Atlag - impulse, skriðpungi - momentum

Momentum

The momentum p of an object is the product of its mass and its velocity:

$$\vec{\mathbf{p}} = m\vec{\mathbf{v}}. \qquad 9.1$$

Figure 9.3 This supertanker transports a huge mass of oil; as a consequence, it takes a long time for a force to change its (comparatively small) velocity. (credit: modification of work by "the_tahoe_guy"/Flickr)

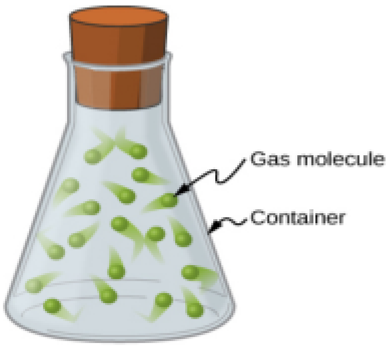

Figure 9.4 Gas molecules can have very large velocities, but these velocities change nearly instantaneously when they collide with the container walls or with each other. This is primarily because their masses are so tiny.

bæði massin m og hraðinn v skipta máli þegar skriðpunginn er reiknaður

$$\bar{p} = m\bar{v}$$

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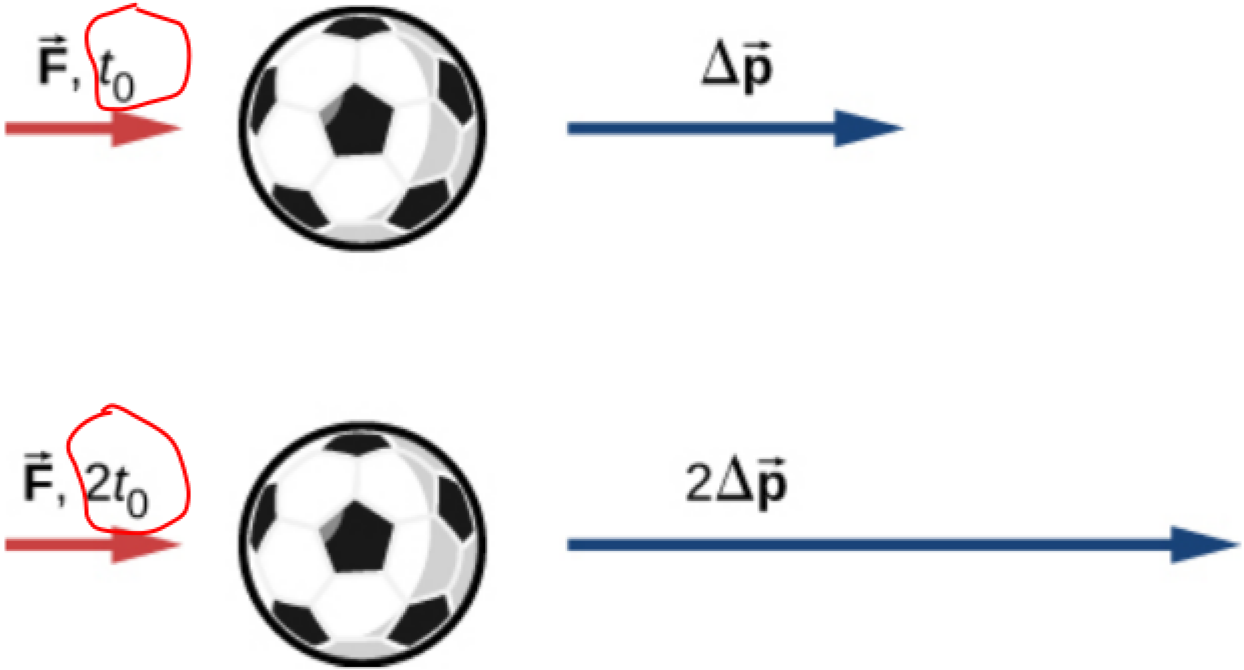
Atlag - impulse



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Impulse

Let $\vec{\mathbf{F}}(t)$ be the force applied to an object over some differential time interval dt (Figure 9.6). The resulting impulse on the object is defined as

$$d\vec{\mathbf{J}} \equiv \vec{\mathbf{F}}(t)dt. \tag{9.2}$$

③

$$\vec{\mathbf{J}} = \int_{t_i}^{t_f} d\vec{\mathbf{J}} \quad \text{or} \quad \vec{\mathbf{J}} \equiv \int_{t_i}^{t_f} \vec{\mathbf{F}}(t)dt$$

