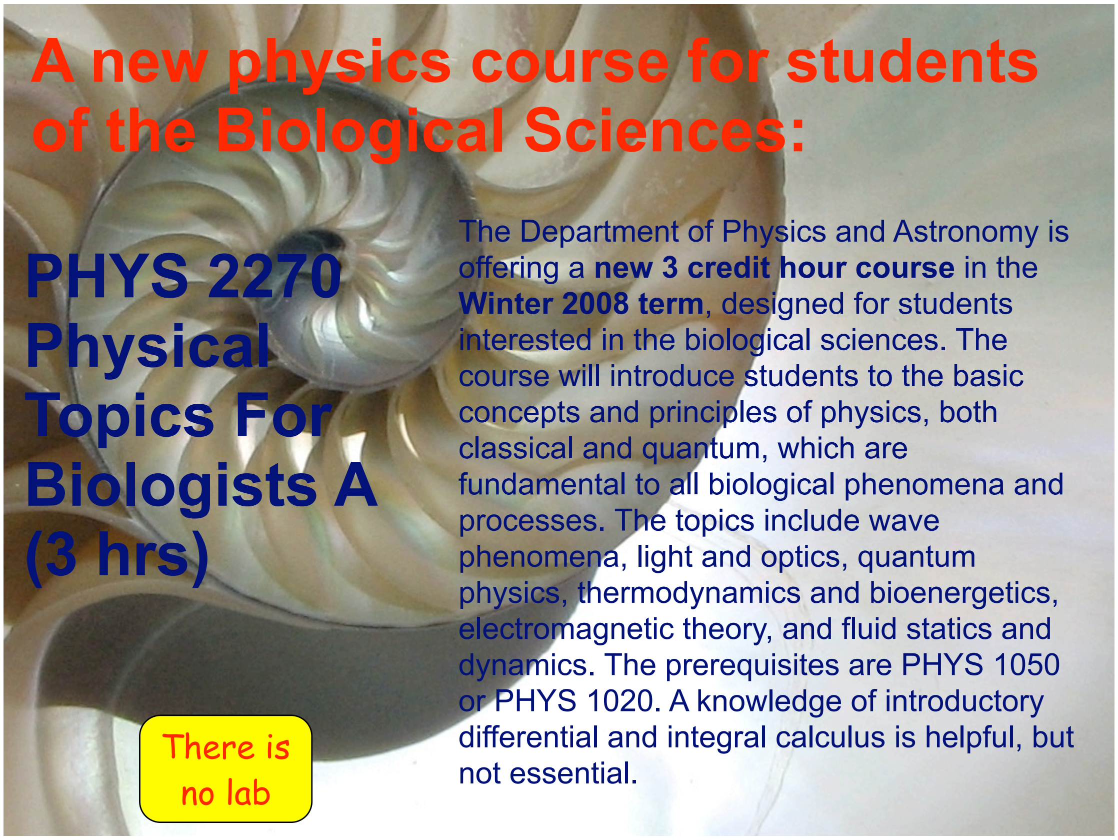


GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007
(lecture schedule is approximate)

8	M	22	19	Chapter 7	Impulse and momentum	No lab or tutorial
	Tue	23	MID-TERM TEST, Ch 1-5, Tuesday, October 23, 7-9 pm			
	W	24	20	Chapter 7	Impulse and momentum	
	F	26	21	Chapter 8, sections 1-3 only	Rotational kinematics	
9	M	29	22			Experiment 3: Forces in Equilibrium
	W	31	23	Chapter 9 sections 1 - 3, 6	Rotational dynamics	
	F	Nov 2	24			
10	M	5	25	Chapter 10 exclude 10.7 and 10.8	Simple harmonic motion, sections 10.5 and 10.6, for self study only	Tutorial and Test 3 ~~(chapters 7, 8)~~ Chapters 6, 7
	W	7	26			
	F	9	27	Chapter 11 exclude 11.11	Fluids	

