Important Projectile Motion Formulas PDF

Formulas
Examples
with Units

List of 14
Important Projectile Motion Formulas

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

Evaluate Formula

Formula

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

Example with Units

$$35.226° = atan\left(\frac{\sqrt{\left(30.01\,m/s^{2}\cdot\left(\sin\left(44.99°\right)\right)^{2}\right) - 2\cdot 9.8066\,m/s^{2}\cdot 11.5\,m}}{30.01\,m/s\cdot\cos\left(44.99°\right)}\right)$$

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

Evaluate Formula

Formula

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

Example with Units

$$21.224\,m/s = 30.01\,m/s\cdot\cos\left(44.99°\right)$$

3) Horizontal Range of Projectile Formula

Evaluate Formula

Formula

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

Example with Units

$$91.8356\,m = \frac{30.01\,m/s^{2}\cdot\sin\left(2\cdot 44.99°\right)}{9.8066\,m/s^{2}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$91.375\,m = 21.5\,m/s\cdot 4.25\,s$$

5) Initial Velocity given Maximum Horizontal Range of Projectile Formula

Evaluate Formula

Formula

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

Example with Units

$$31.0008\,m/s = \sqrt{98\,m\cdot 9.8066\,m/s^{2}}$$

6) Initial Velocity of Particle given Horizontal Component of Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$30.4003\,\text{m/s} = \frac{21.5\,\text{m/s}}{\cos\left(44.99°\right)}$$

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

Evaluate Formula

Formula

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

Example with Units

$$29.4761\,\text{m/s} = \frac{9.8066\,\text{m/s}^2 \cdot 4.25\,\text{s}}{2 \cdot \sin\left(44.99°\right)}$$

8) Initial Velocity of Particle given Vertical Component of Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$31.1181\,\text{m/s} = \frac{22\,\text{m/s}}{\sin\left(44.99°\right)}$$

9) Maximum Height of Projectile on Horizontal Plane Formula

Evaluate Formula

Formula

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

Example with Units

$$22.9509\,\text{m} = \frac{30.01\,\text{m/s}^2 \cdot \sin\left(44.99°\right)^2}{2 \cdot 9.8066\,\text{m/s}^2}$$

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

Evaluate Formula

Formula

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

Example with Units

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

11) Maximum Horizontal Range of Projectile Formula

Evaluate Formula

Formula

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

Example with Units

$$91.8357\,\text{m} = \frac{30.01\,\text{m/s}^2}{9.8066\,\text{m/s}^2}$$

12) Time of Flight of Projectile on Horizontal Plane Formula

Evaluate Formula

Formula

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

Example with Units

$$4.327\,\text{s} = \frac{2 \cdot 30.01\,\text{m/s} \cdot \sin\left(44.99°\right)}{9.8066\,\text{m/s}^2}$$

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

Evaluate Formula

Formula

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

Example with Units

$$25.9817\,\text{m/s} = \sqrt{30.01\,\text{m/s}^2 - 2 \cdot 9.8066\,\text{m/s}^2 \cdot 11.5\,\text{m}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$21.2166\,\text{m/s} = 30.01\,\text{m/s} \cdot \sin\left(44.99^\circ\right)$$

Variables used in list of Projectile Motion Formulas above

- **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 in list of Projectile Motion Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **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.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **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.
- Functions: **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.
- Functions: **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

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