Problems discussed in the videos:

These problems are designed to be solved without the use of a calculator.

$g = 10\ m/s^2$
$\sin 45° = \cos 45° = 0.71$; $\cos 60° = \sin 30° = 0.50$; $\sin 60° = \cos 30° = .87$

Videos (1) – (5)
Rope and bar
A bar of mass M = 10kg and length L = 1m is connected to a hinge attached to a vertical wall so that the bar is free to rotate up or down in a vertical plane. [See sketch drawn on blackboard.] The bar is suspended from the ceiling by a massless rope that is at an angle of 30° from the horizontal. The bar is not moving for parts a) through c). The moment of inertia of a bar rotating about one end is $I = ML^2/3$.
a) Draw a free body diagram for the bar. Please clearly label all forces.
b) What is the tension in the rope?
c) What is the *horizontal component* of the force exerted by the wall on the bar? If this force is nonzero, clearly indicate whether the force points to the left or to the right.
d) Now someone cuts the rope. Draw a free body diagram for the bar immediately after the rope is cut.
e) Immediately after the rope is cut, what is the *vertical component* of the force of the hinge on the bar? Indicate magnitude and direction.
f) Immediately after the rope is cut, what is the angular acceleration of the bar? Please indicate what convention you are using for the sign of clockwise and counterclockwise rotations.
g) What is the total kinetic energy of the bar (including rotational kinetic energy) immediately before it hits the wall at the bottom of its downward swing (see sketch [drawn on blackboard])? Explain your answer.

Videos (6) – (10)
Arm curls and torque

A simple model of an arm is depicted at the right [figure drawn on blackboard]. It consists of a vertical bar connected via a hinge at the elbow to a second bar representing the forearm, which is L_{fa} = 0.3 m long and has mass M_{fa} = 2 kg equally distributed across its length. The biceps muscle connects to the forearm 0.03 m from the hinge, and the arm is supporting a M_w = 10 kg weight. The moment of inertia of a bar about one end is $I = ML^2/3$.

a) Make a free body diagram of the forearm, and make a second, extended diagram showing where each of the forces is acting on the forearm.

b) Using the hinge as your pivot point, what is the torque due to the 10 kg weight? Please indicate your convention for positive torque.

c) What force must be exerted by the biceps muscle on the forearm to keep the arm from moving?

d) What is the magnitude and direction of the force on the forearm from the vertical bar?

e) If the 10 kg weight is let go, what would the angular acceleration of the forearm be immediately after the weight is dropped assuming the biceps continue to exert the same force as before?

f) At that moment, what would the vertical acceleration of the hand be?