

How to use this sheet. The dot product tests for perpendicularity (zero means perpendicular) and the cross product tests for parallelism (zero means parallel). The scalar triple product tests for coplanarity (zero means coplanar). Nearly every question is one of these three tests.

Quick reference — $|a| = \sqrt{\text{sum of squares}}$ · $a \cdot b = |a||b|\cos\theta$ · $|a \times b| = |a||b|\sin\theta = \text{parallelogram area}$
· $[a \ b \ c] = a \cdot (b \times c) = 0$ means coplanar

Section A · Level 1

Eight questions. None should take more than twenty seconds.

1. The magnitude of the vector $3i + 4j$ is:

- (1) 3 (2) 4 (3) 5 (4) 7

2. The unit vector along $2i - 2j + k$ is:

- (1) $(2/3)i - (2/3)j + (1/3)k$ (2) $2i - 2j + k$ (3) $(1/3)(2i - 2j + k)$ (4) Both 1 and 3 are correct

3. If $a \cdot b = 0$ for two non-zero vectors a and b , then a and b are:

- (1) Parallel (2) Perpendicular (3) Equal (4) Opposite in direction

4. If $a \times b = 0$ for two non-zero vectors a and b , then a and b are:

- (1) Perpendicular (2) Parallel (3) Equal in magnitude only (4) Unit vectors

5. The dot product $a \cdot b$ of two vectors equals:

- (1) $|a||b|\sin\theta$ (2) $|a||b|\cos\theta$ (3) $|a||b|\tan\theta$ (4) $|a| + |b|$

6. The magnitude of the cross product $a \times b$ equals:

- (1) $|a||b|\cos\theta$ (2) $|a||b|\sin\theta$ (3) $|a| + |b|$ (4) $|a||b|$

7. For any vector a , the value of $a \times a$ is:

- (1) $|a|^2$ (2) 1 (3) a (4) The zero vector

8. For any vector a , the value of $a \cdot a$ is:

- (1) 0 (2) 1 (3) $|a|^2$ (4) $|a|$

Section B · Level 2

Six questions. Watch the order of the vectors in a cross product.

9. If $a = 2i + 3j + k$ and $b = i - j + 2k$, then $a \cdot b$ equals:

- (1) 1 (2) 3 (3) 6 (4) -1

10. $i \times j$ equals:

- (1) i (2) j (3) k (4) The zero vector

11. $2i \times 3j$ equals:

- (1) $5k$ (2) $6k$ (3) 6 (4) k

12. If $a = i + j$ and $b = j + k$, then $a \times b$ equals:

- (1) $i - j + k$ (2) $i + j - k$ (3) $-i + j - k$ (4) $i - j - k$

13. The area of the parallelogram with adjacent sides $a = 2i + j$ and $b = i + 3j$ is:

(1) 3 (2) 5 (3) 7 (4) 6

14. The scalar triple product $[i \ j \ k]$ equals:

(1) 0 (2) 1 (3) -1 (4) 3

Section C · Level 3

Seven questions. Check for a scalar multiple before assuming two vectors are unrelated.

15. Three vectors a , b and c are coplanar if and only if their scalar triple product $[a \ b \ c]$ equals:

(1) 1 (2) -1 (3) 0 (4) $|a||b||c|$

16. The scalar projection of $a = 3i + 4j$ onto the vector i is:

(1) 0 (2) 3 (3) 4 (4) 5

17. The position vectors of two points are a and b . The position vector of the midpoint of the segment joining them is:

(1) $a + b$ (2) $(a + b)/2$ (3) $a - b$ (4) $(a - b)/2$

18. If the position vectors of points A and B are a and b , then the vector AB (from A to B) is:

(1) $a + b$ (2) $a - b$ (3) $b - a$ (4) $-a - b$

19. If a and b are two vectors such that $|a| = |b|$ and $a \neq b$, the vector $a - b$ is:

(1) Always the zero vector (2) Perpendicular to $a + b$ (3) Parallel to $a + b$ (4) Always equal to $a + b$

20. A vector equation $a = \lambda b$, for some scalar λ , expresses that a and b are:

(1) Perpendicular (2) Parallel (3) Equal in magnitude (4) Unit vectors

21. Given $a = 2i - 2j + k$ and $b = 6i - 6j + 3k$, which of the following is true?

(1) a and b are perpendicular (2) a and b are parallel, since $b = 3a$ (3) a and b are equal (4) a and b are neither parallel nor perpendicular

Answer key: 1. (3) 2. (4) 3. (2) 4. (2) 5. (2) 6. (2) 7. (4) 8. (3) 9. (1) 10. (3) 11. (2) 12. (1) 13. (2) 14. (2) 15. (3) 16. (2) 17. (2) 18. (3) 19. (2) 20. (2) 21. (2)

Stuck on any of these? Bring them to a live class.

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