G PHOTONS AND ELECTRONS

UNIT 1 PHOTOELECTRIC EFFECT

Experiment 17 (demonstration): Page 481

Aim: To investigate the photoelectric effect.

Investigative question:
What type of electromagnetic radiation can release electrons from a negatively charged metal surface?

Hypothesis:
Electromagnetic radiation that possess higher energy, will release photons from the surface more easily.

Variables:

Independent variable (Which is changed.)	**Dependent variable** (Which is measured.)	**Controlled variable(s)** (Which remain(s) the same.)
Type of radiation: UV or white light	**Discharge or not.**	**Zinc, type of charge**

Answer the following questions:

1. Why is it necessary to sand the can lightly?
The aluminium can is painted with a thin layer of paint. The layer of paint prevents the electrons from being emitted from the metal surface.

2. What happens to the foil strips if you touch it with the PVC pipe?
The strips lift up, away from each other.

3. Explain your observation.
The strips of the foil are charged negatively and like charges repel.

4. What do you observe when the can is irradiated with the UV light?
The foil strips move closer to each other.

5. Explain your observation.
The UV light causes electrons to be emitted from the metal surface. The foil strips are discharged.

6. The foil strips are now **positively charged** by means of induction. If you irradiate the can with the UV light now, what do you observe?
The foil strips keep repelling each other and do not fall flat again.

7. Explain your observation.
The UV light cannot supplement the shortage of electrons. Electrons are removed during the photoelectric effect from the metal surface, not added.

8. It is very important not to look directly into the UV light. Explain why it is bad for your eyes.
UV light has a high frequency and the waves have high energy. The energy will damage your eyes.

Repeat the experiment with negatively charged foil strips, but shine the light of an ordinary light bulb on the can.
9. What do you observe?
The foil strips keep repelling each other and do not fall flat again.

10. Explain your observation.
The energy of the visible light waves is not sufficient to cause the electrons to be emitted from the metal surface. The frequency of the photons of visible light is too small.

11. Do you think your observation will change if you use a light bulb with a greater brightness, e.g. 100 W?
No

12. Explain your answer.
An increased intensity, or brightness, means more photons reach the metal surface, but the frequency of the photons remains the same. Therefore the energy of each photon remains the same and it is still not enough. An electron cannot accumulate the energy of many photons until it has enough energy to break free. One photon of the correct frequency and therefore energy, must give all its energy to one electron.

Exercise 31: Page 492

1.1 What is the effect of different frequencies of light on an uncharged electroscope?

1.2 Only certain frequencies (colours) of light will therefore cause the electrons to be emitted, charging the zinc plate and causing the leaves of electroscope to lift.

1.3 The electroscope's foil leaves will not lift.

1.4 The electroscope's foil leaves will lift.

1.5 Ultraviolet light has a higher frequency and therefore higher energy. The photons transfer enough energy to the electrons to be emitted from the orbitals. It means the zinc plate on the electroscope emits photoelectrons and the sheet gains a positive charge, so the rod and foil leaves repel each other. Ordinary light does not supply enough energy to the electrons and the electroscope is not charged.

1.6 The electroscope has a positive charge because electrons have been removed and the foil sheets repel each other. It was not the lamp itself that had charge, but the zinc that gained charge.

1.7 Positive