Spent about 20 minutes on N3.T7, N3.T8

Motion from forces

FBD $\Rightarrow$ $\vec{F}_{net} = m\vec{a}_{cm}$

$\vec{r} \xrightarrow{\text{derivative}} \frac{d\vec{r}}{dt} = \vec{v} \xrightarrow{\text{derivative}} \frac{d\vec{v}}{dt} = \vec{a}$

$\vec{a} \xrightarrow{\text{integral}} \vec{v} \xrightarrow{\text{integral}} \vec{r}$ (antiderivative)

Graphs: slope method [N4.T1]$_E$ ← easy, [N4.T2]$_D$ ← easy → note that answer is not unique: could shift initial point up or down

Analytic:

$V_x(t) = \underbrace{V_{0x}}_{\text{initial velocity}} + \int_0^t a_x(t)\,dt$ $\qquad V_{0x} = V_x(0)$

$x(t) = \underbrace{x_0}_{\text{initial position}} + \int_0^t V_x(t)\,dt$ $\qquad x_0 = x(0)$

[Recall: needed initial position when drawing graphs]

[N4.T3]$_D$ ← easy

[N4.T4]$_E$ ← Everyone gets it wrong!

Special case: const acceleration

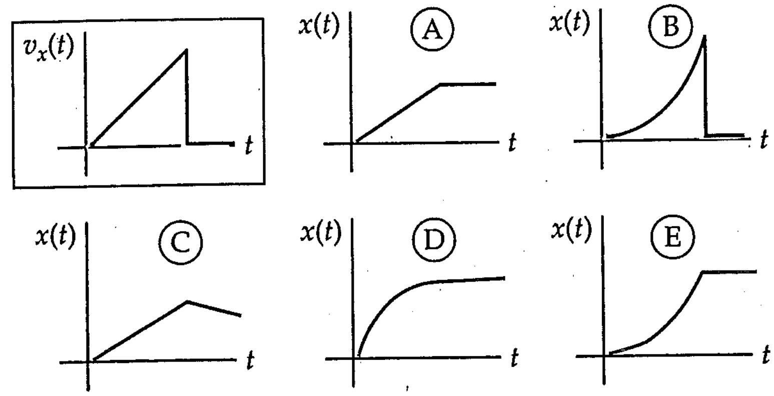
$V_x(t) = V_{0x} + a_x \int dt = V_0 + a_x t$

$x(t) = x_0 + \int (V_0 + a_x t)\,dt$

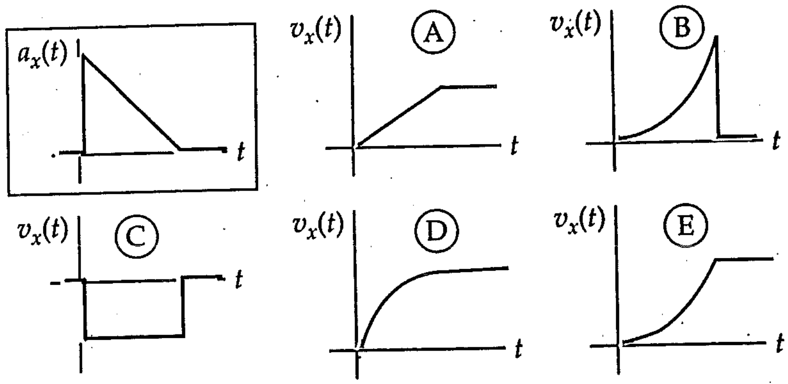
$= x_0 + V_0 t + \frac{1}{2} a_x t^2$

These only apply when acceleration is constant

N4T.1 An object's x-velocity $v_x(t)$ is shown in the boxed graph at the top left. Which of the other graphs in the set most correctly describes its x-position?



N4T.2 An object's x-acceleration $a_x(t)$ is shown in the boxed graph at the top left. Which of the other graphs in the set most correctly describes its x-velocity?



N4T.3 If a car has an x-acceleration of $a_x(t) = -bt + c$, and its initial x-velocity at time $t = 0$ is $v_x(0) = v_0$, which function below best describes $v_x(t)$?

A. $-b$
B. $-b + v_0$
C. $\frac{1}{2}bt^2 + ct + v_0$
D. $-\frac{1}{2}bt^2 + ct + v_0$
E. $-2bt^2 + v_0$
F. $-\frac{1}{2}bt^2 + v_0$

N4T.4 If a car's x-position at time $t = 0$ is $x(0) = 0$ and it has an x-velocity of $v_x(t) = b(t - T)^2$, where b and T are constants, which function below best describes $x(t)$?

A. $x(t) = 2b(t - T)$
B. $x(t) = 3b(t - T)^3$
C. $x(t) = \frac{1}{3}b(t - T)^3$
D. $x(t) = \frac{1}{2}b(t - T)$
E. $x(t) = \frac{1}{3}b[(t - T)^3 + T^3]$
F. Other (specify)

N4T.5 Imagine that you are preparing an actual-size trajectory diagram of a freely falling object. The time interval between positions is 0.02 s. How long should you draw the acceleration arrows on your diagram?

A. 9.8 m
B. 0.20 m
C. 0.04 m
D. 3.9 cm
E. 0.39 cm
F. Other (specify)

N4T.6 At time $t = 0$, a person is sliding due east on a flat, frictionless plane of ice. The net force on this person is due to a battery-powered fan the person holds that exerts a northward thrust force on the person. Assuming that drag is negligible, the eastward component of the person's velocity is unaffected by this force, true (T) or false (F)?

N4T.7 Consider the person described in problem N4T.6. The person's trajectory will look most like which of the following? (The dot shows the person's position at $t = 0$, and east is to the right and north to the top.)