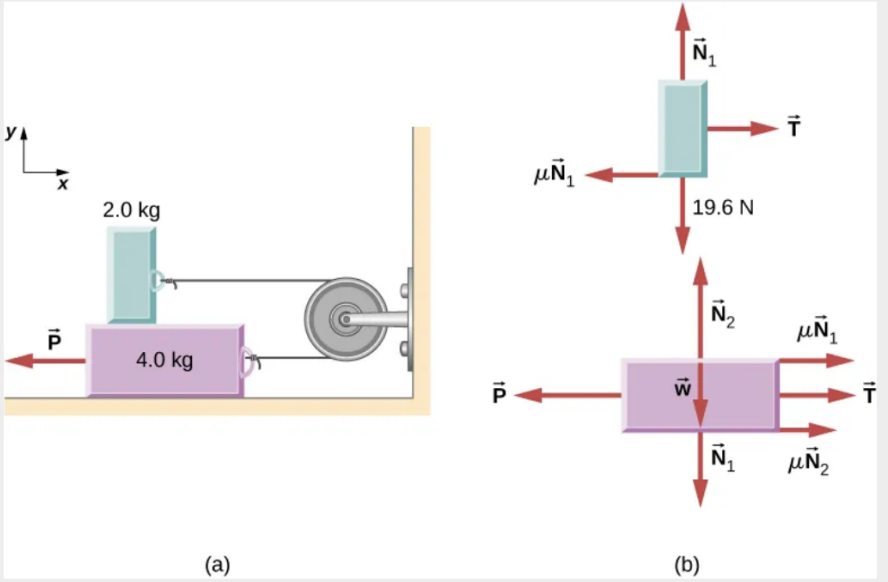
PHYS 1501

Exam 2

Friction

Sliding Blocks

The two blocks of Figure 6.17 are attached to each other by a massless string that is wrapped around a frictionless pulley. When the bottom 4.00-kg block is pulled to the left by the constant force $\vec{\mathbf{P}}$, the top 2.00-kg block slides across it to the right. Find the magnitude of the force necessary to move the blocks at constant speed. Assume that the coefficient of kinetic friction between all surfaces is 0.400.



Power

How much power must an automobile engine expend to move a 1200-kg car up a 15% grade at 90 km/h (Figure 7.15)? Assume that 25% of this power is dissipated overcoming air resistance and friction.