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$$\bar{F}_{ave} = \frac{1}{\Delta t}\int_{t_i}^{t_f} \bar{F}(t)\,dt \longrightarrow \boxed{\bar{J} = \bar{F}_{ave}\,\Delta t}$$

$$\boxed{\bar{J} = \int_{t_i}^{t_f} \bar{F}(t)\,dt} = m\int_{t_i}^{t_f} \bar{a}(t)\,dt = m\int_{t_i}^{t_f} \frac{d\bar{v}}{dt}\,dt$$

$$= m\left[\bar{v}(t_f) - \bar{v}(t_i)\right] = \boxed{m\Delta\bar{v}}$$

$$\bar{J} = m\Delta\bar{v}$$

Impulse-Momentum Theorem

An impulse applied to a system changes the system's momentum, and that change of momentum is exactly equal to the impulse that was applied:

$$\boxed{\vec{\mathbf{J}} = \Delta\vec{\mathbf{p}}.} \quad 9.7$$

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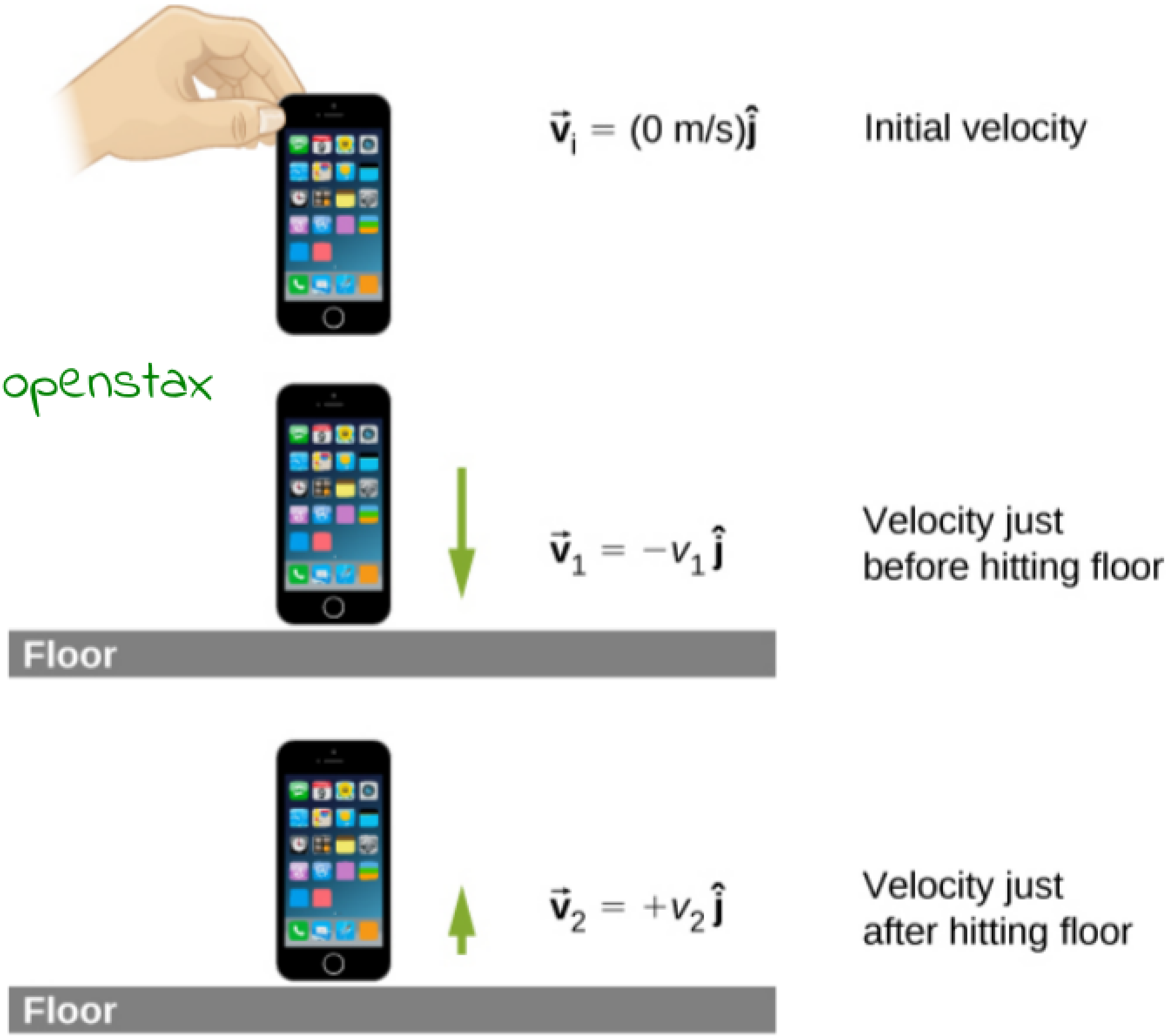
Fall síma, Ex. 9.4

