Show work – except for ♣ fill-in-blanks.

8.1 ♣ Notation, words, pictures: Position, velocity, acceleration. (Sections 3.1, 10.1)

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

${}^{P}\vec{\mathbf{r}}^{Q}$ $\vec{\mathbf{r}}$ denotes ______. P is a ______. Q is a ______.	${}^{N}\vec{\mathbf{v}}^{Q}$ $\vec{\mathbf{v}}$ denotes ______. N is a ______. Q is a ______.	${}^{N}\vec{\mathbf{a}}^{Q}$ $\vec{\mathbf{a}}$ denotes ______. N is a ______. Q is a ______.
Draw P, Q, and ${}^{P}\vec{\mathbf{r}}^{Q}$.	**Draw** Q and N.	

8.2 ♣ 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**

Draw the bagel's center of mass.

Note: The bagel's center of mass is not a piece of dough (has no mass).

8.3 ♣ Concept: What objects have a unique velocity/acceleration? (Section 10.1)

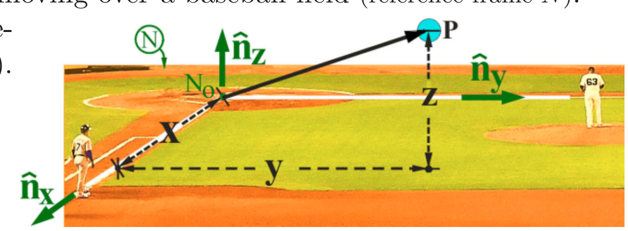
The velocity $\vec{\mathbf{v}}$ of some object S relative to Earth E is to be determined (denoted ${}^{E}\vec{\mathbf{v}}^{S}$).
This object S could be a (circle ***all*** objects that have an ***unambiguously*** defined velocity $\vec{\mathbf{v}}$):

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 E (denoted ${}^{E}\vec{\mathbf{a}}^{S}$) box appropriate objects.

8.4 ♣ Cartesian coordinates, acceleration, and $\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}$. (Sections 10.1, 10.7)

The following figure shows a baseball P of mass m moving over a baseball field (reference frame N). P's position vector $\vec{\mathbf{r}}$ from point N_o (home-plate) is described with ***Cartesian coordinates*** $x(t)$, $y(t)$, $z(t)$.



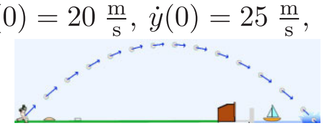
- Form $\vec{\mathbf{r}}$ and P's velocity and acceleration in N.

Result:
$$\vec{\mathbf{r}} = x\,\hat{\mathbf{n}}_x + \_\_\_\,\hat{\mathbf{n}}_y + \_\_\_\,\hat{\mathbf{n}}_z$$
$$\vec{\mathbf{v}} = \dot{x}\,\hat{\mathbf{n}}_x + \_\_\_\,\hat{\mathbf{n}}_y + \_\_\_\,\hat{\mathbf{n}}_z$$
$$\vec{\mathbf{a}} = \ddot{x}\,\hat{\mathbf{n}}_x + \_\_\_\,\hat{\mathbf{n}}_y + \_\_\_\,\hat{\mathbf{n}}_z$$

- $\boxed{\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}}$ Assuming the net force on the baseball is $\vec{\mathbf{F}}_{\text{Net}} = -m\,g\,\hat{\mathbf{n}}_z$, solve for $\ddot{x}$, $\ddot{y}$, $\ddot{z}$.

Result:
$$\underbrace{\_\_\_\_\_\_}_{\vec{\mathbf{F}}_{\text{Net}}} = m\,\underbrace{(\ddot{x}\,\hat{\mathbf{n}}_x + \_\_\_\,\hat{\mathbf{n}}_y + \_\_\_\,\hat{\mathbf{n}}_z)}_{\vec{\mathbf{a}}} \quad \Rightarrow \quad \ddot{x} = 0 \qquad \ddot{y} = \_\_\_ \qquad \ddot{z} = \_\_\_$$

- At time $t = 0$, the baseball is hit from N_o (home-plate) with initial motion $\dot{x}(0) = 20\ \frac{\text{m}}{\text{s}}$, $\dot{y}(0) = 25\ \frac{\text{m}}{\text{s}}$, $\dot{z}(0) = 30\ \frac{\text{m}}{\text{s}}$. Determine $x(t)$, $y(t)$, $z(t)$ (in terms of g, t and initial values).



Result: $x(t) = 20\,t \qquad y(t) = \_\_\_\_ \qquad z(t) = \_\_\_\_ - \frac{1}{2}\,\_\_\_\_$