Week of November 5

Tutorial and Test 3: Chapters 6 & 7

Mastering Physics Assignment 4

Is due Monday, November 12 at 11 pm

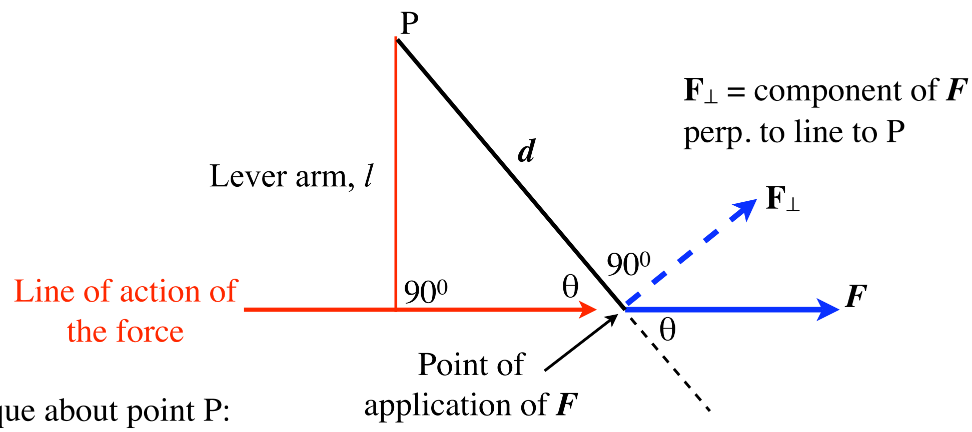
Covers material from chapters 6 and 7

There are 8 questions for practice and 6 for credit

The Final Exam Schedule is Now Final!

PHYS 1020: Monday, December 17, 6 - 9 pm
Frank Kennedy Brown & Gold Gyms
The whole course
30 multiple choice questions
Formula sheet provided

Two ways to calculate torques (moments)



Torque about point P:

1) Torque = (force) × (lever arm): $\tau = Fl = F \times d \sin\theta$

2) Torque = $\mathbf{F}_\perp \times d$: $\tau = F_\perp d = F \sin\theta \times d$

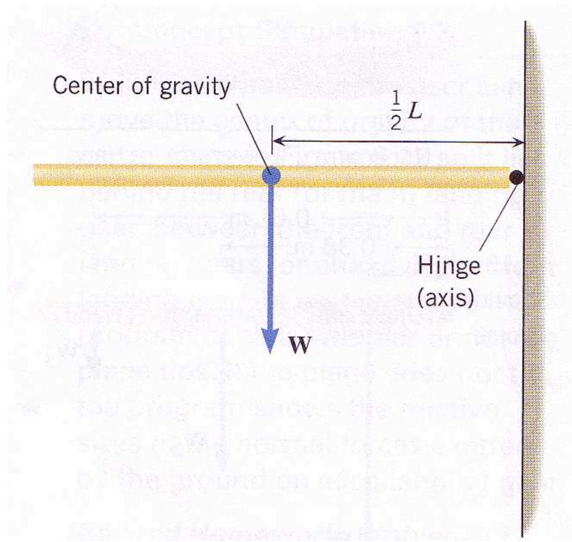
Choose the method that is the more convenient...

