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Projectile Motion Formulas

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List of 14 Projectile Motion Formulas

Projectile Motion

1) Direction of Projectile at given Height above Point of Projection

$$\text{fx } \theta = a \tan \left(\frac{\sqrt{\left(u^2 \cdot (\sin(\alpha))^2\right) - 2 \cdot [g] \cdot h}}{u \cdot \cos(\alpha)} \right)$$

Open Calculator 

$$\text{ex } 37.5709^\circ = a \tan \left(\frac{\sqrt{\left((31\text{m/s})^2 \cdot (\sin(45^\circ))^2\right) - 2 \cdot [g] \cdot 10\text{m}}}{31\text{m/s} \cdot \cos(45^\circ)} \right)$$

2) Horizontal Component of Velocity of Particle Projected Upwards from Point at Angle

$$\text{fx } v = u \cdot \cos(\alpha)$$

Open Calculator 

$$\text{ex } 21.92031\text{m/s} = 31\text{m/s} \cdot \cos(45^\circ)$$



3) Horizontal Range of Projectile

$$fx \quad H = \frac{u^2 \cdot \sin(2 \cdot \alpha)}{[g]}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 97.99473m = \frac{(31m/s)^2 \cdot \sin(2 \cdot 45^\circ)}{[g]}$$

4) Horizontal Range of Projectile given Horizontal Velocity and Time of Flight

$$fx \quad H = V_H \cdot t$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 1500m = 50m/s \cdot 30s$$

5) Initial Velocity given Maximum Horizontal Range of Projectile

$$fx \quad u = \sqrt{R_{max} \cdot [g]}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 31.00083m/s = \sqrt{98m \cdot [g]}$$


6) Initial Velocity of Particle given Horizontal Component of Velocity

$$fx \quad u = \frac{V_H}{\cos(\alpha)}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 70.71068m/s = \frac{50m/s}{\cos(45^\circ)}$$



7) Initial Velocity of Particle given Time of Flight of Projectile 

$$fx \quad u = \frac{[g] \cdot t}{2 \cdot \sin(\alpha)}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 208.0305\text{m/s} = \frac{[g] \cdot 30\text{s}}{2 \cdot \sin(45^\circ)}$$

8) Initial Velocity of Particle given Vertical Component of Velocity 

$$fx \quad u = \frac{V_v}{\sin(\alpha)}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)


$$ex \quad 31.1127\text{m/s} = \frac{22\text{m/s}}{\sin(45^\circ)}$$

9) Maximum Height of Projectile on Horizontal Plane 

$$fx \quad H_{\max} = \frac{u^2 \cdot \sin(\alpha)^2}{2 \cdot [g]}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 24.49868\text{m} = \frac{(31\text{m/s})^2 \cdot \sin(45^\circ)^2}{2 \cdot [g]}$$

10) Maximum Height of Projectile on Horizontal Plane given Average Vertical Velocity 

$$fx \quad H_{\max} = V_{\text{avg}} \cdot t$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 360\text{m} = 12\text{m/s} \cdot 30\text{s}$$



11) Maximum Horizontal Range of Projectile

$$fx \quad H = \frac{u^2}{[g]}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 97.99473m = \frac{(31m/s)^2}{[g]}$$

12) Time of Flight of Projectile on Horizontal Plane

$$fx \quad t = \frac{2 \cdot u \cdot \sin(\alpha)}{[g]}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 4.470499s = \frac{2 \cdot 31m/s \cdot \sin(45^\circ)}{[g]}$$

13) Velocity of Projectile at given Height above Point of Projection

$$fx \quad v = \sqrt{u^2 - 2 \cdot [g] \cdot h}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 27.65623m/s = \sqrt{(31m/s)^2 - 2 \cdot [g] \cdot 10m}$$

14) Vertical Component of Velocity of Particle Projected Upwards from Point at Angle

$$fx \quad V_v = u \cdot \sin(\alpha)$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 21.92031m/s = 31m/s \cdot \sin(45^\circ)$$







Variables Used

- **h** Height (Meter)
- **H** Horizontal Range (Meter)
- **H_{max}** Maximum Height (Meter)
- **R_{max}** Maximum Horizontal Range (Meter)
- **t** Time (Second)
- **u** Initial Velocity (Meter per Second)
- **v** Velocity (Meter per Second)
- **V_{avg}** Average Vertical Velocity (Meter per Second)
- **V_H** Horizontal Component of Velocity (Meter per Second)
- **V_v** Vertical Component of Velocity (Meter per Second)
- **α** Angle of Projection (Degree)
- **θ** Direction of Motion of a Particle (Degree)













Constants, Functions, Measurements used

- **Constant:** **[g]**, 9.80665 Meter/Second²
Gravitational acceleration on Earth
- **Function:** **atan**, atan(Number)
Inverse trigonometric tangent function
- **Function:** **cos**, cos(Angle)
Trigonometric cosine function
- **Function:** **sin**, sin(Angle)
Trigonometric sine function
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Function:** **tan**, tan(Angle)
Trigonometric tangent function
- **Measurement:** **Length** in Meter (m)
Length Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 



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