Sími fellur úr kyrrstöðu, h = 1.5m, hvaða kraftar verka á hann?

Ekki bara $w = -mg$, hvað getum við sagt um kraft gólfsins á hann?



$$\bar{J} = \bar{F}_{ave}\Delta t$$

$$\bar{F}_{ave} = \frac{\bar{J}}{\Delta t}$$

$$\bar{J} = \Delta\bar{p}$$
$$= m\Delta\bar{v}$$

$$\bar{F}_{ave} = \frac{m\Delta\bar{v}}{\Delta t}$$

Ef $\bar{v}_2 = 0$ $\rightarrow$ $m\Delta\bar{v} = m(\bar{v}_2 - \bar{v}_1) = m(0 - (-v_1\hat{j}))$

$$m\Delta\bar{v} = +mv_1\hat{j}$$

eftir fall úr kyrrstöðu

$$v_1 = \sqrt{2hg}$$

$$\rightarrow \quad \bar{F} = \frac{\Delta\bar{p}}{\Delta t} = \frac{m\Delta\bar{v}}{\Delta t} = \frac{mv_1}{\Delta t}\hat{j} = \frac{m\sqrt{2gh}\,\hat{j}}{\Delta t}$$

$m = 0{,}172\,\mathrm{kg}$

$g = 9{,}81\,\mathrm{m/s^2}$

$h = 1{,}5\,\mathrm{m}$

$\Delta t = 0{,}026\,\mathrm{s}$

$$= (36\,\mathrm{N})\hat{j}$$

stefna upp

en $mg = 1{,}68\,\mathrm{N}$

Árekstrartími metinn frá lengd síma 0.14m $= L$

og lokafallferð $v_1 = 5.4\,\mathrm{m/s}$ $\quad \Delta t \simeq \frac{L}{v_1}$

Reiknandi atlagið fengum við

$$\bar{F}_{ave} = \frac{\Delta\bar{p}}{\Delta t}$$

en fyrir samfellda lýsingum var komið

$$\bar{F} = \frac{d\bar{p}}{dt} = \frac{d(m\bar{v})}{dt} \quad m\frac{d\bar{v}}{dt} = m\bar{a}$$

ef m er fastur. því fæst:

Newton's Second Law of Motion in Terms of Momentum

The net external force on a system is equal to the rate of change of the momentum of that system caused by the force:

$$\boxed{\vec{\mathbf{F}} = \frac{d\vec{\mathbf{p}}}{dt}.}$$

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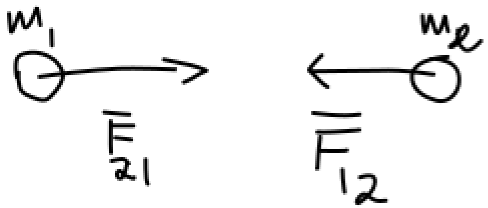
Varðveisla skriðþunga

