen Notes

Physics KSSM F5 2021

Chapter 7:

FIZIK KUANTUM *(QUANTUM PHYSICS)*

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A. TEORI KUANTUM CAHAYA *(THEORY OF LIGHT QUANTUM)*

1. Semua objek berpotensi menjadi **jasad hitam** – jasad unggul yg menyerap semua sinaran elektromagnet yg jatuh ke atasnya

*(All object are potential to become a **black body** – an idealised object that can absorb all electromagnetic radiations that fall on it)*

2. Objek juga boleh menjadi **pemancar jasad hitam** – objek dpt memancarkan SEMUA sinar elektromagnet

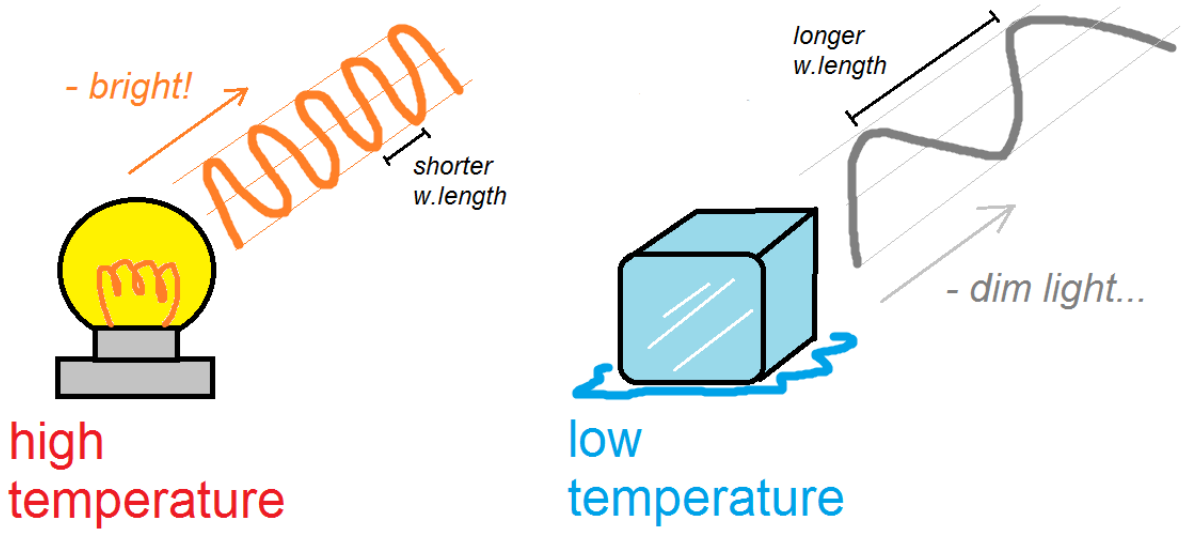
*(Object also can become a **black body radiator** – object which radiates ALL electromagnetic radiations)*

3. Ini bergantung kpd suhu objek:

- semakin suhu tinggi → keamatan sinaran meningkat (makin cerah)
- semakin suhu tinggi → keamatan sinaran maksimum mempunyai **frekuensi makin tinggi**
- semakin suhu tinggi → keamatan sinaran maksimum mempunyai **panjang gelombang paling pendek**

(This depends on the temperature of object:)

- higher temperature → radiation intensity increases (brighter)
*- higher temp. → max radiation intensity has **higher frequency***
*- higher temp. → max radiation intensity has **shorter wavelength***

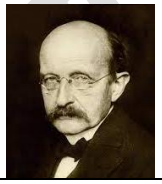
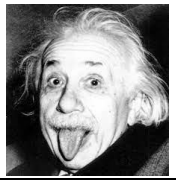


4. Perkembangan teori kuantum cahaya *(Development of light quantum theory)*

a. Teori klasik *(Classical theory)*

I. Newton	T. Young	J. Dalton	JJ Thomson
			
Cahaya sbg aliran zarah *Light as a particle beam*	Cahaya bersifat gelombang *Light is a wave*	Jirim terdiri drpd atom *Matter consists of atoms*	Menemui elektron *Discover electron*

b. Teori kuantum (*Quantum theory)*

M. Planck	A. Einstein	N. Bohr	L d Broglie
			
Memperkenalkan idea kuantum *Introduce idea about quantum*	Memperkenalkan konsep foton *Introduce photon concept*	Jelaskan spektrum garis *Explain line spectrum*	Kedualan gelombang - zarah *Wave-particle duality*

