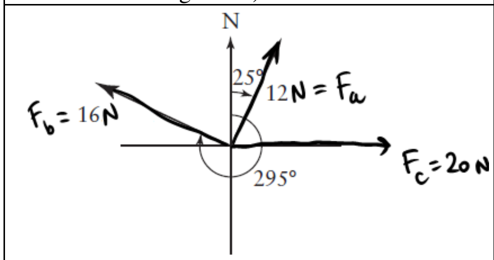
Vectors UNIT B

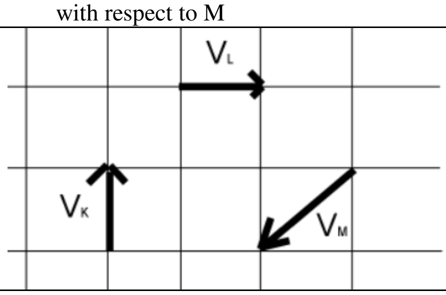
APPLICATION OF VECTORS – journal NAME:_________________

Summarize everything you need to know about these topics. Use examples and concise (not long – but with enough detail) explanations. Include definitions and diagrams if necessary

1. FORCES
   - A. State Newton's 1st & 2nd & 3rd laws of motion. State the gravitational acceleration constant for earth, and discuss units that are valid for acceleration, mass and force.
   - B. Define Applied force, Gravity force, Normal force, Friction force, Tension force, Buoyant force, Air resistance force, Resultant/Net force and Equilibrant force.

C. Find resultant and equilibrant forces. State in algebraic and geometric (using true bearings form)	D. Ramp type:	E. Hanging weight type:
	Devon is holding his father's wheelchair on a ramp inclined at an angle of 20° to the horizontal with a force of magnitude 400 N parallel to the surface of the ramp. a) Draw FBD (define what it is) b) Find the weight of Devon's father with wheelchair (distinguish between the mass) and also find the magnitude of the normal force.	A box weighing 450 N is hanging from two chains attached to an overhead beam at angles of 70° and 78° to the horizontal. a) Draw FBD b) Draw vector diagram showing equilibrium or net force is zero c) Find the tensions in the chains

2. VELOCITY

A. Find velocity of L with respect to K and with respect to M	B. Plane and wind type	C. Boat and current type
	An airplane is flying at an airspeed of 400 km/h on a heading of 220°. A 46-km/h wind is blowing from a bearing of 060°. Determine the ground velocity of the airplane.	A ship's course is set at a heading of 143° at 18 knots. A 10-knot current flows at a bearing of 112°. What is the ground velocity of the ship?

3. DOT PRODUCT
   - A. Copy/Paste the following

Dot Product with Geometric Vectors

$\vec{u}\cdot\vec{v} = |\vec{u}||\vec{v}|\cos\theta$ ← angle between tails $0° \le \theta \le 180°$

Dot Product with Algebraic Vectors

$\vec{u} = (a_1, b_1, c_1)$ $\vec{v} = (a_2, b_2, c_2)$

$\vec{u}\cdot\vec{v} = a_1a_2 + b_1b_2 + c_1c_2$

Dot Product Properties

1. $\vec{u}\cdot\vec{v} = 0$ iff $\vec{u} \perp \vec{v}$
2. $\vec{u}\cdot\vec{v} = \vec{v}\cdot\vec{u}$ commutative
3. $\vec{u}\cdot\vec{u} = |\vec{u}|^2$
4. $\vec{u}\cdot\vec{0} = 0$ (scalar)
5. $\vec{u}\cdot(\vec{a}+\vec{b}) = \vec{u}\cdot\vec{a} + \vec{u}\cdot\vec{b}$ distributive
6. $k(\vec{u}\cdot\vec{v}) = (k\vec{u})\cdot\vec{v} = \vec{u}\cdot(k\vec{v})$

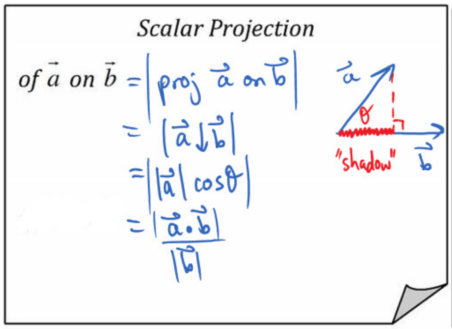
   - B. Find the angle between the following vectors $\vec{u} = (-3, 1, 2)$ and $\vec{v} = (5, -4, -1)$
   - C. Prove

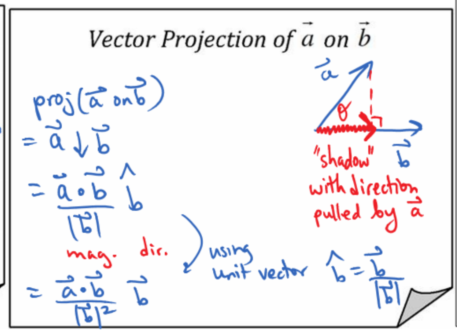
$$\vec{u}\bullet\vec{v} = \tfrac{1}{4}\|\vec{u}+\vec{v}\|^2 - \tfrac{1}{4}\|\vec{u}-\vec{v}\|^2$$

