Exercise 1 – Chemical Bonding

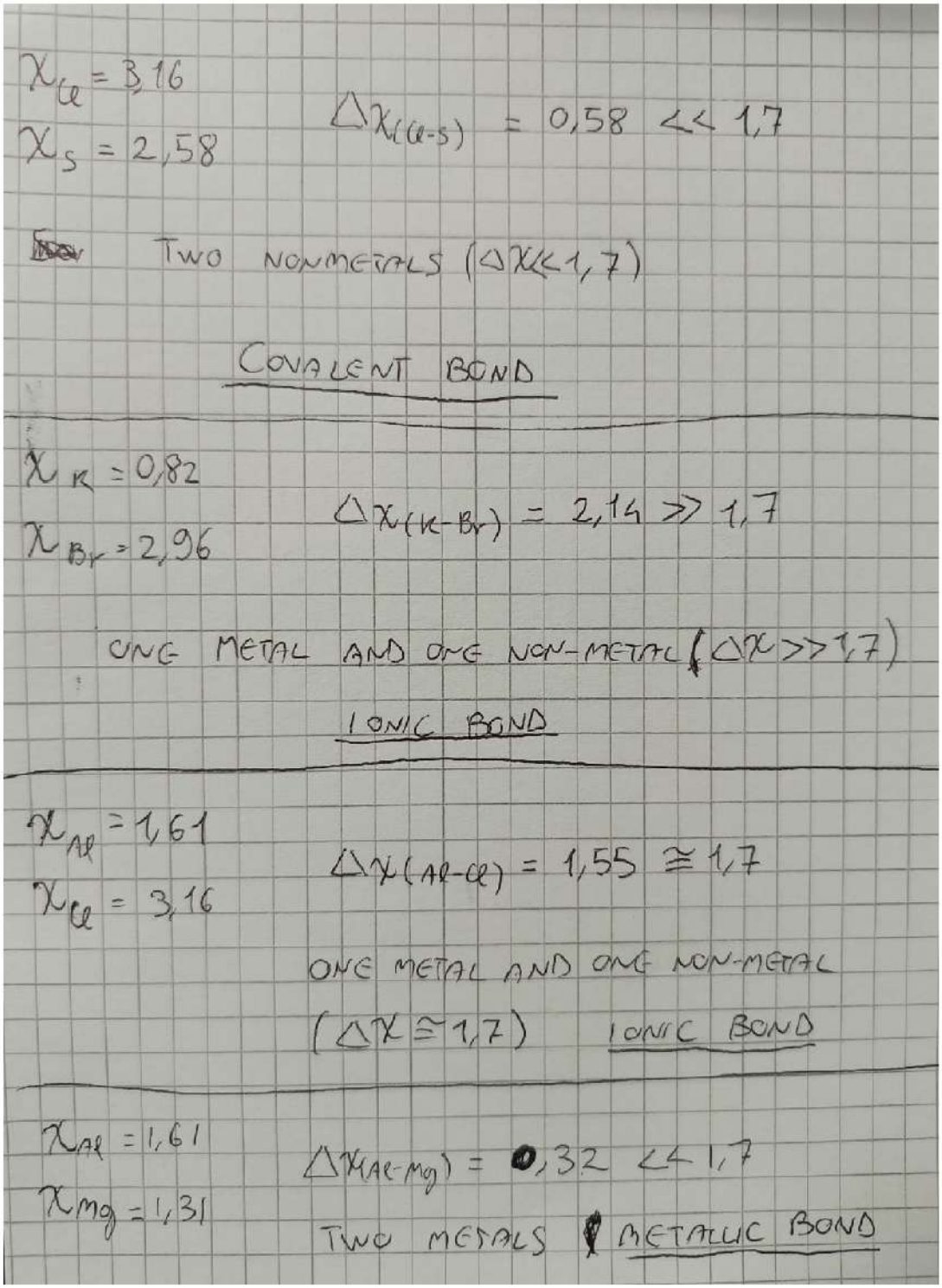
Which combination of atoms is most likely to form a compound with covalent bonds?