Centre of Gravity

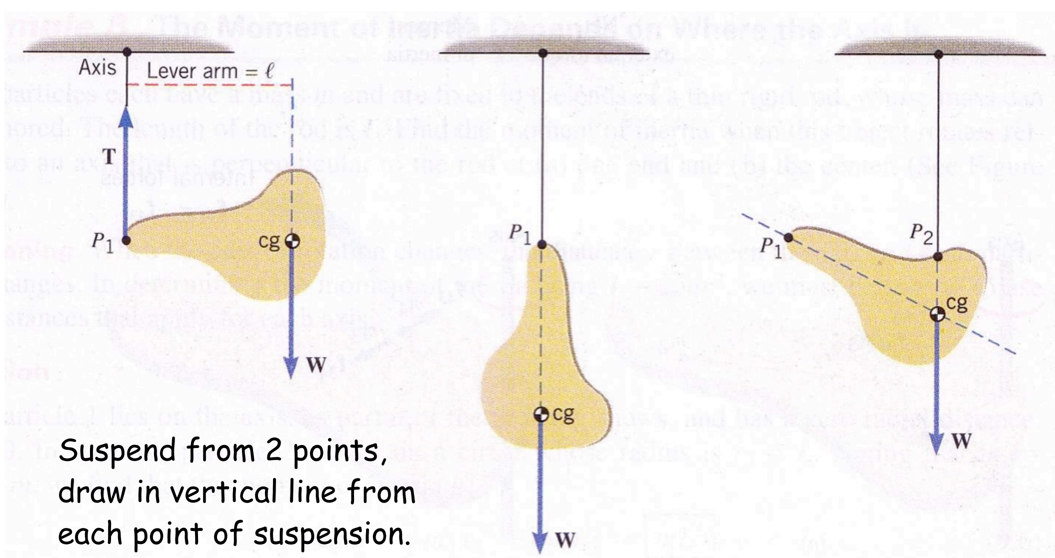
The point at which the whole weight of a solid object can be considered to act.

Torque about hinge:

$$\tau = W \times \frac{L}{2}$$



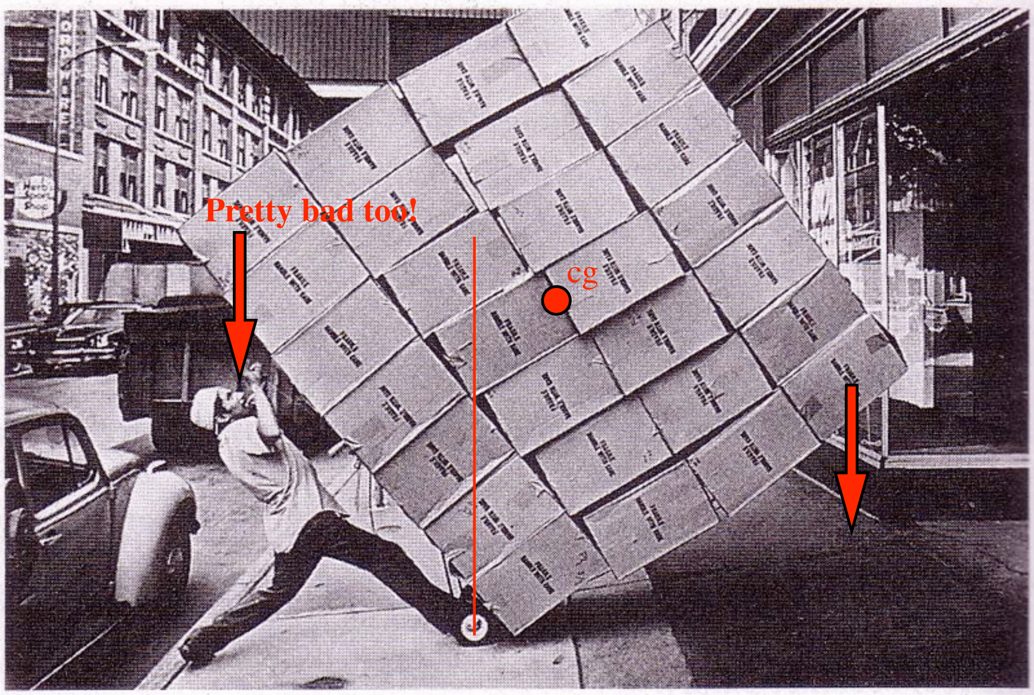
Finding the Centre of Gravity



Suspend from 2 points, draw in vertical line from each point of suspension.

