Quiz 2

⚠ This is a preview of the published version of the quiz

Started: Feb 1 at 7:57am

Quiz Instructions

You may use notes, class notes, lab handouts, solutions -- basically anything you can find through canvas (including texts linked in handouts). You may not use online calculators. You may use the calculator you made for Lab 2.

Don't forget to write units. Try to make them reasonable. e.g., 25 kN instead of 25000 N. Put a space between your number and the units. You won't lose points if you don't format your answer exactly like I have it; you will lose points for missing units.

Question 1	1 pts
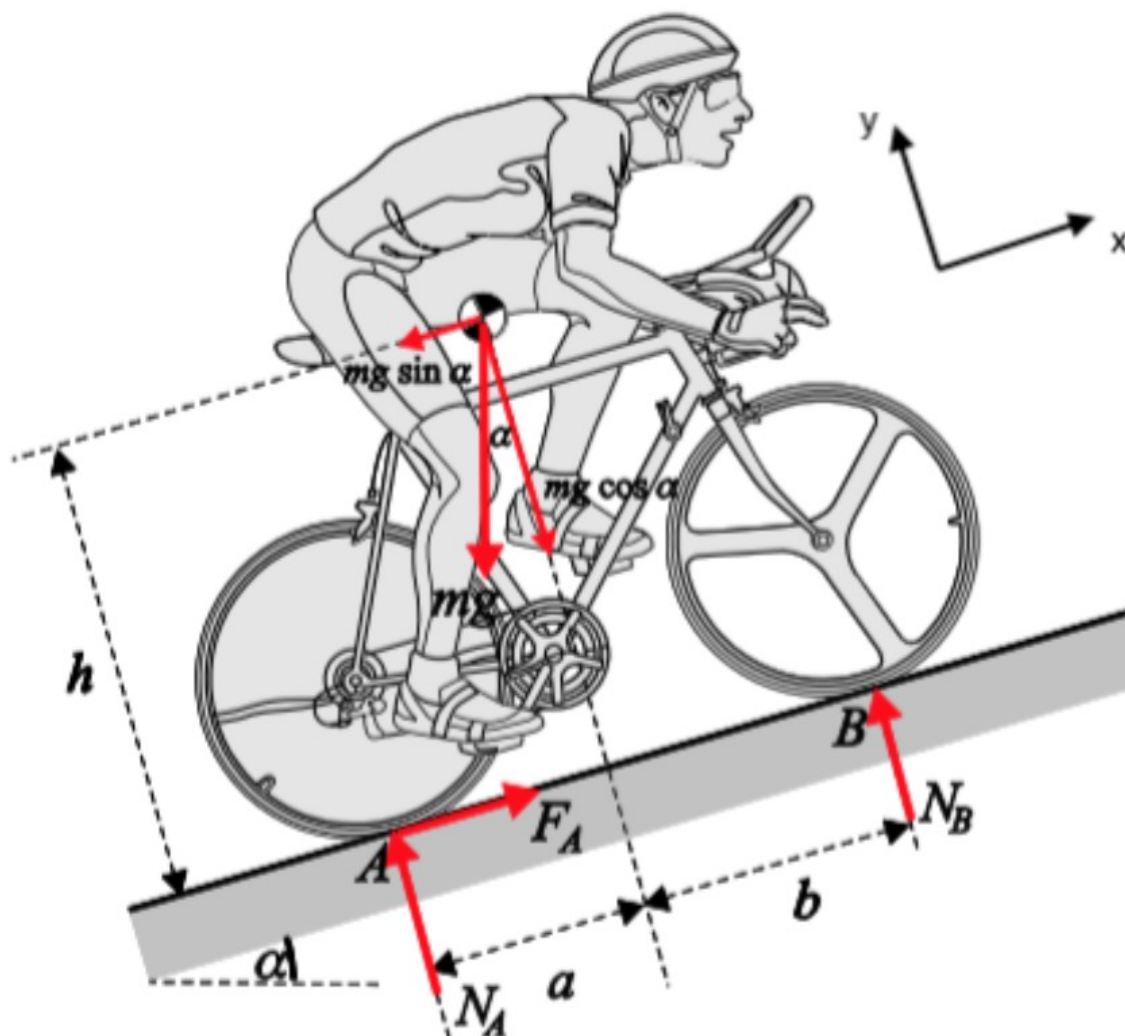
For the figure shown, which is an accurate expression for the contribution of N_B to the moment about point A?

