

IX. АНАЛИТИЧЕСКАЯ ГЕОМЕТРИЯ

Расчетные задания

Задача 1. Написать разложение вектора \mathbf{x} по векторам \mathbf{p} , \mathbf{q} , \mathbf{r} .

- 1.1. $\mathbf{x} = \{-2, 4, 7\}$, $\mathbf{p} = \{0, 1, 2\}$, $\mathbf{q} = \{1, 0, 1\}$, $\mathbf{r} = \{-1, 2, 4\}$.
- 1.2. $\mathbf{x} = \{6, 12, -1\}$, $\mathbf{p} = \{1, 3, 0\}$, $\mathbf{q} = \{2, -1, 1\}$, $\mathbf{r} = \{0, -1, 2\}$.
- 1.3. $\mathbf{x} = \{1, -4, 4\}$, $\mathbf{p} = \{2, 1, -1\}$, $\mathbf{q} = \{0, 3, 2\}$, $\mathbf{r} = \{1, -1, 1\}$.
- 1.4. $\mathbf{x} = \{-9, 5, 5\}$, $\mathbf{p} = \{4, 1, 1\}$, $\mathbf{q} = \{2, 0, -3\}$, $\mathbf{r} = \{-1, 2, 1\}$.
- 1.5. $\mathbf{x} = \{-5, -5, 5\}$, $\mathbf{p} = \{-2, 0, 1\}$, $\mathbf{q} = \{1, 3, -1\}$, $\mathbf{r} = \{0, 4, 1\}$.
- 1.6. $\mathbf{x} = \{13, 2, 7\}$, $\mathbf{p} = \{5, 1, 0\}$, $\mathbf{q} = \{2, -1, 3\}$, $\mathbf{r} = \{1, 0, -1\}$.
- 1.7. $\mathbf{x} = \{-19, -1, 7\}$, $\mathbf{p} = \{0, 1, 1\}$, $\mathbf{q} = \{-2, 0, 1\}$, $\mathbf{r} = \{3, 1, 0\}$.
- 1.8. $\mathbf{x} = \{3, -3, 4\}$, $\mathbf{p} = \{1, 0, 2\}$, $\mathbf{q} = \{0, 1, 1\}$, $\mathbf{r} = \{2, -1, 4\}$.
- 1.9. $\mathbf{x} = \{3, 3, -1\}$, $\mathbf{p} = \{3, 1, 0\}$, $\mathbf{q} = \{-1, 2, 1\}$, $\mathbf{r} = \{-1, 0, 2\}$.
- 1.10. $\mathbf{x} = \{-1, 7, -4\}$, $\mathbf{p} = \{-1, 2, 1\}$, $\mathbf{q} = \{2, 0, 3\}$, $\mathbf{r} = \{1, 1, -1\}$.
- 1.11. $\mathbf{x} = \{6, 5, -14\}$, $\mathbf{p} = \{1, 1, 4\}$, $\mathbf{q} = \{0, -3, 2\}$, $\mathbf{r} = \{2, 1, -1\}$.
- 1.12. $\mathbf{x} = \{6, -1, 7\}$, $\mathbf{p} = \{1, -2, 0\}$, $\mathbf{q} = \{-1, 1, 3\}$, $\mathbf{r} = \{1, 0, 4\}$.
- 1.13. $\mathbf{x} = \{5, 15, 0\}$, $\mathbf{p} = \{1, 0, 5\}$, $\mathbf{q} = \{-1, 3, 2\}$, $\mathbf{r} = \{0, -1, 1\}$.
- 1.14. $\mathbf{x} = \{2, -1, 11\}$, $\mathbf{p} = \{1, 1, 0\}$, $\mathbf{q} = \{0, 1, -2\}$, $\mathbf{r} = \{1, 0, 3\}$.
- 1.15. $\mathbf{x} = \{11, 5, -3\}$, $\mathbf{p} = \{1, 0, 2\}$, $\mathbf{q} = \{-1, 0, 1\}$, $\mathbf{r} = \{2, 5, -3\}$.
- 1.16. $\mathbf{x} = \{8, 0, 5\}$, $\mathbf{p} = \{2, 0, 1\}$, $\mathbf{q} = \{1, 1, 0\}$, $\mathbf{r} = \{4, 1, 2\}$.
- 1.17. $\mathbf{x} = \{3, 1, 8\}$, $\mathbf{p} = \{0, 1, 3\}$, $\mathbf{q} = \{1, 2, -1\}$, $\mathbf{r} = \{2, 0, -1\}$.
- 1.18. $\mathbf{x} = \{8, 1, 12\}$, $\mathbf{p} = \{1, 2, -1\}$, $\mathbf{q} = \{3, 0, 2\}$, $\mathbf{r} = \{-1, 1, 1\}$.

- 1.19. $\mathbf{x} = \{-9, -8, -3\}$, $\mathbf{p} = \{1, 4, 1\}$, $\mathbf{q} = \{-3, 2, 0\}$, $\mathbf{r} = \{1, -1, 2\}$.
- 1.20. $\mathbf{x} = \{-5, 9, -13\}$, $\mathbf{p} = \{0, 1, -2\}$, $\mathbf{q} = \{3, -1, 1\}$, $\mathbf{r} = \{4, 1, 0\}$.
- 1.21. $\mathbf{x} = \{-15, 5, 6\}$, $\mathbf{p} = \{0, 5, 1\}$, $\mathbf{q} = \{3, 2, -1\}$, $\mathbf{r} = \{-1, 1, 0\}$.
- 1.22. $\mathbf{x} = \{8, 9, 4\}$, $\mathbf{p} = \{1, 0, 1\}$, $\mathbf{q} = \{0, -2, 1\}$, $\mathbf{r} = \{1, 3, 0\}$.
- 1.23. $\mathbf{x} = \{23, -14, -30\}$, $\mathbf{p} = \{2, 1, 0\}$, $\mathbf{q} = \{1, -1, 0\}$, $\mathbf{r} = \{-3, 2, 5\}$.
- 1.24. $\mathbf{x} = \{3, 1, 3\}$, $\mathbf{p} = \{2, 1, 0\}$, $\mathbf{q} = \{1, 0, 1\}$, $\mathbf{r} = \{4, 2, 1\}$.
- 1.25. $\mathbf{x} = \{-1, 7, 0\}$, $\mathbf{p} = \{0, 3, 1\}$, $\mathbf{q} = \{1, -1, 2\}$, $\mathbf{r} = \{2, -1, 0\}$.
- 1.26. $\mathbf{x} = \{11, -1, 4\}$, $\mathbf{p} = \{1, -1, 2\}$, $\mathbf{q} = \{3, 2, 0\}$, $\mathbf{r} = \{-1, 1, 1\}$.
- 1.27. $\mathbf{x} = \{-13, 2, 18\}$, $\mathbf{p} = \{1, 1, 4\}$, $\mathbf{q} = \{-3, 0, 2\}$, $\mathbf{r} = \{1, 2, -1\}$.
- 1.28. $\mathbf{x} = \{0, -8, 9\}$, $\mathbf{p} = \{0, -2, 1\}$, $\mathbf{q} = \{3, 1, -1\}$, $\mathbf{r} = \{4, 0, 1\}$.
- 1.29. $\mathbf{x} = \{8, -7, -13\}$, $\mathbf{p} = \{0, 1, 5\}$, $\mathbf{q} = \{3, -1, 2\}$, $\mathbf{r} = \{-1, 0, 1\}$.
- 1.30. $\mathbf{x} = \{2, 7, 5\}$, $\mathbf{p} = \{1, 0, 1\}$, $\mathbf{q} = \{1, -2, 0\}$, $\mathbf{r} = \{0, 3, 1\}$.
- 1.31. $\mathbf{x} = \{15, -20, -1\}$, $\mathbf{p} = \{0, 2, 1\}$, $\mathbf{q} = \{0, 1, -1\}$, $\mathbf{r} = \{5, -3, 2\}$.

Задача 2. Коллинеарны ли векторы \mathbf{c}_1 и \mathbf{c}_2 , построенные по векторам \mathbf{a} и \mathbf{b} ?

