Photons Assignment 1 NAME_____

1. Explain how a photographic plate and very low light conditions can be used to show the existence of photons. /2

2. A light source has a wavelength of 4.50×10^{-7} m.
   a) Calculate the energy of the photons the source would produce. /2
   b) Calculate the magnitude of the momentum of the photons. /2

3. Draw a diagram showing how two-slit interference patterns build up over time when light of very low intensity is used. /2

4.
   a) Describe an experimental method for investigating the relation between the maximum kinetic energy of the emitted electrons (calculated from the measured stopping voltage) and the frequency of the light incident on a metal surface. /4

   b) A group of pterosaurs are developing metal shields in an attempt to protect their eyes from lasers. They are experimenting with various metals because they are sensitive to electricity, and in order to minimise damage they need a work function of at least 1.0eV.
   They are performing the experiment on some metal, using incident light with a frequency of 6.0×10^{14} Hz.
   (i) Calculate, in eV, the energy of the incident photons. /2
   (ii) If the stopping voltage is recorded as 1.49V, use calculations to show whether the work function is high enough. /3

   c) The intensity of the light is then increased, but its frequency remains the same.
   (i) State and explain the effect this change would have on the current. /2
   (ii) State whether the change in intensity of light would affect the previously measured stopping voltage. /1

5. Describe how Einstein used the concept of photons and the conservation of energy to explain the photoelectric effect. /4

TOTAL /24

Photons Assignment 2 NAME_____

1. An experiment is conducted, in which a number of different frequencies of light are incident on a metal plate, and the maximum kinetic energy of the electrons K_{max} is determined, as summarised in the table below:

Incident frequency ($\times 10^{14}$ Hz)	K_{max} ($\times 10^{-19}$ J)
11.8	2.60
9.90	1.81
8.20	1.10
6.90	0.57

a) Plot these results on a graph of K_{max} versus incident frequency and draw the line of best fit. /3

b) Using the line of best fit that you have drawn on the graph:

(1) state the value of the threshold frequency f_0 of the the metal plate P and mark its position on the graph. /1

(2) state the value of the work function W of the metal plate and mark its position on the graph. /1

(3) show how the equation $K_{max} = hf - W$ can be deduced. /1

2.

a) Draw a labelled diagram of an X-ray tube. /3

b) Explain how the device produces X-rays. /2

c) State two desired properties of the target material. /1

d) State why the target needs to be cooled. /1

e) Sketch a graph of the spectrum produced. /2

f) State a reason for each of the following features of the spectrum:

(1) continuous range of frequencies /1

(2) maximum frequency /1

3.

a) Derive the equation for the maximum frequency, $f_{max} = e\Delta V/h$, where ΔV is the potential difference across the X-ray tube. /2

b) Hence calculate the potential difference required for an X-ray tube to produce photons with a maximum frequency of 3.00×10^{17} Hz. /2

4.

a) State three properties of a substance that have an effect on the attenuation of X-rays. State the effect each property has on the attenuation. /3

b) State the effect increasing the potential difference across an X-ray tube will have on the emitted X-rays. /1

c) Explain why a higher filament current produces a clearer image. /1

TOTAL /26