Where Should a pilot start descent?

Wilord Metellus

Pilot

- Someone employed to steer or conduct a ship
- A piece that guides a tool or machine part
- A person who flies or is qualified to fly an aircraft or spacecraft.

Aircraft & Spacecraft

- Every feature of an airplane is crucial to its thorough operation, while the wings play an important role in lifting the airplane.

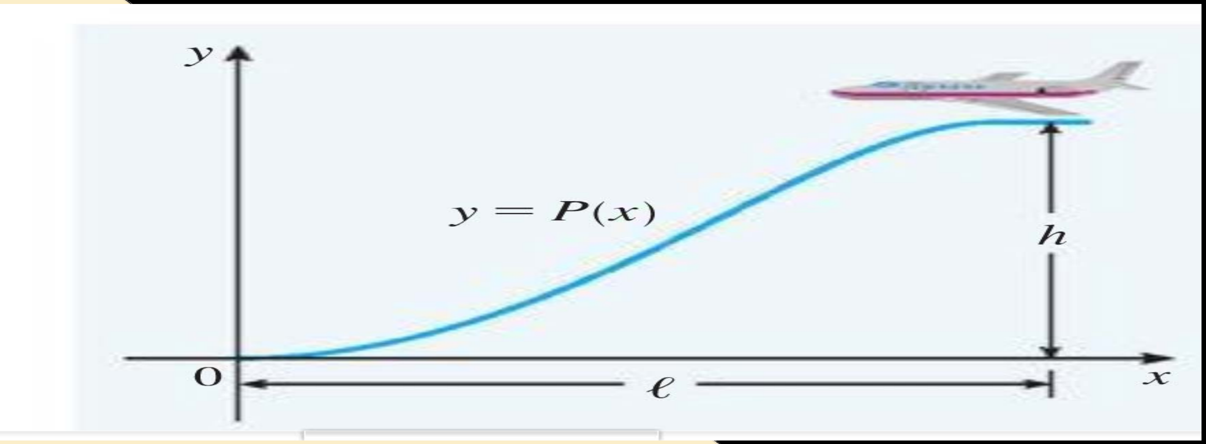
- How wings lift the plane?

Airplane wings are curved on the top, which make air move faster over the top of the wing. It moves slower underneath the wing.

  - The slow air pushes up from below while the faster air pushes down from the top. This forces the wing to lift up into the air.

The air moves faster over the top of a wing
And It moves slower underneath the wing.

Where should a Pilot Start Descent



An approach path for an aircraft landing is shown in the figure and satisfies (i) the cruising altitude h when descent starts at a horizontal distance L from touchdown at the origin.

– Find a cubic polynomial $P(x) = aX^3+bX^2+cX+d$ that satisfies condition (i) by imposing suitable conditions on P(x) and P'(x) at the start of descent and touchdown.

Find Cubic Polynomial

- At touchdown (origin) point, the altitude is zero: $P(0) = 0$;

➔ $P(x) = aX^3+bX^2+cX$

- The pilot want to achieve a smooth transition from landing curve to horizontal motion after touching ground. Hence $P'(0) = 0$

➔ $P(x) = aX^3+bX^2$

- At distance L, the altitude is h: Hence $P(L) = h$

➔ $a \cdot L^3 + b \cdot L^2 = h$

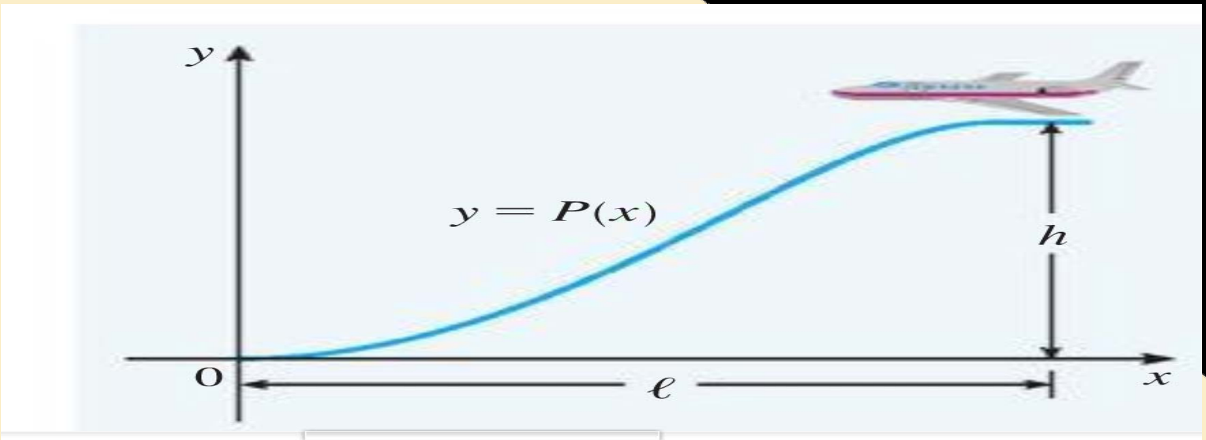
- There is a smooth transition from horizontal motion at distance L: $P'(L) = 0$

