5.7 Unit 5 Pretest Review – Cartesian Vectors

This document was composed and formatted by Annie Bernatchez.

The course material originated from www.jensenmath.ca

This review covers all of Unit 5: Cartesian Vectors, and is meant to be used to prepare for the unit test.

Section 1: 5.1 – Vector Notation

1) Express each vector in terms of vectors $\hat{i}$ and $\hat{j}$

a) $[-3, -6]$	b) $[0, -8]$	c) $[-6, 0]$

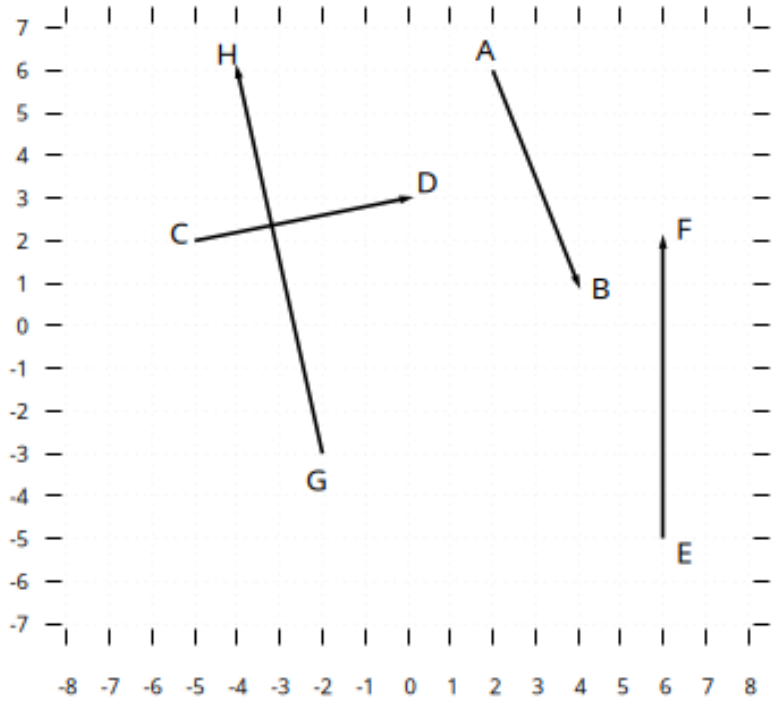
Section 2: 5.1 – Vector Notation

2) Express each vector in the form $[a, b]$

a) $-4\hat{i}$	b) $7\hat{i} - 4\hat{j}$	c) $2\hat{j}$

Section 3: 5.1 – Magnitude of Vectors from a Grid

3) Write the coordinates of each Cartesian Vector in the form $[a, b]$ and determine its magnitude.



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Section 4: 5.1 – Equivalent Vectors

4) You are given the vector $\vec{v} = [5, -1]$. An equivalent vector $\overrightarrow{PQ}$ has its initial point at $P(-2, -7)$. Determine the coordinates of Q.

Section 5: 5.1 – Vectors Between Points

5) Given the points $P(-6, 1)$, $Q(-2, -1)$, and $R(-3, 4)$, find

a) $\overrightarrow{QP}$

b) $|\overrightarrow{RP}|$

c) the perimeter of $\triangle PQR$

Section 6: 5.1 – Scalar Multiplication and Vector Addition

6) If $\vec{u} = [4, -1]$ and $\vec{v} = [2, 7]$, find

a) $8\vec{u}$	b) $-8\vec{u}$
c) $\vec{u} + \vec{v}$	d) $\vec{v} - \vec{u}$
e) $5\vec{u} - 3\vec{v}$	f) $-4\vec{u} + 7\vec{v}$

Section 7: 5.1 – Collinear Vectors

7) Which vector is collinear with $\vec{a} = [6, -4]$? Give proof.