Tveir hlutir víxlverkast, engir aðrir kraftar, 3. lögmál Newtons

Lokað kerfi



$$\bar{F}_{21} = -\bar{F}_{12} \quad \rightarrow \quad m_1\bar{a}_1 = -m_2\bar{a}_2$$

$$\rightarrow \quad \frac{d}{dt}\left[m_1\bar{v}_1\right] = -\frac{d}{dt}\left[m_2\bar{v}_2\right]$$

$$\rightarrow \quad \frac{d\bar{p}_1}{dt} + \frac{d\bar{p}_2}{dt} = 0 \quad \rightarrow \quad \frac{d}{dt}\left[\bar{p}_1 + \bar{p}_2\right] = 0$$

$$\rightarrow \quad \bar{p}_1 + \bar{p}_2 = \text{fasti}$$

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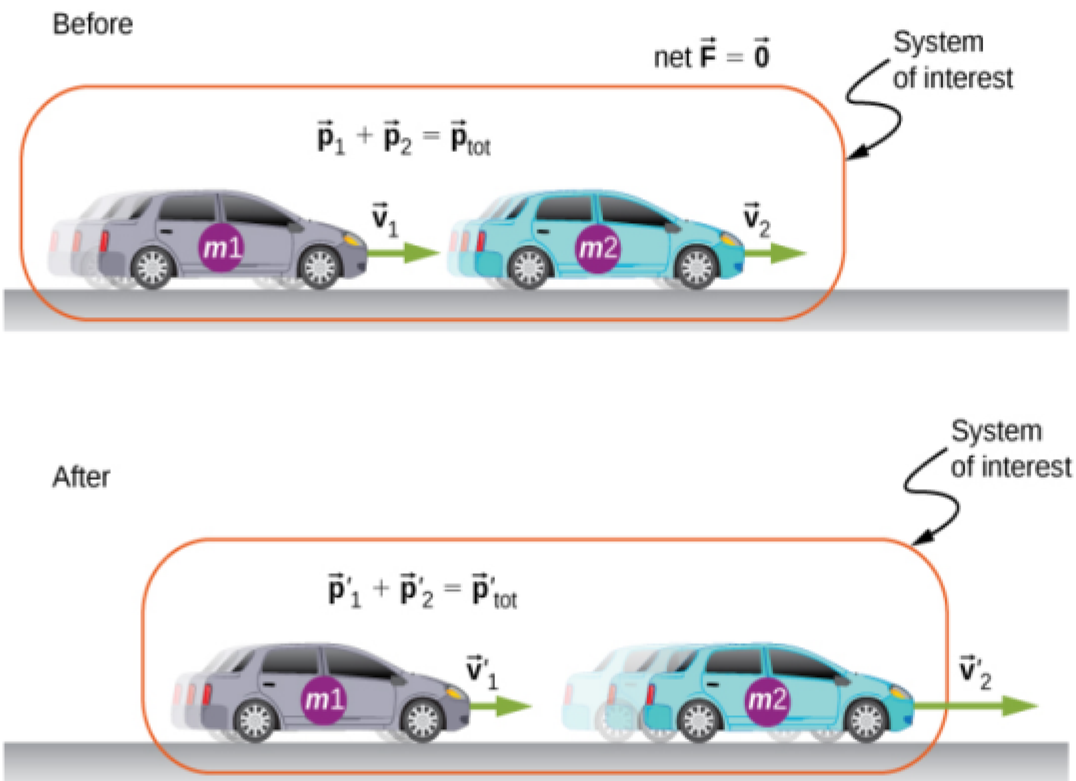
Law of Conservation of Momentum

The total momentum of a closed system is conserved:

$$\boxed{\sum_{j=1}^{N} \vec{\mathbf{p}}_{\mathbf{j}} = \text{constant.}}$$



Við munum ekki fara frekar í flokkun árekstra og þá aðferðafræði sem heppileg er til að greina þá

Þurfum að nefna fyrir hlut eða kerfi agna

Massamiðja

$$\bar{r}_{CM} = \frac{1}{M}\sum_{j=1}^{N} m_j \bar{r}_j \,, \qquad \bar{r}_{CM} = \frac{1}{M}\int \bar{r}\, dm$$