➔ $b = -(3/2) \cdot a \cdot L$

Find Cubic Polynomial

- Insert b into the previous function to find a:
- ➔ $a = -2 \cdot h/L^3$; Therefore, $b = 3 \cdot h/L^2$

- Hence $P(x) = P(x) = (-2 \cdot h/L^3) \cdot x^3 + (3 \cdot h/L^2) \cdot x^2$



Or: <u>$P(x) = = h \cdot [\ 3 \cdot (x/L)^2 - 2 \cdot (x/L)^3\ ]$</u>

Vertical Acceleration ≤ constant K

2. Show that $(6hV^2)/L^2 \leq K$, using the following conditions:

ii. The pilot must maintain a constant horizontal speed v throughout descent.

iii. The absolute value of the vertical acceleration should not exceed a constant k (which is much less than the acceleration due to gravity).

- Vertical Acceleration is: $a_v = d^2P/dt^2$
  $dP/dt = dP/dx . dx/dt = P'(x).V$ (Where V is the horizontal velocity)
- $P''(x) \cdot v^2$; $a_v(x) = v^2 \cdot d^2(h \cdot [3 \cdot (x/L)^2 - 2 \cdot (x/L)^3])/dx^2$
- $A_v(x) = (6 \cdot v^2 \cdot h/L^2) \cdot [(1 - 2 \cdot (x/L)]$

Vertical Acceleration ≤ constant K

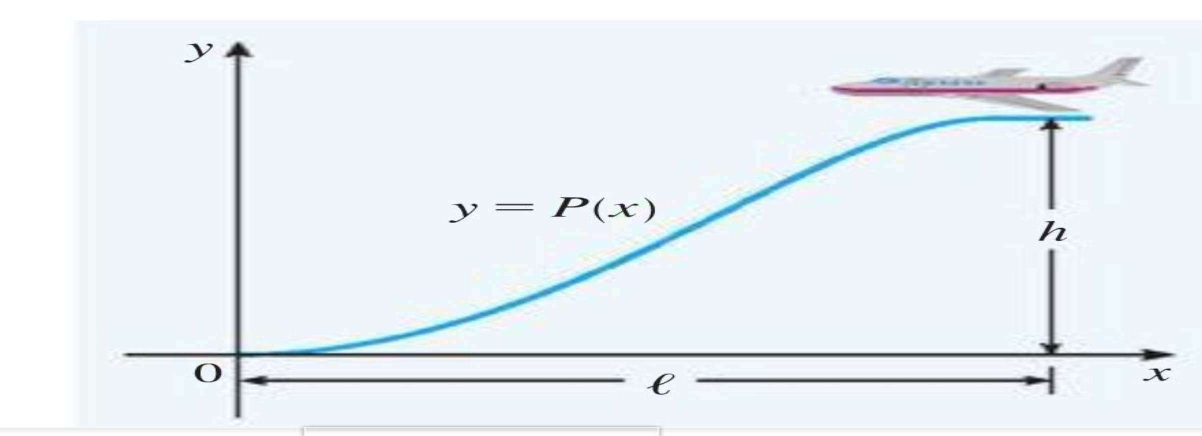
- So it varies linearly with x from av(L) to av(0)
  $av(L) = -6 \cdot v^2 \cdot h/L^2$

  &

  $av(0) = 6 \cdot v^2 \cdot h/L^2$
- These two point represents the greatest absolute value of av(x) along the path.

  Hence:
  $|av(x)| \leq k$

  $\underline{6 \cdot v^2 \cdot h/L^2 \leq k}$



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- 3. Suppose that an airline decides not to allow vertical acceleration of a plane to exceed k =860 mi/h2. If the cruising altitude of a plane is 35,000 ft and the speed is 300 mi/h, how far away from the airport should the pilot start descent?

- At minimum distance; $6 \cdot v^2 \cdot h / L^2 = k$
- ➔ $L = \sqrt{(6 \cdot v^2 \cdot h/k)}$

- ➔ <u>L = 64.52 mi</u>

The Pilot should start descent at 64.52 miles