$\vec{b} = [-9, 6]$, $\vec{c} = [-6, -4]$

Section 8: 5.1 – Resolving a Force into Components

8) A person pulls a sleigh, exerting a force of 180 N along a rope that makes an angle of 30° to the horizontal. Write

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this force in component form as a Cartesian vector.

Section 9: 5.1 – Resolving a Force into Components

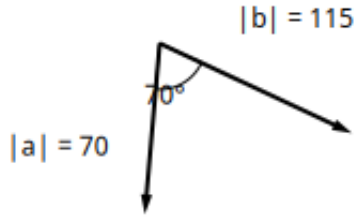
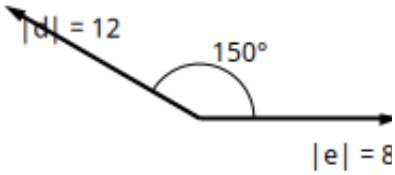
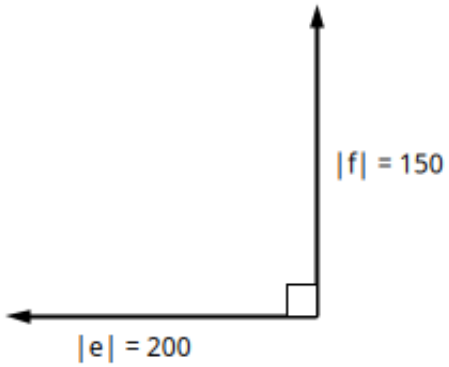
9) A person pushes a lawnmower with a force of 250 N. The handle makes an angle of 35° with the ground. Write this force in component form as a Cartesian vector.

Section 10: 5.1 – Resultant Velocity Using Bearings

10) A ship's course is set at a heading of 192°, with a speed of 30 knots. A current is flowing from a bearing of 112°, at 14 knots. Use Cartesian vectors to determine the resultant velocity of the ship.

Section 11: 5.2 – Dot Product

11) Calculate the dot product of each pair of vectors.

a) $\lvert\vec{a}\rvert = 70$, $\lvert\vec{b}\rvert = 115$, 70° between	b) $\lvert\vec{d}\rvert = 12$, $\lvert\vec{e}\rvert = 8$, 150° between	c) $\lvert\vec{e}\rvert = 200$, $\lvert\vec{f}\rvert = 150$, perpendicular
		
d) $\vec{u} = [2,\ 4]$, $\vec{v} = [3,\ -1]$	e) $\vec{s} = [9,\ -3]$, $\vec{t} = [3,\ -3]$	f) $\vec{a} = 2\hat{i} + 3\hat{j}$, $\vec{b} = 9\hat{i} - 7\hat{j}$

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Section 12: 5.2 – Dot Product Properties

12) Let $\vec{u} = [3, -5]$, $\vec{v} = [-6, 1]$, and $\vec{w} = [4, 7]$. Evaluate each of the following if possible. If it is not possible, explain why not.

a) $\vec{u} \cdot (\vec{v} + \vec{w})$	b) $(\vec{u} + \vec{v}) \cdot (\vec{u} - \vec{v})$
c) $\vec{u} + \vec{v} \cdot \vec{w}$	d) $-3\vec{v} \cdot (2\vec{w})$
e) $(\vec{u} + 2\vec{v}) \cdot (3\vec{w} - \vec{u})$	f) $\vec{v} \cdot \vec{v} + \vec{w} \cdot \vec{w}$

Section 13: 5.2 – Right Triangles Using the Dot Product

13) $\triangle ABC$ has points $A(3, 1)$, $B(-2, 3)$, and $C(5, 6)$. Is it a right-angled triangle? If it is, identify the right angle.

Section 14: 5.2 – Perpendicular Vectors

14) Find a vector that is perpendicular to $\vec{u} = [9, 2]$. Verify that the vectors are perpendicular.

Section 15: 5.2 – Solving for k (Perpendicular Vectors)

15) Determine the value of k so that $\vec{u} = [2, 5]$ and $\vec{v} = [k, 4]$ are perpendicular.

