Result:

1. Assuming intensity of light corresponds with amplitude of light waves explains result 2, but not results 1 and 3.
2. If light comes in quanta with energy per quantum = $h\nu = hc/\lambda$, and if it requires a certain quantity of energy to expel an electron from a metal surface then all three observations can be explained. (Write your explanation before clicking “solution” to see ours.)
3. Minimum energy is 3.7×10^{-19} J.
4. The assumption that some minimum quantity of energy is required to eject an electron from a metal surface can be tested by trying different metals. All metals should have some minimum frequency below which electrons are not ejected (or maximum wavelength above which electrons are not ejected).

Solution:

1. If intensity of light corresponds with amplitude of waves it is reasonable to expect that the more intense the light the greater the number of electrons emitted. Greater number of electrons corresponds with greater current so increasing intensity is expected to correspond with greater electron current (observation 2).
   However, this idea should apply to all wavelengths. For water waves of the same height (amplitude), a boat will rise and fall just as much if the waves arrive at 10 per minute as if they arrive at 2 per minute. Thus, the frequency (or wavelength) should not affect the emission of electrons. This contradicts observations 1 and 3. In observation 1 only wavelengths shorter than 540 nm produce current. In observation 3 only frequencies higher than about 6×10^{14} Hz (based on the graph y-intercept) cause electrons to be emitted.
2. The assumption that light comes in quanta with energy per quantum = $h\nu = hc/\lambda$ together with the assumption that a small quantity of energy is required for each electron to be emitted implies that only light quanta above that small quantity of energy can cause electron emission. Thus, only a light quantum with large enough frequency (or small enough wavelength) can cause emission; smaller frequencies (or longer wavelengths) have insufficient energy per quantum to separate an electron from an atom in the metal surface.
3. $E = h\nu = hc/\lambda = (6.626 \times 10^{34}\text{ J s})(2.998 \times 10^{8}\text{ m s}^{-1}) / (539 \times 10^{-9}\text{ m}) = 3.69 \times 10^{-19}\text{ J}$
4. Using the simulation you can verify that the metals have different maximum wavelengths above which no electrons are emitted. In order of decreasing maximum wavelength the metals are sodium > calcium > zinc > copper > platinum.
   You can also notice in the simulation that electrons are emitted with higher speeds as the wavelength decreases. This can be interpreted this way: a light quantum with shorter wavelength has higher energy than a quantum with longer wavelength; some of that energy is used to cause an electron to be emitted and the rest of the energy provides the kinetic energy of the emitted electron, which depends on the square of the speed of the electron: greater kinetic energy gives greater speed.