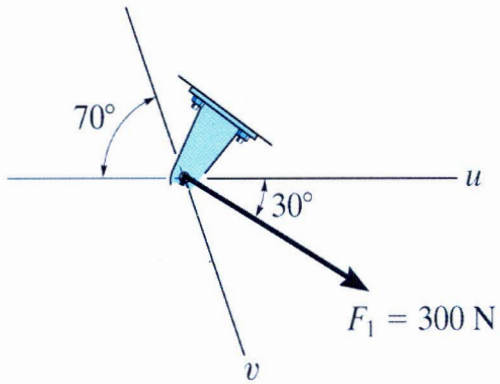
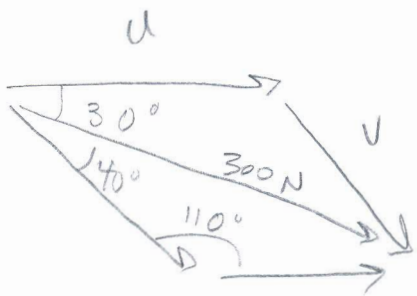
Exam 1
90 points total

Name Key

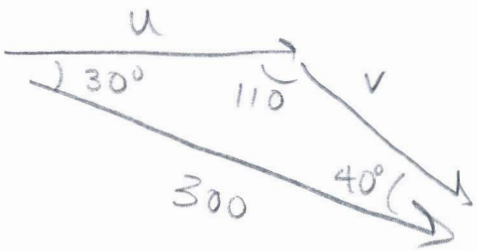
1. (15 pt) Resolve the force into components acting along the *u* and *v* axis and find their magnitudes using the **parallelogram method**. Be sure to include a drawing showing all three vectors and the angles between them.





$360 = 70(2) + \theta(2)$

$\theta = 110°$



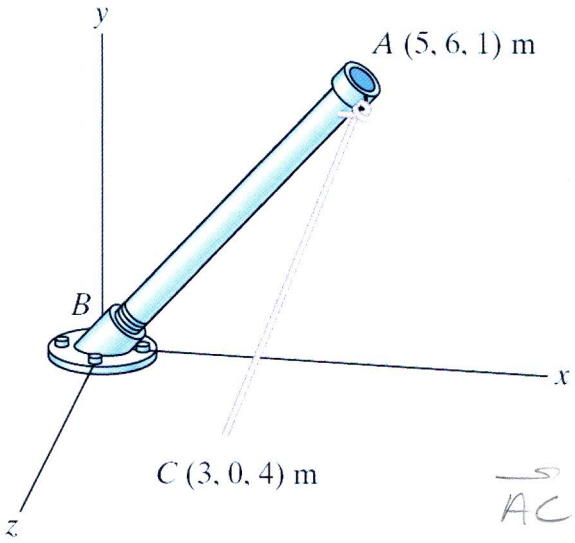
$$\frac{300}{\sin 110°} = \frac{u}{\sin 40}$$

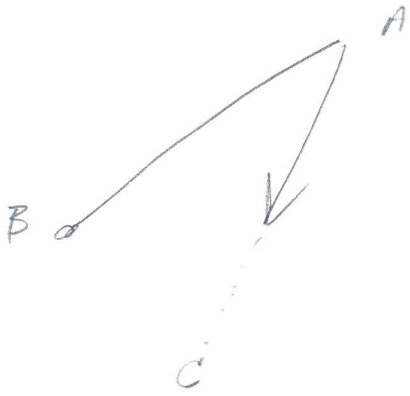
$u = 205.2$ N

$$\frac{300}{\sin 110°} = \frac{V}{\sin 30}$$

$V = 159.6$ N

2. (15 pts) A pole is fixed at *B* and tethered by a rope, as shown. The tension in the rope is 100 N. Ignore the weight of the pole. Find the moment at the base, B.





