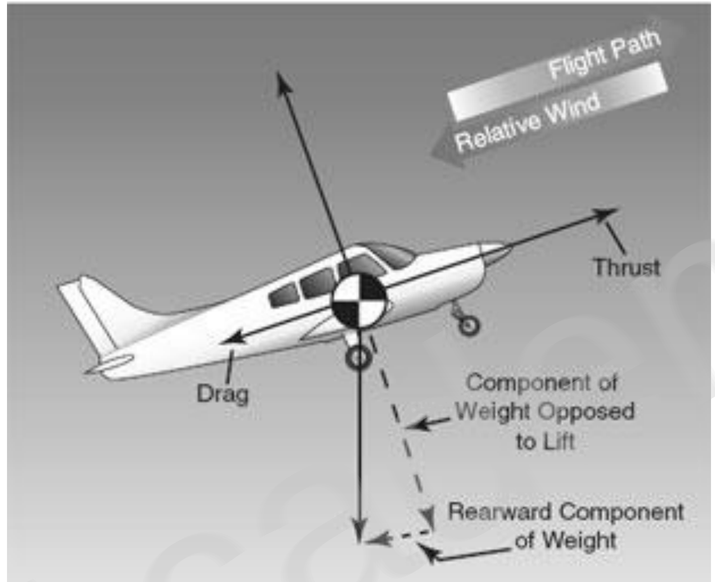
Climb Force Equilibrium



Horizontal Force Balance

$$T = D + W\, sin\theta$$

Engine has to produce more thrust to Compensate the Component of Weight At Climb

Vertical Force Balance

$$L = W\, cos\theta$$

$$\frac{L}{W} = cos\theta < 1$$

Hence Aircraft **Lift < Weight** of the Aircraft At Climb

$$L = W\cos\gamma \qquad D + W\sin\gamma = T$$

$$T - D = W\sin\gamma$$

$$\frac{T - D}{W} = \sin\gamma$$

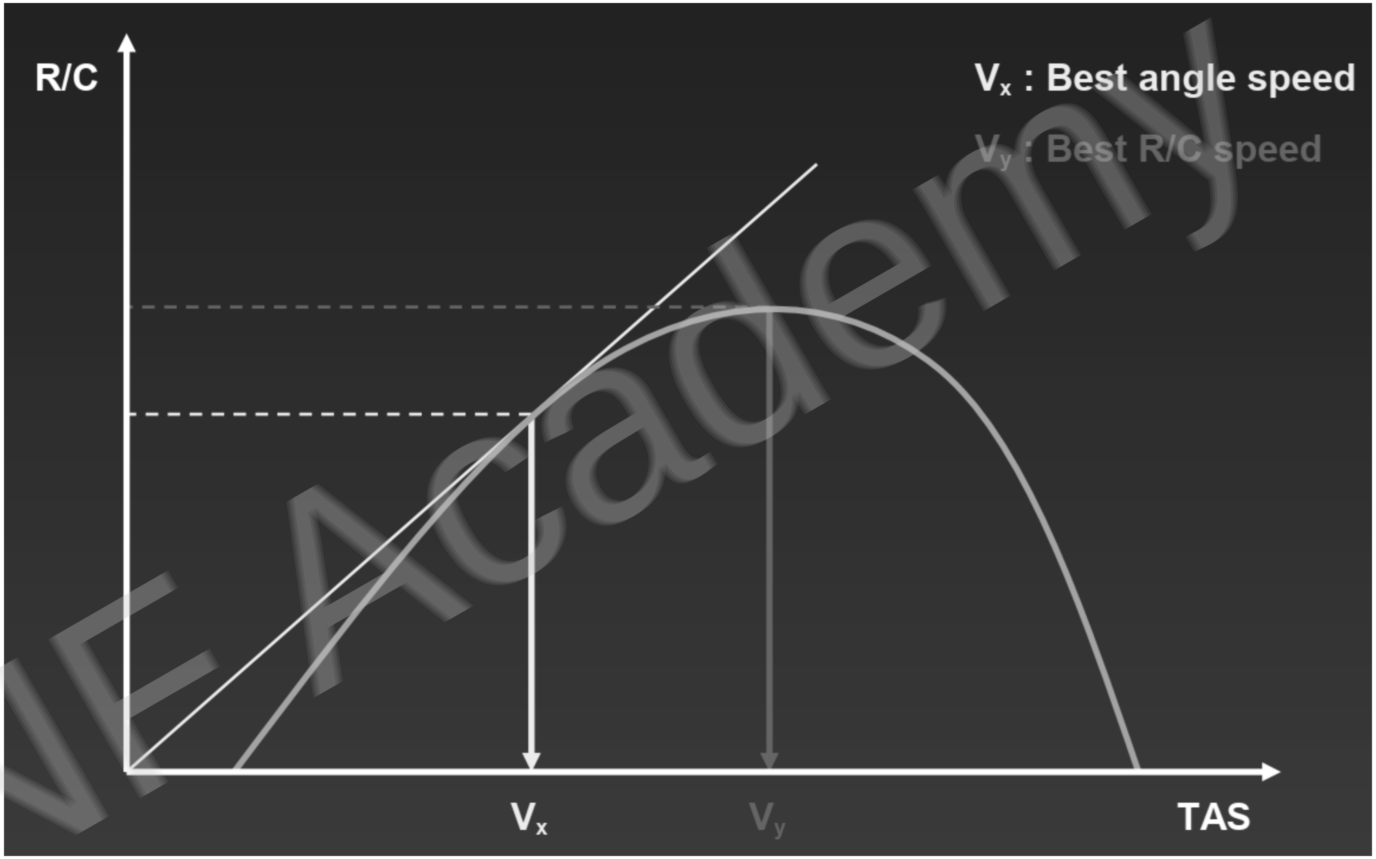
$$\frac{TV - DV}{W} = V\sin\gamma = v \qquad \frac{v}{V} = \sin\gamma$$