- 2.1. $\mathbf{a} = \{1, -2, 3\}$, $\mathbf{b} = \{3, 0, -1\}$, $\mathbf{c}_1 = 2\mathbf{a} + 4\mathbf{b}$, $\mathbf{c}_2 = 3\mathbf{b} - \mathbf{a}$.
- 2.2. $\mathbf{a} = \{1, 0, 1\}$, $\mathbf{b} = \{-2, 3, 5\}$, $\mathbf{c}_1 = \mathbf{a} + 2\mathbf{b}$, $\mathbf{c}_2 = 3\mathbf{a} - \mathbf{b}$.
- 2.3. $\mathbf{a} = \{-2, 4, 1\}$, $\mathbf{b} = \{1, -2, 7\}$, $\mathbf{c}_1 = 5\mathbf{a} + 3\mathbf{b}$, $\mathbf{c}_2 = 2\mathbf{a} - \mathbf{b}$.
- 2.4. $\mathbf{a} = \{1, 2, -3\}$, $\mathbf{b} = \{2, -1, -1\}$, $\mathbf{c}_1 = 4\mathbf{a} + 3\mathbf{b}$, $\mathbf{c}_2 = 8\mathbf{a} - \mathbf{b}$.
- 2.5. $\mathbf{a} = \{3, 5, 4\}$, $\mathbf{b} = \{5, 9, 7\}$, $\mathbf{c}_1 = -2\mathbf{a} + \mathbf{b}$, $\mathbf{c}_2 = 3\mathbf{a} - 2\mathbf{b}$.
- 2.6. $\mathbf{a} = \{1, 4, -2\}$, $\mathbf{b} = \{1, 1, -1\}$, $\mathbf{c}_1 = \mathbf{a} + \mathbf{b}$, $\mathbf{c}_2 = 4\mathbf{a} + 2\mathbf{b}$.

$$2.7. \mathbf{a} = \{1, -2, 5\}, \mathbf{b} = \{3, -1, 0\}, \mathbf{c}_1 = 4\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 2\mathbf{a}.$$

$$2.8. \mathbf{a} = \{3, 4, -1\}, \mathbf{b} = \{2, -1, 1\}, \mathbf{c}_1 = 6\mathbf{a} - 3\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 2\mathbf{a}.$$

$$2.9. \mathbf{a} = \{-2, -3, -2\}, \mathbf{b} = \{1, 0, 5\}, \mathbf{c}_1 = 3\mathbf{a} + 9\mathbf{b}, \mathbf{c}_2 = -\mathbf{a} - 3\mathbf{b}.$$

$$2.10. \mathbf{a} = \{-1, 4, 2\}, \mathbf{b} = \{3, -2, 6\}, \mathbf{c}_1 = 2\mathbf{a} - \mathbf{b}, \mathbf{c}_2 = 3\mathbf{b} - 6\mathbf{a}.$$

$$2.11. \mathbf{a} = \{5, 0, -1\}, \mathbf{b} = \{7, 2, 3\}, \mathbf{c}_1 = 2\mathbf{a} - \mathbf{b}, \mathbf{c}_2 = 3\mathbf{b} - 6\mathbf{a}.$$

$$2.12. \mathbf{a} = \{0, 3, -2\}, \mathbf{b} = \{1, -2, 1\}, \mathbf{c}_1 = 5\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = 3\mathbf{a} + 5\mathbf{b}.$$

$$2.13. \mathbf{a} = \{-2, 7, -1\}, \mathbf{b} = \{-3, 5, 2\}, \mathbf{c}_1 = 2\mathbf{a} + 3\mathbf{b}, \mathbf{c}_2 = 3\mathbf{a} + 2\mathbf{b}.$$

$$2.14. \mathbf{a} = \{3, 7, 0\}, \mathbf{b} = \{1, -3, 4\}, \mathbf{c}_1 = 4\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 2\mathbf{a}.$$

$$2.15. \mathbf{a} = \{-1, 2, -1\}, \mathbf{b} = \{2, -7, 1\}, \mathbf{c}_1 = 6\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 3\mathbf{a}.$$

$$2.16. \mathbf{a} = \{7, 9, -2\}, \mathbf{b} = \{5, 4, 3\}, \mathbf{c}_1 = 4\mathbf{a} - \mathbf{b}, \mathbf{c}_2 = 4\mathbf{b} - \mathbf{a}.$$

$$2.17. \mathbf{a} = \{5, 0, -2\}, \mathbf{b} = \{6, 4, 3\}, \mathbf{c}_1 = 5\mathbf{a} - 3\mathbf{b}, \mathbf{c}_2 = 6\mathbf{b} - 10\mathbf{a}.$$

$$2.18. \mathbf{a} = \{8, 3, -1\}, \mathbf{b} = \{4, 1, 3\}, \mathbf{c}_1 = 2\mathbf{a} - \mathbf{b}, \mathbf{c}_2 = 2\mathbf{b} - 4\mathbf{a}.$$

$$2.19. \mathbf{a} = \{3, -1, 6\}, \mathbf{b} = \{5, 7, 10\}, \mathbf{c}_1 = 4\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 2\mathbf{a}.$$

$$2.20. \mathbf{a} = \{1, -2, 4\}, \mathbf{b} = \{7, 3, 5\}, \mathbf{c}_1 = 6\mathbf{a} - 3\mathbf{b}, \mathbf{c}_2 = \mathbf{b} - 2\mathbf{a}.$$

$$2.21. \mathbf{a} = \{3, 7, 0\}, \mathbf{b} = \{4, 6, -1\}, \mathbf{c}_1 = 3\mathbf{a} + 2\mathbf{b}, \mathbf{c}_2 = 5\mathbf{a} - 7\mathbf{b}.$$

$$2.22. \mathbf{a} = \{2, -1, 4\}, \mathbf{b} = \{3, -7, -6\}, \mathbf{c}_1 = 2\mathbf{a} - 3\mathbf{b}, \mathbf{c}_2 = 3\mathbf{a} - 2\mathbf{b}.$$

$$2.23. \mathbf{a} = \{5, -1, -2\}, \mathbf{b} = \{6, 0, 7\}, \mathbf{c}_1 = 3\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = 4\mathbf{b} - 6\mathbf{a}.$$

$$2.24. \mathbf{a} = \{-9, 5, 3\}, \mathbf{b} = \{7, 1, -2\}, \mathbf{c}_1 = 2\mathbf{a} - \mathbf{b}, \mathbf{c}_2 = 3\mathbf{a} + 5\mathbf{b}.$$

$$2.25. \mathbf{a} = \{4, 2, 9\}, \mathbf{b} = \{0, -1, 3\}, \mathbf{c}_1 = 4\mathbf{b} - 3\mathbf{a}, \mathbf{c}_2 = 4\mathbf{a} - 3\mathbf{b}.$$

$$2.26. \mathbf{a} = \{2, -1, 6\}, \mathbf{b} = \{-1, 3, 8\}, \mathbf{c}_1 = 5\mathbf{a} - 2\mathbf{b}, \mathbf{c}_2 = 2\mathbf{a} - 5\mathbf{b}.$$

2.27. $\mathbf{a} = \{5, 0, 8\}$, $\mathbf{b} = \{-3, 1, 7\}$, $\mathbf{c}_1 = 3\mathbf{a} - 4\mathbf{b}$, $\mathbf{c}_2 = 12\mathbf{b} - 9\mathbf{a}$.

2.28. $\mathbf{a} = \{-1, 3, 4\}$, $\mathbf{b} = \{2, -1, 0\}$, $\mathbf{c}_1 = 6\mathbf{a} - 2\mathbf{b}$, $\mathbf{c}_2 = \mathbf{b} - 3\mathbf{a}$.

2.29. $\mathbf{a} = \{4, 2, -7\}$, $\mathbf{b} = \{5, 0, -3\}$, $\mathbf{c}_1 = \mathbf{a} - 3\mathbf{b}$, $\mathbf{c}_2 = 6\mathbf{b} - 2\mathbf{a}$.

2.30. $\mathbf{a} = \{2, 0, -5\}$, $\mathbf{b} = \{1, -3, 4\}$, $\mathbf{c}_1 = 2\mathbf{a} - 5\mathbf{b}$, $\mathbf{c}_2 = 5\mathbf{a} - 2\mathbf{b}$.

2.31. $\mathbf{a} = \{-1, 2, 8\}$, $\mathbf{b} = \{3, 7, -1\}$, $\mathbf{c}_1 = 4\mathbf{a} - 3\mathbf{b}$, $\mathbf{c}_2 = 9\mathbf{b} - 12\mathbf{a}$.

Задача 3. Найти косинус угла между векторами \overline{AB} и \overline{AC} .

3.1. $A(1, -2, 3)$, $B(0, -1, 2)$, $C(3, -4, 5)$.

3.2. $A(0, -3, 6)$, $B(-12, -3, -3)$, $C(-9, -3, -6)$.

3.3. $A(3, 3, -1)$, $B(5, 5, -2)$, $C(4, 1, 1)$.

3.4. $A(-1, 2, -3)$, $B(3, 4, -6)$, $C(1, 1, -1)$.