$\vec{AC} = (3-5)i + (0-6)j + (4-1)k$

$\vec{AC} = -2i - 6j + 3k$

$|AC| = \sqrt{2^2 + 6^2 + 3^2} = 7$

Find unit vector for AC

$u_{AC} = -\frac{2}{7}i - \frac{6}{7}j + \frac{3}{7}k$

$\vec{F}_{AC} = 100(-0.2857i - 0.8571j + 0.4286k)$

choose "r" can be either $\vec{BC}$ or $\vec{BA}$

using $\vec{BC} = 3i + 0j + 4k$

$\vec{M}_B = \vec{r}_{BC} \times \vec{F}_{AC}$

$$\begin{array}{c|ccc|l} & i & j & k & \\ r & 3 & 0 & 4 & i: (0)(42.86) - (4)(-85.7) \\ F & -28.57 & -85.7 & 42.86 & -j: (3)(42.86) - (4)(-28.57) \\ & & & & k: (3)(-85.7) - (0)(-28.57) \end{array}$$

$i = 342.8$

$j = -242.86$

$k = -257.14$

$\vec{M}_B = (342.8i - 242.86j - 257.14k)$ N.m

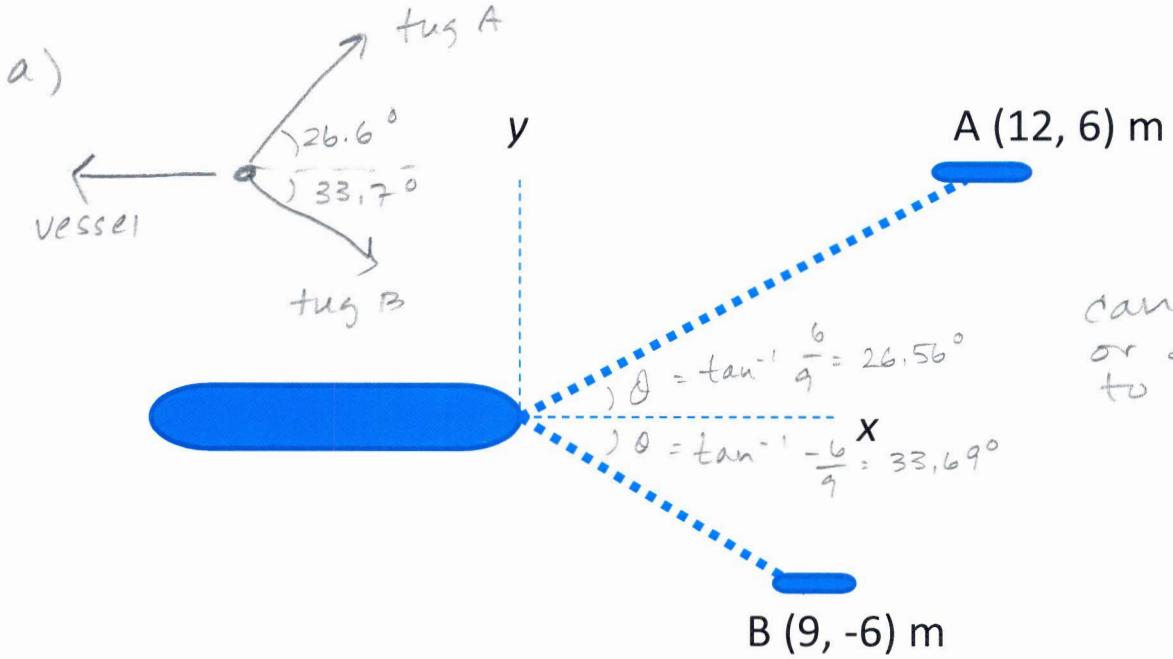
3. A large shipping vessel broke down and is being pulled to shore by rescue tug boats A and B. The tension in each rope is 2,000 N.

a) (5 pts) Draw a free body diagram (FBD) of the situation,

b) (5 pts) determine the resultant force vector created by the two tug boats; and,

c) (5 pts) determine the angle between the two tugboat's ropes as shown below.