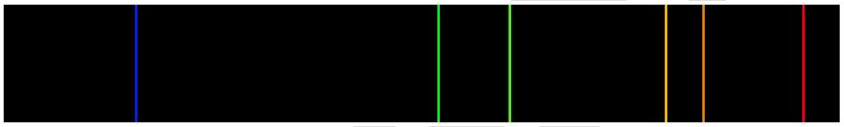
5. 2 jenis spektrum elektromagnet *(2 types of electromagnetic spectrum)*

a. Spektrum selanjar *(continuous spectrum)*

Dihasilkan melalui penyerakan cahaya putih
(*produced by dispersion of white light)*

Tiada jurang pemisahan warna
(no separation gap of colours

b. Spektrum garis (line spectrum)



Dihasilkan oleh objek sebagai pemancar jasad hitam
(produced by object as black body radiator)

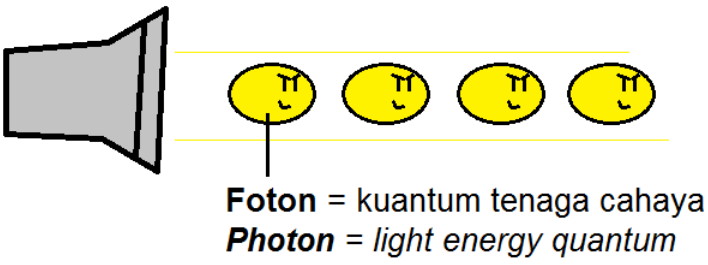
Unsur berbeza menghasilkan spektrum garis berbeza
(Different element produces different line spectrum)

Berguna utk mengenalpasti unsur dlm sesuatu objek
(Useful to identify elements in an object)

6. **Kuantum tenaga/ Energy quantum**

a. Kuantum tenaga = tenaga wujud dlm bentuk paket diskrit & bukan selanjar

Energy quantum = energy exists as discrete packet & not continuous



Foton = kuantum tenaga cahaya
Photon = *light energy quantum*

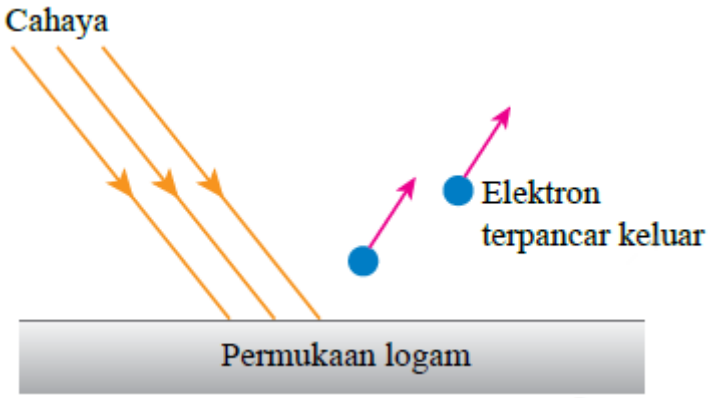
b. Formula terlibat (Formula involved):

Tenaga cahaya *Light energy formula*	Kedualan gelombang-zarah *Wave-particle duality*
$E = hf$ ***expanded into*** **$E = \frac{hc}{\Lambda}$**	**$\Lambda = \frac{h}{mv}$**
E = tenaga foton *(photon energy)* **h** = pemalar Planck (*Planck constant)* **f** = frekuensi gelombang cahaya *(light wave frequency)* **c** = laju cahaya *(light speed)*	**Λ** = panjang gelombang *(wavelength)* **h** = pemalar Planck *(Planck constant)* **m** = jisim zarah *(particle mass)* **v** = halaju zarah *(particle velocity)*

Kuasa foton (*Photon power):*

$P = nhf$
P = kuasa foton *(photon power)* **n** = bilangan foton dipancarkan sesaat *(number of photon released per second)* **h** = pemalar Planck (*Planck constant)* **f** = frekuensi gelombang cahaya *(light wave frequency)*

