Particles and Waves

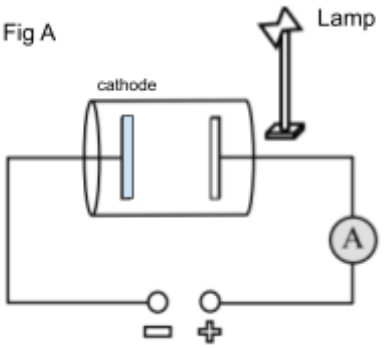
Particle Wave Duality: The photoelectric effect.

Planck's constant = 6.63×10^{-34} Js

1. Calculate the energy of a photon of light with frequency 6.00×10^{14} Hz [3.98×10^{-19} J]	2. Calculate the energy of a photon of light with wavelength 700 nm [2.98×10^{-19} J]
3. A photon of light has an energy of 4.97×10^{-19} J Calculate the wavelength of the photon. [400 nm]	4. A photon of light has an energy of 9.95×10^{-19} J Calculate the frequency of the photon. [1.50×10^{15} Hz]
5. Calculate the energy of a photon of light with wavelength 550 nm [3.62×10^{-19} J]	6. Find the energy of a photon of microwave radiation that has wavelength 3.0 cm [6.6×10^{-24} J]

7) In figure A a lamp shining light of a certain frequency is shone through a glass tube onto a metal at the cathode. The metal has a work function of 3.65×10^{-19} J

Fig A



a) State what is meant by the ***work function*** of the metal

b) When a particular frequency of light is used the ammeter reads zero amps
Explain why the ammeter reading is zero.

c) The frequency of light is changed to 1.00×10^{15} Hz.
Determine whether this frequency ejects electrons from the metal, if so calculate the maximum kinetic energy of the ejected electrons.

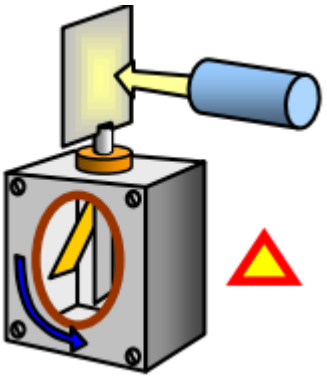
8) A photon of frequency 1.36×10^{17} Hz is incident on sheet of gold which has a work function of 7.82×10^{-19} J

a) Calculate the energy of the photon and determine whether electrons are ejected from the gold metal.
b) Calculate the maximum kinetic energy of the photoelectrons.

9) Use your knowledge of the photoelectric relationships to solve these problems.

(a) A photon of frequency 1.81×10^{17} Hz is incident on sheet of platinum which has a work function of 1.01×10^{-18} J Calculate the energy of the photon and state whether it will eject an electron from the surface of platinum. [1.20×10^{-16}J, yes]	(b) A photon of frequency 4.52×10^{14} Hz is incident on sheet of clean sodium which has a work function of 3.71×10^{-19} J Calculate the energy of the photon and state whether it will eject an electron from the surface of sodium. [3.00×10^{-19}J, No]
(c) A photon has a frequency of 8.50×10^{14}Hz strikes the surface of a piece of calcium metal. The threshold frequency of calcium metal is 7.00×10^{14} Hz. Calculate the energy of the photon, the work function of calcium and the maximum kinetic energy of the photoelectron. [5.64×10^{-19} J, 4.64×10^{-19}J, 9.96×10^{-20} J]	(d) The threshold frequency of a metal is 8.90×10^{14} Hz. A photon of frequency 9.35×10^{14}Hz strikes the surface. Calculate the energy of the photon, the work function of the metal and the maximum kinetic energy of the photoelectron. [6.20×10^{-19} J, 5.90×10^{-19} J, 2.99×10^{-19} J]
(e) The work function of a metal is 7.39×10^{-19} J. A photon of frequency 1.36×10^{17} Hz strikes the surface. Calculate the maximum kinetic energy of the ejected electron. [8.94×10^{-17} J]	(f) The work function of a metal is 4.6×10^{-19} J Calculate the minimum frequency of a photon that will eject an electron from the surface of the metal. [6.94×10^{14} Hz]

10) Ultraviolet light is shone onto the zinc metal cap of an electroscope.



a) In one experiment the electroscope charge was given an unknown electric charge. When ultraviolet light was shone on it the gold leaf did not fall.
Explain why the gold leaf did not fall.

b) The electroscope was discharged and charged with another charge. The electroscope was discharged using a small irradiance ultraviolet light source, State the charge on the electroscope's zinc cap.

c) State, and give a reason, whether a large irradiance white light lamp would discharge situations a) or b).