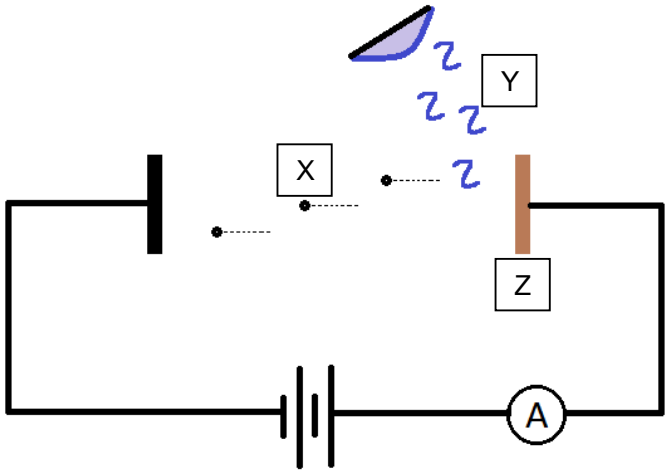
Section Two: Problem-solving **50% (90 Marks)**

This section has **seven (7)** questions. You must answer **all** questions. Write your answers in the space provided. Suggested working time for this section is 90 minutes.

Question 14 **(13 marks)**

The equipment below is used in an experiment to test the particle nature of light.



(a) The part "Y" is the monochromatic light. Name and describe the function of the parts labelled "X" and "Z" (4 mark)

Label	Name	Description of function/behaviour
X	Photoelectrons	Carriers of the electric current, moving from one plate to another
Z	Photoemmisive plate/emitter plate/target metal/photocathode	Releases photoelectrons when hit by incident light

1 mark each entry

(b) Describe what the "work function" means in the context of this experiment. (2 marks)

It is the minimum energy required to remove an electron from the metal 1-2

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(c) To test for the particle nature of light, the light source is monochromatic (i.e.: consisting of a single colour). If the frequency of the light is decreased, photocurrent will halt. Explain how this observation supports the particle model of light: (3 marks)

The wave model predicts that the intensity of light should be the determining factor as to whether or not photoelectrons are ejected, not frequency. 1

The fact that a threshold frequency exists can be explained using bundles of light (photons), transferring their energy to the electrons upon collision with them. The energy of each photon is proportional to the frequency of the light (E=hf) 1

If this energy (frequency) is too low, electrons will not gain sufficient energy to escape the 'potential well'. As this is what we observe with the Photoelectric effect, it supports the particle model for light. 1

Or similar…

(d) Calculate the minimum voltage required between the two plates to ensure the ammeter detects zero current when the wavelength of the incident light is 345 nm and the work function is 1.50 eV (i.e. find the stopping voltage). (4 marks)

Energy of light

$E = hf = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{345\times10^{-9}} = 5.765 \times 10^{-19}\ J$ 1-2

Converts energy into eV (or eV into J)

$E = \frac{5.765\times10^{-19}}{1.60\times10^{-19}} = 3.603\ eV$ 1

Find stopping voltage via kinetic energy

$E_k = E_{light} - W$

$E_k = 3.603 - 1.50 = 2.103\ eV$

$1\ eV\ caused\ by\ 1\ V\ potential\ difference\ for\ fundamental\ charge$

Stopping voltage is 2.10 V 1