○ -N_B*(a+b)

● N_B*(a+b)

○ -N_B*(a+b) cos(alpha)

○ N_B*(a+b) cos(alpha)

○ 0

Question 2   1 pts

Using the same figure as the previous problem, at what angle, alpha, will the bicycle tip over backwards? Assume the bicycle is not traction-limited and <u>write your answer to the nearest degree.</u>

For parameters, use:

- a = 60 cm
- b = 80 cm
- h = 80 cm
- m = 80 kg

We need to find when $N_B \to 0$:

$$\sum M_A = 0 = mgh \sin\alpha - mga\cos\alpha + N_B(a+b) \nearrow^0$$

$$\Rightarrow \quad \frac{\sin\alpha}{\cos\alpha} = \frac{mga}{mgh} = \frac{a}{h}$$

$$\Rightarrow \quad \tan^{-1}(\alpha) = \frac{a}{h} = 0.75$$

$$\Rightarrow \quad \alpha = 36.87° \longrightarrow \boxed{37°}$$

Question 3   1 pts

The cyclist in the figure is riding up a 20 degree incline at a constant speed. Due to the wind, he is just at the point where he is about to tip over backwards.

What is the force of the wind? Use the same parameters as the previous problem. The force of the wind acts horizontally and through the center of gravity.

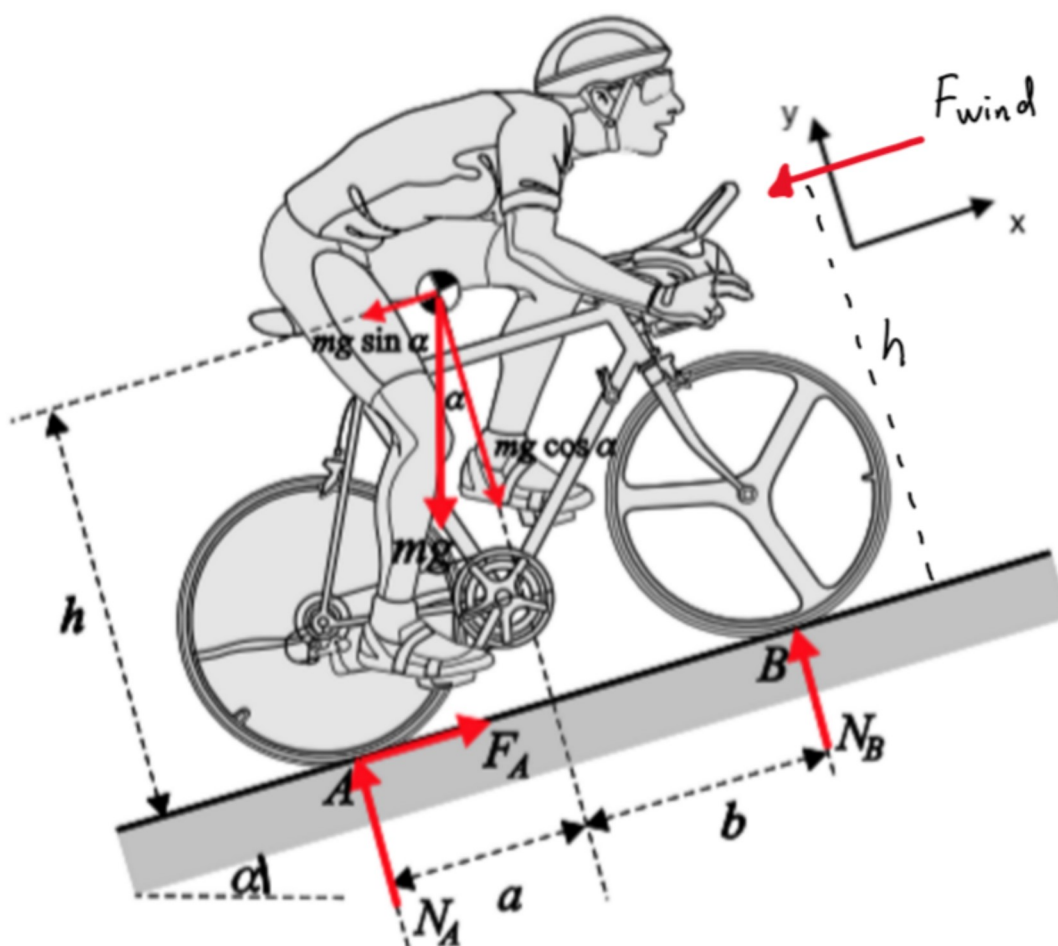Write your answer to three significant digits and don't forget your units!

