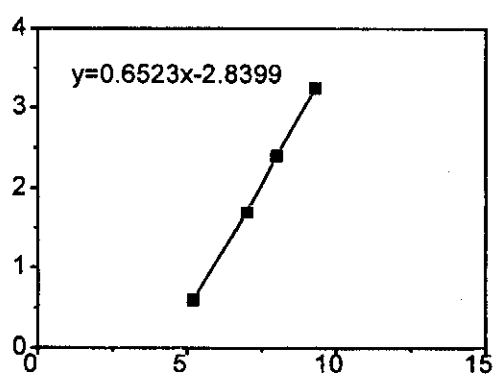
1. (a) The following graph shows the experimental results of shining light of different frequency on a metal surface (x-axis). This effect is known as the photoelectric effect. From the observed linear relationship, **which of the following choices** could be the property displayed on the y-axis: _____. (5%)

A. kinetic energy of electron in 10^{-19} Joule
B. electron current in 10^{-9} Ampere
C. electron speed in 10^{5} m/s?



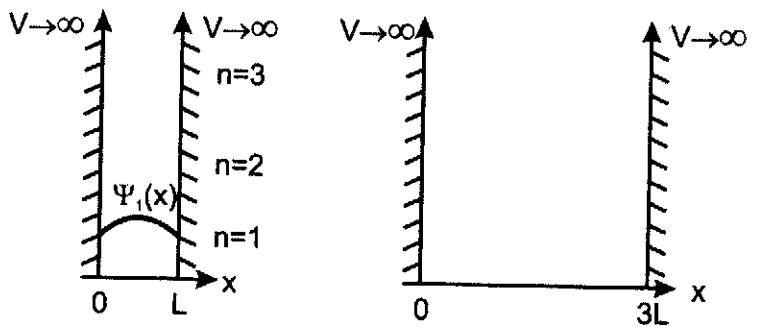
(b)According to the fitted results of the plot y=0.6523x-2.8399,(x in units of 10^{14} Hz) **which of the following materials** could have been used in this experiment: _____(5%)

Materials	Work function (eV)	Density [g/cm^3]
Copper (Cu)	4.35	8.94
Sodium (Na)	1.82	0.98
Platinum (Pt)	5.10	21.45

(c) During the photoelectric experiments, what maximum energy could an emitted electron have if light of 188 nm wavelength was incident on a Platinum surface. _____(eV). (5%)
What is the corresponding speed of the emitted electron_____(m/s). (5%)

Planck constant (h) : 6.6×10^{-34} J·s
Elementary charge (e): 1.6×10^{-19} C
Electron rest mass (m_e): 9.1×10^{-31} kg
speed of light (c): 3×10^{8} m/s

2. Consider the two infinite potential wells, displayed in the figures below:



Left: infinite potential well, size ***L***.　***Right***: Infinite potential well, size ***3L***.

For the potential well on the left, where there are infinite barriers at x = 0 and x = L and with V (x) = 0 in between, the time-independent wavefunction and average energy of each state n is

$$\varphi_n(x) = \sqrt{\frac{2}{L}}\,\mathrm{Sin}\left(\frac{n\pi}{L}x\right); \quad E_n = n^2\frac{\hbar^2\pi^2}{2mL^2}$$

(a) What happens to the ground state energy (n=1) if the well size is increased to 3L? (5%)

A. $E_{n=1}(3L)/\,E_{n=1}\,(1L)=3$

B. $E_{n=1}(3L)/\,E_{n=1}\,(1L)=1/3$

C. $E_{n=1}(3L)/\,E_{n=1}\,(1L)=9$

(b) How does the energy difference between neighboring states change in the case of an infinitely wide well? (5%)

Ans: _____.

(c) calculate the ground state (n=1) of an electron in such infinite wall when L= 5nm, in (eV)

Ans: _____ (eV). (5%)

(d) What is the ground state energy for a 3-dimensional quantum well of the same dimensions as a 1-dimensional well? Ans: _____. (5%)

A. $E_{n=1}(3D)/\,E_{n=1}\,(1D)=1$

B. $E_{n=1}(3D)/\,E_{n=1}\,(1D)=3$

C. $E_{n=1}(3D)/\,E_{n=1}\,(1D)=9$

3.The energy levels of the orbits in the Bohr model of the hydrogen atom are given by

$$E_n = \frac{1}{n^2}\frac{-q^4 m_e}{2(4\pi\epsilon_0)^2\hbar^2}$$

If ground state energy is 13.6 eV, what is the **Energy** of the **photon** required to excite an electron from n=1 to n=3 in units of eV? (a)_____(eV). (5%) ; what is the wavelength of the photon needed in units of nanometers. (b)_____(nm). (5%)

4. Explain the following terms briefly:

(a). Fermi energy (5%)

(b). Doppler effect (5%)

(c). Uncertainty principle (5%)

(d). Light-emitting diode (5%)

5. What is the basic physical principle responsible for the presence of energy bands rather than specific energy levels in a solid? (10%)

6. Sunlight arrives at the earth at the rate of about 1.4 kW/m^2 when the sun is directly overhead. The average radius of the earth's orbit is $1.5x10^{11}$ m and the radius of the sun is $7.0x10^8$ m. From these figures find the surface temperature of the sun on the assumption that it radiates like a blackbody, which is approximately true. (20%)