3.5. $A(-4, -2, 0)$, $B(-1, -2, 4)$, $C(3, -2, 1)$.

3.6. $A(5, 3, -1)$, $B(5, 2, 0)$, $C(6, 4, -1)$.

3.7. $A(-3, -7, -5)$, $B(0, -1, -2)$, $C(2, 3, 0)$.

3.8. $A(2, -4, 6)$, $B(0, -2, 4)$, $C(6, -8, 10)$.

3.9. $A(0, 1, -2)$, $B(3, 1, 2)$, $C(4, 1, 1)$.

3.10. $A(3, 3, -1)$, $B(1, 5, -2)$, $C(4, 1, 1)$.

3.11. $A(2, 1, -1)$, $B(6, -1, -4)$, $C(4, 2, 1)$.

3.12. $A(-1, -2, 1)$, $B(-4, -2, 5)$, $C(-8, -2, 2)$.

3.13. $A(6, 2, -3)$, $B(6, 3, -2)$, $C(7, 3, -3)$.

3.14. $A(0, 0, 4)$, $B(-3, -6, 1)$, $C(-5, -10, -1)$.

- 3.15. $A(2, -8, -1), B(4, -6, 0), C(-2, -5, -1)$.
- 3.16. $A(3, -6, 9), B(0, -3, 6), C(9, -12, 15)$.
- 3.17. $A(0, 2, -4), B(8, 2, 2), C(6, 2, 4)$.
- 3.18. $A(3, 3, -1), B(5, 1, -2), C(4, 1, 1)$.
- 3.19. $A(-4, 3, 0), B(0, 1, 3), C(-2, 4, -2)$.
- 3.20. $A(1, -1, 0), B(-2, -1, 4), C(8, -1, -1)$.
- 3.21. $A(7, 0, 2), B(7, 1, 3), C(8, -1, 2)$.
- 3.22. $A(2, 3, 2), B(-1, -3, -1), C(-3, -7, -3)$.
- 3.23. $A(2, 2, 7), B(0, 0, 6), C(-2, 5, 7)$.
- 3.24. $A(-1, 2, -3), B(0, 1, -2), C(-3, 4, -5)$.
- 3.25. $A(0, 3, -6), B(9, 3, 6), C(12, 3, 3)$.
- 3.26. $A(3, 3, -1), B(5, 1, -2), C(4, 1, -3)$.
- 3.27. $A(-2, 1, 1), B(2, 3, -2), C(0, 0, 3)$.
- 3.28. $A(1, 4, -1), B(-2, 4, -5), C(8, 4, 0)$.
- 3.29. $A(0, 1, 0), B(0, 2, 1), C(1, 2, 0)$.
- 3.30. $A(-4, 0, 4), B(-1, 6, 7), C(1, 10, 9)$.
- 3.31. $A(-2, 4, -6), B(0, 2, -4), C(-6, 8, -10)$.

Задача 4. Вычислить площадь параллелограмма, построенного на векторах \mathbf{a} и \mathbf{b} .

4.1. $\mathbf{a} = \mathbf{p} + 2\mathbf{q}, \mathbf{b} = 3\mathbf{p} - \mathbf{q}; |\mathbf{p}| = 1, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/6$.

4.2. $\mathbf{a} = 3\mathbf{p} + \mathbf{q}, \mathbf{b} = \mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 4, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/4$.

$$4.3. \mathbf{a} = \mathbf{p} - 3\mathbf{q}, \mathbf{b} = \mathbf{p} + 2\mathbf{q}; |\mathbf{p}| = 1/5, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.4. \mathbf{a} = 3\mathbf{p} - 2\mathbf{q}, \mathbf{b} = \mathbf{p} + 5\mathbf{q}; |\mathbf{p}| = 4, |\mathbf{q}| = 1/2, (\mathbf{p} \wedge \mathbf{q}) = 5\pi/6.$$

$$4.5. \mathbf{a} = \mathbf{p} - 2\mathbf{q}, \mathbf{b} = 2\mathbf{p} + \mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = 3\pi/4.$$

$$4.6. \mathbf{a} = \mathbf{p} + 3\mathbf{q}, \mathbf{b} = \mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.7. \mathbf{a} = 2\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + 3\mathbf{q}; |\mathbf{p}| = 3, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.8. \mathbf{a} = 4\mathbf{p} + \mathbf{q}, \mathbf{b} = \mathbf{p} - \mathbf{q}; |\mathbf{p}| = 7, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.9. \mathbf{a} = \mathbf{p} - 4\mathbf{q}, \mathbf{b} = 3\mathbf{p} + \mathbf{q}; |\mathbf{p}| = 1, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/6.$$

$$4.10. \mathbf{a} = \mathbf{p} + 4\mathbf{q}, \mathbf{b} = 2\mathbf{p} - \mathbf{q}; |\mathbf{p}| = 7, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.11. \mathbf{a} = 3\mathbf{p} + 2\mathbf{q}, \mathbf{b} = \mathbf{p} - \mathbf{q}; |\mathbf{p}| = 10, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.12. \mathbf{a} = 4\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + 2\mathbf{q}; |\mathbf{p}| = 5, |\mathbf{q}| = 4, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.13. \mathbf{a} = 2\mathbf{p} + 3\mathbf{q}, \mathbf{b} = \mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 6, |\mathbf{q}| = 7, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.14. \mathbf{a} = 3\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + 2\mathbf{q}; |\mathbf{p}| = 3, |\mathbf{q}| = 4, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.15. \mathbf{a} = 2\mathbf{p} + 3\mathbf{q}, \mathbf{b} = \mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.16. \mathbf{a} = 2\mathbf{p} - 3\mathbf{q}, \mathbf{b} = 3\mathbf{p} + \mathbf{q}; |\mathbf{p}| = 4, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/6.$$

$$4.17. \mathbf{a} = 5\mathbf{p} + \mathbf{q}, \mathbf{b} = \mathbf{p} - 3\mathbf{q}; |\mathbf{p}| = 1, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.18. \mathbf{a} = 7\mathbf{p} - 2\mathbf{q}, \mathbf{b} = \mathbf{p} + 3\mathbf{q}; |\mathbf{p}| = 1/2, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.19. \mathbf{a} = 6\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + \mathbf{q}; |\mathbf{p}| = 3, |\mathbf{q}| = 4, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.20. \mathbf{a} = 10\mathbf{p} + \mathbf{q}, \mathbf{b} = 3\mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 4, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/6.$$

$$4.21. \mathbf{a} = 6\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + 2\mathbf{q}; |\mathbf{p}| = 8, |\mathbf{q}| = 1/2, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.22. \mathbf{a} = 3\mathbf{p} + 4\mathbf{q}, \mathbf{b} = \mathbf{q} - \mathbf{p}; |\mathbf{p}| = 2,5, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.23. \mathbf{a} = 7\mathbf{p} + \mathbf{q}, \mathbf{b} = \mathbf{p} - 3\mathbf{q}; |\mathbf{p}| = 3, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = 3\pi/4.$$

$$4.24. \mathbf{a} = \mathbf{p} + 3\mathbf{q}, \mathbf{b} = 3\mathbf{p} - \mathbf{q}; |\mathbf{p}| = 3, |\mathbf{q}| = 5, (\mathbf{p} \wedge \mathbf{q}) = 2\pi/3.$$

$$4.25. \mathbf{a} = 3\mathbf{p} + \mathbf{q}, \mathbf{b} = \mathbf{p} - 3\mathbf{q}; |\mathbf{p}| = 7, |\mathbf{q}| = 2, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.26. \mathbf{a} = 5\mathbf{p} - \mathbf{q}, \mathbf{b} = \mathbf{p} + \mathbf{q}; |\mathbf{p}| = 5, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = 5\pi/6.$$

$$4.27. \mathbf{a} = 3\mathbf{p} - 4\mathbf{q}, \mathbf{b} = \mathbf{p} + 3\mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = \pi/4.$$

$$4.28. \mathbf{a} = 6\mathbf{p} - \mathbf{q}, \mathbf{b} = 5\mathbf{q} + \mathbf{p}; |\mathbf{p}| = 1/2, |\mathbf{q}| = 4, (\mathbf{p} \wedge \mathbf{q}) = 5\pi/6.$$

$$4.29. \mathbf{a} = 2\mathbf{p} + 3\mathbf{q}, \mathbf{b} = \mathbf{p} - 2\mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 1, (\mathbf{p} \wedge \mathbf{q}) = \pi/3.$$

$$4.30. \mathbf{a} = 2\mathbf{p} - 3\mathbf{q}, \mathbf{b} = 5\mathbf{p} + \mathbf{q}; |\mathbf{p}| = 2, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = \pi/2.$$

$$4.31. \mathbf{a} = 3\mathbf{p} + 2\mathbf{q}, \mathbf{b} = 2\mathbf{p} - \mathbf{q}; |\mathbf{p}| = 4, |\mathbf{q}| = 3, (\mathbf{p} \wedge \mathbf{q}) = 3\pi/4.$$