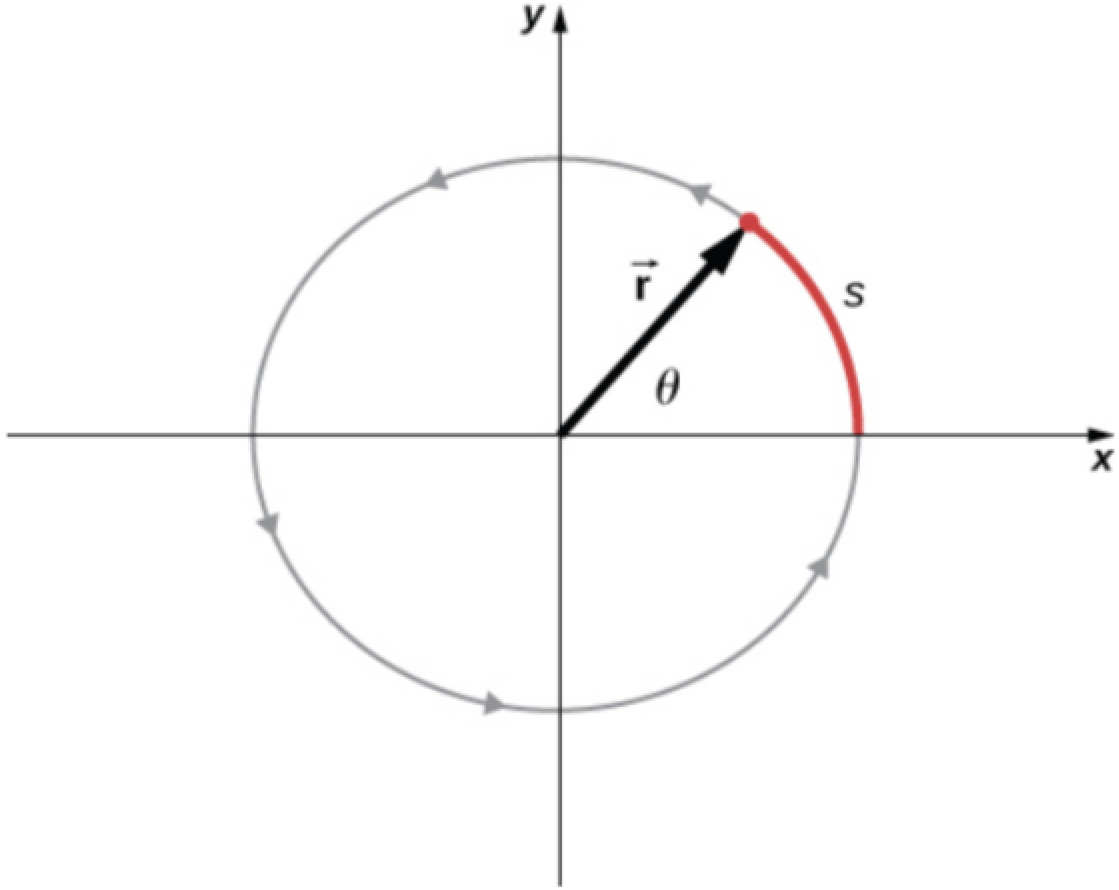
$$\bar{v}_{CM} = \frac{1}{M}\sum_{j=1}^{N} m_j \bar{v}_j \,, \qquad \boxed{\bar{F}_{ext} = \sum_{j=1}^{N} \frac{d\bar{p}_j}{dt}}$$