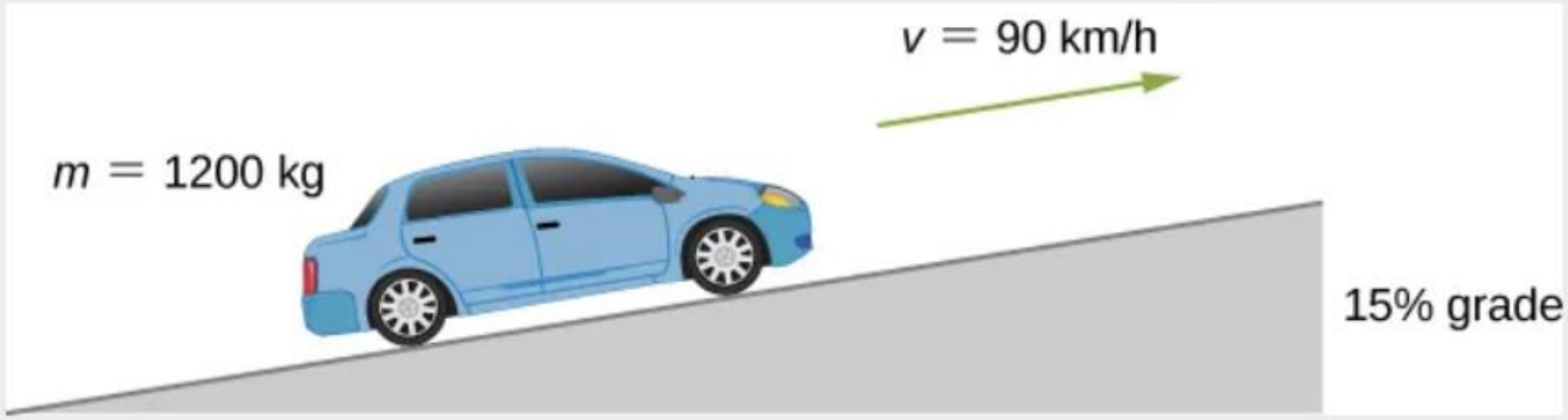


Figure 7.15 We want to calculate the power needed to move a car up a hill at constant speed.

Center of Mass

Determine how far the center of mass of the Earth-moon system is from the center of Earth. Compare this distance to the radius of Earth, and comment on the result. Ignore the other objects in the solar system.

$$m_e = 5.97 \times 10^{24}\ \text{kg}$$

$$m_m = 7.36 \times 10^{22}\ \text{kg}$$

$$r_m = 3.82 \times 10^{8}\ \text{m}.$$

Lets take a short break

Conservation of Momentum

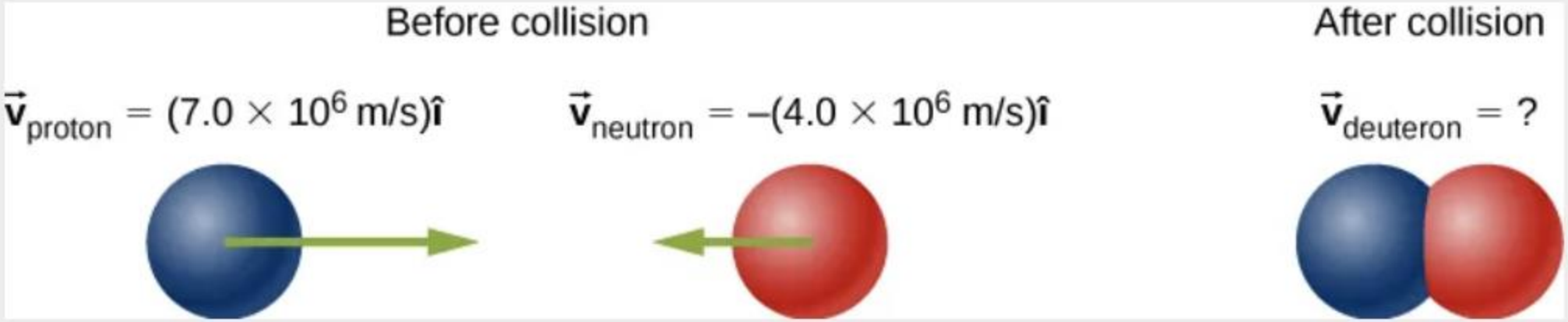
Thor vs. Iron Man

The 2012 movie “The Avengers” has a scene where Iron Man and Thor fight. At the beginning of the fight, Thor throws his hammer at Iron Man, hitting him and throwing him slightly up into the air and against a small tree, which breaks. From the video, Iron Man is standing still when the hammer hits him. The distance between Thor and Iron Man is approximately 10 m, and the hammer takes about 1 s to reach Iron Man after Thor releases it. The tree is about 2 m behind Iron Man, which he hits in about 0.75 s. Also from the video, Iron Man’s trajectory to the tree is very close to horizontal. Assuming Iron Man’s total mass is 200 kg:

a. Estimate the mass of Thor’s hammer
b. Estimate how much kinetic energy was lost in this collision

Inelastic Collisions

A proton (mass 1.67×10^{-27} kg) collides with a neutron (with essentially the same mass as the proton) to form a particle called a *deuteron*. What is the velocity of the deuteron if it is formed from a proton moving with velocity 7.0×10^{6} m/s to the left and a neutron moving with velocity 4.0×10^{6} m/s to the right?