Задача 5. Компланарны ли векторы \mathbf{a} , \mathbf{b} и \mathbf{c} ?

$$5.1. \mathbf{a} = \{2, 3, 1\}, \mathbf{b} = \{-1, 0, -1\}, \mathbf{c} = \{2, 2, 2\}.$$

$$5.2. \mathbf{a} = \{3, 2, 1\}, \mathbf{b} = \{2, 3, 4\}, \mathbf{c} = \{3, 1, -1\}.$$

$$5.3. \mathbf{a} = \{1, 5, 2\}, \mathbf{b} = \{-1, 1, -1\}, \mathbf{c} = \{1, 1, 1\}.$$

$$5.4. \mathbf{a} = \{1, -1, -3\}, \mathbf{b} = \{3, 2, 1\}, \mathbf{c} = \{2, 3, 4\}.$$

$$5.5. \mathbf{a} = \{3, 3, 1\}, \mathbf{b} = \{1, -2, 1\}, \mathbf{c} = \{1, 1, 1\}.$$

$$5.6. \mathbf{a} = \{3, 1, -1\}, \mathbf{b} = \{-2, -1, 0\}, \mathbf{c} = \{5, 2, -1\}.$$

$$5.7. \mathbf{a} = \{4, 3, 1\}, \mathbf{b} = \{1, -2, 1\}, \mathbf{c} = \{2, 2, 2\}.$$

- 5.8. $\mathbf{a} = \{4, 3, 1\}$, $\mathbf{b} = \{6, 7, 4\}$, $\mathbf{c} = \{2, 0, -1\}$.
- 5.9. $\mathbf{a} = \{3, 2, 1\}$, $\mathbf{b} = \{1, -3, -7\}$, $\mathbf{c} = \{1, 2, 3\}$.
- 5.10. $\mathbf{a} = \{3, 7, 2\}$, $\mathbf{b} = \{-2, 0, -1\}$, $\mathbf{c} = \{2, 2, 1\}$.
- 5.11. $\mathbf{a} = \{1, -2, 6\}$, $\mathbf{b} = \{1, 0, 1\}$, $\mathbf{c} = \{2, -6, 17\}$.
- 5.12. $\mathbf{a} = \{6, 3, 4\}$, $\mathbf{b} = \{-1, -2, -1\}$, $\mathbf{c} = \{2, 1, 2\}$.
- 5.13. $\mathbf{a} = \{7, 3, 4\}$, $\mathbf{b} = \{-1, -2, -1\}$, $\mathbf{c} = \{4, 2, 4\}$.
- 5.14. $\mathbf{a} = \{2, 3, 2\}$, $\mathbf{b} = \{4, 7, 5\}$, $\mathbf{c} = \{2, 0, -1\}$.
- 5.15. $\mathbf{a} = \{5, 3, 4\}$, $\mathbf{b} = \{-1, 0, -1\}$, $\mathbf{c} = \{4, 2, 4\}$.
- 5.16. $\mathbf{a} = \{3, 10, 5\}$, $\mathbf{b} = \{-2, -2, -3\}$, $\mathbf{c} = \{2, 4, 3\}$.
- 5.17. $\mathbf{a} = \{-2, -4, -3\}$, $\mathbf{b} = \{4, 3, 1\}$, $\mathbf{c} = \{6, 7, 4\}$.
- 5.18. $\mathbf{a} = \{3, 1, -1\}$, $\mathbf{b} = \{1, 0, -1\}$, $\mathbf{c} = \{8, 3, -2\}$.
- 5.19. $\mathbf{a} = \{4, 2, 2\}$, $\mathbf{b} = \{-3, -3, -3\}$, $\mathbf{c} = \{2, 1, 2\}$.
- 5.20. $\mathbf{a} = \{4, 1, 2\}$, $\mathbf{b} = \{9, 2, 5\}$, $\mathbf{c} = \{1, 1, -1\}$.
- 5.21. $\mathbf{a} = \{5, 3, 4\}$, $\mathbf{b} = \{4, 3, 3\}$, $\mathbf{c} = \{9, 5, 8\}$.
- 5.22. $\mathbf{a} = \{3, 4, 2\}$, $\mathbf{b} = \{1, 1, 0\}$, $\mathbf{c} = \{8, 11, 6\}$.
- 5.23. $\mathbf{a} = \{4, -1, -6\}$, $\mathbf{b} = \{1, -3, -7\}$, $\mathbf{c} = \{2, -1, -4\}$.
- 5.24. $\mathbf{a} = \{3, 1, 0\}$, $\mathbf{b} = \{-5, -4, -5\}$, $\mathbf{c} = \{4, 2, 4\}$.
- 5.25. $\mathbf{a} = \{3, 0, 3\}$, $\mathbf{b} = \{8, 1, 6\}$, $\mathbf{c} = \{1, 1, -1\}$.
- 5.26. $\mathbf{a} = \{1, -1, 4\}$, $\mathbf{b} = \{1, 0, 3\}$, $\mathbf{c} = \{1, -3, 8\}$.
- 5.27. $\mathbf{a} = \{6, 3, 4\}$, $\mathbf{b} = \{-1, -2, -1\}$, $\mathbf{c} = \{2, 1, 2\}$.

5.28. $\mathbf{a} = \{4, 1, 1\}$, $\mathbf{b} = \{-9, -4, -9\}$, $\mathbf{c} = \{6, 2, 6\}$.

5.29. $\mathbf{a} = \{-3, 3, 3\}$, $\mathbf{b} = \{-4, 7, 6\}$, $\mathbf{c} = \{3, 0, -1\}$.

5.30. $\mathbf{a} = \{-7, 10, -5\}$, $\mathbf{b} = \{0, -2, -1\}$, $\mathbf{c} = \{-2, 4, -1\}$.

5.31. $\mathbf{a} = \{7, 4, 6\}$, $\mathbf{b} = \{2, 1, 1\}$, $\mathbf{c} = \{19, 11, 17\}$.

Задача 6. Вычислить объем тетраэдра с вершинами в точках A_1, A_2, A_3, A_4 и его высоту, опущенную из вершины A_4 на грань $A_1A_2A_3$.

6.1. $A_1(1, 3, 6)$, $A_2(2, 2, 1)$, $A_3(-1, 0, 1)$, $A_4(-4, 6, -3)$.

6.2. $A_1(-4, 2, 6)$, $A_2(2, -3, 0)$, $A_3(-10, 5, 8)$, $A_4(-5, 2, -4)$.

6.3. $A_1(7, 2, 4)$, $A_2(7, -1, -2)$, $A_3(3, 3, 1)$, $A_4(-4, 2, 1)$.

6.4. $A_1(2, 1, 4)$, $A_2(-1, 5, -2)$, $A_3(-7, -3, 2)$, $A_4(-6, -3, 6)$.

6.5. $A_1(-1, -5, 2)$, $A_2(-6, 0, -3)$, $A_3(3, 6, -3)$, $A_4(-10, 6, 7)$.

6.6. $A_1(0, -1, -1)$, $A_2(-2, 3, 5)$, $A_3(1, -5, -9)$, $A_4(-1, -6, 3)$.

6.7. $A_1(5, 2, 0)$, $A_2(2, 5, 0)$, $A_3(1, 2, 4)$, $A_4(-1, 1, 1)$.

6.8. $A_1(2, -1, -2)$, $A_2(1, 2, 1)$, $A_3(5, 0, -6)$, $A_4(-10, 9, -7)$.

6.9. $A_1(-2, 0, -4)$, $A_2(-1, 7, 1)$, $A_3(4, -8, -4)$, $A_4(1, -4, 6)$.

6.10. $A_1(14, 4, 5)$, $A_2(-5, -3, 2)$, $A_3(-2, -6, -3)$, $A_4(-2, 2, -1)$.

6.11. $A_1(1, 2, 0)$, $A_2(3, 0, -3)$, $A_3(5, 2, 6)$, $A_4(8, 4, -9)$.

6.12. $A_1(2, -1, 2)$, $A_2(1, 2, -1)$, $A_3(3, 2, 1)$, $A_4(-4, 2, 5)$.

6.13. $A_1(1, 1, 2)$, $A_2(-1, 1, 3)$, $A_3(2, -2, 4)$, $A_4(-1, 0, -2)$.