a)



can use this or dot product to solve

b) $\Sigma F_x = 2000 \cos 26.56 + 2000 \cos 33.69^\circ = 3453\ N$

$\Sigma F_y = 2000 \sin 26.56 - 2000 \sin 33.69 = -215.1\ N$

$\vec{F}_R = (3453\,i - 215\,j)\ N$

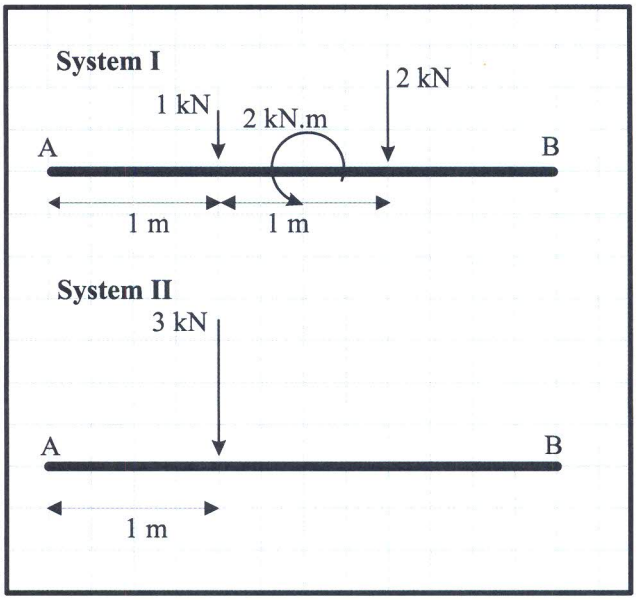
c) $26.56 + 33.69 = \boxed{60.25^\circ}$

or

$\theta = \cos^{-1} \dfrac{(12)(9) + (6)(-6)}{(13.4)(10.8)} = 60.2^\circ$

$\sqrt{12^2 + 6^2}$ $\sqrt{9^2 + 6^2}$

4. (10 pt) Are the two systems below equivalent? Show your work.



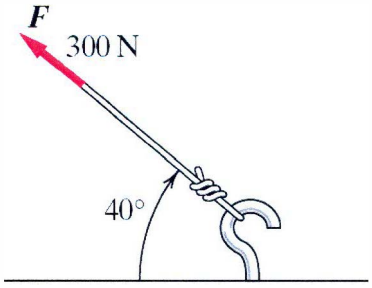
$\overrightarrow{M_A} = 1\,kN(1m) + 2 - (2kN)(2m)$

$= -3\,kN\cdot m$ ↻

$\overrightarrow{M_A} = 3\,kN(1m) = -3$ ↻

yes, they are equivalent

5. A cable force F acts on a hook as shown. Describe the force relative to horizontal and vertical axes in terms of:



a) a unit vector along its line of action (5 pts)
b) its direction cosines (5 pts)
c) its scalar components (5 pts)

a) $-\cos 40^\circ = -0.766\,i$

$\sin 40^\circ = 0.643\,j$

$\vec{u} = -0.766\,i + 0.643\,j$

b) $\cos 140^\circ$

$\cos 50^\circ$

c) $F_x = 300(-0.766) = 229.8\ N$

$F_y = 300(0.643) = 192.8\ N$

6. (2 pt) The dot product of a vector is a _____ (scalar/ vector)

7. (4 pts) List one exam*p*le each of a scalar and a vector

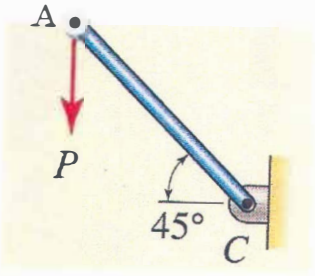
Scalar:

1. length time mass
2. volume temperature speed

Vector:

1. velocity moment position
2. force acceleration

8. (10 pt) If the length of rod CA is 10 m and P = 20 N, find a) the moment about C; and, b) the moment about A.



a) $M_C = 10 \cos 45^\circ \, (20\ N) = 141.4\ \circlearrowright\ N.m$

b) $M_A = 0$ ⇒ there is no offset or distance from the force; the force acts through the pivot point

9. (4 pts) Circle the system(s) below that experience the same couple moment from A as this one