Rotational Kinematics

A Spinning Bicycle Wheel

A bicycle mechanic mounts a bicycle on the repair stand and starts the rear wheel spinning from rest to a final angular velocity of 250 rpm in 5.00 s. (a) Calculate the average angular acceleration in $\mathrm{rad/s^2}$. (b) If she now hits the brakes, causing an angular acceleration of –87.3 $\mathrm{rad/s^2}$, how long does it take the wheel to stop?

Moment of Inertia

Moment of Inertia of a System of Particles

Six small washers are spaced 10 cm apart on a rod of negligible mass and 0.5 m in length. The mass of each washer is 20 g. The rod rotates about an axis located at 25 cm, as shown in Figure 10.19. (a) What is the moment of inertia of the system? (b) If the two washers closest to the axis are removed, what is the moment of inertia of the remaining four washers? (c) If the system with six washers rotates at 5 rev/s, what is its rotational kinetic energy?

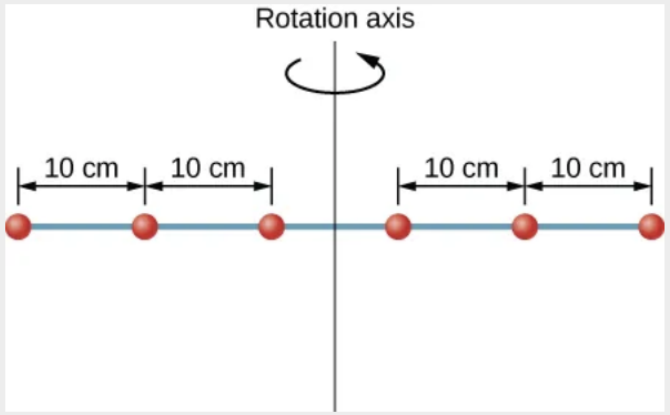


Figure 10.19 Six washers are spaced 10 cm apart on a rod of negligible mass and rotating about a vertical axis.

Torque

Calculating Torque on a rigid body

Figure 10.35 shows several forces acting at different locations and angles on a flywheel. We have $|\vec{F}_1| = 20\ \text{N}$, $|\vec{F}_2| = 30\ \text{N}$, $|\vec{F}_3| = 30\ \text{N}$, and $r = 0.5\ \text{m}$. Find the net torque on the flywheel about an axis through the center.

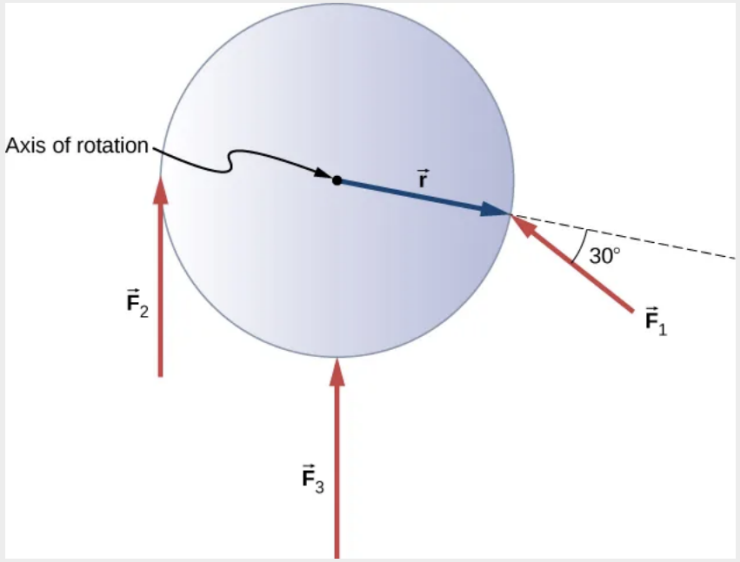


Figure 10.35 Three forces acting on a flywheel.

You Got This!