Resistive Forces & Terminal Velocity

Force & Dynamics · 4 questions · step-by-step answers at the end

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USEFUL EQUATIONS

$m\,dv/dt = mg - bv$ $v_T = mg/b,\ \tau = m/b$ $v(t) = v_T(1 - e^{-t/\tau})$ $v_T = \sqrt{(mg/c)}$

Questions

Show your working in the space under each question.

1. A 70 kg skydiver has quadratic drag with c = 0.25 kg/m. Find the terminal velocity.

2. A 2.0 kg object falls from rest with linear drag b = 0.50 kg/s. Find v_T, τ and the speed after 4.0 s.

3. For linear drag, what is the acceleration when $v = v_T/2$?

4. A raindrop reaches 95% of v_T after how many time constants (linear drag)?

Step-by-step answers

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1. $v_T = \sqrt{(mg/c)} = \sqrt{(70 \times 9.8 / 0.25)} \approx$ **52 m/s**.

2. 1. $v_T = mg/b = (2.0)(9.8)/0.50 =$ **39.2 m/s**.
2. $\tau = m/b = 2.0/0.50 =$ **4.0 s**.
3. At $t = 4.0\text{ s} = \tau$: $v = 39.2(1 - e^{-1}) = 39.2(0.632) =$ **24.8 m/s**.
4. Without drag it would be going $gt = 39.2$ m/s already, so drag clearly matters.

Answer: v_T = 39 m/s, τ = 4.0 s, v(4 s) = 25 m/s

3. $a = g - (b/m)(v_T/2) = g - g/2 =$ **g/2**.

4. $1 - e^{-t/\tau} = 0.95 \rightarrow t = \tau \ln 20 \approx$ **3.0 τ**.