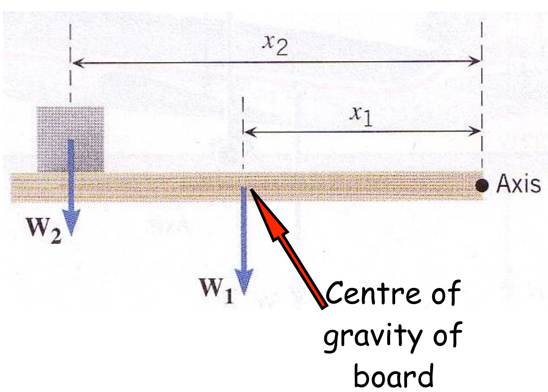
Where the lines meet is the centre of gravity.

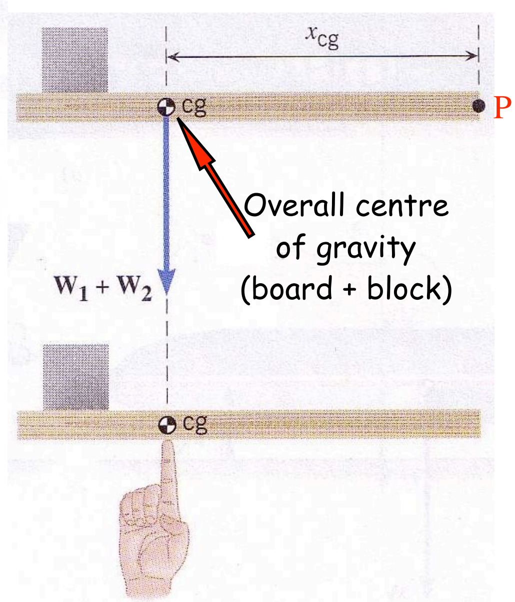
9.C24 Torque: the worst box?



(© Paul Miller Photography)

Centre of Gravity





The whole weight concentrated at the overall centre of gravity should give the correct torque –

Torques about P at the right:

$$(W_1 + W_2)x_{cg} = W_1x_1 + W_2x_2$$

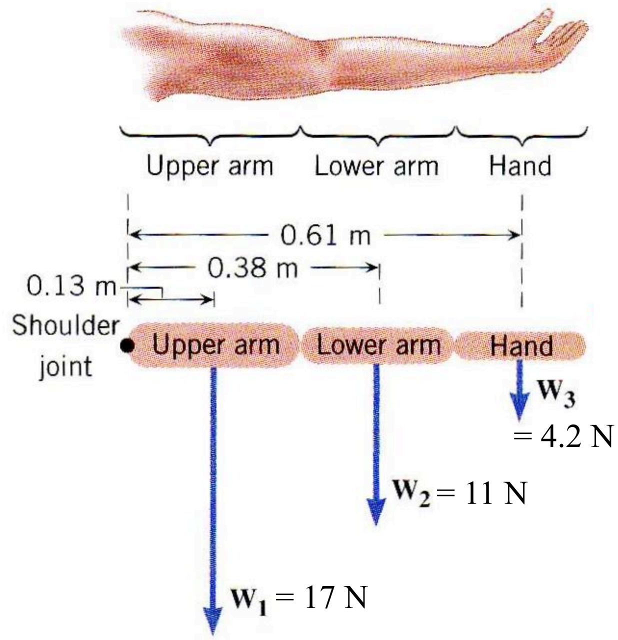
$$\boxed{x_{cg} = \frac{W_1x_1 + W_2x_2}{W_1 + W_2}}$$