B. KESAN FOTOELEKTRIK *(PHOTOELECTRIC EFFECT)*



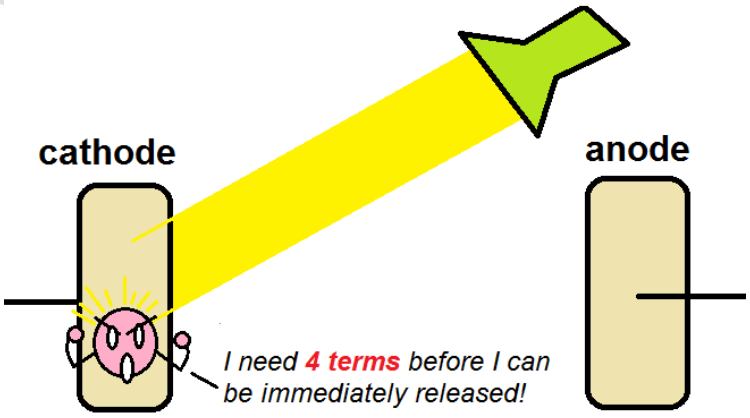
1. Definisi = Fenomena permukaan logam (**katod**) membebaskan elektron **(fotoelektron)** apabila disinari cahaya dgn frekuensi tertentu

*Definition = phenomenon of metal surface (**cathode**) releasing electron (**photoelectron**) when illuminated with light with certain frequency*

2. Empat ciri-ciri kesan fotoelektrik *(Four characteristics of photoelectric effect)*

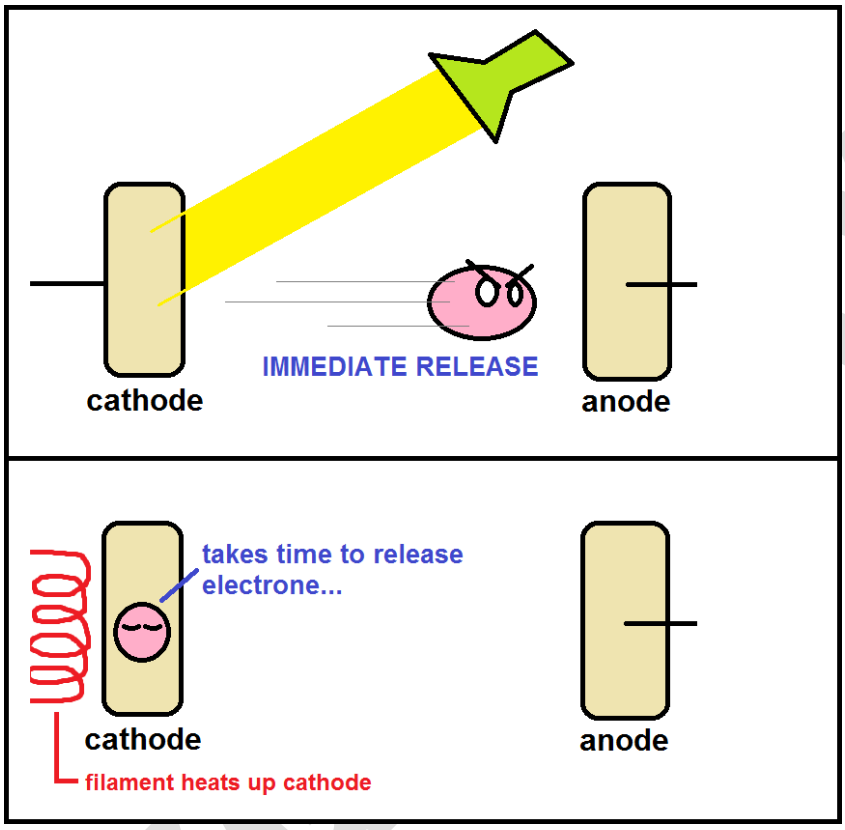
a. 4 syarat perlu dipenuhi sebelum fotoelektron dibebaskan - **fungsi kerja, voltan pengaktifan, frekuensi ambang (paling minimum), & panjang gelombang maksimum)**

*(Terms to release the photoelectron - **work function, activation voltage, threshold (minimum) frequency, & maximum wavelength**)*