eða

$$\boxed{\bar{F} = \frac{d\bar{p}_{CM}}{dt}}$$

Aðeins ytri kraftar hafa áhrif á hreyfingu massamiðjunnar

Hraði í hringhreyfingu



Viljum endurbæta lýsingu hringhreyfingar. Byrjum á að skilgreina hornhraðavigur

Áður var komið að

$$s = r\theta$$

allt skalarstærðir

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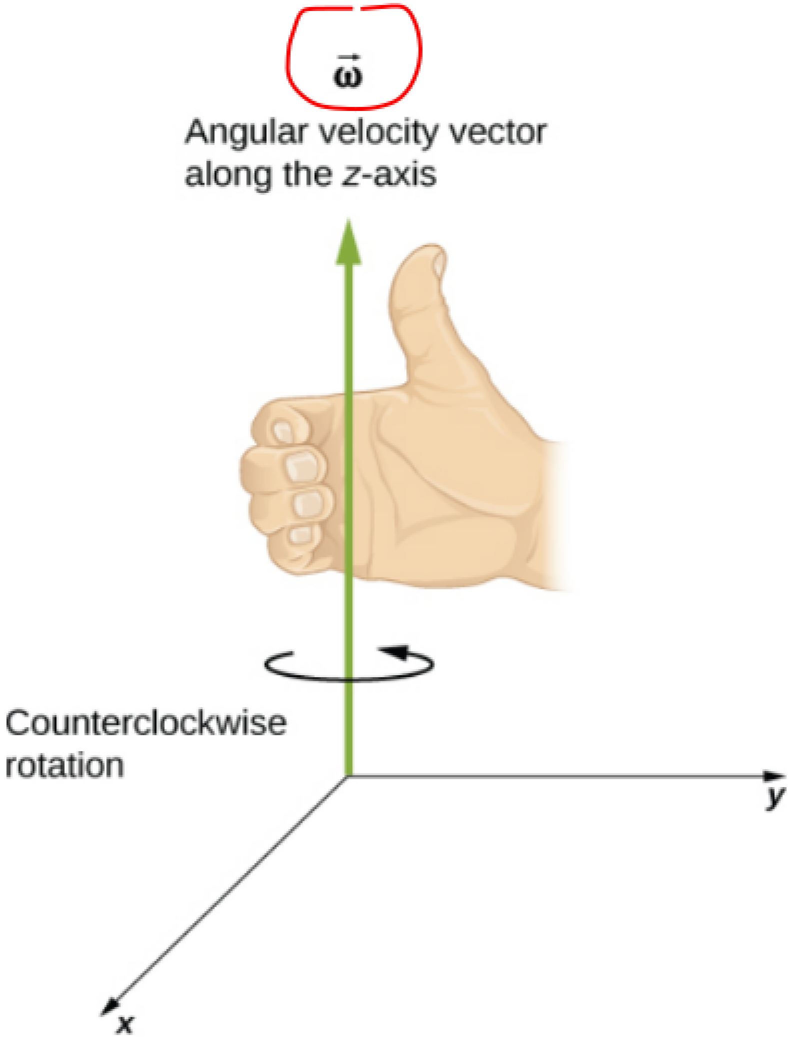
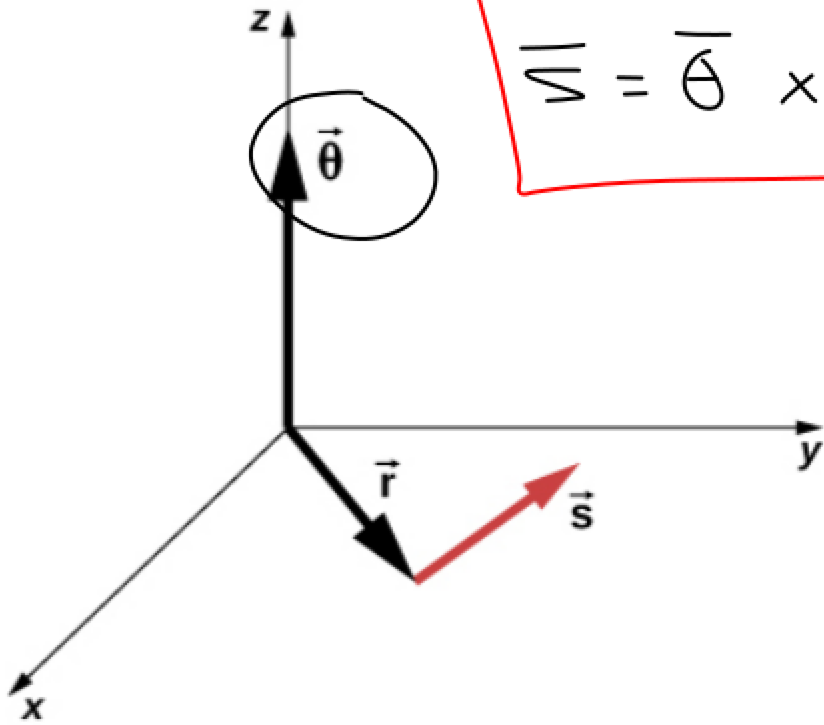
Skiptum yfir í vigurstærðir (vectors)

Hringhreyfing í x-y-sléttu, (andsælis)





$$\boxed{\bar{s} = \bar{\theta} \times \bar{r}}$$

$$\boxed{\bar{v} = \bar{\omega} \times \bar{r}}$$

$$\omega = \frac{d\theta}{dt}$$

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snertilferð (tangential speed)

$$\boxed{v_t = \frac{ds}{dt} = \frac{d}{dt}(r\theta) = \theta \underbrace{\frac{dr}{dt}}_{=0} + r\frac{d\theta}{dt} = r\frac{d\theta}{dt} = r\omega}$$

