DeAnza College

First Name

Last Name

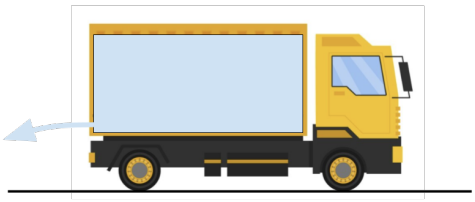
Campus ID

PHYS 4A – Spring 2024 – Midterm 2

Question:	1	2	3	4	Total
Points:	6	8	8	8	30
Bonus Points:	2	2	0	0	4
Score:					

Remember to pay attention to significant figures and don't get lost in long calculations. The answers are usually only a few lines.

1. There is a truck filled with water and it's at rest. Suddenly the valve for the tank is opened and water starts flowing out horizontally at a rate of 5.00 kg/s with a speed of 20.0 m/s relative to the truck.



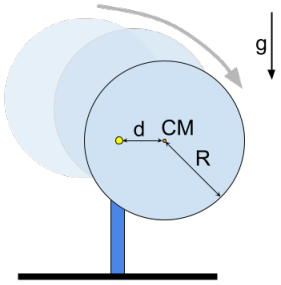
Hint: Use rocket equations

(a) (3 points) What is the thrust force created by the water jet on the truck?

(b) (3 points) Assuming mass flow rate and speed is constant, what is the final velocity of the truck after 2.00×10^3 kg of water have been ejected?

(c) (2 points (bonus)) Is the acceleration of the truck constant? If not, when is acceleration highest and when is it lowest?

2. A uniform disc of mass m and radius R is attached to a vertical pole with a frictionless hinge a distance d away from it's center and allowed to rotate freely subject to gravity. The **lowest** angular velocity observed is ω_L. *Ignore air friction.* $I_{\text{CM}} = mR^2/2$



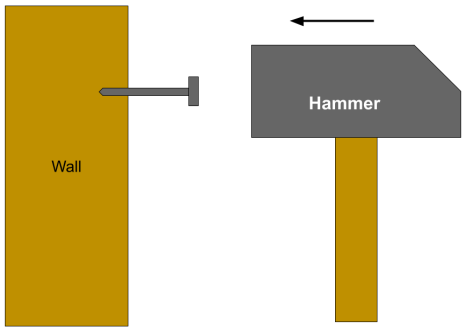
(a) (2 points) At what positions will ω_L and ω_H be observed respectively? (Describe as the position of the *center of mass* CM with respect to the hinge).

(b) (2 points) What is the difference in potential energy between the positions corresponding to ω_L and ω_H

(c) (4 points) Calculate the expression for ω_H in terms of d, R, g, ω_L.

(d) (2 points (bonus)) Show that if $d = 0$ then $\omega_L = \omega_H$. Explain why that's the case.

3. When hammering a nail into wood, the worker gives the hammer an initial speed of $v_i = 10.0\,\text{m/s}$ just before it hits the nail. The hammer drives the nail in by $d = 1.5\,\text{cm}$ and comes to a complete stop. The nail experiences a resistive force of $F_R = 1.20\,\text{kN}$ to penetrate the wood.

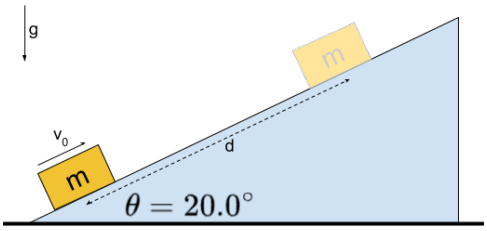


(a) (2 points) What is the total work done on the nail?

(b) (2 points) Is momentum conserved for the hammer? Explain.

(c) (4 points) Calculate the mass of the hammer assuming all the energy is transferred to the nail.

4. An object of mass $m = 1.00\,\text{kg}$ is given an initial velocity of $v_0 = 8.00\,\text{m/s}$ on an incline with an angle $\theta = 20.0°$. The object comes to rest after travelling a distance $d = 7.00\,\text{m}$ on the incline due to friction.



(a) (2 points) Draw a box within which energy is conserved and calculate the initial energy of the system.

(b) (2 points) Calculate the amount of non-conservative work done.

(c) (4 points) Calculate the coefficient of friction μ_k.