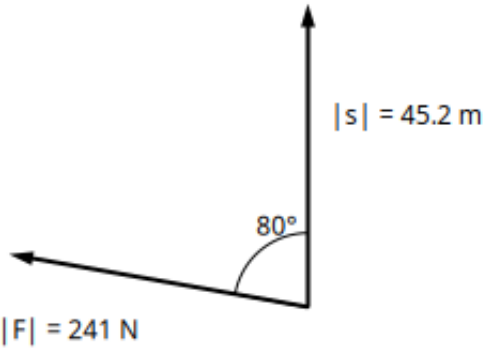
Section 16: 5.2 – Solving for k (Perpendicular Vectors)

16) Determine the value of k so that $\vec{u} = [k, 3]$ and $\vec{v} = [k, 2k]$ are perpendicular.

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Section 17: 5.3 – Work

17) Determine the work done by force $\vec{F}$, in Newtons, for an object moving along the vector $\vec{s}$, in meters.

a) $\vec{F} = [5, 2]$, $\vec{s} = [7, 4]$	b) $\vec{F} = [100, 400]$, $\vec{s} = [12, 27]$	c) 

Section 18: 5.3 – Angle Between Two Vectors

18) Calculate the angle between the vectors in each pair.

a) $\vec{p} = [7, 8]$, $\vec{q} = [4, 3]$	b) $\vec{t} = [-7, 2]$, $\vec{u} = [6, 11]$

Section 19: 5.3 – Projection of a Vector

19) Determine the projection of $\vec{u}$ on $\vec{v}$

a) $\|\vec{u}\| = 56$, $\|\vec{v}\| = 100$, angle θ between $\vec{u}$ and $\vec{v}$ is 125°.	b) $\vec{u} = [7, 1]$, $\vec{v} = [9, -3]$

Section 20: 5.3 – Projection of a Vector

20) Find the magnitude of the projection of $\vec{a}$ on $\vec{b}$ and also the vector projection of $\vec{a}$ on $\vec{b}$ if $\vec{a} = [6, -1]$ and $\vec{b} = [11, 5]$

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Section 21: 5.3 – Work

21) A superhero pulls herself 15 m up the side of a wall with a force of 500 N, at an angle of 12° to the vertical. What is the work done?

Section 22: 5.3 – Work

22) A crate is dragged 3 meters along a smooth level floor by a 30 N force, applied at 25° to the floor. Then, it is pulled 4 meters up a ramp inclined at 20° to the horizontal, using the same force. Then, the crate is dragged a further 5 meters along a level platform using the same force again. Determine the total work done in moving the crate.

Section 23: 5.3 – Work Against Gravity

23) How much work is done against gravity by a worker who carries a 25-kg carton up a 6 meter long set of stairs, inclined at 30°.

Section 24: 5.4 – Plotting Vectors in 3-Space

24) Draw each position vector. Then, determine its exact magnitude.

$\vec{a} = [-1,\ 5,\ -2]$

$\vec{b} = [-2,\ 0,\ -4]$

Section 25: 5.4 – Collinear Vectors in 3-Space

25) Are the vectors $\vec{u} = [6,\ -2,\ -5]$ and $\vec{v} = [-12,\ 4,\ 10]$ collinear? Explain.

Section 26: 5.4 – Collinear Vectors in 3-Space

26) Find a and b such that $\vec{u} = [a,\ 3,\ 6]$ and $\vec{v} = [-8,\ 12,\ b]$ are collinear.

