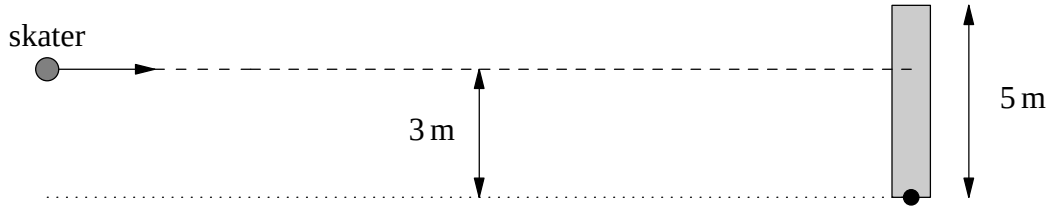
Physics 131-01 (8 am)
April 23, 2007
Test 3

Name: _____

If any question is unclear, *please* ask immediately. Be sure to show your work **clearly** and **draw a box around your answer**. Partial credit may be given for work *if* it can be understood.

If you get stuck on the **math** at any point, be sure to indicate clearly the **physics** you are using and how you would continue if you could do the math.

1. (30 pts.) A 70-kg ice skater is moving in a straight line along a frictionless icy pond with initial speed of 3 m/s, as shown in the figure. He grabs onto a bar of mass 100 kg and length 5 m that is mounted on a frictionless vertical axle at one end of the bar (the bottom end in the figure). The bar was initially at rest. Your ultimate goal will be to find the final angular velocity of the bar+skater.



a. (5 pts.) *Before doing any calculations*, can you assume that the total angular momentum of the bar+skater remains constant? Justify your answer briefly but clearly.

b. (5 pts.) *Before doing any calculations*, can you assume that the total mechanical energy of the bar+skater remains constant? Justify your answer briefly but clearly.

c. (20 pts.) What is the final angular velocity of the bar+skater?

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Name: SOLUTIONS

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1. (30 pts.) A 70-kg ice skater is moving in a straight line along a frictionless icy pond with initial speed of 3 m/s, as shown in the figure. He grabs onto a bar of mass 100 kg and length 5 m that is mounted on a frictionless vertical axle at one end of the bar (the bottom end in the figure). The bar was initially at rest. Your ultimate goal will be to find the final angular velocity of the bar+skater.

a. (5 pts.) *Before doing any calculations*, can you assume that the total angular momentum of the bar+skater remains constant? Justify your answer briefly but clearly. Yes. There are no external torques, so $\Sigma \tau_{ext} = 0$.

Note: It is possible for $\Sigma \vec{F}_{ext} = 0$ but still have $\Sigma \tau_{ext} \neq 0$. Here's an example: $\vec{F} \rightarrow \square \leftarrow \vec{F}$ The net force is 0, but the torque is not.

b. (5 pts.) *Before doing any calculations*, can you assume that the total mechanical energy of the bar+skater remains constant? Justify your answer briefly but clearly. No. You can't assume that the skater–bar forces are conservative. Though those forces are internal, they still affect Energy.

c. (20 pts.) What is the final angular velocity of the bar+skater?

$L_i = L_f$

$m v_i b + 0 = (I_{bar} + m b^2)\omega_f$

$I_{bar} = \frac{1}{3} M L^2$

$\omega_f = \frac{m v_i b}{I_{bar} + m b^2} = \frac{(70)(3)(3)}{\frac{1}{3}(100)(5)^2 + (70)(3)^2}$

$\omega_f = 0.431 \text{ rad/s}$