Centre of gravity of an arm

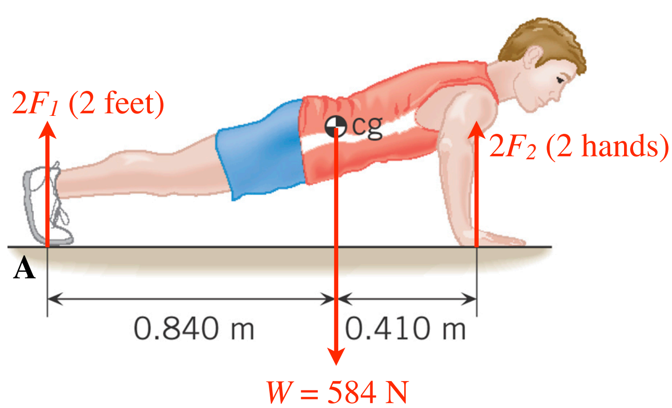
$$x_{cm} = \frac{W_1 x_1 + W_2 x_2 + W_3 x_3}{W_1 + W_2 + W_3}$$

$W_1 = 17\ \text{N}, x_1 = 0.13\ \text{m}$
$W_2 = 11\ \text{N}, x_2 = 0.38\ \text{m}$
$W_3 = 4.2\ \text{N}, x_3 = 0.61\ \text{m}$

$x_{cm} = 0.28\ \text{m}$



9.11: Find the normal force exerted by the floor on each hand and each foot.

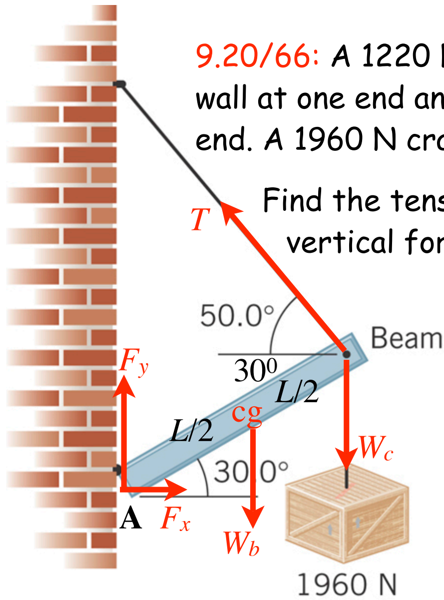


Torques about A: $-W \times 0.84 + 2F_2 \times (0.84+0.41) = 0 \rightarrow F_2 = 196$ N

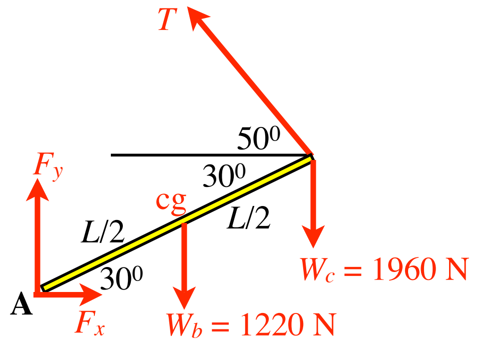
Forces: $2F_1 + 2F_2 - W = 0 \rightarrow F_1 = 96$ N

9.20/66: A 1220 N uniform beam is attached to a vertical wall at one end and is supported by a cable at the other end. A 1960 N crate hangs from the far end of the beam.

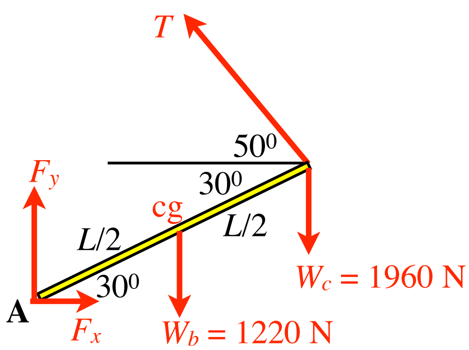
Find the tension in the cable and the horizontal and vertical forces exerted on the left end of the beam by the wall.



