

# Physics CST (2021-22) Homework 3

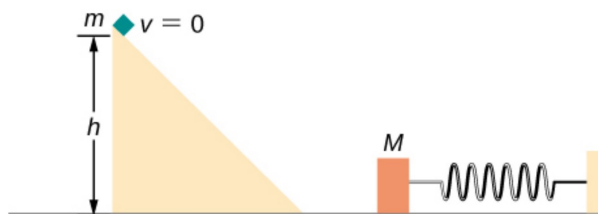
Please send the completed file to my mailbox [yy.lam@qq.com](mailto:yy.lam@qq.com) by November 3rd, with using the filename format:

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Please answer the questions by filling on these sheets.

1. To develop muscle tone, a man lifts a 8.0 kg weight held in his hand. He uses his biceps muscle to flex the lower arm through an angle of  $60^\circ$ . (a) What is the angular acceleration if the weight is 28 cm from the elbow joint, here forearm has a moment of inertia of  $0.29 \text{ kgm}^2$ , and the net force he exerts is 1180 N at an effective perpendicular lever arm of 2.5 cm? (b) What is the angular velocity at  $50^\circ$ ? (c) How much work does he do to go through the whole process ( $60^\circ$ )?
2. Competitive divers pull their limbs in and curl up their bodies when they do flips. Just before entering the water, they fully extend their limbs to enter straight down. Explain the effect of both actions on their angular velocities. Also explain the effect on their angular momenta.

3. **(Energy conservation).** A block of mass  $m$ , after sliding down a frictionless incline, strikes another block of mass  $M$  that is attached to a spring of spring constant  $k$ . The blocks stick together upon impact and travel together. (a) Find the compression of the spring in terms of  $m, M, g$  and  $k$  when the combination comes to rest. (b) The loss of kinetic energy as a result of the bonding of the two masses upon impact is stored in the so-called binding energy of the two masses. Calculate the binding energy.



4. A pendulum consists of a rod of length 2 m and mass 2.4 kg with a solid sphere of mass 1.8 kg and radius 0.3 m attached at one end. (i) Find the moment of inertia of the pendulum about the axis. (ii) Find the centre of mass of it from the axis. (iii) What is the angular velocity of the pendulum at its lowest point if it is released from rest at an angle of  $25^\circ$ ?



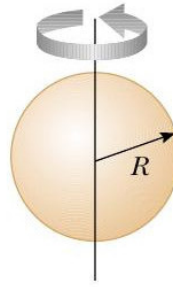
5. A 4.50 kg squid initially at rest ejects 0.220 kg of fluid with a velocity of  $10.0 \text{ ms}^{-1}$ . (a) What is the recoil velocity of the squid if the ejection is done in 0.100 s and there is a 5.30 N frictional force opposing the squid's movement? (b) How much energy is lost to work done against friction? (*Hint: consider the launching rocket problem with gravity*)

6. Oil of density  $750 \text{ kgm}^{-3}$  is poured on top of a tank of water, and it floats on the water without mixing. A block of plastic of density  $830 \text{ kgm}^{-3}$  is placed in the tank, and it is about floating at the interface of the two liquids (completely immerses in the liquids). What fraction of the block's volume is immersed in water?

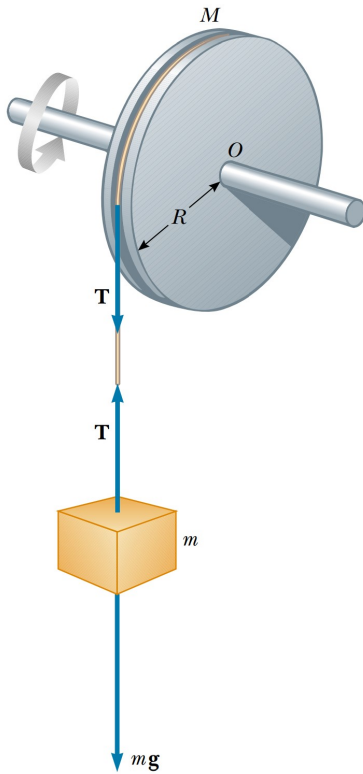
7. Drive the formula for  $I_{\text{CM}}$  as shown in the figure. (Hint: Imagine a solid sphere being the infinite sum of a stack of infinitesimal varying size of thin solid cylinders. )

Solid sphere

$$I_{\text{CM}} = \frac{2}{5} MR^2$$



8. A 8 kg solid cylinder with radius 0.2 m starts from rest to rotate about its cylindrical axis under a vertical force produced by a 12 kg mass connecting to a cord wound around the cylinder. (a) Find the angular acceleration, (b) the torque of the cylinder, and (c) the angular speed when revolving of a two and a half cycles.



9. A ball is rolling down along the slope without sliding. Please find the linear speed  $v_{CM}$  of the ball in terms of the given information.