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Section 27: 5.4 – Vectors Between Points in 3-Space

27) Draw the vector $\overrightarrow{AB}$ joining each pair of points. Then, write the vector in the form $[x, y, z]$ and determine its magnitude.

a) $A(2, 1, 3)$, $B(5, 7, 1)$	b) $A(3, -4, 1)$, $B(6, -1, 5)$

Section 28: 5.4 – Vector Operations in 3-Space

28) Given the vectors $\vec{a} = [-4, 1, 7]$, $\vec{b} = [2, 0, -3]$, and $\vec{c} = [1, -1, 5]$, simplify each expression.

a) $7\vec{a}$	b) $3\vec{a} - 2\vec{b} + 4\vec{c}$
c) $\vec{a} \cdot \vec{c}$	d) $(\vec{a} + \vec{b}) \cdot (\vec{a} - \vec{b})$

Section 29: 5.4 – Angle Between Vectors in 3-Space

29) Determine the angle between the vectors $\vec{g} = [6, 1, 2]$ and $\vec{h} = [-5, 3, 6]$

Section 30: 5.4 – Orthogonal Vectors in 3-Space

30) Determine a vector that is orthogonal to $\vec{e} = [3, -1, 4]$

Section 31: 5.4 – Classifying a Triangle in 3-Space

31) Identify the type of triangle with vertices $A(2, 3, -5)$, $B(-4, 8, 1)$, and $C(6, -4, 0)$.

Section 32: 5.5 – Magnitude of the Cross Product

32) Determine $\vec{u} \times \vec{v}$

$|\vec{v}| = 80$, $|\vec{u}| = 60$, $55°$ between

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Section 33: 5.5 – Cross Product of Algebraic Vectors

33) Determine $\vec{a} \times \vec{b}$ for each pair of vectors

a) $\vec{a} = [3, -2, 9]$, $\vec{b} = [1, 1, 6]$	b) $\vec{a} = [-8, 10, 3]$, $\vec{b} = [2, 0, 5]$

Section 34: 5.5 – Area of a Parallelogram

34) Determine the area of the parallelogram defined by each pair of vectors.

a) $\vec{p} = [6, 3, 8]$, $\vec{q} = [3, 3, 5]$	b) $\lvert\vec{v}\rvert = 27$, $\lvert\vec{u}\rvert = 43$, 32° between

Section 35: 5.5 – Cross Product Expressions

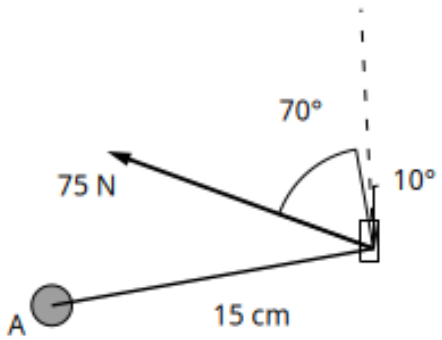
35) Given $\vec{a} = [2, -6, 3]$, $\vec{b} = [-1, 5, 8]$, and $\vec{c} = [-4, 5, 6]$, evaluate each of the following.

a) $\vec{a} \times (\vec{b} + \vec{c})$

b) $\vec{a} \times \vec{b} - \vec{a} \times \vec{c}$

Section 36: 5.6 – Torque

36) A bicycle pedal is pushed by a 75 N force, exerted as shown in the diagram. The shaft of the pedal is 15 cm long. Find the magnitude of the torque vector, in Newton-meters, about point A.



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Section 37: 5.6 – Work in 3-Space

37) A force of $\vec{F} = [3, 5, 12]$, in Newtons, is applied to lift a box, with displacement $\vec{s} = [2, 1, 6]$. Calculate the work against gravity and compare it to the work in the direction of travel.

Section 38: 5.6 – Projection in 3-Space

38) Determine the projection, and its magnitude, of $\vec{u} = [3, 1, 4]$ on $\vec{v} = [6, 2, 7]$.

Section 39: 5.6 – Triple Scalar Product

39) Given $\vec{a} = [-2, 3, 5]$, $\vec{b} = [4, 0, -1]$, and $\vec{c} = [2, -2, 3]$, evaluate $\vec{a} \cdot \vec{b} \times \vec{c}$

Section 40: 5.6 – Volume of a Parallelepiped

40) Find the volume of the parallelepiped, defined by the vectors $\vec{u} = [1, 4, 3]$, $\vec{v} = [2, 5, 6]$, and $\vec{w} = [1, 2, 7]$.

