Solutions

Quiz 2

1. Find the terminal velocity of an object subject to gravity $F = -mg\hat{y}$ and $\vec{F} = -b\,\vec{v}$.

v_{term} = constant $\Rightarrow \vec{a} = 0 \Rightarrow \vec{F} = m\vec{a} = 0$

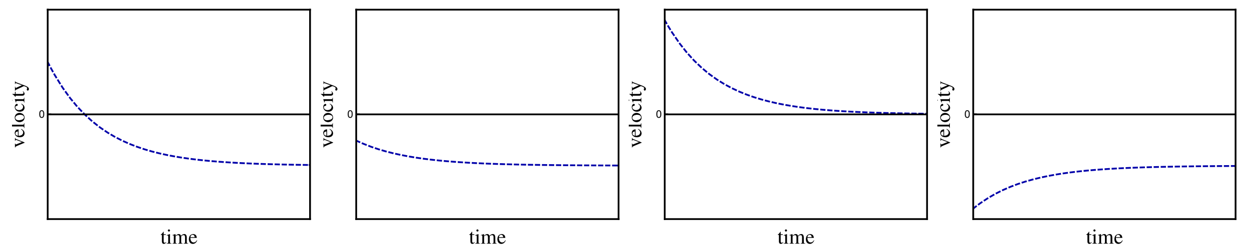
$-mg\,\hat{y} - bv(-\hat{y}) = 0$

$-mg\,\cancel{\hat{y}} + bv\,\cancel{\hat{y}} = 0$

$-mg + bv = 0$

$v = \boxed{\frac{mg}{b} = v_{term}}$

2. Consider the plots of velocity vs. time below. For each description of a physical system, select plot matches the description. Assume a coordinate system where gravity points in the $-\hat{y}$ direction (in other words, moving "up" gives a positive velocity, and moving "down" gives a negative velocity).



(a) (b) (c) (d)

(c) (i) The horizontal velocity of a particle subject to linear drag force $\boxed{(c)}$ As $t \to \infty$, $v \to 0$

(b) (ii) The vertical velocity of particle falling down, starting with a speed smaller in magnitude than its terminal velocity $\boxed{(b)}$ As $t \to \infty$, $v \to -(\text{constant})$, so not (c). No direction change, so not (a). Then (b) starts with smaller $|v|$, so $\boxed{(b)}$

(a) (iii) The vertical velocity of a particle subject to linear drag force that is thrown upwards, then eventually reverses direction and falls down $\boxed{(a)}$ (v must go through zero)

(d) (iv) The vertical velocity of particle falling down, starting with a speed larger in magnitude than its terminal velocity

As $t \to \infty$, $v \to -(\text{constant})$, so not (c). No direction change, so not (a) } Starts with larger $|v|$, so $\boxed{(d)}$

3. Simplify the following equation:

$$1 + i\theta + \frac{(i\theta)^2}{2!} + \frac{(i\theta)^3}{3!} + \frac{(i\theta)^4}{4!}$$

such that each term only has at most one power of i. You can leave the factorials as they are.

$$1 + i\theta + \frac{i^2\theta^2}{2!} + \frac{i^3\theta^3}{3!} + \frac{i^4\theta^4}{4!}$$

$i^2 = -1$ by definition

$i^3 = i^2 i = (-1)i = -i$

$i^4 = i^2 i^2 = (-1)(-1) = +1$

$$= \boxed{1 + i\theta - \frac{\theta^2}{2!} - \frac{i\theta^3}{3!} + \frac{\theta^4}{4!}}$$