6.14. $A_1(2, 3, 1)$, $A_2(4, 1, -2)$, $A_3(6, 3, 7)$, $A_4(7, 5, -3)$.

- 6.15. $A_1(1, 1, -1)$, $A_2(2, 3, 1)$, $A_3(3, 2, 1)$, $A_4(5, 9, -8)$.
- 6.16. $A_1(1, 5, -7)$, $A_2(-3, 6, 3)$, $A_3(-2, 7, 3)$, $A_4(-4, 8, -12)$.
- 6.17. $A_1(-3, 4, -7)$, $A_2(1, 5, -4)$, $A_3(-5, -2, 0)$, $A_4(2, 5, 4)$.
- 6.18. $A_1(-1, 2, -3)$, $A_2(4, -1, 0)$, $A_3(2, 1, -2)$, $A_4(3, 4, 5)$.
- 6.19. $A_1(4, -1, 3)$, $A_2(-2, 1, 0)$, $A_3(0, -5, 1)$, $A_4(3, 2, -6)$.
- 6.20. $A_1(1, -1, 1)$, $A_2(-2, 0, 3)$, $A_3(2, 1, -1)$, $A_4(2, -2, -4)$.
- 6.21. $A_1(1, 2, 0)$, $A_2(1, -1, 2)$, $A_3(0, 1, -1)$, $A_4(-3, 0, 1)$.
- 6.22. $A_1(1, 0, 2)$, $A_2(1, 2, -1)$, $A_3(2, -2, 1)$, $A_4(2, 1, 0)$.
- 6.23. $A_1(1, 2, -3)$, $A_2(1, 0, 1)$, $A_3(-2, -1, 6)$, $A_4(0, -5, -4)$.
- 6.24. $A_1(3, 10, -1)$, $A_2(-2, 3, -5)$, $A_3(-6, 0, -3)$, $A_4(1, -1, 2)$.
- 6.25. $A_1(-1, 2, 4)$, $A_2(-1, -2, -4)$, $A_3(3, 0, -1)$, $A_4(7, -3, 1)$.
- 6.26. $A_1(0, -3, 1)$, $A_2(-4, 1, 2)$, $A_3(2, -1, 5)$, $A_4(3, 1, -4)$.
- 6.27. $A_1(1, 3, 0)$, $A_2(4, -1, 2)$, $A_3(3, 0, 1)$, $A_4(-4, 3, 5)$.
- 6.28. $A_1(-2, -1, -1)$, $A_2(0, 3, 2)$, $A_3(3, 1, -4)$, $A_4(-4, 7, 3)$.
- 6.29. $A_1(-3, -5, 6)$, $A_2(2, 1, -4)$, $A_3(0, -3, -1)$, $A_4(-5, 2, -8)$.
- 6.30. $A_1(2, -4, -3)$, $A_2(5, -6, 0)$, $A_3(-1, 3, -3)$, $A_4(-10, -8, 7)$.
- 6.31. $A_1(1, -1, 2)$, $A_2(2, 1, 2)$, $A_3(1, 1, 4)$, $A_4(6, -3, 8)$.

Задача 7. Найти расстояние от точки M_0 до плоскости, проходящей через точки M_1 , M_2 , M_3 .

- 7.1. $M_1(-3, 4, -7)$, $M_2(1, 5, -4)$, $M_3(-5, -2, 0)$, $M_0(-12, 7, -1)$.

- 7.2. $M_1(-1, 2, -3)$, $M_2(4, -1, 0)$, $M_3(2, 1, -2)$, $M_0(1, -6, -5)$.
- 7.3. $M_1(-3, -1, 1)$, $M_2(-9, 1, -2)$, $M_3(3, -5, 4)$, $M_0(-7, 0, -1)$.
- 7.4. $M_1(1, -1, 1)$, $M_2(-2, 0, 3)$, $M_3(2, 1, -1)$, $M_0(-2, 4, 2)$.
- 7.5. $M_1(1, 2, 0)$, $M_2(1, -1, 2)$, $M_3(0, 1, -1)$, $M_0(2, -1, 4)$.
- 7.6. $M_1(1, 0, 2)$, $M_2(1, 2, -1)$, $M_3(2, -2, 1)$, $M_0(-5, -9, 1)$.
- 7.7. $M_1(1, 2, -3)$, $M_2(1, 0, 1)$, $M_3(-2, -1, 6)$, $M_0(3, -2, -9)$.
- 7.8. $M_1(3, 10, -1)$, $M_2(-2, 3, -5)$, $M_3(-6, 0, -3)$, $M_0(-6, 7, -10)$.
- 7.9. $M_1(-1, 2, 4)$, $M_2(-1, -2, -4)$, $M_3(3, 0, -1)$, $M_0(-2, 3, 5)$.
- 7.10. $M_1(0, -3, 1)$, $M_2(-4, 1, 2)$, $M_3(2, -1, 5)$, $M_0(-3, 4, -5)$.
- 7.11. $M_1(1, 3, 0)$, $M_2(4, -1, 2)$, $M_3(3, 0, 1)$, $M_0(4, 3, 0)$.
- 7.12. $M_1(-2, -1, -1)$, $M_2(0, 3, 2)$, $M_3(3, 1, -4)$, $M_0(-21, 20, -16)$.
- 7.13. $M_1(-3, -5, 6)$, $M_2(2, 1, -4)$, $M_3(0, -3, -1)$, $M_0(3, 6, 68)$.
- 7.14. $M_1(2, -4, -3)$, $M_2(5, -6, 0)$, $M_3(-1, 3, -3)$, $M_0(2, -10, 8)$.
- 7.15. $M_1(1, -1, 2)$, $M_2(2, 1, 2)$, $M_3(1, 1, 4)$, $M_0(-3, 2, 7)$.
- 7.16. $M_1(1, 3, 6)$, $M_2(2, 2, 1)$, $M_3(-1, 0, 1)$, $M_0(5, -4, 5)$.
- 7.17. $M_1(-4, 2, 6)$, $M_2(2, -3, 0)$, $M_3(-10, 5, 8)$, $M_0(-12, 1, 8)$.
- 7.18. $M_1(7, 2, 4)$, $M_2(7, -1, -2)$, $M_3(-5, -2, -1)$, $M_0(10, 1, 8)$.
- 7.19. $M_1(2, 1, 4)$, $M_2(3, 5, -2)$, $M_3(-7, -3, 2)$, $M_0(-3, 1, 8)$.
- 7.20.
- $M_1(-1, -5, 2)$, $M_2(-6, 0, -3)$, $M_3(3, 6, -3)$, $M_0(10, -8, -7)$.
- 7.21. $M_1(0, -1, -1)$, $M_2(-2, 3, 5)$, $M_3(1, -5, -9)$, $M_0(-4, -13, 6)$.

- 7.22. $M_1(5, 2, 0)$, $M_2(2, 5, 0)$, $M_3(1, 2, 4)$, $M_0(-3, -6, -8)$.
- 7.23. $M_1(2, -1, -2)$, $M_2(1, 2, 1)$, $M_3(5, 0, -6)$, $M_0(14, -3, 7)$.
- 7.24. $M_1(-2, 0, -4)$, $M_2(-1, 7, 1)$, $M_3(4, -8, -4)$, $M_0(-6, 5, 5)$.
- 7.25. $M_1(14, 4, 5)$, $M_2(-5, -3, 2)$, $M_3(-2, -6, -3)$, $M_0(-1, -8, 7)$.
- 7.26. $M_1(1, 2, 0)$, $M_2(3, 0, -3)$, $M_3(5, 2, 6)$, $M_0(-13, -8, 16)$.
- 7.27. $M_1(2, -1, 2)$, $M_2(1, 2, -1)$, $M_3(3, 2, 1)$, $M_0(-5, 3, 7)$.
- 7.28. $M_1(1, 1, 2)$, $M_2(-1, 1, 3)$, $M_3(2, -2, 4)$, $M_0(2, 3, 8)$.
- 7.29. $M_1(2, 3, 1)$, $M_2(4, 1, -2)$, $M_3(6, 3, 7)$, $M_0(-5, -4, 8)$.
- 7.30. $M_1(1, 1, -1)$, $M_2(2, 3, 1)$, $M_3(3, 2, 1)$, $M_0(-3, -7, 6)$.
- 7.31. $M_1(1, 5, -7)$, $M_2(-3, 6, 3)$, $M_3(-2, 7, 3)$, $M_0(1, -1, 2)$.

Задача 8. Написать уравнение плоскости, проходящей через точку A перпендикулярно вектору \overline{BC} .