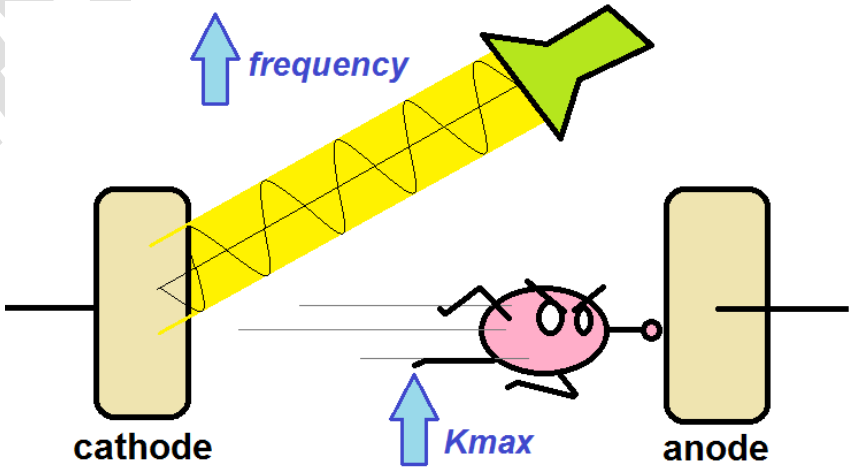
b. Fotoelektron dibebaskan serta-merta, berbanding dlm pancaran termion dimana elektron mengambil masa utk dibebaskan

(*Immediate release of photoelectron, compared to thermionic emission in cathode ray which takes its sweet time to do so)*



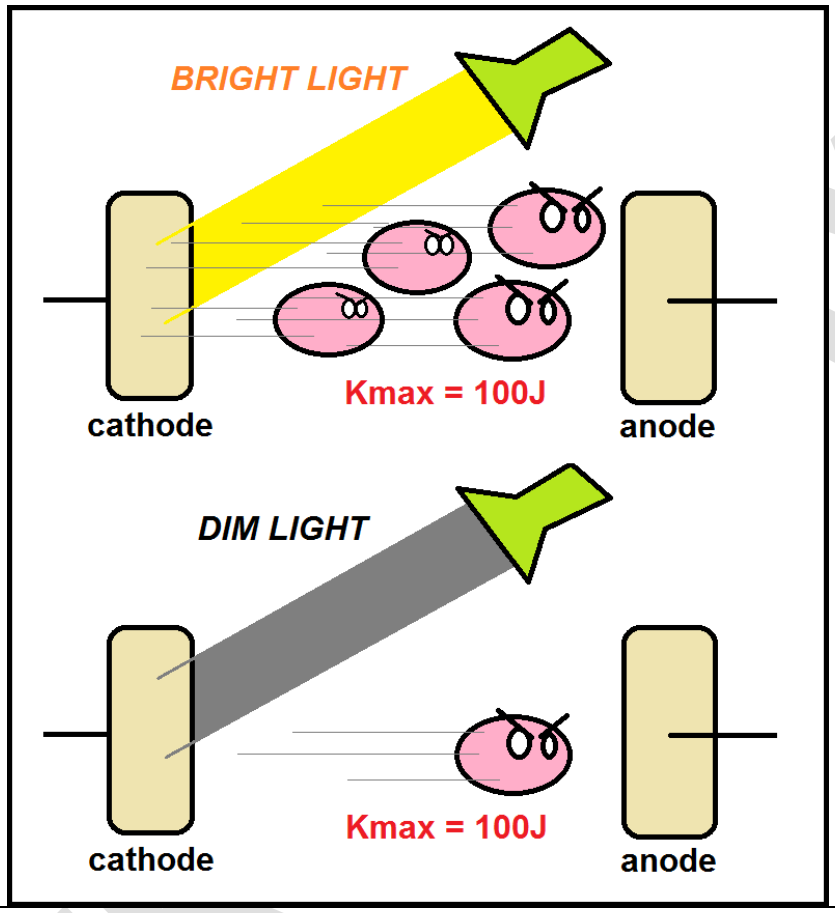
c. Frekuensi cahaya mempengaruhi tenaga kinetik maksimum fotoelektron

(Frequency of light affects the photoelectron's maximum kinetic energy)



d. Keamatan cahaya mempengaruhi kadar pembebasan fotoelektron, tetapi tidak mempengaruhi tenaga kinetik maksimum fotoelektron).

