1. A cannon is fired from a castle wall at some unknown height above the ground. The cannonball leaves the cannon with speed 30.0 m/s at angle 30° above the horizontal and hits the level ground at a horizontal distance 100 m from the wall.

a) Calculate the time it takes the cannon ball to hit the ground.
b) Calculate the height of the castle wall.
c) What are the $x$- and $y$-components of the cannon ball’s velocity at the highest point of its trajectory?
d) What are the $x$- and $y$-components of the cannon ball’s velocity just before it hits the ground?
e) Sketch, qualitatively, $x$-$t$, $y$-$t$, $v_x$-$t$ and $v_y$-$t$ graphs for the cannon ball’s motion.

2. An electron is moving between two plates, A and B. It starts at plate A with an initial velocity of magnitude $V_0$ that is directed at an angle $\theta$ with respect to the plate, as shown in the figure. It is under the influence of a constant acceleration of magnitude $a$ that is directed to the left.

The figure shows a view from above. You may disregard gravity which is directed into the page, perpendicular to your paper.

a) Derive an expression, in terms of system parameters, for the maximum distance $D$ to the right of plate A the electron reaches.
b) Derive an expression, in terms of system parameters, for the distance $L$, measured parallel to the plates, the electron travels before it returns to plate A.
3. In a lecture demonstration, the instructor aims a blow gun directly at Barney, a stuffed purple dinosaur, who is suspended from the ceiling at a vertical height $H$ above the muzzle of the blow gun, a horizontal distance $D$ away. At the instant she launches a dart with speed $v_0$, Barney is released from rest.

a) Derive an expression, in terms of system parameters, for the **dart's vertical position** when the dart has covered the horizontal distance $D$.

b) Derive an expression, in terms of system parameters, for **Barney’s vertical position** at the instant the dart has covered the horizontal distance $D$.

Hint: The angle $\theta$ between initial velocity and the horizontal is not given, but you can find $\sin \theta$, $\cos \theta$ and $\tan \theta$ from the given distances.

4. A package is dropped from an airplane flying horizontally with constant speed $V$ in the positive $x$-direction. The package is released at time $t = 0$ from a height $H$ above the origin. In addition to the **vertical component** of acceleration due to gravity, a strong wind blowing from the right gives the package a **horizontal component** of acceleration of magnitude $\frac{1}{4}g$ to the left.

Derive an expression for the horizontal distance $D$ from the origin where the package hits the ground.