

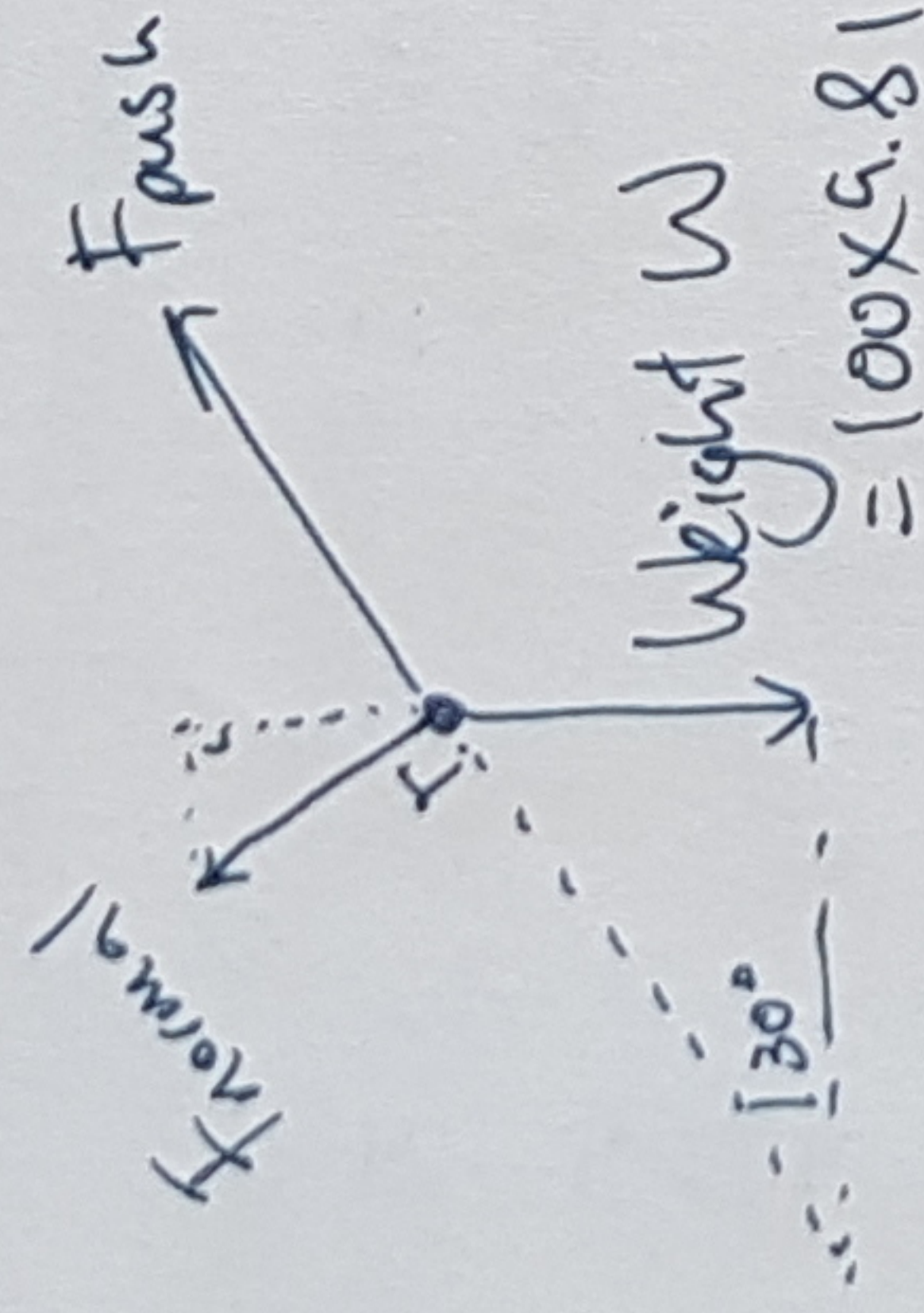
# Quiz 1

MATH 32A-3, CALCULUS OF SEVERAL VARIABLES, FALL 2016  
SECTION: 3A 3B 3C 3D 3E 3F (CIRCLE ONE)

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You have 15 minutes to solve the following two problems. Show all of your work. To receive full credit, your answers must be neatly written and logically organized.

**Problem 1.** (5 points.) Calculate the force (in newtons N) required to push a 100kg wagon up a  $30^\circ$  (frictionless) incline. See the figure<sup>1</sup>.



By physics, all forces have a net  $\sum$  of 0 N.

$$\therefore F_{\text{normal}} + F_{\text{push}} = +W$$

$$F_{\text{normal}} (\sin 30^\circ, \cos 30^\circ) + F_{\text{push}} (\cos 30^\circ, \sin 30^\circ) = 981 \mathbf{i}$$

$$F_{\text{normal}} \sin 30^\circ + F_{\text{push}} \cos 30^\circ = 0$$

$$F_{\text{push}} = \frac{-F_{\text{normal}} \sin 30^\circ}{\cos 30^\circ} = -F_{\text{normal}} \frac{1}{\sqrt{3}} \quad \text{--- (1)}$$

$$F_{\text{normal}} \cos 30^\circ + F_{\text{push}} \sin 30^\circ = 981$$

$$F_{\text{push}} = \frac{981 - F_{\text{normal}} \cos 30^\circ}{\sin 30^\circ} = (962 - \sqrt{3} F_{\text{normal}}) \quad \text{--- (2)}$$

$$\therefore 981 \cos 60^\circ = \frac{981}{2} = 490.5 \text{ N}$$

**Problem 2.** (5 points.) Find the area of the parallelogram spanned by  $\mathbf{u} = \langle 1, 0, 3 \rangle$  and  $\mathbf{v} = \langle 2, 1, 1 \rangle$ .

Area of parallelogram =  $\|\mathbf{u} \times \mathbf{v}\|$

$$= \left\| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 0 & 3 \\ 2 & 1 & 1 \end{vmatrix} \right\|$$

$$= \left\| 0\hat{i} + 1\hat{j} + 1\hat{k} + 1\hat{j} + 1\hat{k} \right\|$$

$$= \left\| \langle 0, 2, 2 \rangle \right\|$$

$$= \sqrt{0^2 + 2^2 + 2^2} = \sqrt{8} = 2\sqrt{2}$$

<sup>1</sup>We note that the force of gravity,  $F_g$ , has magnitude  $\|F_g\| = mg$  where  $m$  is the mass of the block and  $g = 9.8 \text{ m/s}^2$