Hornhröðun

$$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$$

Snertilhröðun

$$\overline{a}_t = \overline{\alpha} \times \overline{r}$$

$$a_t = r\alpha$$

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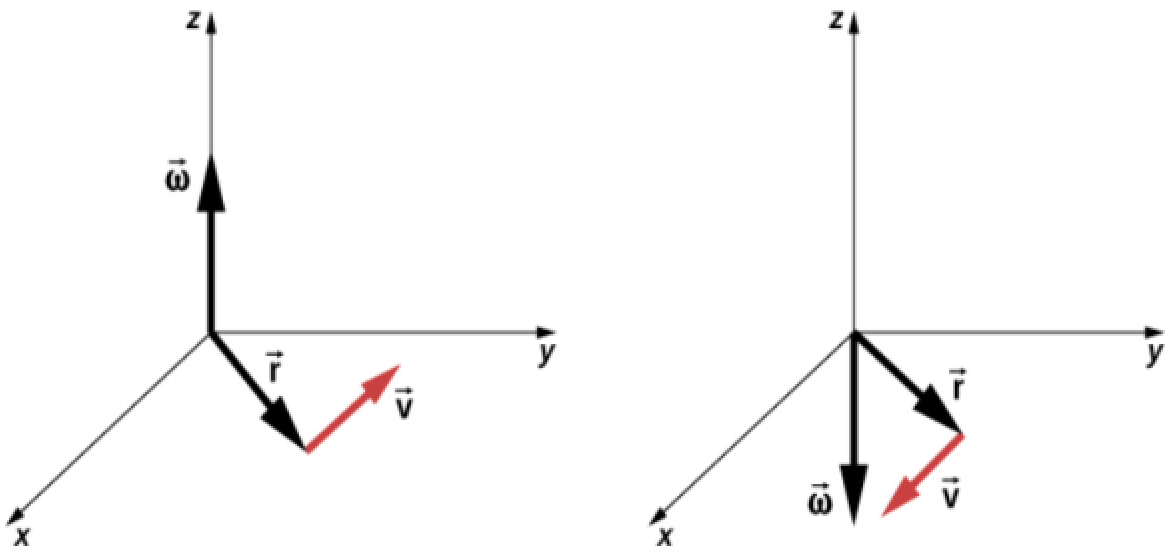

(14)

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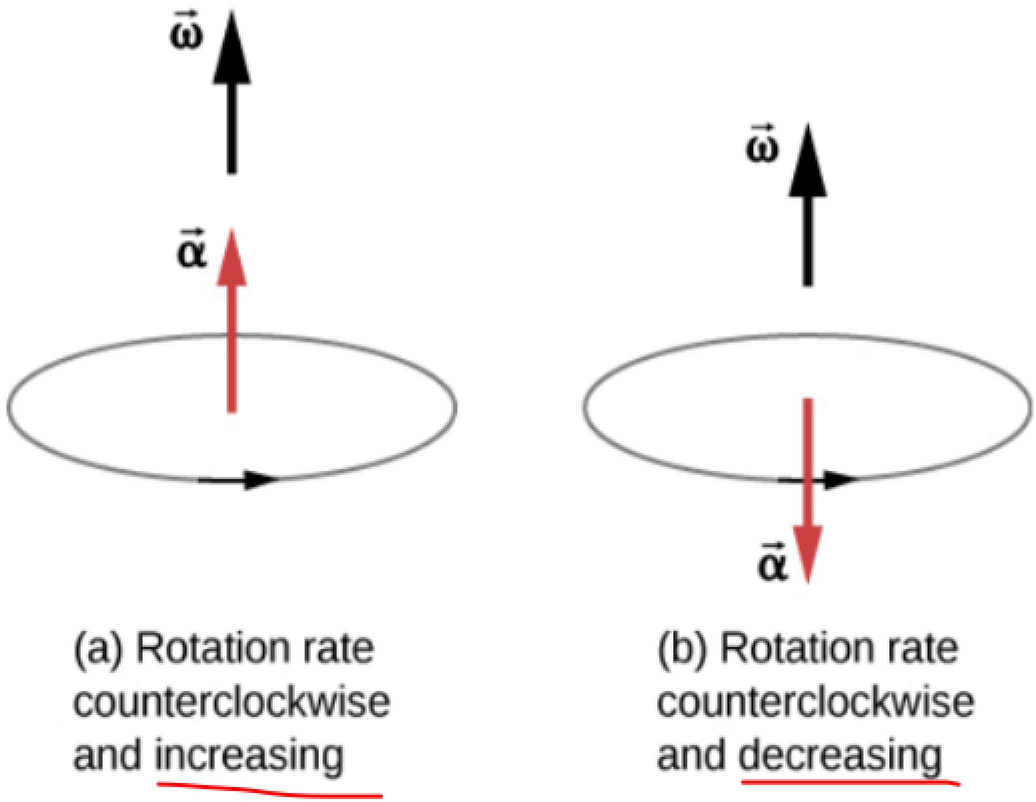