The length of the beam is L. It is uniform, so its cg is half way along



Free-body diagram - forces on the beam



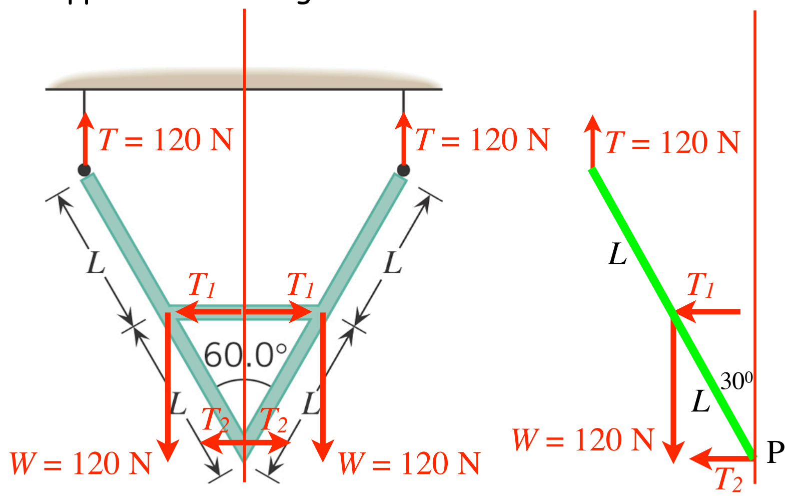
Torques about A: $TL\sin 80° - W_b(L/2)\times\cos 30° - W_c L\cos 30° = 0$

$$\rightarrow T = \frac{(W_c + W_b/2)\cos 30°}{\sin 80°} = 2260\ \text{N}$$

Forces in x: $F_x = T\cos 50° = 1453\ \text{N}$

Forces in y: $F_y + T\sin 50° - W_b - W_c = 0 \rightarrow F_y = 1449\ \text{N}$

9.25/71: Each leg of the "A" has weight 120 N. The horizontal crossbar has negligible weight. Find the force that the crossbar applies to each leg.



Torques about P: $T_1 L \cos 30° + W L \sin 30° = T \times 2L \sin 30°$

$$\rightarrow T_1 = \tan 30° [2T - W] = 69 \text{ N}$$

Angular Momentum

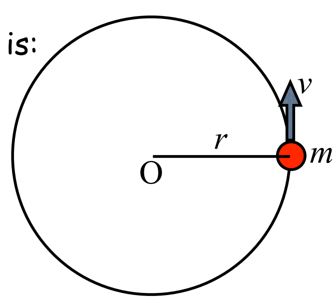
Angular momentum is conserved if the net torque acting on an object is zero.

The angular momentum of the mass about O is:

L = mvr

With v = rω, angular velocity ω,

L = m(rω)r = mr$^2\omega$

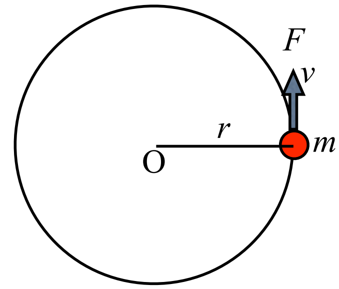


Define **I = mr^2 = "moment of inertia"** about centre of circle

Angular momentum, L = mvr = Iω

Conservation of Angular Momentum

Apply a force, F, in the direction of the instantaneous velocity of the mass. The mass is constrained to move in a circular path (eg by a string).



The mass accelerates:

$$F = ma = m\frac{\Delta v}{\Delta t}$$

The torque applied by F is $\tau = Fr = mr\frac{\Delta v}{\Delta t}$

As angular momentum is $L = mvr$ and $\Delta L = mr\Delta v$

$$\tau = \frac{\Delta L}{\Delta t} = I\frac{\Delta \omega}{\Delta t} \text{ as } L = I\omega, \text{ so } \Delta L = I\Delta\omega$$

Angular momentum is constant if net torque is zero
Rate of change of angular momentum = torque applied

