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no 1

a) $W = \{(x_1, x_2, x_1 + x_2) \mid x_1, x_2 \in \mathbb{R}\}$

zero vector

$x_1 = 0$ $(0,0,0+0)$

$x_2 = 0$ $(0,0,0)$ ✓

closure under addition

$\vec{u} = (u_1, u_2, u_1 + u_2)$

$\vec{t} = (t_1, t_2, t_1 + t_2)$

$\vec{u} + \vec{t} = (\underbrace{u_1 + t_1}_{x_1}, \underbrace{u_2 + t_2}_{x_2}, \underbrace{u_1 + u_2 + t_1 + t_2}_{x_1 + x_2}) \in \mathbb{R}$ ✓

closure under scalar multiplication

$a\vec{u} = (au_1, au_2, au_1 + au_2) \in \mathbb{R}$ ✓

(a(any scalar number))

∴ a is a subspace of $R^3$

b) $w = \{(x, x^2, x^3) \mid x \in \mathbb{R}\}$

zero vector

$x = 0$

$(0, (0)^2, (0)^3)$

$(0,0,0)$ ✓

closure under addition

$\vec{a} = (a, a^2, a^3)$

$\vec{b} = (b, b^2, b^3)$

$\vec{a} + \vec{b} = (\underbrace{a+b}_{x}, \underbrace{a^2+b^2}_{x^2}, \underbrace{a^3+b^3}_{x^3})$

$a^2 + b^2 \neq (a+b)^2$

Problem 2:

a) $W = \{(0, x, y) \mid x, y \in \mathbb{R}\}$

zero vector

$x = 0$

$y = 0$ $(0,0,0)$ ✓

closure under addition

$\vec{a} = (0, a_1, a_2)$

$\vec{b} = (0, b_1, b_2)$

$\vec{a} + \vec{b} = (0, a_1 + b_1, a_2 + b_2) \in \mathbb{R}$ ✓

closure under scalar multiplication

$a\vec{b} = (0, ab_1, ab_2) \in \mathbb{R}$ ✓

b) $w = \{(x, y, 5x + 3y) \mid x, y \in \mathbb{R}\}$

zero vector

$x = 0$ $(0, 0, 5(0) + 3(0))$

$y = 0$ ~~$(0,0,0)$~~ ✓

$(0,0,0)$ ✓

closure under addition

$\vec{a} = (a_1, b_1, 5a_1 + 3b_1)$

$\vec{b} = (a_2, b_2, 5a_2 + 3b_2)$

$\vec{a} + \vec{b} = (a_1 + a_2, b_1 + b_2, 5a_1 + 3b_1 + 5a_2 + 3b_2) \in \mathbb{R}$ ✓

→ closure under scalar multiplication

$c\vec{a} = (ca_1, cb_1, 5ca_1 + 3cb_1) \in \mathbb{R}$ ✓

a an b of problem 2 are both subspace of $\mathbb{R}^3$

problem 3

a) $W = \{(x_1, x_2, x_3) \mid x_1 + x_2, x_3 = 0\}$

zero vector

$x_1 + x_2, x_3 = 0$

$(0, 0, 0)$ ✓

closure under addition

$\vec{a} = (a_1 + a_2 + a_3)$

$\vec{b} = (b_1 + b_2 + b_3)$

$\vec{a} + \vec{b} = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$

$= (0, 0, 0)$ ✓

closure under scalar multiplication

$a\vec{b} = (ab_1 + ab_2 + ab_3)$

$= (0)$ ✓

∴ a is a subspace of $\mathbb{R}^3$

b) $W = \{(x, y, z) \mid xyz = 0\}$

zero vector

$(0, 0, 0)$ ✓

closure under addition

$\vec{a} = (a_1 + a_2 + a_3)$

$\vec{b} = (b_1 + b_2 + b_3)$

$\vec{a} + \vec{b} = (b_1, a_2, a_3 + b_3)$

$(b_1)(a_2)(b_3 + a_3) \neq 0$ ✗