Similar to before, but with wind:

$$\sum M_A = mgh \sin\alpha - mga\cos\alpha + N_B(a+b)\nearrow^0 + F_w h = 0$$

$$\Rightarrow \quad F_w = \frac{mga\cos\alpha - mgh\sin\alpha}{h} = mg \frac{a\cos\alpha - h\sin\alpha}{h}$$

$$= 80\,kg \cdot 9.81\,\frac{m}{s^2} \left[\frac{60\,cm \cdot \cos(20) - 80\,cm \cdot \sin(20)}{80} \right]$$

$$= 284.7\,N \longrightarrow \boxed{285\,N}$$

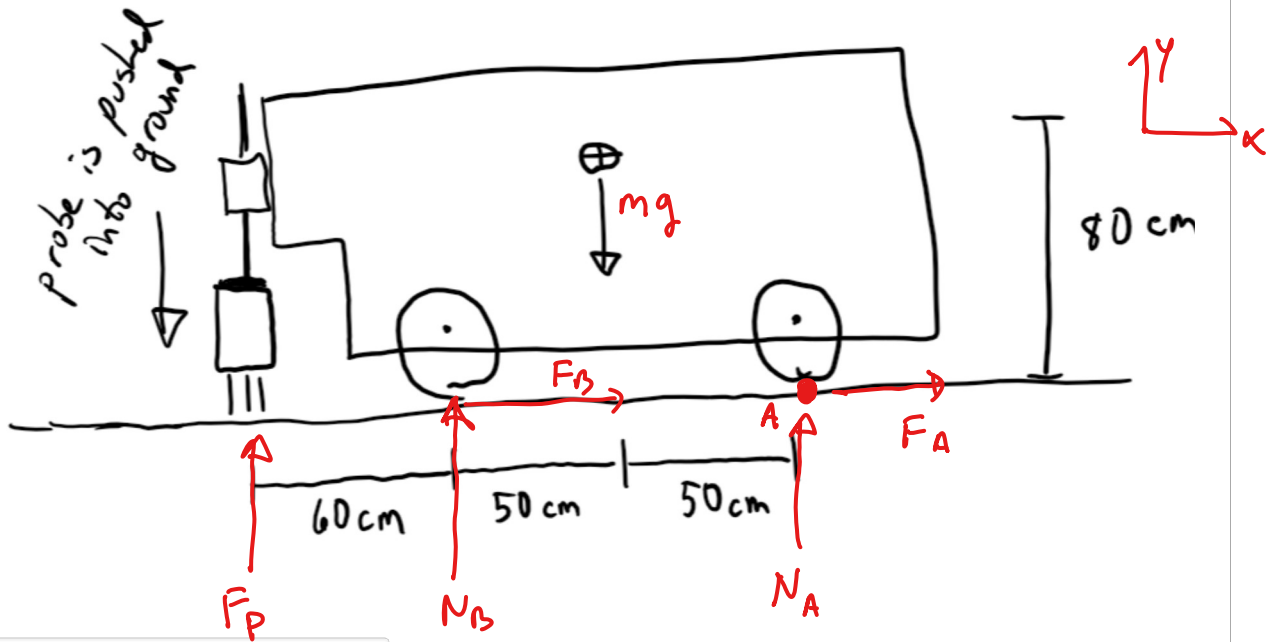## Question 4   1 pts

You are building a robot to drive around a vineyard and measure soil moisture. The geometry of the system is shown in the figure. If the robot weights 40 kg, how much force can it apply to the soil probe when it just starts to lift the front wheels off the level ground? Write your answer to three significant digits and don't forget your units!

$$\Sigma M_A = mg \cdot 50\,cm - N_B \cdot 100\,cm - F_p \cdot 140\,cm = 0$$

$$\text{Solve for } N_B = 0 \Rightarrow \quad F_p = mg\,\frac{50\,cm}{140\,cm} = 40\,kg \cdot 9.81\,\frac{m}{s^2} \cdot \frac{50}{140}$$

