

# 5 page summary of physics engine

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## position

$$s = vt$$

## velocity

$$v = at$$

## acceleration

$$a$$

## force

$$F = ma$$

## momentum

$$p = mv$$

## impulse

$$I = Ft$$

$$\begin{aligned} \Delta I &= F \Delta t \\ &= ma \Delta t \\ &= m \Delta v \\ &= \Delta p \end{aligned}$$

## rotation

$$\theta = \omega t$$

## angular velocity

$$\omega = v_t / r$$

$$= (r \times v) / r^2 \quad (\text{see Fig. 1})$$

## angular acceleration

$$\alpha = (r \times a) / r^2$$

## torque

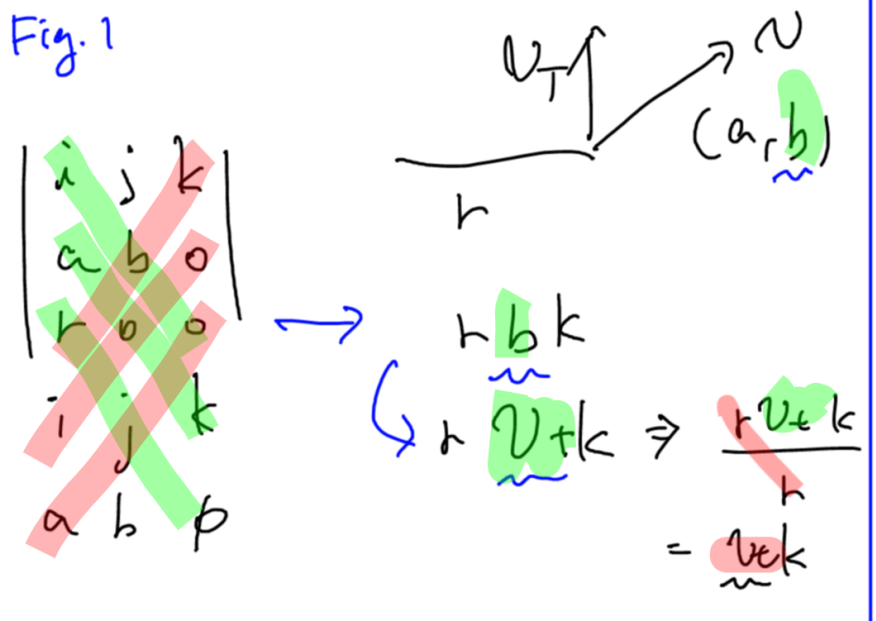
## inertia

$$\tau = r \times F = I \alpha$$

## angular momentum

$$L = r \times p = I \omega$$

Fig. 1



(26)

$$s = vt$$

$$\theta = \omega t$$

$$v = at$$

$$\omega = \cancel{v}_T / r \quad (\text{fig 1})$$

$$= (r \times v) / r^2$$

$$a$$

$$a = (r \times \omega) / r^2$$

$$\vec{F} = ma$$

$$\tau = r \times F = I \alpha$$

$$p = mv$$

$$L = r \times p = I \omega$$



$$I = Ft$$

$$\begin{aligned} \Delta I &= F \Delta t \\ &= m a \Delta t \\ &= m \Delta v \\ &= \Delta p \end{aligned}$$

Fig. 1

$$\begin{vmatrix} i & j & k \\ a & b & 0 \\ r & 0 & 0 \\ i & j & k \\ a & b & p \end{vmatrix}$$



$$\begin{array}{c} v_T \uparrow \\ \hline r \end{array} \quad \begin{array}{c} \nearrow v \\ (a, \underline{b}) \end{array}$$

$$r \underline{b} k$$

$$\hookrightarrow r \underline{v_T} k \Rightarrow \frac{r v_T k}{r} = \underline{v_T} k$$

(27)

$$s = vt$$

$$\theta = \omega t$$

$$v = at$$

$$\omega = v_T / r$$

$$= (r \times v) / r^2 \quad [\text{Fig. 1}]$$

a

$$a = (r \times \omega) / r^2$$

$$\vec{F} = m\vec{a}$$

$$\tau = r \times F = I\alpha$$

$$p = mv$$

$$L = r \times p = I\omega$$

$$I = F t$$

$$\begin{aligned} \Delta I &= F \Delta t \\ &= m a \Delta t \\ &= m \Delta v \\ &= \Delta p \end{aligned}$$

Fig. 1

$$\begin{vmatrix} i & j & k \\ a & b & 0 \\ r & 0 & 0 \\ i & j & k \\ a & b & p \end{vmatrix}$$



$$\frac{v_T}{r} \rightarrow \frac{v}{(a, b)}$$

$$\begin{aligned} & r b k \\ & r v_T k \Rightarrow \frac{r v_T k}{r} \\ & = v_T k \end{aligned}$$