Figure 10.7 The rotation is counterclockwise in both (a) and (b) with the angular velocity in the same direction. (a) The angular acceleration is in the same direction as the angular velocity, which increases the rotation rate. (b) The angular acceleration is in the opposite direction to the angular velocity, which decreases the rotation rate.

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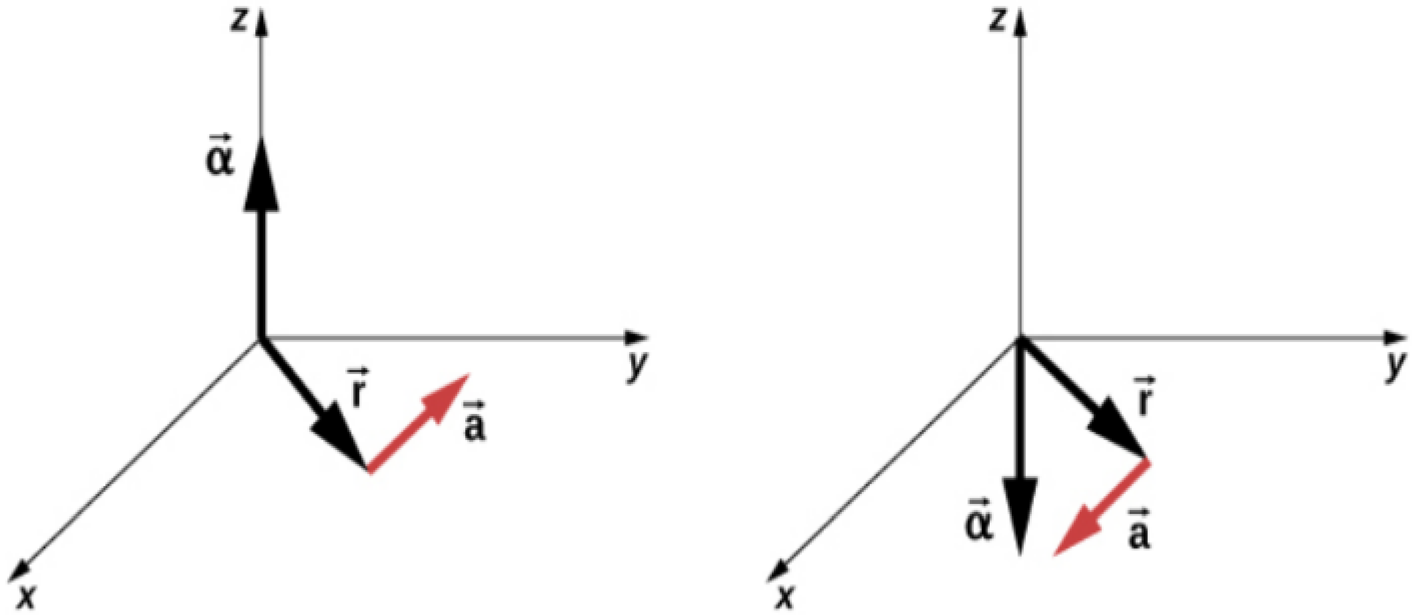

(a) (b)

Figure 10.8 (a) The angular acceleration is the positive *z*-direction and produces a tangential acceleration in a counterclockwise sense. (b) The angular acceleration is in the negative *z*-direction and produces a tangential acceleration in the clockwise sense.

$$\boxed{\bar{a}_t = \bar{\alpha} \times \bar{r}}$$