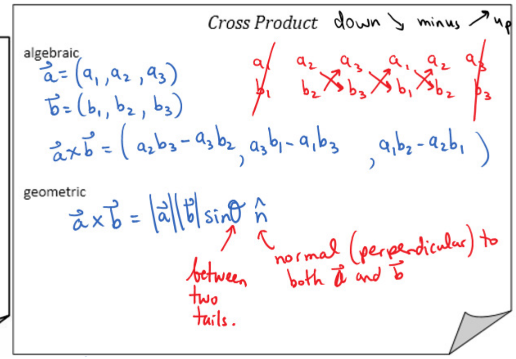
   - D. Use the dot product to prove that the diagonals of a rectangle are perpendicular if and only if the rectangle is a square

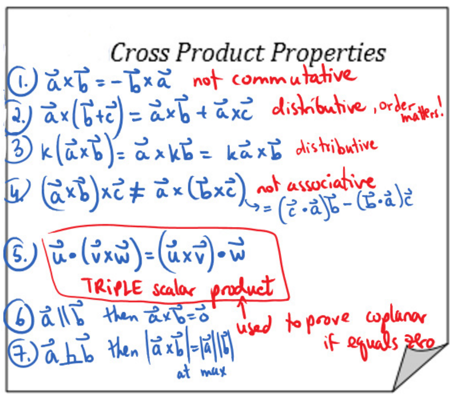
4. PROJECTIONS & CROSS PRODUCT

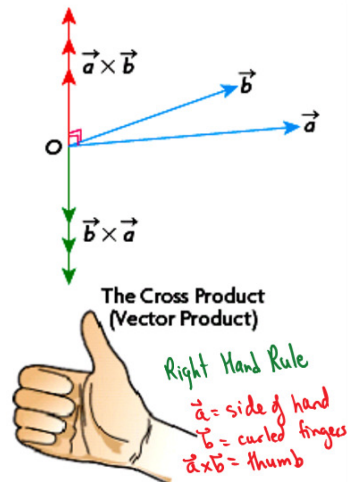
A. Copy/Paste the following



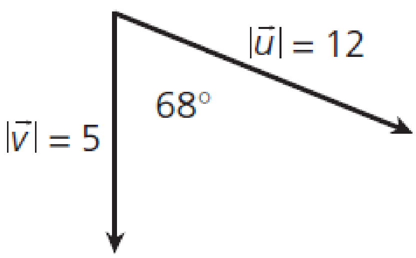




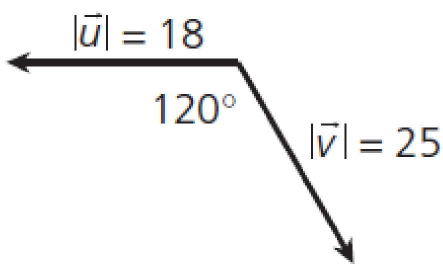




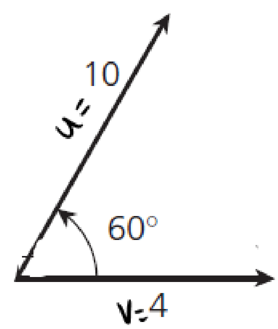
B. Explain and show how to draw the scalar projection $|\vec{v}\downarrow\vec{u}|$ on the diagram. Find the magnitude



C. Explain and show how to draw the vector projection $\vec{v}\downarrow\vec{u}$. Find the vector.



D. Find magnitude and discuss direction of $\vec{u}\times\vec{v}$



E. $\vec{a}$ = [5, 4, –1] and $\vec{b}$ = [1, –2, 3].

a) Find $|\vec{a}\downarrow\vec{b}|$

b) Find $\vec{b}\downarrow\vec{a}$

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

F.

Under what circumstances is

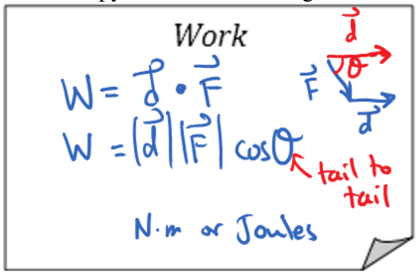
a. Proj($\vec{u}$ onto $\vec{v}$) = Proj($\vec{v}$ onto $\vec{u}$)?

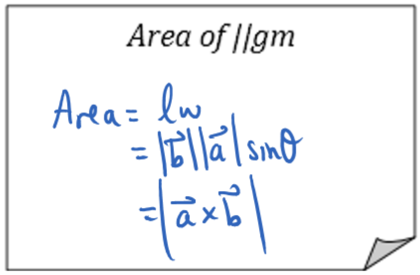
b. |Proj($\vec{u}$ onto $\vec{v}$)| = |Proj($\vec{v}$ onto $\vec{u}$)| ?

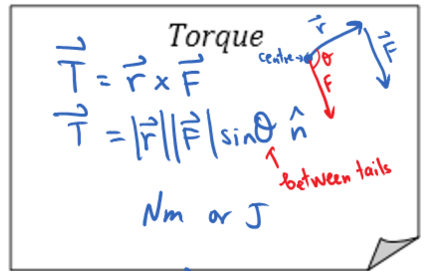
5. APPLICATIONS

A. Define Work and Torque

B. Copy/Paste the following







C. Work example (Note that displacement must be in correct units)	D. Torque example	E. Find volume of parallelepiped given points A(0,1,3), B(1, 0, 2) C(1,2,0) E(4,4,4)
How much work does it take to slide a crate 200cm along a loading dock by pulling on it with a 200 N force at an angle of 30º from horizontal?	A 20 N force is applied at the end of a wrench that is 40 cm in length. The force is applied at an angle of 60º to the wrench. Calculate the magnitude of the torque about the point of rotation M and discuss direction.