A) Cl and S

B) K and Br

C) Al and Cl

D) Mg and Al



Exercise 2 – Gibbs Free Energy and Reaction Spontaneity

Consider the following reaction:

$$Al(s) + 3/2\ Cl_2(g) \rightarrow AlCl_3(s)$$

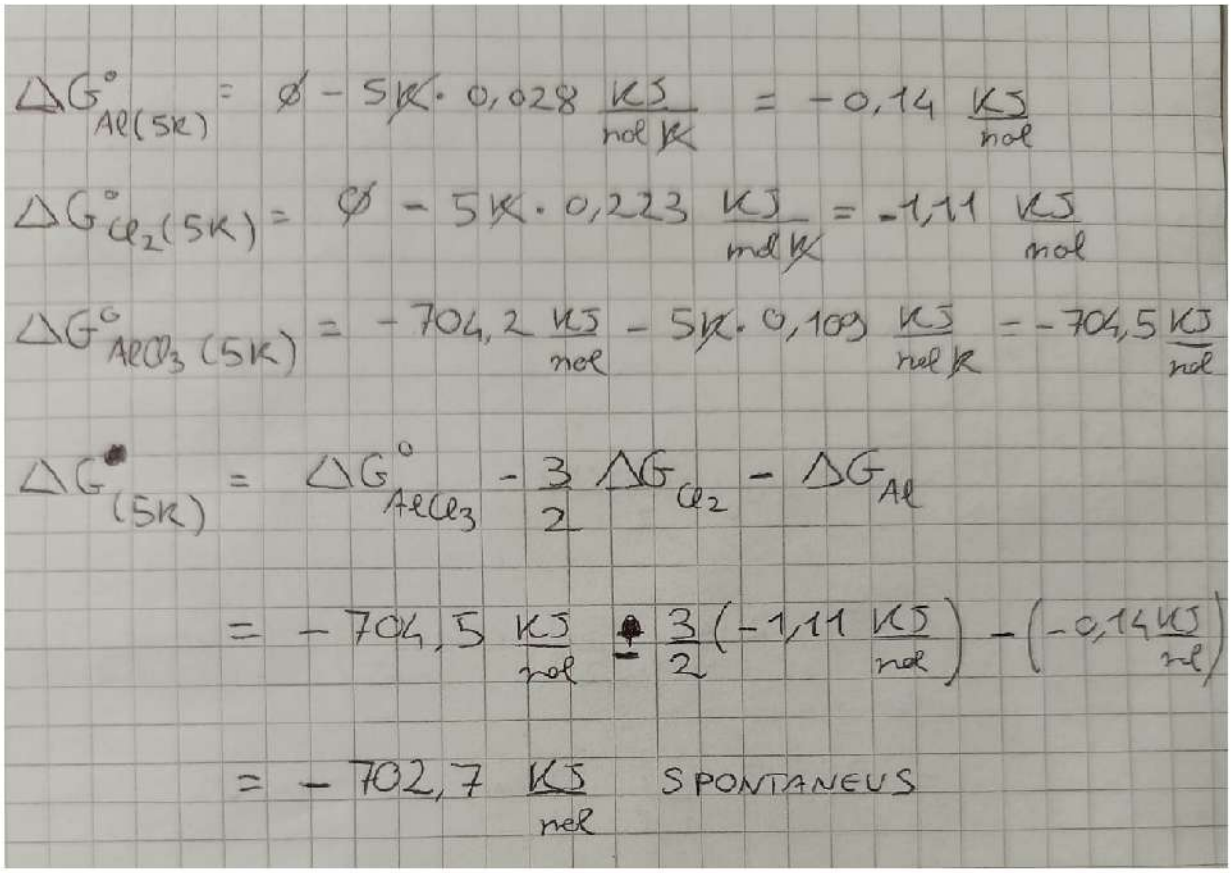
The following thermodynamic data are available at standard conditions:

Substance	$\Delta H°f$ (kJ/mol)	$S°$ (J/mol·K)
Al(s)	0	28.3
$Cl_2(g)$	0	223.1
$AlCl_3(s)$	−704.2	109.3

Questions:

1. Calculate the standard Gibbs free energy change ($\Delta G°$) at 5 K and 3000 K.

2. Determine at which temperature the reaction is spontaneous. Justify your answer using the sign of $\Delta G°$.



$$\Delta G^\circ_{Al(3000K)} = \emptyset - 3000K \cdot 0{,}028 \frac{KJ}{mol\,K} = -84 \frac{KJ}{mol}$$

$$\Delta G^\circ_{O_2(3000K)} = \emptyset - 3000K \cdot 0{,}223 \frac{KJ}{mol\,K} = -669 \frac{KJ}{mol}$$

$$\Delta G^\circ_{Al_2O_3(3000K)} = -704{,}2 \frac{KJ}{mol} - 3000K \cdot 0{,}109 \frac{KJ}{mol\,K} = -377 \frac{KJ}{mol}$$

$$\Delta G^\circ_{(3000K)} = \Delta G^\circ_{Al_2O_3} - \frac{3}{2}\Delta G^\circ_{O_2} - \Delta G^\circ_{Al}$$

$$= -704{,}2 \frac{KJ}{mol} - \frac{3}{2}\left(-669 \frac{KJ}{mol}\right) - \left(-84 \frac{KJ}{mol}\right)$$

$$= 383{,}3 \frac{KJ}{mol}$$ NON-SPONTANEOUS