(Light intensity affects the rate of photoelectron being released, but it does not affect the photoelectron's maximum kinetic energy)



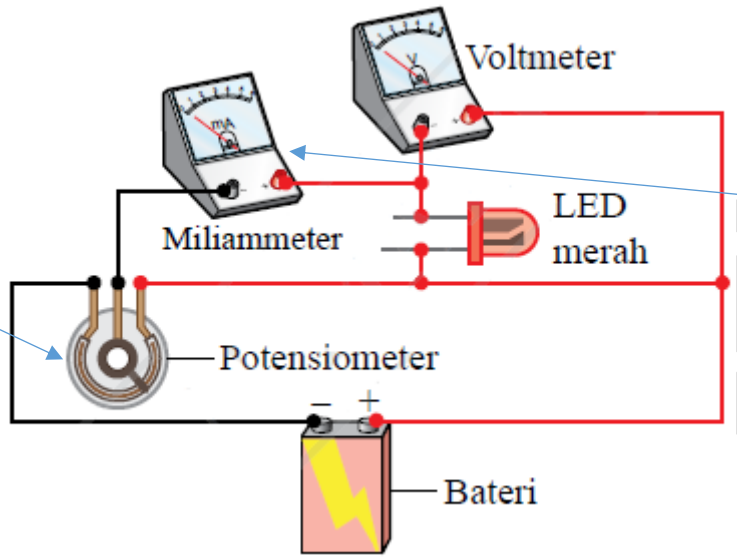
3. 2 siri eksperimen melibatkan kesan fotoelektrik *(2 series of experiments involving photoelectric effect)*

EXP 1	Mengkaji hubungan antara **voltan** & **arus** *(Investigate relationship between **voltage** & **current**)*
EXP 2	Mengkaji hubungan antara **panjang gelombang** & **voltan pengaktifan** *(Investigate relationship between **wavelength** & **activation voltage**)*

EXP 1:
Mengkaji hubungan antara **voltan** & **arus**
*(Investigate relationship between **voltage** & **current**)*

MV : Selaraskan potensiometer utk mengubah nilai voltan

(Adjust potentiometer to change the voltage)



RV : Perhatikan bacaan miliammeter utk nilai arus

(Observe miliammeter reading for current value)

Keputusan/ *result:*

Arus meningkat secara linear dgn voltan
(Current increases linearly with the voltage)

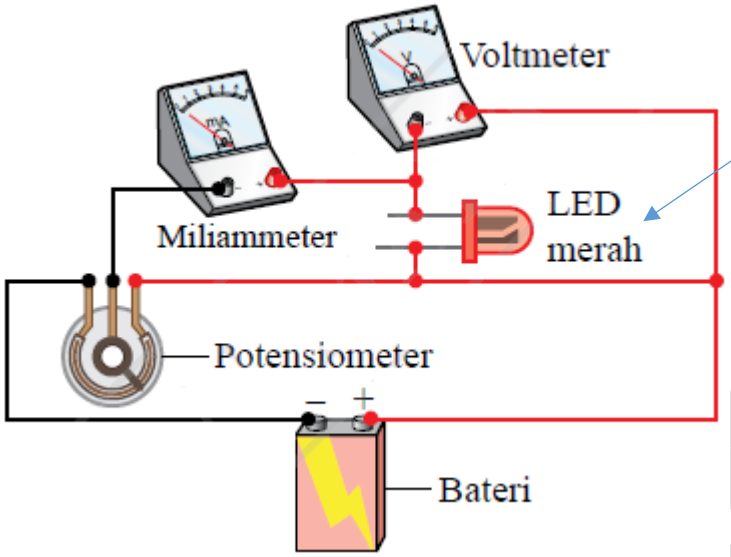
Drpd pintasan-V:

kita boleh cari **voltan pengaktifan, Va** (voltan minimum diperlukan utk kesan fotoelektrik berlaku)

From V-intercept:

*we can find **activation voltage, Va** (minimum voltage needed for photoelectric effect to happen)*

EXP 2:
Mengkaji hubungan antara **panjang gelombang** & **voltan pengaktifan**
*(Investigate relationship between **wavelength** & **activation voltage**)*



MV: Ulang eksperimen tadi dgn warna LED berbeza (panjang gelombang berbeza)

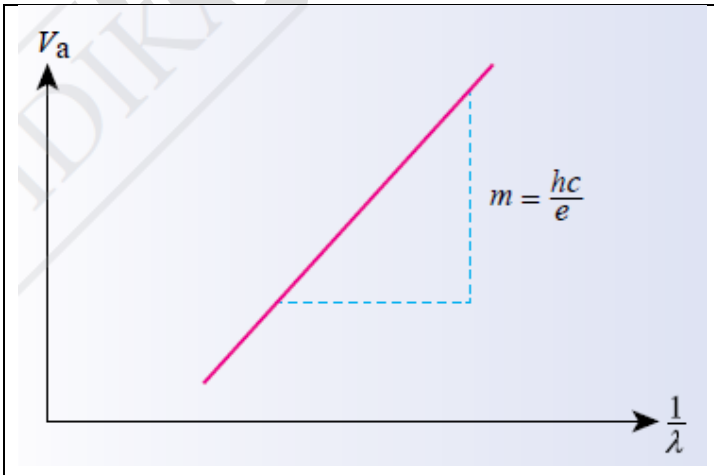
(Repeat previous experiment using different LED colour (different wave length)

