Name.....MARKING SCHEME.....Adm No.....Class.....

KISII SCHOOL
FORM 4G PHYSICS RAT 9
TERM ONE 2020
Time: 30 minutes

PHOTOELECTRIC EFFECT

1. (a) Explain what is meant by the term *photoelectric emission.* (1 mark)

This is the process through which electrons are emitted from a metal surface when the surface is radiated with an electromagnetic radiation of sufficient frequency. ✓

(b) State the meaning of the following terms as used in photoelectric emission.

(i) threshold frequency. (1 mark)

This is the minimum frequency of a radiation below which emission of photoelectrons will not occur from a metal surface. ✓

(ii) threshold wavelength. (1 mark)

This is the maximum wavelength of a radiation beyond which emission of photoelectrons will not occur from a metal surface. ✓

(iii) Work function. (1 mark)

This is the minimum amount of energy of a radiation needed to dislodge an electrons from a metal surface. ✓

2. It is observed that when ultra-violet radiation is directed onto a clean zinc plate connected to the cap of a negatively charged leaf electroscope, the leaf falls.

(i) Explain this observation. (2 marks)

– Ultra-violet radiation emits photoelectrons from the zinc plate, and since the zinc plate is negatively charged, the photoelectrons are repelled. ✓
– This makes the electroscope to be discharged and the leaf divergence decreases. ✓

(ii) State why this observation does not occur if the electroscope is positively charged. (1 mark)

This is because when ultra-violet radiation emits photoelectrons from the zinc plate, the photoelectrons are immediately attracted back since the zinc plate is positively charged, hence there is no effect on the leaf divergence of the electroscope. ✓

(iii) Explain why the leaf of the electroscope does not fall when infra-red radiation is directed onto the zinc plate. (1 mark)

Infra-red radiation does not have sufficient frequency or energy to dislodge (emit) electrons from the surface of the zinc plate. ✓

3. A surface whose work function, $\phi = 6.4 \times 10^{-19}$ joules is illuminated with light of frequency 3.0×10^{15} Hz. Find the maximum Kinetic energy of the emitted photoelectrons. (Take Planck's constant, $h = 6.63 \times 10^{-34}$ joules second) (3 marks)

$E = W_o + K.E.$

$hf = W_o + K.E.$ ✓

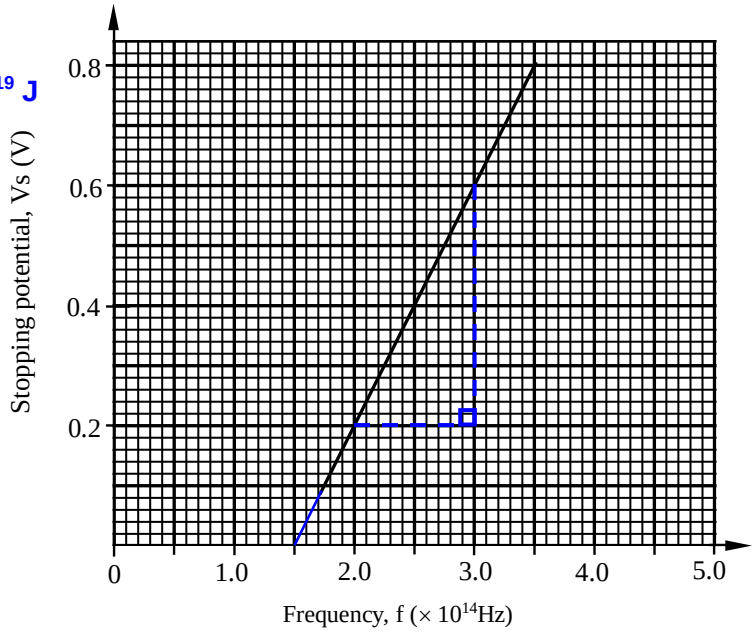
$6.63 \times 10^{-34} \times 3.0 \times 10^{15} = 6.4 \times 10^{-19} + K.E.$ ✓

$1.989 \times 10^{-18} = 6.4 \times 10^{-19} + K.E.$

$K.E. = 1.349 \times 10^{-18}$ J ✓

4. The figure below shows a graph of stopping potential, Vs against frequency, f, in an experiment on photoelectric effect.

Please note that:
1 eV = 1.6×10^{-19} J



Rewrite Einstein's Equation in the form y = mx + c:

$hf = W_o + K.E.$

$\Rightarrow hf = W_o + eV$

$\Rightarrow eV = hf - W_o$

$\Rightarrow \frac{eV}{e} = \frac{hf}{e} - \frac{W_o}{e}$

$\Rightarrow V = \frac{h}{e} f - \frac{W_o}{e}$

Gradient $= \frac{h}{e}$

V-intercept $= -\frac{W_o}{e}$

Determine from the graph:

(i) the Planck's constant. (5 marks)
(Take Charge of an electron, **e = 1.6×10^{-19} C**)

$h = \text{gradient} \times e$ ✓

$h = \frac{\Delta V}{\Delta f} \times e$ ✓

$h = \frac{0.6 - 0.2}{(3.0 - 2.0) \times 10^{14}} \times 1.6 \times 10^{-19}$ ✓ ✓

$h = 6.4 \times 10^{-34}$ Js ✓

(ii) the work function of the metal surface in electron volt. (4 marks)

Threshold frequency = Horizontal axis intercept (frequency intercept)

$f_o = 1.5 \times 10^{14}$ Hz ✓

$W_o = hf_o$ ✓

$W_o = 6.4 \times 10^{-34} \times 1.5 \times 10^{14}$ ✓

$W_o = 9.6 \times 10^{-20}$ J

$= 0.6$ eV ✓