Section 41: 5.6 – Area of a Triangle Using the Cross Product

41) A triangle has vertices $A(-2, 1, 3)$, $B(7, 8, -4)$, and $C(5, 0, 2)$. Determine the area of $\triangle ABC$.

Answer Key

1. a) $-3\hat{i} - 6\hat{j}$ b) $-8\hat{j}$ c) $-6\hat{i}$

2. a) $[-4, 0]$ b) $[7, -4]$ c) $[0, 2]$

3. $\overrightarrow{AB} = [2, -5]$, $|\overrightarrow{AB}| = \sqrt{29}$ units; $\overrightarrow{CD} = [5, 1]$, $|\overrightarrow{CD}| = \sqrt{26}$ units; $\overrightarrow{EF} = [0, 7]$, $|\overrightarrow{EF}| = 7$ units; $\overrightarrow{GH} = [-2, 9]$, $|\overrightarrow{GH}| = \sqrt{85}$ units

4. $Q(3, -8)$

5. a) $[-4, 2]$ b) $3\sqrt{2}$ units c) 13.8 units

6. a) $[32, -8]$ b) $[-32, 8]$ c) $[6, 6]$ d) $[-2, 8]$ e) $[14, -26]$ f) $[-2, 53]$

7. $\vec{b}$ is collinear with $\vec{a}$; $\vec{b} = -\frac{3}{2}\vec{a}$

8. $[180\cos 30°, 180\sin 30°]$

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9. $[250\cos(-35°),\ 250\sin(-35°)]$

10. 30.8 km/h on a bearing of 218.6°

11. a) 2753.3 b) -83.1 c) 0 d) 2 e) 36 f) -3

12. a) -46 b) -3 c) This is not possible. It is the sum of a vector and a scalar. d) 102 e) -159 f) 102

13. It is a right angled triangle. $\angle A$ is the right angle.

14. $[2,\ -9]$ (answers will vary)

15. $k = -10$

16. $k = 0,\ -6$

17. a) 43 J b) 12 000 J c) 1891.6 J

18. a) 11.9° b) 102.7°

19. a) $-32.1\hat{v}$ b) $[6,\ -2]$

20. $|proj_{\vec{b}}\vec{a}| = \frac{61}{\sqrt{146}}$; $proj_{\vec{b}}\vec{a} = \left[\frac{671}{146},\ \frac{305}{146}\right]$

21. 7336.1 J

22. 337.1 J

23. 735 J

24. $|\vec{a}| = \sqrt{30}$; $|\vec{b}| = 2\sqrt{5}$

25. Yes. $\vec{v} = -2\vec{u}$

26. $a = -2,\ b = 24$

27. a) $\overrightarrow{AB} = [3,\ 6,\ -2]$; $|\overrightarrow{AB}| = 7$ b) $\overrightarrow{AB} = [3,\ 3,\ 4]$; $|\overrightarrow{AB}| = \sqrt{34}$

28. a) $[-28,\ 7,\ 49]$ b) $[-12,\ -1,\ 47]$ c) 30 d) 53

29. 106.3°

30. Answers will vary. Ex. $[0,\ 4,\ 1]$. Use dot product to verify your answer

31. Scalene

32. $3931.9\hat{n}$

33. a) $[-21,\ -9,\ 5]$ b) $[50,\ 46,\ -20]$

34. a) $3\sqrt{22}$ units^2 b) 615.2 units^2

35. a) $[-114,\ -43,\ -10]$ b) $[-12,\ 5,\ 18]$

36. 11.1 N·m

37. 72 J; 83 J

38. $\frac{48}{89}[6,\ 2,\ 7]$; $\frac{48}{\sqrt{89}}$

39. -78

40. 12 units^3

41. 35.9 units^2

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