RV: Berdasarkan graf V lawan I yg dibina, cari voltan pengaktifan

Based on V-I graph you built, find activation voltage

Keputusan/ *result:*

Voltan pengaktifan meningkat secara linear dgn 1/panjang gelombang
Activation voltage increases linearly with 1/wavelength)



Drpd kecerunan m, kita boleh cari **pemalar Planck**
*(From gradient m, we can find **Planck's constant**)*

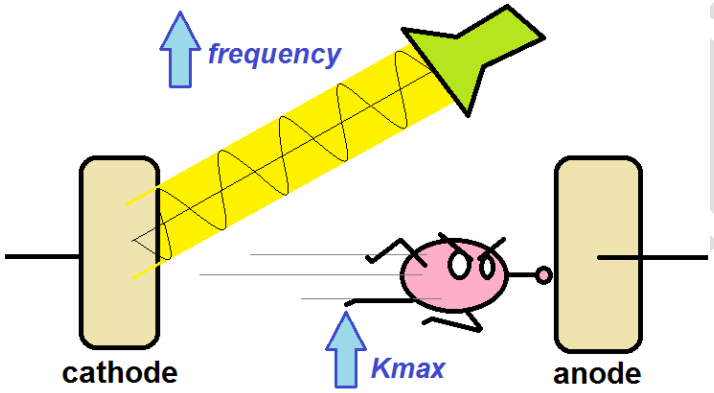
m = hc/ e

h = pemalar Planck
c = laju cahaya (*light speed)*
e = cas satu elektron
(*charge of one electron)*

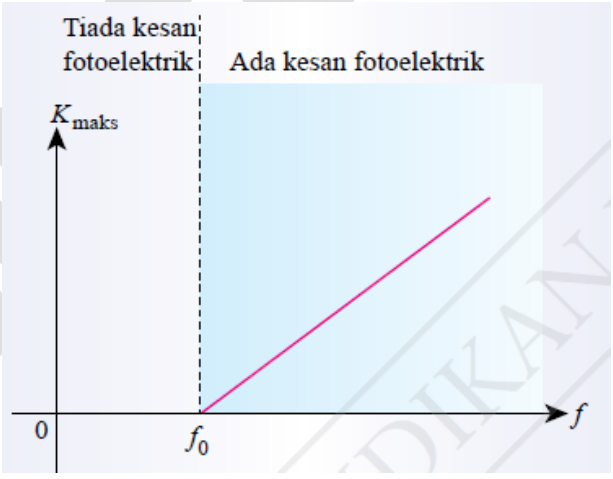
C. TEORI FOTO ELEKTRIK EINSTEIN *(EINSTEIN'S PHOTOELECTRIC THEORY)*

1. Kita telah belajar bahawa frekuensi cahaya mempengaruhi tenaga kinetik maksimum fotoelektron

(We learnt that frequency of light affects the photoelectron's maximum kinetic energy)

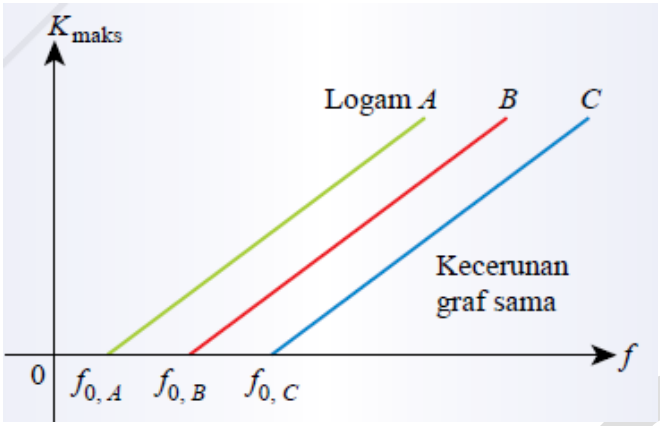


2. Analisis graf terlibat (*graph analysis):*



a. Tenaga kinetik maksimum fotoelektron meningkat secara linear dgn frekuensi cahaya (*Photoelectron's maximum kinetic energy increases linearly with light frequency)*
b. Pintasan-f = **frekuensi ambang, f_0** = frekuensi minimum diperlukan utk kesan fotoelektrik berlaku (*f-intercept =* ***threshold frequency, f_0*** *= minimum frequency for photoelectric effect to happen)*

