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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

fx Open Calculator

$$\theta_{pr} = a\tan\left(\frac{\sqrt{\left(v_{pm}^2 \cdot \left(\sin\left(\alpha_{pr}\right)\right)^2\right) - 2 \cdot [g] \cdot h}}{v_{pm} \cdot \cos\left(\alpha_{pr}\right)}\right)$$

ex

$$35.22605^\circ = a\tan\left(\frac{\sqrt{\left((30.01\text{m/s})^2 \cdot \left(\sin(44.99^\circ)\right)^2\right) - 2 \cdot [g] \cdot 11.5\text{m}}}{30.01\text{m/s} \cdot \cos(44.99^\circ)}\right)$$

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

fx $v_h = v_{pm} \cdot \cos\left(\alpha_{pr}\right)$ Open Calculator

ex $21.22398\text{m/s} = 30.01\text{m/s} \cdot \cos(44.99^\circ)$

3) Horizontal Range of Projectile

Open Calculator

$$H = \frac{v_{pm}^2 \cdot \sin\left(2 \cdot \alpha_{pr}\right)}{[g]}$$

$$91.83565\text{m} = \frac{(30.01\text{m/s})^2 \cdot \sin(2 \cdot 44.99^\circ)}{[g]}$$

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

Open Calculator

$$H = v_h \cdot t_{pr}$$

$$91.375\text{m} = 21.5\text{m/s} \cdot 4.25\text{s}$$

5) Initial Velocity given Maximum Horizontal Range of Projectile

Open Calculator

$$v_{pm} = \sqrt{H_{max} \cdot [g]}$$

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

6) Initial Velocity of Particle given Horizontal Component of Velocity

Open Calculator

$$v_{pm} = \frac{v_h}{\cos\left(\alpha_{pr}\right)}$$

$$30.40029\text{m/s} = \frac{21.5\text{m/s}}{\cos(44.99^\circ)}$$

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

Open Calculator

$$v_{pm} = \frac{[g] \cdot t_{pr}}{2 \cdot \sin(\alpha_{pr})}$$

$$29.47613\text{m/s} = \frac{[g] \cdot 4.25\text{s}}{2 \cdot \sin(44.99^\circ)}$$

8) Initial Velocity of Particle given Vertical Component of Velocity

Open Calculator

$$v_{pm} = \frac{v_v}{\sin(\alpha_{pr})}$$

$$31.11813\text{m/s} = \frac{22\text{m/s}}{\sin(44.99^\circ)}$$

9) Maximum Height of Projectile on Horizontal Plane

Open Calculator

$$h_{max} = \frac{v_{pm}^2 \cdot \sin(\alpha_{pr})^2}{2 \cdot [g]}$$

$$22.9509\text{m} = \frac{(30.01\text{m/s})^2 \cdot \sin(44.99^\circ)^2}{2 \cdot [g]}$$

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

Open Calculator

$$h_{max} = v_{ver} \cdot t_{pr}$$

$$23.375\text{m} = 5.5\text{m/s} \cdot 4.25\text{s}$$

11) Maximum Horizontal Range of Projectile

Open Calculator

fx $$H = \frac{v_{pm}^2}{[g]}$$

ex $$91.83565\text{m} = \frac{(30.01\text{m/s})^2}{[g]}$$

12) Time of Flight of Projectile on Horizontal Plane

Open Calculator

fx $$t_{pr} = \frac{2 \cdot v_{pm} \cdot \sin(\alpha_{pr})}{[g]}$$

ex $$4.326976\text{s} = \frac{2 \cdot 30.01\text{m/s} \cdot \sin(44.99^\circ)}{[g]}$$

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

Open Calculator

fx $$v_p = \sqrt{v_{pm}^2 - 2 \cdot [g] \cdot h}$$

ex $$25.98167\text{m/s} = \sqrt{(30.01\text{m/s})^2 - 2 \cdot [g] \cdot 11.5\text{m}}$$

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

Open Calculator

fx $$v_v = v_{pm} \cdot \sin(\alpha_{pr})$$

ex $$21.21657\text{m/s} = 30.01\text{m/s} \cdot \sin(44.99^\circ)$$

Variables Used

- **h** Height *(Meter)*
- **H** Horizontal Range *(Meter)*
- h_{max} Maximum Height *(Meter)*
- H_{max} Maximum Horizontal Range *(Meter)*
- t_{pr} Time Interval *(Second)*
- v_h Horizontal Component of Velocity *(Meter per Second)*
- v_p Velocity of Projectile *(Meter per Second)*
- v_{pm} Initial Velocity of Projectile Motion *(Meter per Second)*
- v_v Vertical Component of Velocity *(Meter per Second)*
- v_{ver} Average Vertical Velocity *(Meter per Second)*
- α_{pr} Angle of Projection *(Degree)*
- θ_{pr} Direction of Motion of a Particle *(Degree)*

Constants, Functions, Measurements used

- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- 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

Check other formula lists

- **Projectile Motion Formulas**

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