- 8.1. $A(1, 0, -2)$, $B(2, -1, 3)$, $C(0, -3, 2)$.
- 8.2. $A(-1, 3, 4)$, $B(-1, 5, 0)$, $C(2, 6, 1)$.
- 8.3. $A(4, -2, 0)$, $B(1, -1, -5)$, $C(-2, 1, -3)$.
- 8.4. $A(-8, 0, 7)$, $B(-3, 2, 4)$, $C(-1, 4, 5)$.
- 8.5. $A(7, -5, 1)$, $B(5, -1, -3)$, $C(3, 0, -4)$.
- 8.6. $A(-3, 5, -2)$, $B(-4, 0, 3)$, $C(-3, 2, 5)$.
- 8.7. $A(1, -1, 8)$, $B(-4, -3, 10)$, $C(-1, -1, 7)$.
- 8.8. $A(-2, 0, -5)$, $B(2, 7, -3)$, $C(1, 10, -1)$.

- 8.9. $A(1, 9, -4)$, $B(5, 7, 1)$, $C(3, 5, 0)$.
- 8.10. $A(-7, 0, 3)$, $B(1, -5, -4)$, $C(2, -3, 0)$.
- 8.11. $A(0, -3, 5)$, $B(-7, 2, 6)$, $C(-3, 2, 4)$.
- 8.12. $A(5, -1, 2)$, $B(2, -4, 3)$, $C(4, -1, 3)$.
- 8.13. $A(-3, 7, 2)$, $B(3, 5, 1)$, $C(4, 5, 3)$.
- 8.14. $A(0, -2, 8)$, $B(4, 3, 2)$, $C(1, 4, 3)$.
- 8.15. $A(1, -1, 5)$, $B(0, 7, 8)$, $C(-1, 3, 8)$.
- 8.16. $A(-10, 0, 9)$, $B(12, 4, 11)$, $C(8, 5, 15)$.
- 8.17. $A(3, -3, -6)$, $B(1, 9, -5)$, $C(6, 6, -4)$.
- 8.18. $A(2, 1, 7)$, $B(9, 0, 2)$, $C(9, 2, 3)$.
- 8.19. $A(-7, 1, -4)$, $B(8, 11, -3)$, $C(9, 9, -1)$.
- 8.20. $A(1, 0, -6)$, $B(-7, 2, 1)$, $C(-9, 6, 1)$.
- 8.21. $A(-3, 1, 0)$, $B(6, 3, 3)$, $C(9, 4, -2)$.
- 8.22. $A(-4, -2, 5)$, $B(3, -3, -7)$, $C(9, 3, -7)$.
- 8.23. $A(0, -8, 10)$, $B(-5, 5, 7)$, $C(-8, 0, 4)$.
- 8.24. $A(1, -5, -2)$, $B(6, -2, 1)$, $C(2, -2, -2)$.
- 8.25. $A(0, 7, -9)$, $B(-1, 8, -11)$, $C(-4, 3, -12)$.
- 8.26. $A(-3, -1, 7)$, $B(0, 2, -6)$, $C(2, 3, -5)$.
- 8.27. $A(5, 3, -1)$, $B(0, 0, -3)$, $C(5, -1, 0)$.
- 8.28. $A(-1, 2, -2)$, $B(13, 14, 1)$, $C(14, 15, 2)$.

8.29. $A(7, -5, 0)$, $B(8, 3, -1)$, $C(8, 5, 1)$.

8.30. $A(-3, 6, 4)$, $B(8, -3, 5)$, $C(10, -3, 7)$.

8.31. $A(2, 5, -3)$, $B(7, 8, -1)$, $C(9, 7, 4)$.

Задача 9. Найти угол между плоскостями.

9.1. $x - 3y + 5 = 0$, $2x - y + 5z - 16 = 0$.

9.2. $x - 3y + z - 1 = 0$, $x + z - 1 = 0$.

9.3. $4x - 5y + 3z - 1 = 0$, $x - 4y - z + 9 = 0$.

9.4. $3x - y + 2z + 15 = 0$, $5x + 9y - 3z - 1 = 0$.

9.5. $6x + 2y - 4z + 17 = 0$, $9x + 3y - 6z - 4 = 0$.

9.6. $x - y\sqrt{2} + z - 1 = 0$, $x + y\sqrt{2} - z + 3 = 0$.

9.7. $3y - z = 0$, $2y + z = 0$.

9.8. $6x + 3y - 2z = 0$, $x + 2y + 6z - 12 = 0$.

9.9. $x + 2y + 2z - 3 = 0$, $16x + 12y - 15z - 1 = 0$.

9.10. $2x - y + 5z + 16 = 0$, $x + 2y + 3z + 8 = 0$.

9.11. $2x + 2y + z - 1 = 0$, $x + z - 1 = 0$.

9.12. $3x + y + z - 4 = 0$, $y + z + 5 = 0$.

9.13. $3x - 2y - 2z - 16 = 0$, $x + y - 3z - 7 = 0$.

9.14. $2x + 2y + z + 9 = 0$, $x - y + 3z - 1 = 0$.

9.15. $x + 2y + 2z - 3 = 0$, $2x - y + 2z + 5 = 0$.

9.16. $3x + 2y - 3z - 1 = 0$, $x + y + z - 7 = 0$.

9.17. $x - 3y - 2z - 8 = 0$, $x + y - z + 3 = 0$.

9.18. $3x - 2y + 3z + 23 = 0$, $y + z + 5 = 0$.

9.19. $x + y + 3z - 7 = 0$, $y + z - 1 = 0$.

9.20. $x - 2y + 2z + 17 = 0$, $x - 2y - 1 = 0$.

9.21. $x + 2y - 1 = 0$, $x + y + 6 = 0$.

9.22. $2x - z + 5 = 0$, $2x + 3y - 7 = 0$.

9.23. $5x + 3y + z - 18 = 0$, $2y + z - 9 = 0$.

9.24. $4x + 3z - 2 = 0$, $x + 2y + 2z + 5 = 0$.

9.25. $x + 4y - z + 1 = 0$, $2x + y + 4z - 3 = 0$.

9.26. $2y + z - 9 = 0$, $x - y + 2z - 1 = 0$.

9.27. $2x - 6y + 14z - 1 = 0$, $5x - 15y + 35z - 3 = 0$.

9.28. $x - y + 7z - 1 = 0$, $2x - 2y - 5 = 0$.

9.29. $3x - y - 5 = 0$, $2x + y - 3 = 0$.

9.30. $x + y + z\sqrt{2} - 3 = 0$, $x - y + z\sqrt{2} - 1 = 0$.

9.31. $x + 2y - 2z - 7 = 0$, $x + y - 35 = 0$.

Задача 10. Найти координаты точки A , равноудаленной от точек B и C .

10.1. $A(0, 0, z)$, $B(5, 1, 0)$, $C(0, 2, 3)$.

10.2. $A(0, 0, z)$, $B(3, 3, 1)$, $C(4, 1, 2)$.

10.3. $A(0, 0, z)$, $B(3, 1, 3)$, $C(1, 4, 2)$.

10.4. $A(0, 0, z)$, $B(-1, -1, -6)$, $C(2, 3, 5)$.

10.5. $A(0, 0, z)$, $B(-13, 4, 6)$, $C(10, -9, 5)$.

10.6. $A(0, 0, z)$, $B(-5, -5, 6)$, $C(-7, 6, 2)$.

10.7. $A(0, 0, z)$, $B(-18, 1, 0)$, $C(15, -10, 2)$.

10.8. $A(0, 0, z)$, $B(10, 0, -2)$, $C(9, -2, 1)$.

10.9. $A(0, 0, z)$, $B(-6, 7, 5)$, $C(8, -4, 3)$.

10.10. $A(0, 0, z)$, $B(6, -7, 1)$, $C(-1, 2, 5)$.

10.11. $A(0, 0, z), B(7, 0, -15), C(2, 10, -12)$.

10.12. $A(0, y, 0), B(3, 0, 3), C(0, 2, 4)$.

10.13. $A(0, y, 0), B(1, 6, 4), C(5, 7, 1)$.

10.14. $A(0, y, 0), B(-2, 8, 10), C(6, 11, -2)$.

10.15. $A(0, y, 0), B(-2, -4, 6), C(7, 2, 5)$.

10.16. $A(0, y, 0), B(2, 2, 4), C(0, 4, 2)$.

10.17. $A(0, y, 0), B(0, -4, 1), C(1, -3, 5)$.

10.18. $A(0, y, 0), B(0, 5, -9), C(-1, 0, 5)$.