$$= 122.4\,N \rightarrow \boxed{123\,N}$$
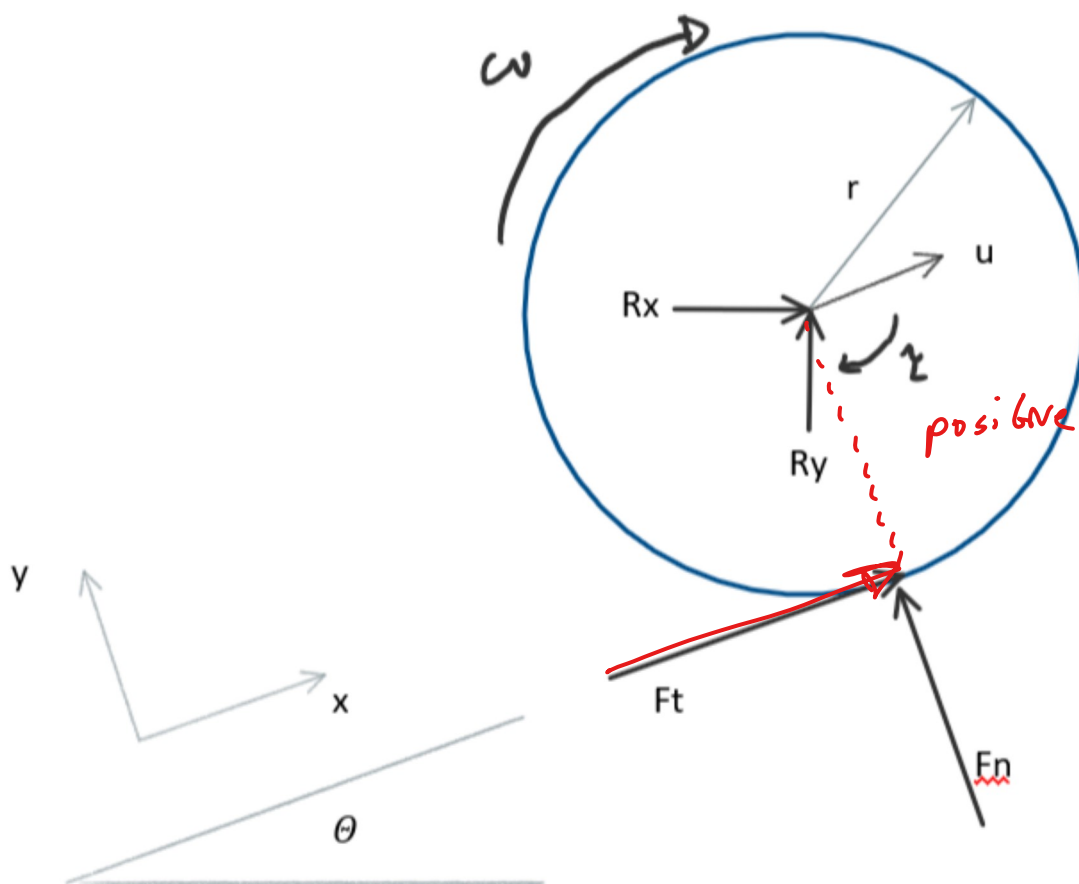
Question 5   **1 pts**

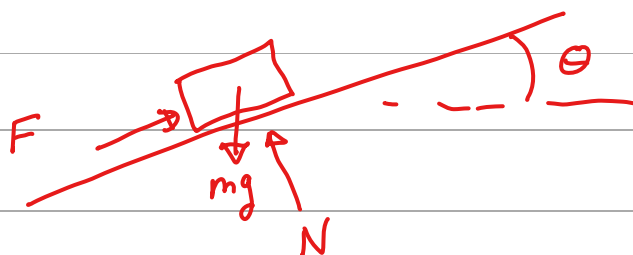In the figure shown, what effect does the force F_T have on the total moment about the wheel axis?

○ positive

○ negative

○ zero

Question 6   1 pts

How much power is required to drive a 1000kg car up a 6 degree grade at 88 km/h (55 mph)? ~~Remember that percent grade is rise over run.~~ *NOT NEEDED.*

Write your answer to three significant digits and don't forget your units!

$$\Sigma F_x = F - mg\sin\theta \implies F = mg\sin\theta$$

$$P = F \cdot u = mg\sin\theta \cdot u$$

$$= 1000\,kg \cdot 9.81\,\tfrac{m}{s^2} \cdot \sin(6) \cdot 88\,\tfrac{km}{h} \times \frac{1h}{3600s} \times \frac{1000m}{1km}$$

$= 25066 \, W \longrightarrow 25100 \, W \text{ or } 25.1 \, kW$

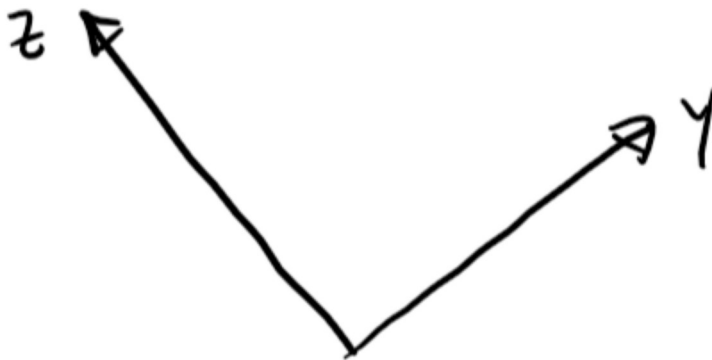## Question 7   1 pts

A wheel is delivering 200W of power at 500 rpm. How much torque is needed to turn the wheel? Write your answer to three significant digits and don't forget your units!

