Proof

9) Generally :

If $T \in \mathcal{L}(\mathbb{R}^3, \mathbb{R}^2)$, then the dual map of T is the linear map $T' \in \mathcal{L}(\mathbb{R}^{2'}, \mathbb{R}^{3'})$ defined by

$T'(\varphi) = \varphi \circ T$ for $\varphi \in \mathbb{R}^{2'}$

Specifically, for any $(x, y, z) \in \mathbb{R}^3$

$$T'(\varphi_1)(x,y,z) = \varphi_1 \circ T(x,y,z) = \varphi_1(4x+5y+6z, 7x+8y+9z)$$
$$= 4x+5y+6z$$

$$T'(\varphi_2)(x,y,z) = \varphi_2 \circ T(x,y,z) = \varphi_2(4x+5y+6z, 7x+8y+9z)$$
$$= 7x+8y+9z$$