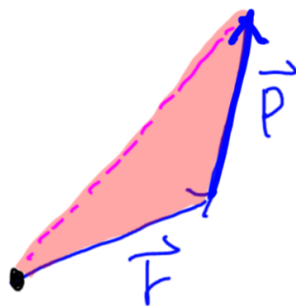
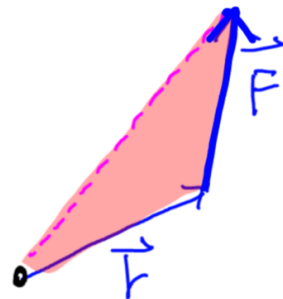
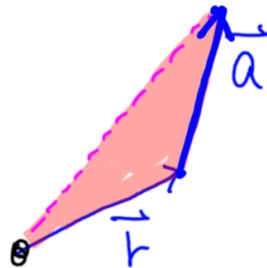
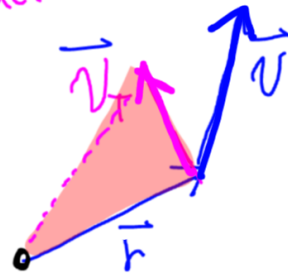
①  $S = vt$   
 differentiation  
 $V = at$

②  $a$   
 differentiation  
 $\bar{F} = ma$

③  $\bar{F} = ma$   
 integration  
 $P = mv$

④  $I = Ft$

$$\begin{aligned}\Delta I &= F \Delta t \\ &= ma \Delta t \\ &= m \Delta v \\ &= \Delta p\end{aligned}$$



$$\theta = \omega t$$

$$\omega = v_T / r = (r \times v) / r^2 \quad [\text{Fig. 1}]$$

$$\alpha = (r \times a) / r^2$$

$$\tau = r \times F = I \alpha$$

$$L = r \times P = I \omega$$

Fig. 1

$$\begin{vmatrix} i & j & k \\ a & b & 0 \\ r & 0 & 0 \\ i & j & k \\ a & b & p \end{vmatrix}$$



$$\frac{v_T}{r} = \frac{v}{(a, b)}$$

$$\begin{aligned} & r b k \\ & \rightarrow r v_T k \Rightarrow \frac{r v_T k}{r} \\ & = v_T k \end{aligned}$$

① differentiation  
 $S = vt$   
 $V = at$   
 ④ integration

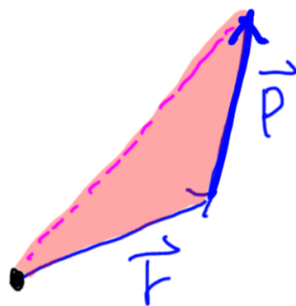
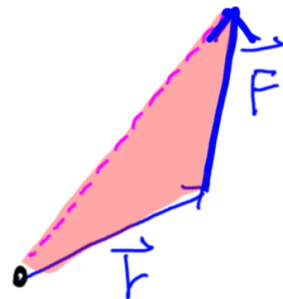
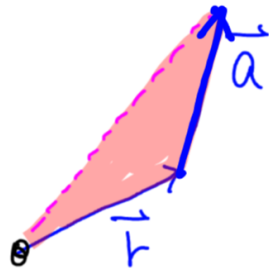
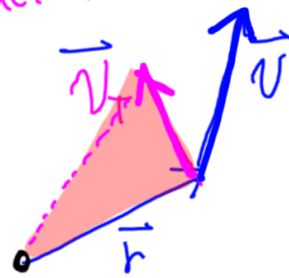
② differentiation  
 $a = \frac{dv}{dt}$   
 ③ integration

③ differentiation  
 $\vec{F} = m\vec{a}$   
 ② integration

① integration  
 $\vec{p} = m\vec{v}$

① integration  
 $I = \vec{F}t$

$$\begin{aligned}\Delta I &= F \Delta t \\ &= m a \Delta t \\ &= m \Delta v \\ &= \Delta p\end{aligned}$$



⑤ differentiation  
 $\theta = \omega t$   
 ④ integration  
 $\omega = \frac{v_T}{r}$   
 $= (r \times v) / r^2$  [Fig. 1]

④ integration  
 $\alpha = (r \times a) / r^2$

③ differentiation  
 $\tau = r \times F = I \alpha$

③ differentiation  
 $\omega = L / I$

② differentiation  
 $L = r \times p = I \omega$

Fig. 1

$$\begin{vmatrix} i & j & k \\ a & b & 0 \\ r & 0 & 0 \\ i & j & k \\ a & b & p \end{vmatrix}$$



Diagram showing a vector  $\vec{r}$  and a vector  $\vec{v}_T$  (tangential velocity). The angle between them is  $\theta$ . The vector  $\vec{v}_T$  is perpendicular to  $\vec{r}$ . The vector  $\vec{v}$  is shown at an angle  $\theta$  to  $\vec{r}$ . The components are labeled  $(a, b)$ .

$$\begin{aligned}& r b k \\ & \rightarrow r v_T k \Rightarrow \frac{r v_T k}{r} \\ & = v_T k\end{aligned}$$