**Activity: Investigating the Frictional Properties of Agricultural Produce**

**Date: 27.3.2025**

**Objective:**

To understand the **frictional properties** (angle of repose and angle of internal friction) of different agricultural produce and how factors like shape, size, and surface texture affect friction.

**Materials Needed:**

1. Different types of agricultural produce (e.g., wheat, corn, rice, beans, peanuts).
2. A wooden or metal board (tilting plane).
3. A protractor (for measuring angles).
4. A ruler or measuring tape.
5. A small container or box for holding the produce.
6. A weighing scale (optional, for mass measurements).

**Procedure:**

**Part 1: Measuring the Angle of Repose**

1. Pour a small quantity of one type of produce onto a flat surface to form a pile.
2. Carefully measure the **height (h)** and **radius (r)** of the pile.
3. Use the formula:

   $\theta=\tan^{-1}(\frac{h}{r})$

to calculate the **angle of repose**.

4. Repeat with different types of produce and compare the results.

**Part 2: Measuring the Angle of Internal Friction**

1. Place a small amount of seeds on the tilting plane.
2. Slowly increase the angle of the plane until the seeds **begin to slide**.
3. Measure and record this angle (φ\phiφ), which represents the **angle of internal friction**.
4. Repeat for different produce and analyze the differences.

**Example 1: Using the Friction Force Formula**

Consider that **10 kg** of wheat grain is sliding on a horizontal surface. The force required to keep it moving at a constant speed is **30 N**. What is the coefficient of kinetic friction ?( μk)

**Step 1: Calculate Normal Force (Fn)**

Since the grain is on a horizontal surface, the normal force is equal to the weight:

Fn=mg

Where:

- m=10 kg (mass of the body)

- $g=9.81\ m/s^2$ (acceleration due to gravity)

$Fn=10\times9.81=98.1\ N$

**Step 2: Use the Friction Formula**

Given that the friction force $Ff=30\ N$:

$\mu k=Ff/Fn = 30/98.1$

So, the coefficient of kinetic friction is **0.31**.

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**Example 2: Using an Inclined Plane**

A block is placed on an inclined plane, and it **just starts to slide** when the angle reaches **30°**. Find the coefficient of static friction ($\mu_s$).

**Solution:**

Since the object starts to slide at $\theta=30\circ$

we use:

$\mu_s=\tan(\theta)$

$=\tan(30\circ)\approx0.577$

So, the coefficient of static friction is **0.577**.

**Discussion Questions:**

- Which produce had the highest/lowest angle of repose?
- How does the surface texture of seeds affect friction?
- Why do rounder seeds slide more easily than irregularly shaped ones?
- How can farmers use this information in storage and transportation?

**How can farmers use this information in storage and transportation?**

Farmers can use the **frictional properties** of agricultural produce in several ways to improve **storage, handling, and transportation** efficiency.

**1. Storage Optimization**

- **Grain Bin Design:**
    - A **higher angle of repose** means the grain forms steeper piles, allowing for **better stacking** and efficient use of space.
    - A **lower angle of repose** means the grain spreads more, requiring different storage designs.
- **Silo Discharge Efficiency:**
    - Crops with **high internal friction** (e.g., rough seeds) may flow poorly and require **vibrators or aeration systems** to prevent clogging.
    - **Smooth, round seeds** (e.g., soybeans) flow more easily, reducing the risk of blockage.

**2. Transportation Handling**

- **Bulk Transport Efficiency:**
    - Knowing the **angle of repose** helps farmers decide how to load grains onto trucks or ships to **prevent spills**.
    - A **low angle of repose** may require higher sidewalls to contain the produce.
- **Reducing Product Loss & Damage:**
    - Seeds with high internal friction require gentler handling to avoid mechanical damage.
    - Round seeds with lower friction flow smoothly through conveyors, reducing energy use.

**3. Machinery & Equipment Design**

- **Conveyor Belt Selection:**
    - Materials with high friction need **stronger belts** to move them efficiently.
    - Low-friction materials require **steeper conveyor angles** to prevent slipping.
- **Auger & Chute Design:**
    - Crops with high internal friction might get stuck in **narrow chutes**, requiring a wider design or smoother surface.
    - Farmers can use coatings or materials like **polished steel or Teflon** to reduce sticking.

**4. Preventing Spoilage & Ensuring Safety**

- **Aeration & Drying Considerations:**
    - Seeds that pack tightly due to high internal friction may **trap moisture**, increasing the risk of mold.
    - Understanding friction helps design **better airflow systems** for drying grains evenly.
- **Preventing Grain Bin Collapses:**
    - High-friction grains may create **bridging effects**, leading to dangerous empty spaces inside silos.
    - Proper unloading techniques and periodic checks can prevent sudden collapses.

By applying this knowledge, farmers can **reduce waste, improve efficiency, and enhance safety** in storage and transport.