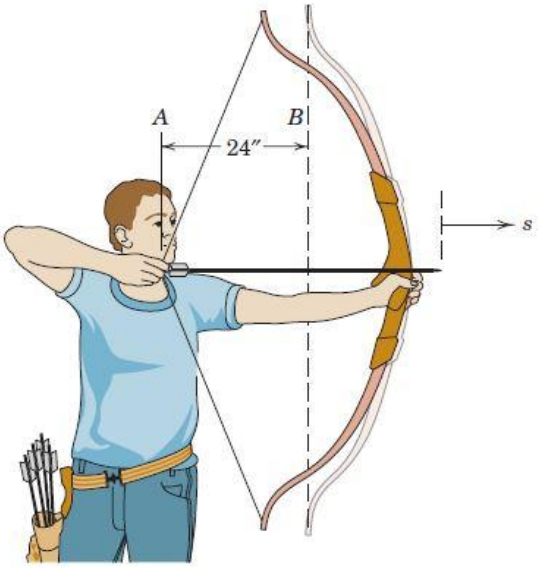
Dynamics, ESO209A

Date: 1/8/18.

Here are some homework problems from Meriam and Karaige, 7th edition (MK7). It is my intention to add to these problems, include notes, etc., from time to time, and to send you updated pdfs, so that you will not have to keep track of too many documents.

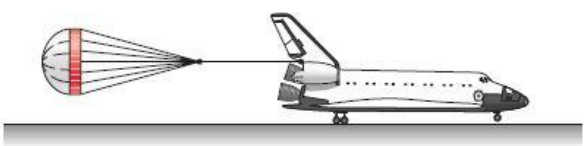
Tutors will discuss these problems next Tuesday if you need help, but you should not. I think you should be able to work these out at this time, or maybe after today's class.

2/36 In an archery test, the acceleration of the arrow decreases linearly with distance s from its initial value of 16,000 ft/sec^2 at A upon release to zero at B after a travel of 24 in. Calculate the maximum velocity v of the arrow.

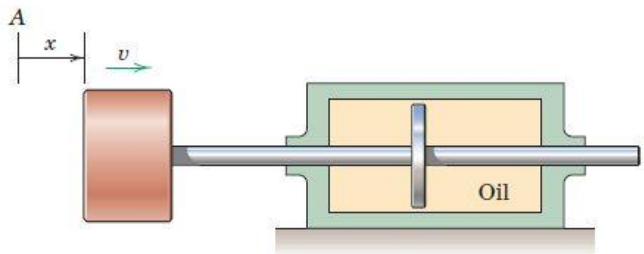


Problem 2/36

2/37 The 230,000-lb space-shuttle orbiter touches down at about 220 mi/hr. At 200 mi/hr its drag parachute deploys. At 35 mi/hr, the chute is jettisoned from the orbiter. If the deceleration in feet per second squared during the time that the chute is deployed is $-0.0003v^2$ (speed v in feet per second), determine the corresponding distance traveled by the orbiter. Assume no braking from its wheel brakes.

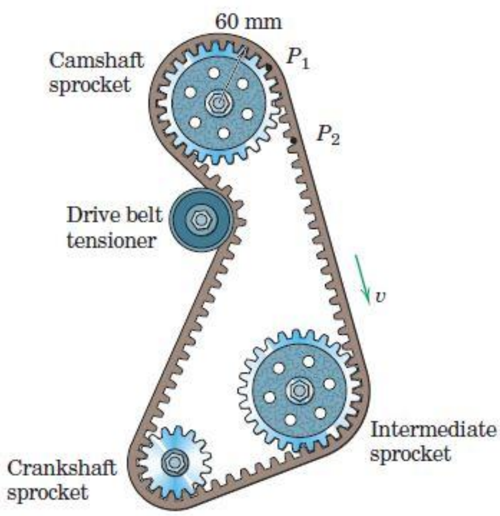


2/52 The horizontal motion of the plunger and shaft is arrested by the resistance of the attached disk which moves through the oil bath. If the velocity of the plunger is v_0 in the position A where $x = 0$ and $t = 0$, and if the deceleration is proportional to v so that $a = -kv$, derive expressions for the velocity v and position coordinate x in terms of the time t. Also express v in terms of x.



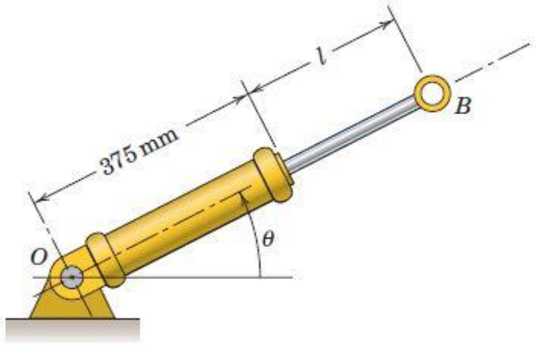
Problem 2/52

2/119 The design of a camshaft-drive system of a four-cylinder automobile engine is shown. As the engine is revved up, the belt speed v changes uniformly from 3 m/s to 6 m/s over a two-second interval. Calculate the magnitudes of the accelerations of points P_1 and P_2 halfway through this time interval.