10.19. $A(0, y, 0), B(-2, 4, -6), C(8, 5, 1)$.

10.20. $A(0, y, 0), B(7, 3, -4), C(1, 5, 7)$.

10.21. $A(0, y, 0), B(0, -2, 4), C(-4, 0, 4)$.

10.22. $A(x, 0, 0), B(0, 1, 3), C(2, 0, 4)$.

10.23. $A(x, 0, 0), B(4, 0, 5), C(5, 4, 2)$.

10.24. $A(x, 0, 0), B(8, 1, -7), C(10, -2, 1)$.

10.25. $A(x, 0, 0), B(3, 5, 6), C(1, 2, 3)$.

10.26. $A(x, 0, 0), B(4, 5, -2), C(2, 3, 4)$.

10.27. $A(x, 0, 0), B(-2, 0, 6), C(0, -2, -4)$.

10.28. $A(x, 0, 0), B(1, 5, 9), C(3, 7, 11)$.

10.29. $A(x, 0, 0), B(4, 6, 8), C(2, 4, 6)$.

10.30. $A(x, 0, 0), B(1, 2, 3), C(2, 6, 10)$.

$$10.31. A(x, 0, 0), B(-2, -4, -6), C(-1, -2, -3).$$

Задача 11. Пусть k – коэффициент преобразования подобия с центром в начале координат. Верно ли, что точка A принадлежит образу плоскости α ?

$$11.1. A(1, 2, -1), \alpha: 2x + 3y + z - 1 = 0, k = 2.$$

$$11.2. A(2, 1, 2), \alpha: x - 2y + z + 1 = 0, k = -2.$$

$$11.3. A(-1, 1, 1), \alpha: 3x - y + 2z + 4 = 0, k = 1/2.$$

$$11.4. A(-2, 4, 1), \alpha: 3x + y + 2z + 2 = 0, k = 3.$$

$$11.5. A(1, 1/3, -2), \alpha: x - 3y + z + 6 = 0, k = 1/3.$$

$$11.6. A(1/2, 1/3, 1), \alpha: 2x - 3y + 3z - 2 = 0, k = 1,5.$$

$$11.7. A(2, 0, -1), \alpha: x - 3y + 5z - 1 = 0, k = -1.$$

$$11.8. A(1, -2, 1), \alpha: 5x + y - z + 6 = 0, k = 2/3.$$

$$11.9. A(2, -5, 4), \alpha: 5x + 2y - z + 3 = 0, k = 4/3.$$

$$11.10. A(2, -3, 1), \alpha: x + y - 2z + 2 = 0, k = 5/2.$$

$$11.11. A(-2, 3, -3), \alpha: 3x + 2y - z - 2 = 0, k = 3/2.$$

$$11.12. A(1/4, 1/3, 1), \alpha: 4x - 3y + 5z - 10 = 0, k = 1/2.$$

$$11.13. A(0, 1, -1), \alpha: 6x - 5y + 3z - 4 = 0, k = -3/4.$$

$$11.14. A(2, 3, -2), \alpha: 3x - 2y + 4z - 6 = 0, k = -4/3.$$

$$11.15. A(-2, -1, 1), \alpha: x - 2y + 6z - 10 = 0, k = 3/5.$$

$$11.16. A(5, 0, -1), \alpha: 2x - y + 3z - 1 = 0, k = 3.$$

$$11.17. A(1, 1, 1), \alpha: 7x - 6y + z - 5 = 0, k = -2.$$

11.18. $A(1/3, 1, 1), \alpha: 3x - y + 5z - 6 = 0, k = 5/6.$

11.19. $A(2, 5, 1), \alpha: 5x - 2y + z - 3 = 0, k = 1/3.$

11.20. $A(-1, 2, 3), \alpha: x - 3y + z + 2 = 0, k = 2, 5.$

11.21. $A(4, 3, 1), \alpha: 3x - 4y + 5z - 6 = 0, k = 5/6.$

11.22. $A(3, 5, 2), \alpha: 5x - 3y + z - 4 = 0, k = 1/2.$

11.23. $A(4, 0, -3), \alpha: 7x - y + 3z - 1 = 0, k = 3.$

11.24. $A(-1, 1, -2), \alpha: 4x - y + 3z - 6 = 0, k = -5/3.$

11.25. $A(2, -5, -1), \alpha: 5x + 2y - 3z - 9 = 0, k = 1/3.$

11.26. $A(-3, -2, 4), \alpha: 2x - 3y + z - 5 = 0, k = -4/5.$

11.27. $A(5, 0, -6), \alpha: 6x - y - z + 7 = 0, k = 2/7.$

11.28. $A(1, 2, 2), \alpha: 3x - z + 5 = 0, k = -1/5.$

11.29. $A(3, 2, 4), \alpha: 2x - 3y + z - 6 = 0, k = 2/3.$

11.30. $A(7, 0, -1), \alpha: x - y - z - 1 = 0, k = 4.$

11.31. $A(0, 3, -1), \alpha: 2x - y + 3z - 1 = 0, k = 2.$

Задача 12. Написать канонические уравнения прямой.

12.1. $2x + y + z - 2 = 0, 2x - y - 3z + 6 = 0.$

12.2. $x - 3y + 2z + 2 = 0, x + 3y + z + 14 = 0.$

12.3. $x - 2y + z - 4 = 0, 2x + 2y - z - 8 = 0.$

12.4. $x + y + z - 2 = 0, x - y - 2z + 2 = 0.$

12.5. $2x + 3y + z + 6 = 0, x - 3y - 2z + 3 = 0.$

12.6. $3x + y - z - 6 = 0, 3x - y + 2z = 0.$

$$12.7. x + 5y + 2z + 11 = 0, \quad x - y - z - 1 = 0.$$

$$12.8. 3x + 4y - 2z + 1 = 0, \quad 2x - 4y + 3z + 4 = 0.$$

$$12.9. 5x + y - 3z + 4 = 0, \quad x - y + 2z + 2 = 0.$$

$$12.10. x - y - z - 2 = 0, \quad x - 2y + z + 4 = 0.$$

$$12.11. 4x + y - 3z + 2 = 0, \quad 2x - y + z - 8 = 0.$$

$$12.12. 3x + 3y - 2z - 1 = 0, \quad 2x - 3y + z + 6 = 0.$$

$$12.13. 6x - 7y - 4z - 2 = 0, \quad x + 7y - z - 5 = 0.$$

$$12.14. 8x - y - 3z - 1 = 0, \quad x + y + z + 10 = 0.$$

$$12.15. 6x - 5y - 4z + 8 = 0, \quad 6x + 5y + 3z + 4 = 0.$$

$$12.16. x + 5y - z - 5 = 0, \quad 2x - 5y + 2z + 5 = 0.$$

$$12.17. 2x - 3y + z + 6 = 0, \quad x - 3y - 2z + 3 = 0.$$

$$12.18. 5x + y + 2z + 4 = 0, \quad x - y - 3z + 2 = 0.$$

$$12.19. 4x + y + z + 2 = 0, \quad 2x - y - 3z - 8 = 0.$$

$$12.20. 2x + y - 3z - 2 = 0, \quad 2x - y + z + 6 = 0.$$

$$12.21. x + y - 2z - 2 = 0, \quad x - y + z + 2 = 0.$$

$$12.22. x + 5y - z + 11 = 0, \quad x - y + 2z - 1 = 0.$$

$$12.23. x - y + z - 2 = 0, \quad x - 2y - z + 4 = 0.$$

$$12.24. 6x - 7y - z - 2 = 0, \quad x + 7y - 4z - 5 = 0.$$

$$12.25. x + 5y + 2z - 5 = 0, \quad 2x - 5y - z + 5 = 0.$$

$$12.26. x - 3y + z + 2 = 0, \quad x + 3y + 2z + 14 = 0.$$

$$12.27. 2x + 3y - 2z + 6 = 0, \quad x - 3y + z + 3 = 0.$$

$$12.28. 3x + 4y + 3z + 1 = 0, \quad 2x - 4y - 2z + 4 = 0.$$

$$12.29. 3x + 3y + z - 1 = 0, \quad 2x - 3y - 2z + 6 = 0.$$

$$12.30. 6x - 5y + 3z + 8 = 0, \quad 6x + 5y - 4z + 4 = 0.$$

$$12.31. 2x - 3y - 2z + 6 = 0, \quad x - 3y + z + 3 = 0.$$

Задача 13. Найти точку пересечения прямой и плоскости.

