Newtonian Olympics

1. Consider a 78.0 kg circus clown, initially h = 10.0 m above the ground, sliding at V_A = 10.0 m/s down a rough linear slide inclined θ = 40.0° above the horizontal. At the bottom of the slide, the clown has decreased in speed to V_B = 5.00 m/s and begins to slide horizontally across the same surface. After some unknown horizontal displacement the clown comes to rest. The instant the clown stops moving she reaches outward and touches a button which simultaneously releases an atmosphere into the environment and removes the floor supporting the clown. The clown begins to fall downward with a drag force linearly proportional to its velocity with a drag coefficient, b = 125 kg/s.

A. Derive and calculate the coefficient of kinetic friction between the clown and the surface she slides on.

B. Derive and calculate the horizontal displacement during the horizontal skid between the bottom of the ramp and the point at which the clown comes to rest.

C. Derive a function that describes the clown's velocity as the fall through the atmosphere.

D. Derive a function that describes the clown's acceleration as they fall through the atmosphere.

E. Calculate the clown's acceleration when she reaches 63% of her terminal velocity.

F. Sketch qualitative graphs of the clowns velocity and acceleration vs. time.

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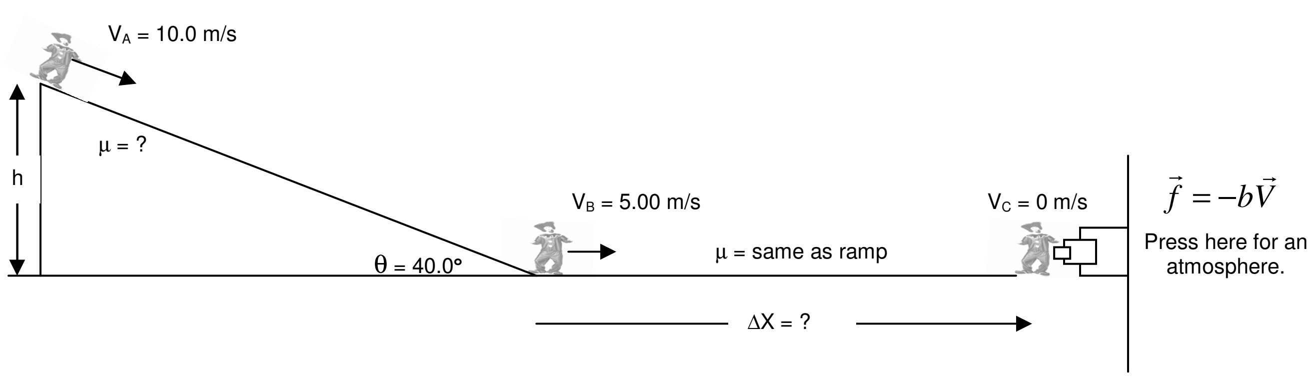

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2. Consider a 78.0 kg clown initially sliding V_o = 25.0 m/s upward at the bottom of a rough ramp h = 8.00 m high inclined at θ = 60.0° above the horizontal with a coefficient of kinetic friction between the clown and the ramp μ = 0.480. The clown slides up the ramp and freefalls off the top. At the apex of the clown's parabolic trajectory, the clown lands on the roof of an adjacent building and begins to decelerate with a drag force linearly proportional to their speed. The drag coefficient b = 125 kg/s.

A. Derive and calculate the horizontal distance between the edge of the ramp and the edge of the building.

B. Derive a function that describes the clown's velocity starting from their landing on the rooftop.

C. Derive a function that describes the clown's position starting from their landing on the rooftop.

D. Calculate the maximum distance the clown will travel before coming to rest on the rooftop.

E. Sketch qualitative graphs of the clowns velocity and position vs. time. Indicate on the position graph the answer to part D.