Physics in the Museum

Investigations for Year 11/12 Physics students

Task:

1. Explore the Museum exhibitions, looking for applications of physics in the objects on display.
2. Develop a topic for further study. This may be based on a specific object, or cover a broader theme (see examples below). Use the HyperPhysics website to identify concepts for investigation.
3. Develop a presentation that explains the physics concepts in your topic, with reference to the Museum object(s). The HyperPhysics site has formulae and calculators to help.

Below are some possible ideas for investigations at the Queensland Museum, South Bank:

Physics Concepts

Identify examples in the Museum that illustrate these physics concepts:

- Mechanics
- Heat and thermodynamics
- Sound and Hearing
- Light and Vision
- Electricity and Magnetism

Body mechanics (level 2; Marine Creatures)

- Investigate **skeletons as mechanical systems** involving multiple levers:
    - Estimate the mechanical advantage of the jaw structures of Megalania, Diprotodon, False Killer Whale, Elephant, Sabre-toothed Tiger.
    - Compare the leg structures (several examples in Dragons and Diprotodons) to make inferences about mobility.
    - Investigate stance, centre of gravity and support base to make inferences about agility, stability and balance of different creatures. Would the Muttaburrasaurus skeleton in the foyer fall over if it was not held on place?
- Investigate the **mobility** of marine creatures:
    - Estimate the surface area of power systems (fins, flippers, tail) as a proportion of total body surface area. Use this data to make inferences about the relative speed & power of humpback whale, leatherback turtle, crocodile, and porcupine fish.

Energy Conversion (Wheels, Wings and Water; Inquiry Centre)

- Identify machines in the Museum that convert energy from one form to another.
- Choose an interesting example and provide details on how it works.
- Some examples: pedal-powered radio, gramophones, rifles, musical instruments.

Harpoon gun (Marine Creatures)

- Given the range and elevation angle of the harpoon, calculate its muzzle velocity.
- Given the mass of the harpoon and the length of the barrel, calculate the acceleration of the harpoon and the amount of energy required.
    - Data required: Mass of harpoon, angle of barrel, range

Escalators (levels 2 and 3)

- How much work is done lifting a person to the next floor?
- How much power is required to lift a person?
- Estimate the maximum number of people who could use the escalator at once and calculate the maximum power required by the machine.
    - Data required: height of lift; angle, length of tread

Levers

- Identify examples of levers you find in the Museum and estimate the mechanical advantage they provide. Some examples: wheelbarrows, woomeras, tennis racquet, brake pedals on vehicles.

Engines (Wheels, Wings and Water)

- Calculate the power to weight ratio of vehicles. Include the bicycle fire engine and horse-drawn vehicles.
    - Data required: power, mass
    - Research: power of horse, human cyclist.
- Compare the two aircraft engines by calculating their power/weight and power/capacity ratios.
- Collect data on power, capacity and year of manufacture on as many engines as possible. Calculate a power/capacity ratio; present this information in a table and comment on any apparent trends.
- You will notice that the two steam engines have massive flywheels. Investigate their function. Why don't the other engines need flywheels like these?
- Given the mass, speed and diameter of a flywheel, calculate the kinetic energy it stores.