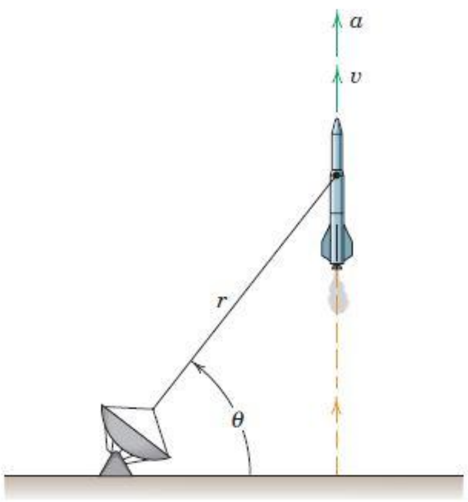
Problem 2/119

2/136 As the hydraulic cylinder rotates around O, the exposed length l of the piston rod P is controlled by the action of oil pressure in the cylinder. If the cylinder rotates at the constant rate $\dot{\theta} = 60$ deg/s and l is decreasing at the constant rate of 150 mm/s, calculate the magnitudes of the velocity $\mathbf{v}$ and acceleration $\mathbf{a}$ of end B when $l = 125$ mm.



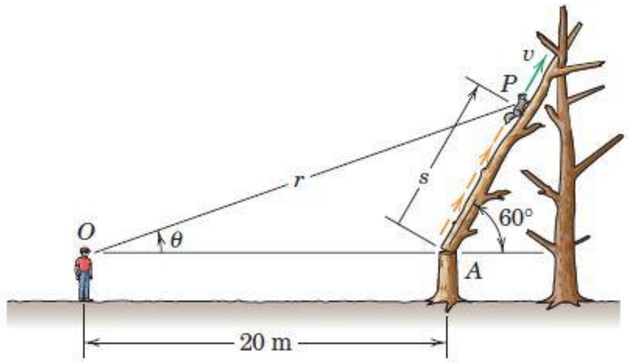
Problem 2/136

2/143 The rocket is fired vertically and tracked by the radar station shown. When θ reaches 60°, other corresponding measurements give the values $r = 30{,}000$ ft, $\ddot{r} = 70$ ft/sec^2, and $\dot{\theta} = 0.02$ rad/sec. Calculate the magnitudes of the velocity and acceleration of the rocket at this position.



Problem 2/143

2/144 A hiker pauses to watch a squirrel P run up a partially downed tree trunk. If the squirrel's speed is $v = 2$ m/s when the position $s = 10$ m, determine the corresponding values of $\dot{r}$ and $\dot{\theta}$.



Problem 2/144

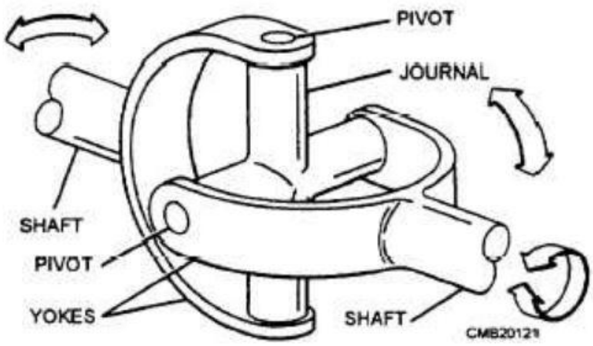
In addition to the above problems, also pay attention to the (different) problems being discussed in class, involving FBDs, moments about axes, wheels, and friction.

Date: 3/8/18

Discussions with individual students indicate to me that students are not used to the idea that forces and moments initially shown on free body diagrams (before further analysis) must correspond to motion restrictions at those locations.

I think universal joints can help to clarify these issues.

Here is a picture of a universal joint, taken from http://constructionmanuals.tpub.com/14273/css/Cross-and-Roller-Universal-Joint-179.htm



Note that the two shafts can be at an angle to each other, and the joint can still transmit torques. Here is another picture, from https://apexbits.com/ms20270-b12-apex-universal-joint-light-duty-bored-hub.aspx

The picture shows the possibility of the two shafts being at an angle.

For simple analysis, treat the shaft on the right as being horizontal and held in a bearing that allows free rotation; and treat the shaft on the left as being at 45 degrees (CW from vertical), also held in a bearing that allows free rotation. If a torque T is applied to the shaft on the left, how much is the shaft on the right transmitting? The pins in the coupler ("journal" above) may be taken as (i) one at 45 degrees (CCW from vertical), and (ii) one coming out of the page.

Tutors will discuss this on Tuesday.