## 7.1 ♣ Notation, words, pictures for position, velocity, and acceleration. (Sections 3.1 and 8.1)

Complete each blank with a word: | point | reference frame | position | velocity | acceleration |

| $\vec{\mathbf{r}}^{\,Q/P}$ | $^N\vec{\mathbf{v}}^{\,Q}$ | $^N\vec{\mathbf{a}}^{\,Q}$ |
|---|---|---|
| $\vec{\mathbf{r}}$ denotes _____. <br> $P$ is a _____. <br> $Q$ is a _____. | $\vec{\mathbf{v}}$ denotes _____. <br> $N$ is a _____. <br> $Q$ is a _____. | $\vec{\mathbf{a}}$ denotes _____. <br> $N$ is a _____. <br> $Q$ is a _____. |
| **Draw** $P$, $Q$, and $\vec{\mathbf{r}}^{\,Q/P}$. | **Draw** $Q$ and $N$. | |

## 7.2 ♣ What is a point and a particle? (Section 3.1)

| Statement | True or False |
|---|---|
| A point has all the attributes of a particle. | **True/False** |
| A particle has all the attributes of a point. | **True/False** |
| A point with mass (massive point) is a particle. | **True/False** |
| The center of mass of a rigid body is a point. | **True/False** |
| The center of mass of a rigid body is a particle. | **True/False** |

To visualize center of mass, draw a doughnut.

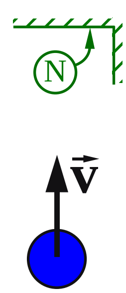
## 7.3 ♣ Concept: What objects have a unique velocity/acceleration? (Section 8.1)

The velocity $\vec{\mathbf{v}}$ of some object $S$ relative to Earth is to be determined.
This object $S$ could be a (circle ***all*** objects that have an ***unambiguously*** defined velocity $\vec{\mathbf{v}}$):

| | | | |
|---|---|---|---|
| Real number | Line | Set of points | Center of a circle |
| Vector | Triangle | Reference frame | Mass center of set of particles |
| Matrix | Point | Rigid body | Mass center of a rigid body |
| 3D orthogonal basis | Particle | Flexible body | System of particles and bodies |

Repeat for the acceleration $\vec{\mathbf{a}}$ of some object $S$ relative to Earth box appropriate objects.

## 7.4 ♣ Concept: Velocity, acceleration, and differentiation. (Sections 1.6.1 and 8.1)




A baseball (particle) is thrown straight upward on Earth (a Newtonian reference frame $N$). Knowing the baseball's velocity $\vec{\mathbf{v}} = \vec{\mathbf{0}}$ when the ball reaches maximum height and Earth's gravitational acceleration constant $g \approx 9.8 \frac{\text{m}}{\text{s}^2}$, decide if the following statement about $\vec{\mathbf{a}}$ (the ball's acceleration in $N$) is true. If false, box the incorrect part of the statement.

$$\vec{\mathbf{a}} \triangleq \frac{^N d\vec{\mathbf{v}}}{dt} = \frac{^N d\,(\vec{\mathbf{0}})}{dt} = \frac{d\,\vec{\mathbf{0}}}{dt} = \vec{\mathbf{0}} \qquad \textbf{True/False}$$

**Explain:** _____

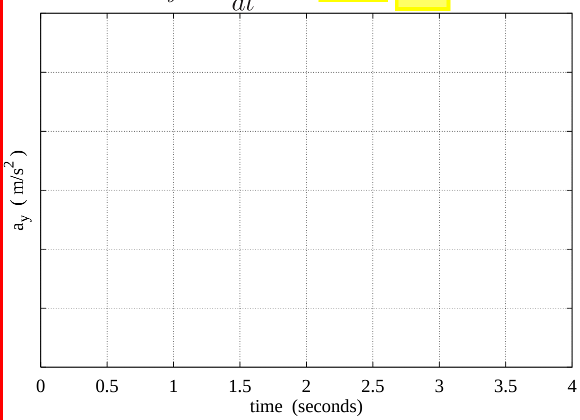
## 7.5 ♣ FE/EIT Review: Graphing $\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}$ for a sky-diver and rocket-sled.

Complete the missing statements, axes values, and graphs. Use Earth's gravitational acceleration $g \approx 10\ \frac{\text{m}}{\text{s}^2}$.

