TZDII 13.48) a) Using Drude's formlua and known conductivities of metals, make an order of magnitude estimate of the collision time
b) Compute the thermal speed of electrons at room temperature
c) Compute the mean-free-path & compare to lattice spacings.

k =	1.38E-23	J/K	T_{room} =	20 °C	=	293.15 K
$m_{electron}$ =	9.11E-31	kg	e =	1.60E-19	C	
σ_{Ag} =	6.21E+07	Ωm	n_{Ag} =	5.86E+28	m^{-3}	
σ_{Cu} =	5.88E+07	Ωm	n_{Cu} =	8.47E+28	m^{-3}	
σ_{Al} =	3.65E+07	Ωm	n_{Al} =	1.81E+29	m^{-3}	
σ_{Pb} =	4.80E+06	Ωm	n_{Pb} =	1.32E+29	m^{-3}	

a) Drude's equation gives

$$\tau = \frac{m\sigma}{ne^2}$$

$$\tau_{Ag} = \frac{m_e\sigma}{ne^2} = \frac{5.66E\text{-}23}{1.50E\text{-}09} = 3.76E\text{-}14 \text{ s}$$

$$\tau_{Cu} = \frac{m_e\sigma}{ne^2} = \frac{5.36E\text{-}23}{2.17E\text{-}09} = 2.46E\text{-}14 \text{ s}$$

$$\tau_{Al} = \frac{m_e\sigma}{ne^2} = \frac{3.33E\text{-}23}{4.65E\text{-}09} = 7.16E\text{-}15 \text{ s}$$

$$\tau_{Pb} = \frac{m_e\sigma}{ne^2} = \frac{4.37E\text{-}24}{3.39E\text{-}09} = 1.29E\text{-}15 \text{ s}$$

b) For a classical gas at 20° C

$$v_{rms} = \sqrt{\frac{3kT}{m_e}}$$

$$v_{rms} = 1.15E{+}05 \text{ m/s}$$

c) The mean-free-path is

$$x_{mfp} = v_{rms}\tau$$

$x_{mfp,\,Ag} = v_{rms}\tau_{Ag} =$ 4.34E-09 m = 4.342 nm = 10.6 λ_{Ag}

$\lambda_{Ag} =$ 0.41 nm

$x_{mfp,\,Cu} = v_{rms}\tau_{Cu} =$ 2.84E-09 m = 2.844 nm = 7.9 λ_{Cu}

$\lambda_{Cu} =$ 0.36 nm

$x_{mfp,\,Al} = v_{rms}\tau_{Al} =$ 8.26E-10 m = 0.826 nm = 2.1 λ_{Al}

$\lambda_{Al} =$ 0.40 nm

$x_{mfp,\,Pb} = v_{rms}\tau_{Pb} =$ 1.49E-10 m = 0.149 nm = 0.3 λ_{Pb}

$\lambda_{Pb} =$ 0.495 nm

For silver, copper, and aluminum the mean-free-paths computed here are larger than the interatomic spacing. For Lead, though, it's oddly smaller … both show Drude's model does not quite describe reality.