$100 cm^2 = 10 cm \times 10 cm$
$= 0.1 \times 0.1$
$= 0.01$

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National Junior College
JC2 Physics Topical Quiz 4
Quantum Physics

Name: Tan Zhi Yong **Marks:** /25
Reg. No: 03SGH124 **Time:** 20 mins

1a. Explain what is meant by the work function of a metal surface. [1]

The minimum amount of energy required for one electron to be ~~emitted~~ ejected from the surface of the metal.

b. Light from a distant star has a mean wavelength of 6.00 x 10^{-7} m and arrives at the Earth with a power of 3.00 x 10^{-9} W on each square metre of surface. Calculate the following.

arrrr!!

(i) the photon energy; [2]

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

Intensity $= 3.00 \times 10^{-9}\ Wm^{-2}$

$E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{6.00 \times 10^{-7}}$

$= 3.32 \times 10^{-19}\ J$ (3s.f)

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(ii) the number of photons arriving per second on a photocell with an area of 100 cm^2. [2]

$P = nhf$

$n = \frac{P}{hf}$

$= \frac{3.00 \times 10^{-9}}{3.315 \times 10^{-19}}$

$I = \frac{N(hf)}{A \cdot t}$

$= 9.05 \times 10^{9}$

Number of photons per second on $100 cm^2 = \frac{9.050 \times 10^{9}}{0.01} \times 0.01$

$= 9.05 \times 10^{11}$ photons

X.

(iii) the photoelectric current produced if a photon has a 1 in 10 chance of producing a photoelectron. [2]

Current

$= 9.05 \times 10^{11} \times \frac{1}{10} \times 1.6 \times 10^{-19}$

$= 1.45 \times 10^{-8}\ A$ (3s.f)

ecf 2

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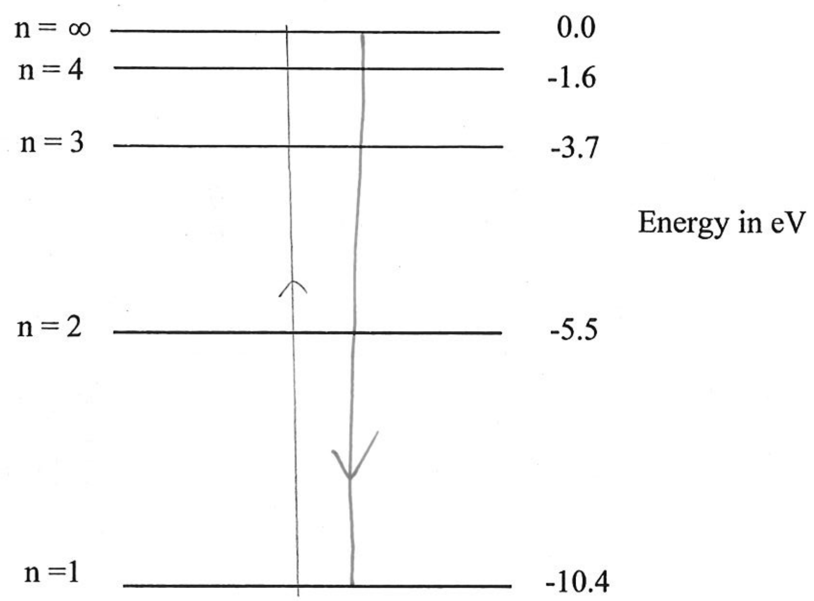
2. Some of the energy levels of the mercury atom are shown in the following diagram.



a. Indicate on the diagram above the transition that results in the shortest wavelength when a photon is emitted. Calculate this wavelength. [3]

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

$E \propto \frac{1}{\lambda}$ $= \frac{6.67\times10^{-34}\times3.0\times10^{8}}{\cancel{1.6\times1.6\times10^{-19}}\ \cancel{1.6\times8}\ 8.8\times1.6\times10^{-19}}$

$\uparrow E, \downarrow\lambda$ $= \cancel{\ldots}\ 1.42\times10^{-7}\ m$ (3s.f) X

b. Distinguish between excitation and ionisation of the mercury atom. State the ionisation energy of mercury. [3]

Atom is excited when electrons are promoted to a higher energy level when they absorb energy of photons.
Ionisation occurs when electrons are emitted from the atom as the photon energy is higher than work function of metal. X
Ionisation energy of mercury = 10.4 eV
~~M~~

(2)

c. What is the minimum amount of energy retained by the bombarding electron after a mercury atom in the ground state has a collision with an electron of energy

(i) 5.0 eV and

~~All energy is retained as electrons of mercury atom cannot be are not promoted to higher energy levels.~~

Min energy retained $= 5 - (-5.5 - (-10.4))$

$= 0.1$ eV

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(ii) 10.0 eV? [2]

Electrons of mercury atom can be promoted to $n=4$ at most.

Energy retained by bombarding electron ~~$= 10 - 1.6 - (-10.4)$~~

$= 10 - (-1.6 - (-10.4))$

$= 1.2$ eV

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d. A photon of energy E collides with a mercury atom. What would happen if

(i) E = 4.9 eV?

All energy of photon is absorbed by ~~electrons of mercy~~ an electron of the mercury atom and the electron is promoted to energy level $n=2$.

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(ii) E = 8.0 eV? [3]

~~$E_k = hf - \phi$~~

Nothing happens as the photon energy must be exactly the same as the difference in energy between energy levels. No electrons are promoted to higher energy levels.

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e. Describe what happens after an electron in the atom has been excited to a higher energy level. [2]

The electron may fall back to a lower energy level ~~again~~ and emit a photon with the same amount of energy ~~with~~ as the difference in the initial and final energy levels.

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