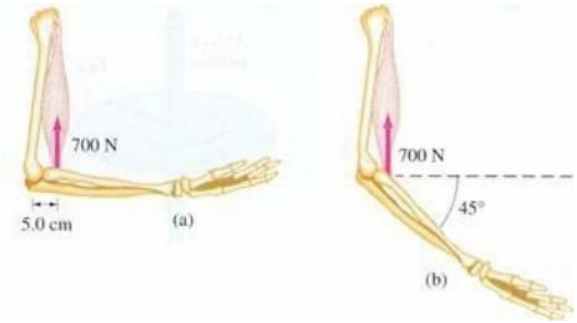
Name: _____ Date: _____

WS 2.5A: Rotational Equilibrium I

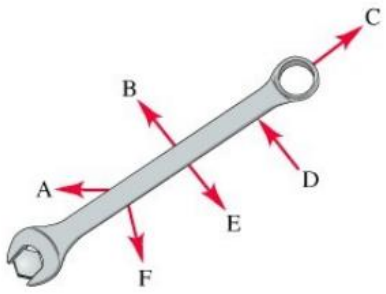
Unit 2: Dynamics and Equilibrium

1. Your forearm can be considered a lever that can generate torques. The bicep muscle attaches to the forearm near the elbow as show. The bicep is capable of producing a force, F = 700N.

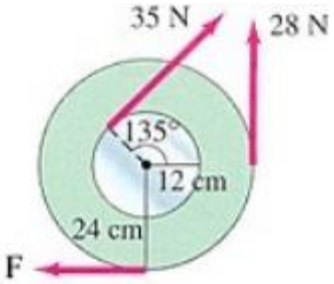
Calculate the torque produced by the bicep about the elbow in each position.



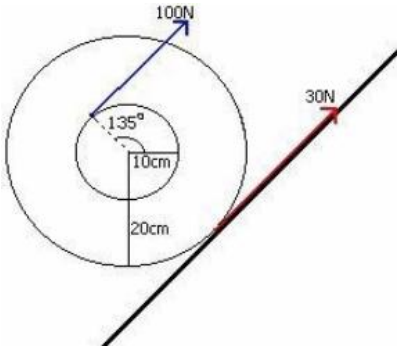
2. Forces of the same magnitude act on a wrench depicted below. Some of the locations and orientations are more effective than others in loosening the nut. Rank the forces according to their ability to generate a torque on the nut. Rank them from maximum torque to minimum and justify your rankings according to the definition of torque. Maximum torque can be those that generate the greatest ability to loosen the nut while minimum will be those that tighten.



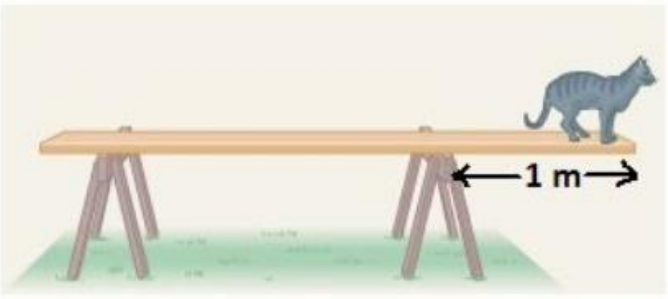
3. If the net torque is zero, what is F? **Show your work.**



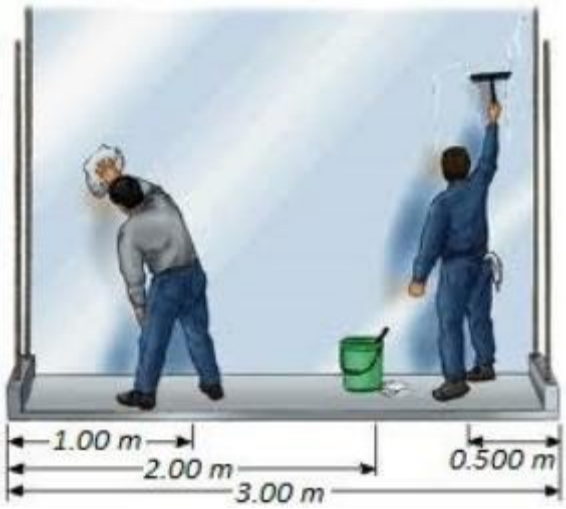
4. Only two forces act on the wheel below. A string is attached to the inner axel generating a force of 100N up the ramp. A friction force of 30N acts between the outer wheel and the ramp (up the ramp) preventing the wheel from slipping. What is the net torque on the wheel?



5. A 7kg cat walks to the end of a 15 kg board resting on two saw horses as shown below. When the cat is at the 1m position as shown, the board "just" lifts off of the left hand support. How long is the board?



6. Two painters each of mass 75kg are positioned on a scaffold of mass 30kg as shown below. A paint can of mass 5kg is also on the scaffold.



a. Assuming the left rope has a tension of $\boldsymbol{F_{T1}}$ and the right rope has a tension of $\boldsymbol{F_{T2}}$, which rope will have the greater tension acting on it? Justify your answer *(no math required – only an explanation)*.

b. Label all of the forces acting on the scaffold directly on the diagram above. What forces are unknown?

c. The board is not rotating or accelerating. What two equilibrium conditions must be satisfied for this to be true? Write the formulas below.

d. Since the board is not accelerating we may assume that $F_{NET} = 0$. Use this equilibrium condition to determine the magnitude of the sum of $\boldsymbol{F_{T1}} + \boldsymbol{F_{T2}}$? State the equation first, then solve.

e. Starting with your net torque equilibrium condition (τ_{NET}), determine the tension in each rope. Show all work below.

f. At some time during the day the workers get a call from their supervisor from the ground. He is in a panic. Apparently the ropes on the scaffold are dangerously old and need to be replaced. Each rope can only handle 925N of force. Fortunately our workers know their physics and reposition themselves quickly. What did they do to remain safe?

7. A diver of mass 50 kg is positioned at the end of a 4 m long diving board as shown. The mass of the uniform board is 20 kg.

a. The diving board is bolted down at only one of the supports. Which of the supports makes the most sense (A or B)? Answer by considering the removal of the bolts, and then discuss the solution.

b. Construct a free-body diagram showing all of the forces acting on the board. Use this diagram to determine the magnitude and direction of the forces acting on support A and B.

***Answers**: **1:** (a) 35Nm; (b) 24.7Nm **| 2**: DBACFE **| 3**: -10.5N **| 4**: 4 Nm (CW) **| 5**: 2.93 m **| 6**: (a)F_{T1} (b)Tensile Forces (c) $F_{net}=0$; $\tau_{net}=0$ (d) 1813N (e)$F_{T1}=776N$; $F_{T2}=1037N$ (f) move to center **| 7**: (a) Bolt at A (b) $F_A=1670$ N; $F_B=2350$ N*