Chapter 1 - 4 review

Conversion of units

Motion with constant acceleration (1d, 2d, 3d)

Circular motion

Relative motion

Example

- **Convert mph to km/s**
- **Convert Thrust in Imperial Units (lb^2ft/s^2) to Thrust in SI units (kg^2m/s^2)**

Example

You drop a pebble in a well and hear a splash 2 s later. How far down is the water?

Example

Your friend drops a stone from a cliff of height h=500 m. You throw your stone 2 s later. At what velocity pointing down you need to throw you stone so that it hits the ground first?

Example

A high-speed passenger train traveling at speed 160 mph rounds a bend. The engineer and is shocked to see 0.5 mile ahead a slow locomotive moving with a speed of 30 mph moving away. The engineer hits the brakes, which de-accelerates the train at 0.1g. Will be the collision avoided?

Example

$$\vec{a} = 3\hat{\mathrm{i}} + 4\hat{\mathrm{j}}$$

$$\vec{b} = -3\hat{\mathrm{i}} + 4\hat{\mathrm{j}}$$

Draw two vectors

Find length of each of the two vectors

Find sum of the two vectors $\vec{c} = \vec{a} + \vec{b}$

Find their scalar product $\vec{c} = \vec{a} \cdot \vec{b}$

Find the vector of their cross-product $\vec{c} = \vec{a} \times \vec{b}$

Example

$$\vec{r}(t) = (3t + 2)\hat{\mathrm{i}} + (2t^2 - 1)\hat{\mathrm{j}}$$

Find vector of velocity at t=1 s

- magnitude
- direction

Find magnitude of average velocity between t=0 and 2 s

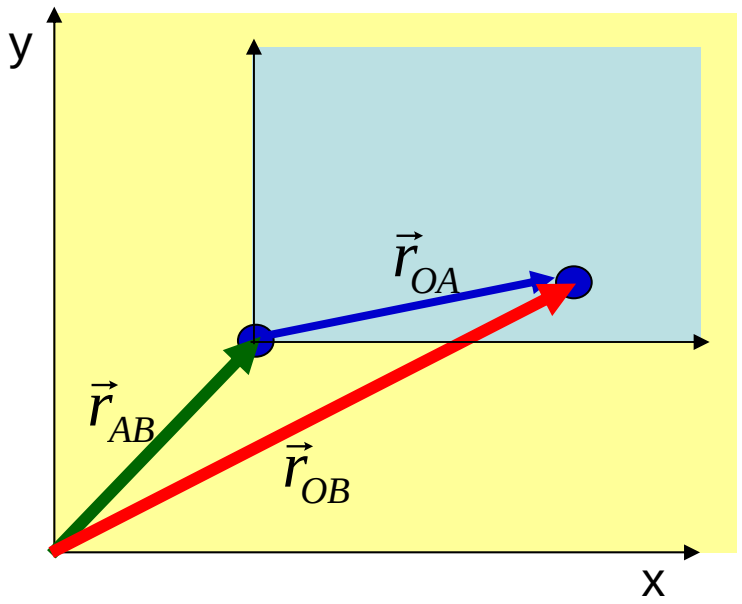
Example

A pilot is tested in a centrifuge of radius 5 m.

The centrifuge makes 20 turns per min.

What is the centripetal acceleration experienced by the pilot?

Relative motion



Blue – coordinate system A
Yellow – coordinate system B

$\vec{r}_{OA}$ -- position of object O in coordinate system A

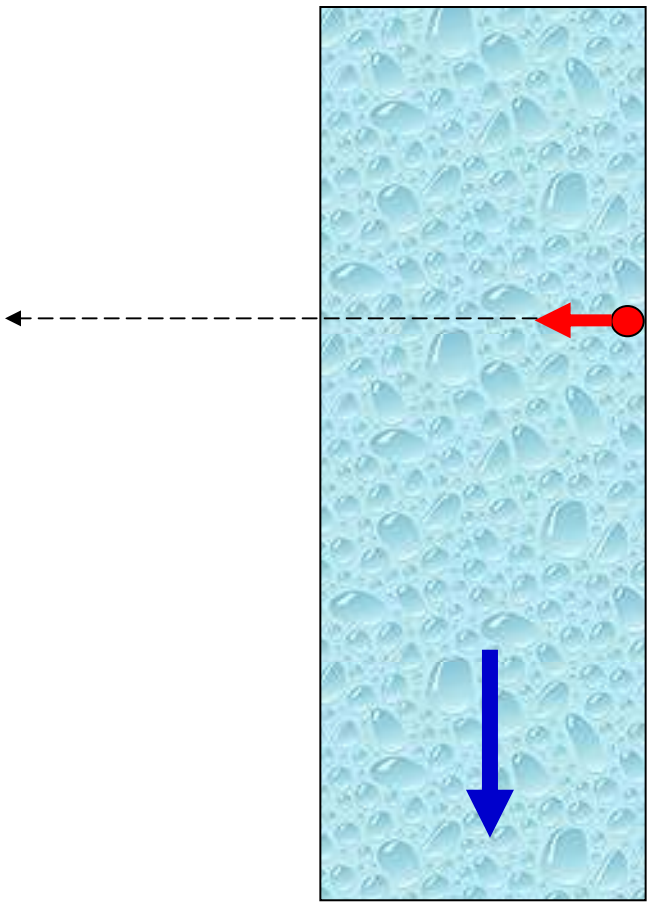
$\vec{r}_{AB}$ -- position of coordinate system A origin in coordinate system B

$\vec{r}_{OB}$ -- position of object O in coordinate system B

$$\vec{r}_{OB} = \vec{r}_{AB} + \vec{r}_{OA}$$

$$\frac{d\vec{r}_{OB}}{dt} = \frac{d\vec{r}_{AB}}{dt} + \frac{d\vec{r}_{OA}}{dt} \rightarrow \boxed{\vec{v}_{OB} = \vec{v}_{AB} + \vec{v}_{OA}}$$

Example



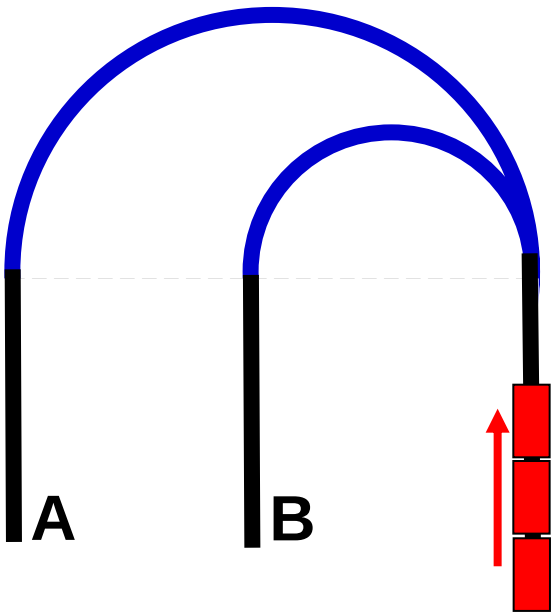
River flows south with speed v_r

You swim west toward sunset with speed v_o

How long will it take you to cross the river?

How far downstream will you land?

HITT quiz



There are 2 possible semi-circular turns for the train with radii r_A:r_B=2. Train can enter the turn A at speed v_A and the turn B at speed v_B so that v_A:v_B=2.

What is the ratio of centripetal accelerations experienced by passengers on such turns, a_A:a_B=?

(*a*) 4 (*b*) 2 (*c*) 1 (*d*) 0.5 (*e*) 0.25