YOUNG MASTER CHALLENGE

Student Learning Pack Bumblebee (MATHEMATICS)

Resources:

Maths in life Concept: Engineering

📝 Worksheet 1: Roller Coaster Engineering 🎢

Learning Objectives:

- Apply energy conservation to real-world roller coasters.
- Understand frictional losses.
- Explore parabolic paths with quadratic functions.

Questions:

1. A 300 kg roller coaster starts at 25 m high. With no friction, what is its speed at the bottom?
2. If 5,000 J of energy is lost to friction, what is the corrected final speed?
3. An engineer models a hill with $y=-0.05x^2+16$. What is the max height and where is it located?
4. Why must the first hill be the tallest?

Reflection Questions:

- Why do roller coasters need careful design to balance thrill and safety?
- How does energy loss to friction change the experience for riders?
- If you could design a ride, what mathematical functions would you use for different track shapes?

📝 Worksheet 2: Crash Science – Kinetic Energy & Safety 🚗

Learning Objectives:

- Explore kinetic energy growth with speed.
- Link stopping distance to KE.
- Understand crumple zones & airbags.

Questions:

1. A 1,000 kg car at 15 m/s — find its KE.
2. If speed doubles, what happens to KE?
3. If stopping distance is 20 m at 50 km/h, estimate at 100 km/h.
4. Explain how airbags reduce force on passengers.

Reflection Questions:

- Why do speed limits exist in different areas (e.g., school zones vs highways)?
- How do car safety features show the importance of applied mathematics?

📝 Worksheet 3: Fluids & Buoyancy 🚢

Learning Objectives:

- Apply Archimedes' principle.
- Connect volume, density, and buoyant force.

Questions:

1. A 0.05 m^3 block in water (ρ = 1000) — find upthrust.
2. Why do ships float even though made of steel?
3. If a submarine displaces 500 m^3 of seawater (ρ=1025), what buoyant force acts?

Reflection Questions:

- Why do some objects sink while others float, even if made of the same material?
- How do submarines use buoyancy to dive and surface?
- What might happen if engineers miscalculated buoyant force in ship design?

📝 Worksheet 4: Pascal's Law & Hydraulics 🔧

Learning Objectives:

- Understand pressure transmission in fluids.
- Apply Pascal's principle to car lifts.

Questions:

1. Define Pascal's Law.
2. A hydraulic press has input piston area 0.01 m^2 and output 0.5 m^2. Input force = 200 N. Find output force.
3. A car of weight 15,000 N is lifted with a small piston of 0.02 m^2 and a large piston of 1.0 m^2. Find input force required.

Reflection Questions:

- How do hydraulics make construction and car repair possible with relatively little effort?
- Why does increasing piston area increase output force?
- Can you think of everyday devices that use hydraulics?