$$13.1. \frac{x-2}{-1} = \frac{y-3}{-1} = \frac{z+1}{4}, \quad x + 2y + 3z - 14 = 0.$$

$$13.2. \frac{x+1}{3} = \frac{y-3}{-4} = \frac{z+1}{5}, \quad x + 2y - 5z + 20 = 0.$$

$$13.3. \frac{x-1}{-1} = \frac{y+5}{4} = \frac{z-1}{2}, \quad x - 3y + 7z - 24 = 0.$$

$$13.4. \frac{x-1}{1} = \frac{y}{0} = \frac{z+3}{2}, \quad 2x - y + 4z = 0.$$

$$13.5. \frac{x-5}{1} = \frac{y-3}{-1} = \frac{z-2}{0}, \quad 3x + y - 5z - 12 = 0.$$

$$13.6. \frac{x+1}{-3} = \frac{y+2}{2} = \frac{z-3}{-2}, \quad x + 3y - 5z + 9 = 0.$$

$$13.7. \frac{x-1}{-2} = \frac{y-2}{1} = \frac{z+1}{-1}, \quad x - 2y + 5z + 17 = 0.$$

$$13.8. \frac{x-1}{2} = \frac{y-2}{0} = \frac{z-4}{1}, \quad x - 2y + 4z - 19 = 0.$$

$$13.9. \frac{x+2}{-1} = \frac{y-1}{1} = \frac{z+4}{-1}, \quad 2x - y + 3z + 23 = 0.$$

$$13.10. \frac{x+2}{1} = \frac{y-2}{0} = \frac{z+3}{0}, \quad 2x - 3y - 5z - 7 = 0.$$

$$13.11. \frac{x-1}{2} = \frac{y-1}{-1} = \frac{z+2}{3}, \quad 4x + 2y - z - 11 = 0.$$

$$13.12. \frac{x-1}{1} = \frac{y+1}{0} = \frac{z-1}{-1}, \quad 3x - 2y - 4z - 8 = 0.$$

$$13.13. \frac{x+2}{-1} = \frac{y-1}{1} = \frac{z+3}{2}, \quad x + 2y - z - 2 = 0.$$

- 13.14. $\frac{x+3}{1} = \frac{y-2}{-5} = \frac{z+2}{3}$, $5x - y + 4z + 3 = 0$.
- 13.15. $\frac{x-2}{2} = \frac{y-2}{-1} = \frac{z-4}{3}$, $x + 3y + 5z - 42 = 0$.
- 13.16. $\frac{x-3}{-1} = \frac{y-4}{5} = \frac{z-4}{2}$, $7x + y + 4z - 47 = 0$.
- 13.17. $\frac{x+3}{2} = \frac{y-1}{3} = \frac{z-1}{5}$, $2x + 3y + 7z - 52 = 0$.
- 13.18. $\frac{x-3}{2} = \frac{y+1}{3} = \frac{z+3}{2}$, $3x + 4y + 7z - 16 = 0$.
- 13.19. $\frac{x-5}{-2} = \frac{y-2}{0} = \frac{z+4}{-1}$, $2x - 5y + 4z + 24 = 0$.
- 13.20. $\frac{x-1}{8} = \frac{y-8}{-5} = \frac{z+5}{12}$, $x - 2y - 3z + 18 = 0$.
- 13.21. $\frac{x-3}{1} = \frac{y-1}{-1} = \frac{z+5}{0}$, $x + 7y + 3z + 11 = 0$.
- 13.22. $\frac{x-5}{-1} = \frac{y+3}{5} = \frac{z-1}{2}$, $3x + 7y - 5z - 11 = 0$.
- 13.23. $\frac{x-1}{7} = \frac{y-2}{1} = \frac{z-6}{-1}$, $4x + y - 6z - 5 = 0$.
- 13.24. $\frac{x-3}{1} = \frac{y+2}{-1} = \frac{z-8}{0}$, $5x + 9y + 4z - 25 = 0$.
- 13.25. $\frac{x+1}{-2} = \frac{y}{0} = \frac{z+1}{3}$, $x + 4y + 13z - 23 = 0$.
- 13.26. $\frac{x-1}{6} = \frac{y-3}{1} = \frac{z+5}{3}$, $3x - 2y + 5z - 3 = 0$.
- 13.27. $\frac{x-2}{4} = \frac{y-1}{-3} = \frac{z+3}{-2}$, $3x - y + 4z = 0$.

$$13.28. \frac{x-1}{2} = \frac{y+2}{-5} = \frac{z-3}{-2}, \quad x+2y-5z+16=0.$$

$$13.29. \frac{x-1}{1} = \frac{y-3}{0} = \frac{z+2}{-2}, \quad 3x-7y-2z+7=0.$$

$$13.30. \frac{x+3}{0} = \frac{y-2}{-3} = \frac{z+5}{11}, \quad 5x+7y+9z-32=0.$$

$$13.31. \frac{x-7}{3} = \frac{y-3}{1} = \frac{z+1}{-2}, \quad 2x+y+7z-3=0.$$

Задача 14. Найти точку M' , симметричную точке M относительно прямой (для вариантов 1 – 15) или плоскости (для вариантов 16 – 31).

$$14.1. M(0, -3, -2), \quad \frac{x-1}{1} = \frac{y+1,5}{-1} = \frac{z}{1}.$$

$$14.2. M(2, -1, 1), \quad \frac{x-4,5}{1} = \frac{y+3}{-0,5} = \frac{z-2}{1}.$$

$$14.3. M(1, 1, 1), \quad \frac{x-2}{1} = \frac{y+1,5}{-2} = \frac{z-1}{1}.$$

$$14.4. M(1, 2, 3), \quad \frac{x-0,5}{0} = \frac{y+1,5}{-1} = \frac{z-1,5}{1}.$$

$$14.5. M(1, 0, -1), \quad \frac{x-3,5}{2} = \frac{y-1,5}{2} = \frac{z}{0}.$$

$$14.6. M(2, 1, 0), \quad \frac{x-2}{0} = \frac{y+1,5}{-1} = \frac{z+0,5}{1}.$$

$$14.7. M(-2, -3, 0), \quad \frac{x+0,5}{1} = \frac{y+1,5}{0} = \frac{z-0,5}{1}.$$

$$14.8. M(-1, 0, -1), \quad \frac{x}{-1} = \frac{y-1,5}{0} = \frac{z-2}{1}.$$

$$14.9. M(0, 2, 1), \quad \frac{x-1,5}{2} = \frac{y}{-1} = \frac{z-2}{1}.$$

$$14.10. M(3, -3, -1), \frac{x-6}{5} = \frac{y-3,5}{4} = \frac{z+0,5}{0}.$$

$$14.11. M(3, 3, 3), \frac{x-1}{-1} = \frac{y-1,5}{0} = \frac{z-3}{1}.$$

$$14.12. M(-1, 2, 0), \frac{x+0,5}{1} = \frac{y+0,7}{-0,2} = \frac{z-2}{2}.$$

$$14.13. M(2, -2, -3), \frac{x-1}{-1} = \frac{y+0,5}{0} = \frac{z+1,5}{0}.$$

$$14.14. M(-1, 0, 1), \frac{x+0,5}{0} = \frac{y-1}{0} = \frac{z-4}{2}.$$

$$14.15. M(0, -3, -2), \frac{x-0,5}{0} = \frac{y+1,5}{-1} = \frac{z-1,5}{1}.$$

$$14.16. M(1, 0, 1), 4x + 6y + 4z - 25 = 0.$$

$$14.17. M(-1, 0, -1), 2x + 6y - 2z + 11 = 0.$$

$$14.18. M(0, 2, 1), 2x + 4y - 3 = 0.$$

$$14.19. M(2, 1, 0), y + z + 2 = 0.$$

$$14.20. M(-1, 2, 0), 4x - 5y - z - 7 = 0.$$

$$14.21. M(2, -1, 1), x - y + 2z - 2 = 0.$$

$$14.22. M(1, 1, 1), x + 4y + 3z + 5 = 0.$$

$$14.23. M(1, 2, 3), 2x + 10y + 10z - 1 = 0.$$

$$14.24. M(0, -3, -2), 2x + 10y + 10z - 1 = 0.$$

$$14.25. M(1, 0, -1), 2y + 4z - 1 = 0.$$

$$14.26. M(3, -3, -1), 2x - 4y - 4z - 13 = 0.$$

$$14.27. M(-2, -3, 0), x + 5y + 4 = 0.$$

14.28. $M(2, -2, -3), y + z + 2 = 0.$

14.29. $M(-1, 0, 1), 2x + 4y - 3 = 0.$

14.30. $M(3, 3, 3), 8x + 6y + 8z - 25 = 0.$

14.31. $M(-2, 0, 3), 2x - 2y + 10z + 1 = 0.$