[4]

[2]

A4. (a) photoelectric current / rate of emission independent of frequency;
photoelectric current / rate of emission depends on intensity of radiation;
(max) kinetic energy of electron dependent on frequency;
existence of threshold frequency;
instantaneous ejection;
etc.; ***[3 max]***

(b) (i) $hf = hf_0 + eV_s$;
Accept φ *instead of* hf_0.
identifies h and e;
identifies f_0 / φ; ***[3]***

(ii) re-arranging, $V_s = \frac{h}{e} \times f - \frac{h}{e} \times f_0$;

compares with $y = mx + c$ and hence gradient $\frac{h}{e}$; ***[2]***

(iii) $f_0 = 0.96 \times 10^{15}$ Hz;
work function $= 6.6 \times 10^{-34} \times 0.96 \times 10^{15}$
$= 6.3 \times 10^{-19}$ J / 3.9 eV; ***[2]***

A4. (a) all particles have a wavelength associated with them / *OWTTE*;
the de Broglie hypothesis gives the associated wavelength as $\lambda = \frac{h}{p}$;
where h is the Planck constant and p is the momentum of the particle; ***[3]***
*If answers just quote the formula from the data book then award **[1]** for showing at least they recognize which formula relates to the hypothesis.*

(b) (i) $\text{KE} = Ve = 850 \times 1.6 \times 10^{-19}\ \text{J} = 1.4 \times 10^{-16}\ \text{J}$; ***[1]***

(ii) use $E = \frac{p^2}{2m}$ to get $p = \sqrt{2mE}$;
substitute $p = \sqrt{2 \times 9.1 \times 10^{-31} \times 1.4 \times 10^{-16}} = 1.6 \times 10^{-23}\ \text{N s}$; ***[2]***

(iii) $\lambda = \frac{h}{p}$;
substitute $\lambda = \frac{6.6 \times 10^{-34}}{1.6 \times 10^{-23}} = 4.1 \times 10^{-11}\ \text{m}$; ***[2]***