3. Logam berbeza mempunyai frekuensi ambang berbeza *(different metals have different threshold frequency)*



4. Dgn menggunakan frekuensi ambang, kita boleh cari **fungsi kerja, W** = tenaga minimum utk kesan fotoelektrik berlaku

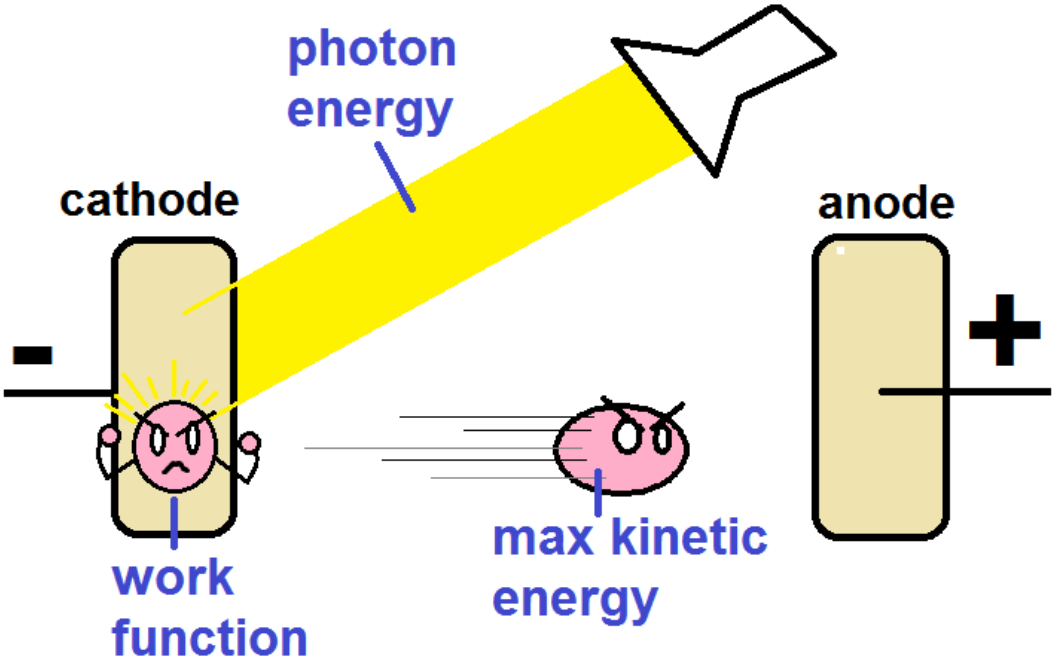
*(Using threshold frequency, we can find the **work function, W** = for photoelectric effect to happen)*

$W = hf_0$
W = fungsi kerja *(work function)* **h** = pemalar Planck (*Planck constant)* **f_0** = frekuensi ambang (threshold frequency)

5. Hubungan tenaga foton, fungsi kerja, & tenaga kinetik maksimum *(Relationship between photon energy, work function, & max kinetic energy)*

Tenaga foton	**= Fungsi kerja**	**+**	**Tenaga kinetik maksimum**
(Photon energy	***= Work function***	**+**	***Max kinetic energy)***

$$hf = hf_0 + \tfrac{1}{2} mv_{max}^2$$



h = pemalar Planck (*Planck constant)*

f = frekuensi gelombang cahaya *(light wave frequency)*

$\mathbf{f_0}$ = frekuensi ambang (threshold frequency)

m = jisim fotoelektron *(mass of photoelectron)*

$\mathbf{v_{max}}$ = halaju fotoelektron maksimum *(maximum velocity of photoelectron)*

6. Maka, kita boleh buat kesimpulan bahawa dlm fenomena kesan fotoelektrik:

Tenaga foton bertukar menjadi fungsi kerja & tenaga kinetik fotoelektron

(So, we can deduce that in the phenomenon of photoelectric effect:

Photon energy is converted into work function & maximum kinetic energy of photoelectron)

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