1a. $a(t) = (-20 - 10t)\hat{e}_y$

$$\boxed{V_x = 100 \qquad V_y = (-20t - 5t^2)}$$

1b. $$\boxed{x(t) = 100t \qquad y(t) = \left(-10t^2 - \frac{5}{3}t^3\right)}$$

1c. $x(t) = 100t \rightarrow t_{exit} = \frac{L}{100} = \frac{2}{100} = \boxed{\frac{1}{50}\text{ sec}}$

1d. $y(t) = -10t^2 - \frac{5}{3}t^3$

$y_{exit} = -10\left(\frac{1}{50}\right)^2 - \frac{5}{3}\left(\frac{1}{50}\right)^3 \rightarrow \boxed{y_{exit} = -4.01 \times 10^{-3}\,m}$

1e. $V_y = -20t - 5t^2$

@ $t = \frac{1}{50}$

$V_y = -20\left(\frac{1}{50}\right) - 5\left(\frac{1}{50}\right)^2 = -0.402\ m/s$

$\theta = \tan^{-1}\left(\frac{-0.402}{100}\right) = -0.00402$ rad

$$\boxed{= -0.23^\circ}$$

2a. The Reynold's Number measures the ratio of internal vs. viscous forces

Low Re → Smooth flow

High Re → Rough flow, bumpy

$$f_{lin} = 3\pi \eta D v$$

$$f_{quad} = k \rho A v^2$$

$$A_{sphere} = \frac{\pi D^2}{4}, \quad k = 0.25$$

$$f_{quad}/f_{lin} = \frac{0.25\rho(\pi D^2/4)v^2}{3\pi \eta D v}$$

$$= \frac{\rho D v}{48\eta} \rightarrow \frac{f_{quad}}{f_{lin}} = \frac{Re}{48}$$

$Re < 48$; lin drag

$Re > 48$; quad drag

2b. Low Re → Small bacteria swimming in water

High Re → Airplane flying in the air

Low ——————— High

raindrop, Parachutist, Car, Plane

2c. The Péclet number is a dimensionless number that represents the diffusion rate of something (E.g. Heat transfer, Mass transfer)

$$Pe = \frac{\text{advective transport rate}}{\text{diffusive transport rate}} = \frac{vL}{D}$$

Low Pe: Heat conduction in solids

High Pe: Oxygen transporting in blood