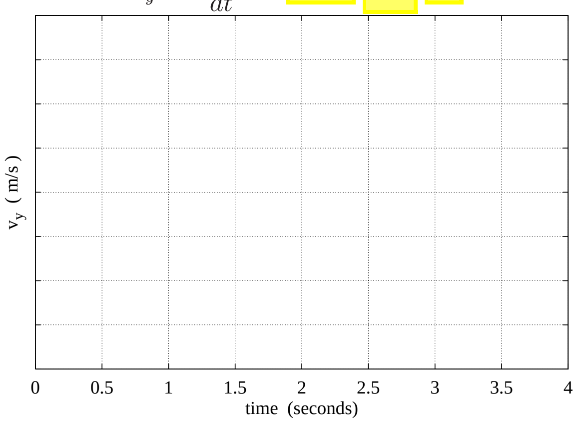
A sky-diver free-falls for 4 seconds after leaving a stationary helicopter from a height $y = 200$ m above Earth ($y$ is positive-upward).

The only relevant force is Earth's gravity.

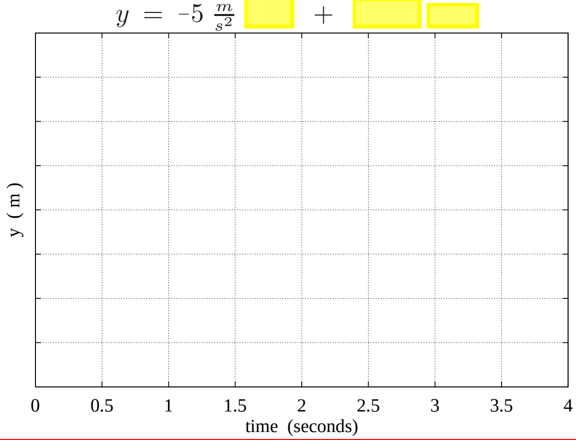
$a_y \triangleq \frac{d^2y}{dt^2} =$ ___ ___



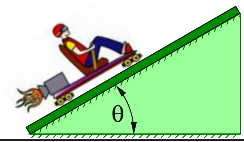

$v_y \triangleq \frac{dy}{dt} =$ ___ ___ ___



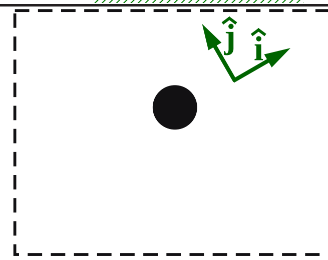

$y = -5\ \frac{m}{s^2}$ ___ + ___ ___




A rocket-sled of mass $m$ is thrust along smooth inclined rails with time-varying force $F_T$.
The variable $x$ measure's the sled's position along the rails.
Initially, $x = 0$ and $\dot{x} = 0$.




**FBD**. <u>Draw forces</u>




Below: Form $\vec{\mathbf{F}}_{\text{Net}}$ and then set $\vec{\mathbf{F}}_{\text{Net}} = m\,\vec{\mathbf{a}}$.
Use symbols $m$, $g$, $F_T$, $F_N$, $\theta$.

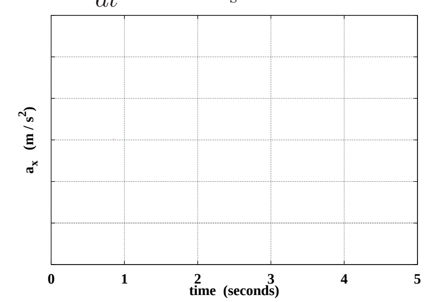
___ $\hat{\mathbf{i}}$ + ___ $\hat{\mathbf{j}}$ = $m$ ___ $\hat{\mathbf{i}}$

$\hat{\mathbf{i}}$: ___ = ___ $\Rightarrow$ $\frac{d^2x}{dt^2} =$ ___ $-$ ___

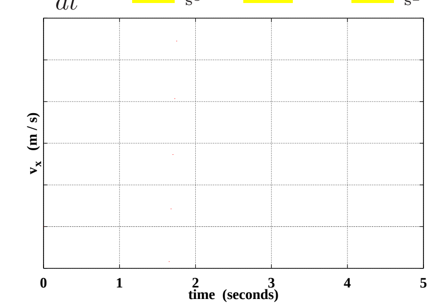
$\hat{\mathbf{j}}$: ___ = ___ $\Rightarrow$ $F_N =$ ___

Use $\theta = 30°$, $m = 100$ kg, $F_T = 600\ \frac{\text{N}}{\text{s}} * t$ for the following.

$a_x \triangleq \frac{dv_x}{dt} =$ ___ $\frac{\text{m}}{\text{s}^3}$ $*$ ___ $-$ ___ $\frac{\text{m}}{\text{s}^2}$




$v_x \triangleq \frac{dx}{dt} =$ ___ $\frac{\text{m}}{\text{s}^3}$ $*$ ___ $-$ ___ $\frac{\text{m}}{\text{s}^2}$ $*$ ___




$x =$ ___ $\frac{\text{m}}{\text{s}^3}$ $*$ ___ $-$ ___ $\frac{\text{m}}{\text{s}^2}$ $*$ ___