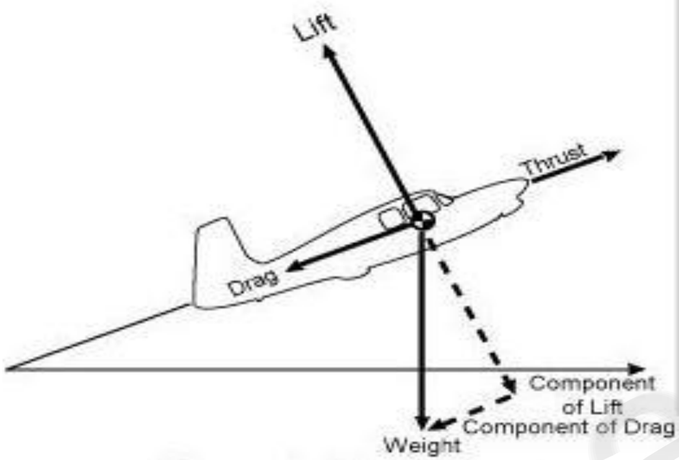
$$\frac{P_a - P_r}{W} = V\sin\gamma$$

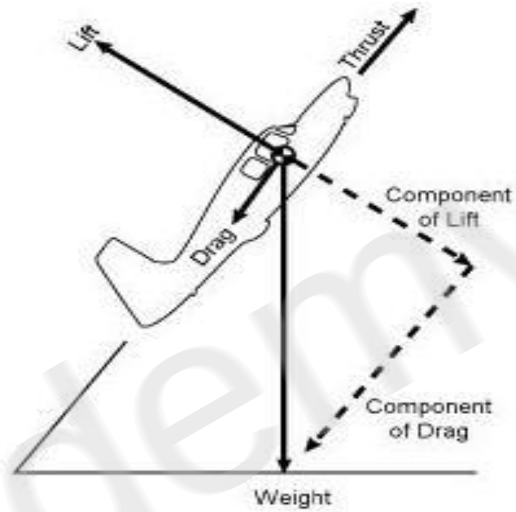
$$\frac{\Delta P}{W} = v$$

$$Rate\,of\,climb = v = \frac{Excess\ power}{weight}$$

V – flight speed, W – weight of A/C


R/C
V_x : Best angle speed
V_y : Best R/C speed
V_x
V_y
TAS



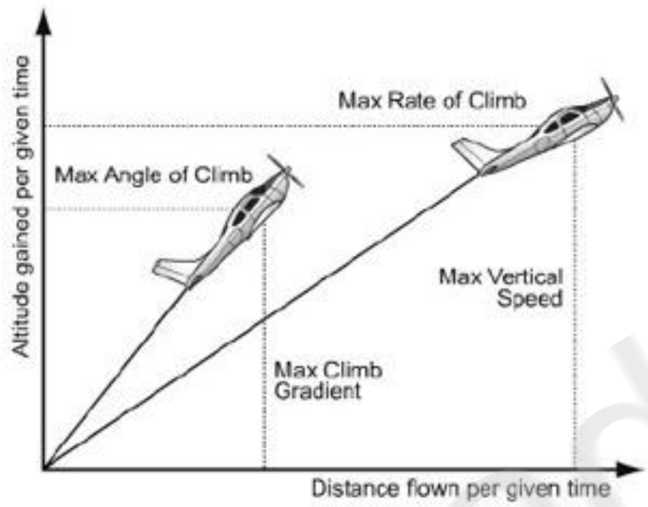


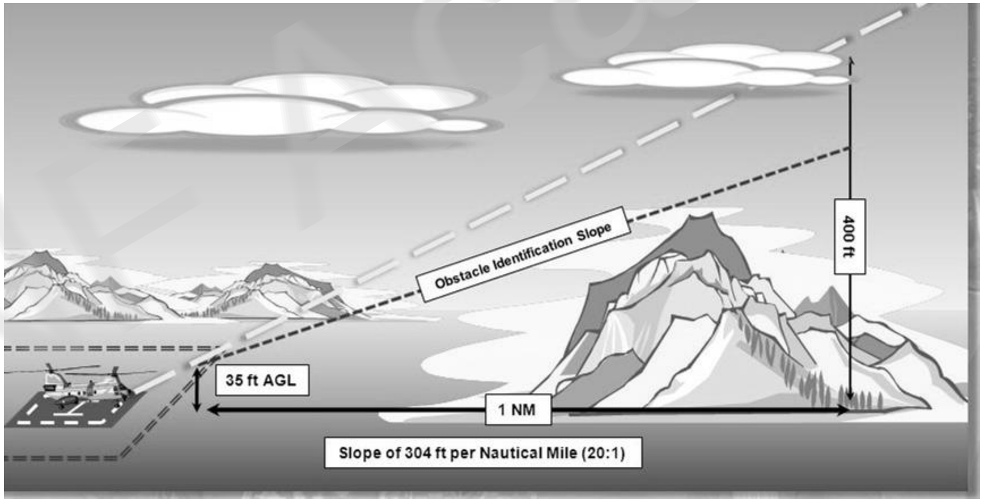
Shallow Climb

- Altitude will be reached faster with higher horizontal distance covered
- Most desired Approach

Steep Climb

- Altitude will be reached slower with less horizontal distance covered
- Not most desired approach


Max Rate of Climb
Max Angle of Climb
Altitude gained per given time
Max Vertical Speed
Max Climb Gradient
Distance flown per given time


Obstacle Identification Slope
400 ft
35 ft AGL
1 NM
Slope of 304 ft per Nautical Mile (20:1)

An aircraft is climbing at a constant speed in a straight line at a steep angle of climb. The load factor it sustains during the climb is:

(A) equal to 1.0
(B) greater than 1.0
(C) positive but less than 1.0
(D) dependant on the weight of the aircraft

Soln.

By force balance during climb $L = W\cos\theta$

$\Rightarrow \frac{L}{W} = \cos\theta$ (θ - climb angle).

$\frac{L}{W}$ = load factor = $\cos\theta < 1$ ($\because 0 < \cos\theta < 1$, for $\theta = 0$ to $\pi/2$)

general climb angle is 10° to 20°, so during climb load factor always be less than 1 but greater than zero.

Hence the answer is +ve but less than 1.

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An aircraft of mass 2500 kg in straight and level flight at a constant speed of 100 m/s has available excess power of 1.0×10^6 W. The steady rate of climb it can attain at that speed is

(A) 100 m/s (B) 60 m/s (C) 40 m/s ✓ (D) 20 m/s

Soln.

Gn. mass = 2500 kg, $V_\infty = 100$ m/s, $EP = 1.0 \times 10^6$ W

$$R/C = \frac{\text{Excess power}}{\text{weight}}$$

$$= \frac{1 \times 10^6}{\text{mass} \times g}$$

$$= \frac{10^6}{2500 \times 10}$$

$$R/C = 40 \text{ m/s}$$