Connecting Algebra 2 with Physics

Logic&Motion

Learning Goals

- Relate the **vertex** of a quadratic to the peak of vertical motion.
- Model experimental data with $h(t) = s_0 + v_0 t - \frac{1}{2}gt^2$.
- Apply the model to compute maximum height and potential energy.

Quadratic Model And Vertical Motion

Quadratic Form

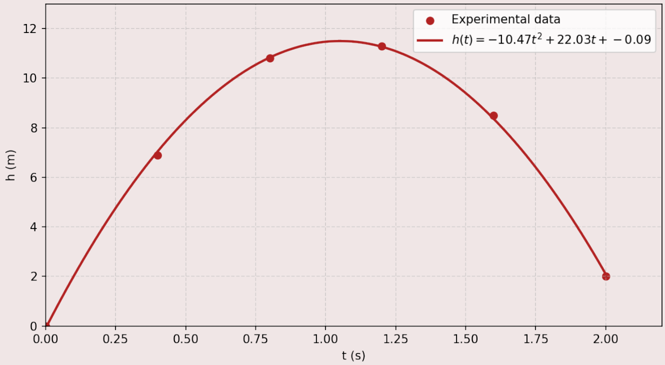
$$y = ax^2 + bx + c \qquad \Rightarrow \qquad x_{\text{vertex}} = -\frac{b}{2a}$$

Vertical Motion Model

$$h(t) = s_0 + v_0 t - \frac{1}{2}gt^2$$

Mapping: $a = -\frac{g}{2},\ b = v_0,\ c = s_0$

Experimental Data Fit



Exercise

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A ball is launched vertically from ground level with initial speed $v_0 = 19.6$ m/s.

Determine:

1. the time at which it reaches maximum height;
2. the maximum height;
3. the maximum gravitational potential energy $\left(m = 0.35 \text{ kg},\ g = 9.8 \text{ m/s}^2\right)$.

Solution

$$t_{\text{max}} = -\frac{b}{2a} = 2 \text{ s}$$
$$h_{\text{max}} = -4.9(2)^2 + 19.6 \cdot 2 = 19.6 \text{ m}$$
$$E_{p,\text{max}} = mgh_{\text{max}} = 0.35 \cdot 9.8 \cdot 19.6 \approx 67.1 \text{ J}$$

More to Explore

Beyond the Core Lesson

- **Vertex vs Standard Form**: completing the square, parameter sensitivity.
- **Full Projectile Path**: add horizontal motion $x(t) = v_{0x}t,\ y(t) = v_{0y}t - \frac{1}{2}gt^2$.
- **Optimal Launch Angle**: proof that 45° maximizes range.
- **Energy Bar Charts**: compare kinetic and potential energy frame-by-frame.
- **Real-World Data Lab**: phone-video analysis and quadratic fit.

Mini-Unit Roadmap

Three Stand-Alone Modules

1. Parabolic Motion & Quadratics (core + extensions)
2. Newton's Laws via Linear Systems (core + Atwood variants)
3. Radioactive Decay & Exponentials (core + half-life lab)

Teacher Note (0.5 page)

Class time (core lesson): 15–20 min
Tech: any PDF viewer; optional Desmos/GeoGebra file with data.
Extensions:

- Compare Earth vs Moon ($g_{\text{Moon}} \approx 1.6\ \text{m/s}^2$).
- Let students collect their own data with phone video.