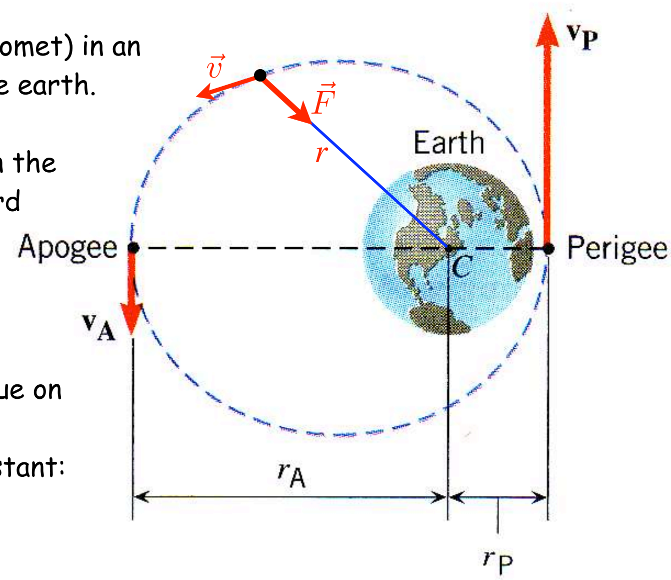
Conservation of Angular Momentum

Motion of a satellite (or comet) in an eccentric orbit around the earth.

The gravitational force on the satellite is directed toward the earth, the axis of rotation - zero torque.

As gravity exerts no torque on the satellite, its angular momentum about C is constant:

$$L = mvr$$



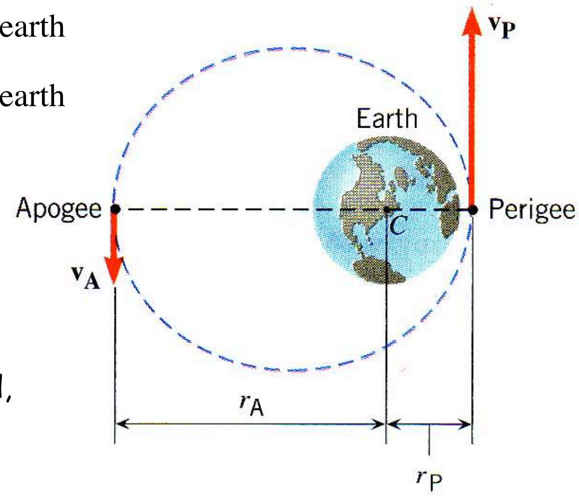
is constant around the orbit. → $v_A r_A = v_P r_P$

Example: comets speed up as they approach the sun

$r_A = 25.1 \times 10^6$ m from centre of earth

$r_P = 8.37 \times 10^6$ m from centre of earth

If $v_P = 8450$ m/s, find v_A.



Angular momentum is conserved,

$$m\, v_A\, r_A = m\, v_P\, r_P$$

$$\text{So, } v_A = \frac{v_P \times r_P}{r_A}$$

$$= \frac{8450 \times 8.37 \times 10^6}{25.1 \times 10^6} = 2818 \text{ m/s}$$

Conservation of Angular Momentum

The skater pulls in her arms, moving mass closer to the axis of rotation and decreasing her moment of inertia (divide body into chunks of mass m_i at distance r_i from axis of rotation, add up all of the $m_i r_i^2$).

As $L = I\omega$ is constant, the rotation rate increases as I decreases.

9.-/52: A woman is standing at the centre of a rotating platform that is turning at 5 rad/s. The total moment if inertia of woman and platform is 5.4 kg.m^2.

By pulling in her arms, she reduces her moment of inertia to 3.8 kg.m^2.

Find the new angular speed.

Conservation of angular momentum:

$$\text{Angular momentum, } L = I_0\, \omega_0 = I_f\, \omega_f$$

$$\text{Therefore, } \omega_f = \frac{I_0\, \omega_0}{I_f} = \frac{5.4 \times 5}{3.8} = 7.1 \text{ rad/s}$$