$$P = \tau \cdot \omega \implies \tau = \frac{P}{\omega} = \frac{200 \, W}{500 \frac{rot}{min} \times \frac{min}{60 sec} \times \frac{2\pi}{rot}}$$

$$= 3.8197 \, W \cdot s \times \frac{1 \, N \cdot m/s}{1 \, W}$$

$$= \boxed{3.82 \, N \cdot m}$$

Question 8   1 pts

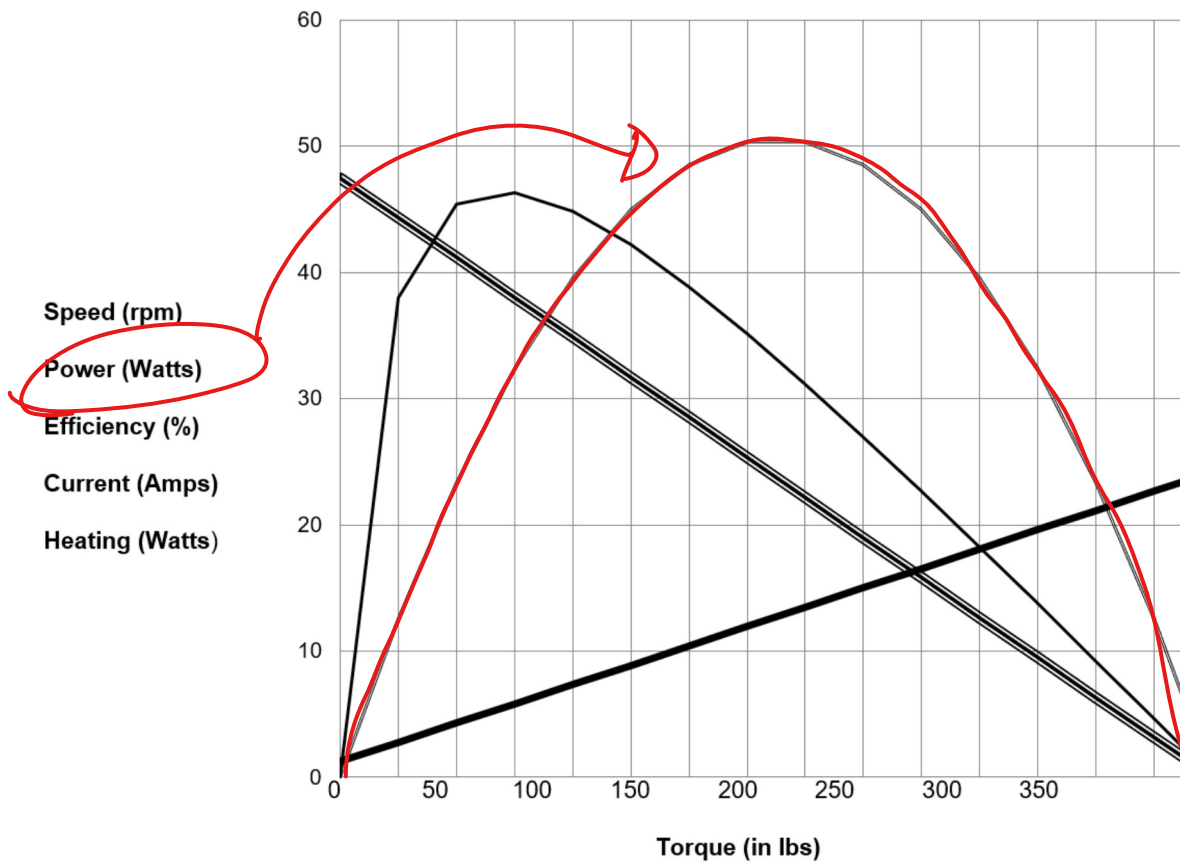

For the axes shown (note that they are the y and z axes!!!), which way does the x-axis point?

○ Into the screen, away from the viewer

◉ Out of the screen, towards the viewer

○ Parallel to the z-axis

Question 9   1 pts

In the motor performance curve shown, which of the following is represented by the inverted parabola?

Speed (rpm)

Power (Watts)

Efficiency (%)

Current (Amps)

Heating (Watts)

○ Torque

○ Speed

● Power

○ Efficiency

○ Current

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