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# Quantum Physics

**Q1.** Radio waves from a certain station have a wavelength of 25m. Determine the energy of a photon of a radio wave. (ans: $7.96 \times 10^{-27}$ J)

**Q2.** Given that the mass of an electron is $9.11 \times 10^{-31}$ kg, determine the de Broglie's wavelength of an electron moving with a velocity of $3 \times 10^{7}$ $ms^{-1}$ (ans: $2.43 \times 10^{-11}$ m)

**Q3.** A neon bulb of 65 W radiates light with a wavelength of 648 nm. How many photons are emitted in one second? (ans: $2.12 \times 10^{20}$ $s^{-1}$)

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**Q4.** A beacon emits red light of frequency 400 THz. If $3.5 \times 10^{16}$ photons are emitted at millisecond intervals, determine power of the light source. (ans: 9.28 W)

**Q5.** If the work function for gold is $8.155 \times 10^{-20}$ J, what is the minimum frequency of light irradiated on the surface of gold that will emit photo electrons? (ans: $1.23 \times 10^{14}$ Hz)

**Q6.** A metal surface is illuminated by photons of energy 4.0 eV and emits photoelectrons of maximum velocity $2.0 \times 10^{5}$ $ms^{-1}$. What is the maximum wavelength of the incident light wave that will emit electrons from the metal surface? (ans: $3.199 \times 10^{-7}$ m)

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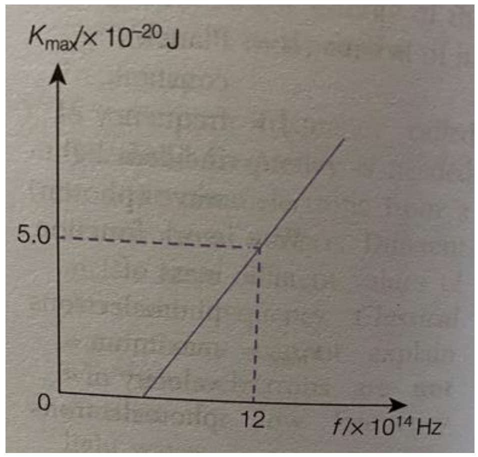
**Q7.** The graph below shows the variation of maximum KE of a photoelectron emitted from a metal surface with the frequency of light incident on the metal surface. Determine the work function and threshold frequency of the metal. (ans: W = $7.456 \times 10^{-19}$ J, $f_0$ = $1.125 \times 10^{15}$ Hz)



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## Q8.

Photoelectrons of maximum KE 1.02 eV are emitted when a monochromatic light of wavelength 550 nm is incident on a metal surface. The maximum KE energy becomes 1.35 eV when a light of 480 nm is used.

a) Deduce the value of Planck's constant. $6.64 \times 10^{-34}$ Js)
b) Determine the work function of the metal in units of eV. (ans: 1.24 eV)

## Q9. A photon of green light has a wavelength of 475 nm. Calculate

a) The frequency of the light. [2 marks]
b) The energy of the photon in [4 marks]
   i) Joules
   ii) eV

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## Q10.

a) Briefly explain the concept of wave-particle duality. [2 marks]
b) An electron is accelerated across a potential difference of 5 kV. What is de Broglie's wavelength of the electron? [2 marks]
c) What will happen to the wavelength in 2b) if the accelerating potential increases? Suggests how this would influence the operating potential and magnification power of an electron microscope. [ 2 marks]

## Q11.

The maximum wavelength of light to emit photoelectrons from sodium is 650 nm. In order for photoelectric effect to take place, a monochromatic light of wavelength 450 nm is used to Illuminate the surface of the sodium.

a) Determine the threshold frequency of sodium [2 marks]
b) Determine the maximum KE of the photoelectrons emittted [2 marks]
c) Suggests a way to measure the maximum KE of the photoelectrons [5 marks]

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Q9 ans:

a) $6.32 \times 10^{-14}$ Hz
b) $4.19 \times 10^{-19}$ J
c) 2.62 eV

Q10 ans:

a) EM wave such as light can behave as particles like photon as its energy is quantized.
Particles such as electrons can behave as wave as electron beam experience wave phenomenon such as diffraction.
Thus, waves behave as particles under certain condition and particles as waves vice versa.
b) $1.74 \times 10^{-11}$ m
c) Wavelength of the electron decreases when the accelerating potential increases.
Hence, electron microscope is operated at high potential so that it has higher power of magnification.

Q11 ans:

a) $4.615 \times 10^{14}$ Hz
b) $1.36 \times 10^{-19}$ J
c) A photocell circuit can be used to measure the maximum kinetic energy of the photoelectrons.
A reverse potential is connected across the photocell.
The potential difference across the photocell is adjusted until no current flows in the circuit.
At this instant, the photoelectrons with maximum kinetic energy are stopped.
Assuming that energy is conserved, the maximum kinetic energy of the photoelectrons is equal to the electric potential energy supplied to the photocell.