

Prof. D.D.L. Chung

Homework No. 7

SOLUTION

Problem 1

(24%)

(a)

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1})}{1.602 \times 10^{-19} \text{ J}\cdot\text{eV}^{-1} \lambda}$$

where E is in eV and λ is in m. Hence,

$$E = \frac{1.24 \times 10^{-6}}{\lambda} \text{ eV} \quad (\lambda \text{ in m})$$

$$\text{AuK}\alpha_1 : 68.815 \text{ keV}$$

$$\text{AuK}\alpha_2 : 67.00 \text{ keV}$$

$$\text{GeK}\alpha_1 : 9.888 \text{ keV}$$

$$\text{GeK}\alpha_2 : 9.856 \text{ keV}$$

$$\text{AuK}\beta_1 : 77.99 \text{ keV}$$

$$\text{AuL}\alpha_1 : 9.715 \text{ keV}$$

$$\text{GeK}\beta_1 : 10.98 \text{ keV}$$

$$\text{GeL}\alpha_1 : 1.188 \text{ keV}$$

(20%)

$$(b) \text{AuL}\alpha_1 : \lambda = 1.27640 \text{ \AA}$$

$$d_{111}^{\text{Ge}} = \frac{a^{\text{Ge}}}{\sqrt{3}} = \frac{5.6577 \text{ \AA}}{\sqrt{3}} = 3.2665 \text{ \AA}$$

$$\sin \theta = \frac{\lambda}{2d} = 0.1954$$

$$\theta = 11.29 \quad \Rightarrow \quad 2\theta = \underline{\underline{22.57^\circ}}$$

(12%)

$$(c) \text{ No, since } \lambda_{\text{AuL}\alpha_1} (1.2764 \text{ \AA}) > \lambda_{\text{Ge(K edge)}} (1.1166 \text{ \AA}).$$

(12%)

$$(d) \text{ Yes, since } \lambda_{\text{AuL}\alpha_1} (1.2764 \text{ \AA}) < \lambda_{\text{Ge(L edge)}} (10.187 \text{ \AA}).$$

Problem 2 (32%) AuL α_1 : 9.715 keV

$$\text{No. of electron-hole pairs created} = \frac{9.715 \text{ keV}}{3.8 \text{ eV}} = \underline{\underline{2556}}$$

Some commonly used K wavelengths

Element	$K\alpha$ (weighted average)*	$K\alpha_2$ strong	$K\alpha_1$ very strong	$K\beta_1$ weak
Cr	2.29100	2.293606	2.28970	2.08487
Fe	1.937355	1.939980	1.936042	1.75661
Co	1.790260	1.792850	1.788965	1.62079
Cu	1.541838	1.544390	1.540562	1.392218
Mo	0.710730	0.713590	0.709300	0.632288

* $K\alpha_1$ is given twice the weight of $K\alpha_2$.

Characteristic L Lines of Tungsten

Line	Relative intensity	Wavelength
$L\alpha_1$	Very strong	1.47639
$L\alpha_2$	Weak	1.48743
$L\beta_1$	Strong	1.281809
$L\beta_2$	Medium	1.24460
$L\beta_3$	Weak	1.26269
$L\gamma_1$	Weak	1.09855