MATERIALS

NOTES

LEARNING OUTCOMES:

1. List the various types of materials and relate their properties to their uses.

2. Compare materials based on their common physical properties.
   - Strength
   - Flexibility
   - Elasticity
   - Transparency
   - Waterproof
   - Ability to float or sink
   - Heat conductivity
   - Electrical conductivity
   - Brittleness

SOURCES OF MATERIALS

1. There are many kinds of materials around us.

2. Materials can be natural or man-made.

3. Natural materials can be from animals, plants or the ground.

Source	Material	From	Properties	Uses
Animal	Leather	Animal skin	• Flexible	Belts, bag, shoes
	Wool	Sheep's fleece	• Light • Soft	Scarf, hat, sweater.
	Silk	Silkworm's cocoon	• Flexible • Soft • Light • Strong	Scarf, dress
Plant	Rubber	Sap of rubber tree	• Flexible • Elastic • Waterproof	Rubber boots, eraser, balloon, tyre, rubber gloves
	Wood	Tree trunks	• Light • Floats on water	Paper, wooden chair, wooden table, wooden bench, wooden boat
	Cotton	Cotton plant	• Light • Soft • Flexible	Soft toy, T-shirt, pillow
Ground	Metal	Earth's crust	• Strong • Heavy • Sinks in water • Waterproof • Good conductor of heat and electricity	Kettle, tools, spoon, keys
	Rocks (Clay, sand, stones)	Earth's crust	• Strong • Brittle • Heavy • Sinks in water	Brick, vase, ceramic bowl

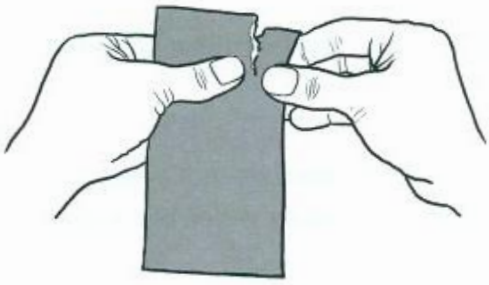
4. Man-made materials are materials like plastic, nylon, polyester and glass.

Material	Made from	Properties	Uses
Plastic, Polyester	Petroleum	• Light • Strong • Waterproof • Transparent/ Translucent/ Opaque • Flexible • Poor conductor of heat and electricity	Cup, bottle, raincoat, umbrella
Glass	Silica(sand)	• Transparent • Waterproof • Fragile • Sinks in water	Science apparatus, spectacle lens, glass, mirror
Nylon	Chemicals found in petroleum	• Soft • Light • Strong • Flexible	Clothes, stockings

PROPERTIES OF MATERIALS

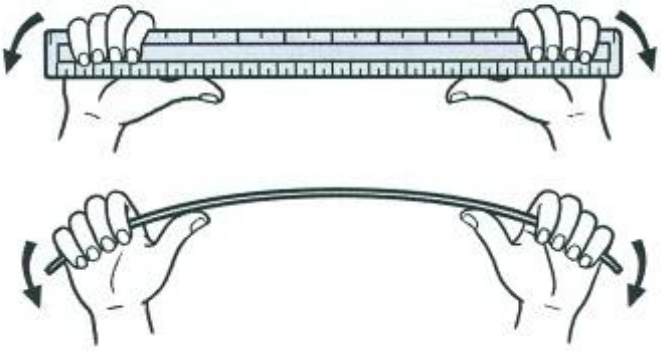
1. Strength

- Strength refers to the ability to not tear or break easily.
- Materials that can withstand tearing or breaking are strong.



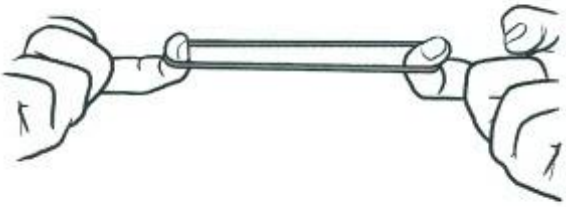
Paper can be torn easily so it is weak.

2. Flexibility
   - Flexibility refers to the ability to be bent without breaking.



Plastic ruler is flexible so it can be bent.

3. Elasticity
   - Elasticity refers to the ability to be stretched.



Rubber band is elastic so it can be stretched.

4. Transparency
   - Transparency refers to the ability of the material to allow light to pass through it.
   - Transparent materials like glass or clear plastic allow most light to pass through.
   - Translucent materials like tissue paper, frosted glass or rice paper allow some light to pass though.
   - Opaque materials like wood or metal do not allow light to pass through.

5. Waterproof
   - Materials that absorb water are not waterproof.
   - Materials that do not absorb water are waterproof.

6. Ability to float or sink
   - Materials that has a lower density than water floats.
   - A cork or a life buoy floats on water

Cork

Life buoy

   - Materials that have a higher density that water sink.
   - A coin sinks in water

7. Heat conductivity
   - Materials like metals that have the ability to conduct heat easily are good conductors of heat.
   - Materials like wood that does not conduct heat easily are poor conductor of heat.
   - Good conductors of heat allow heat to pass through easily while poor conductors of heat allow heat to pass through slowly.

8. Electrical conductivity
   - Materials like metals that have the ability to conduct electricity easily are good conductors of electricity.
   - Materials like wood that does not conduct electricity are insulators of electricity.

9. Brittleness **(Fragile or not)**
   - Brittleness refers to the ability to break easily.

Glass breaks easily

EXPERIMENTS

Experiment 1

Materials needed:

- 1 metal object (coin)
- 1 plastic object (plastic spoon)
- 1 ceramic object (ceramic spoon)
- 1 Styrofoam object (Styrofoam board)
- 1 basin of water

Steps:

1. Put the objects into the basin of water.
2. Observe the set-up for 2 minutes.
   - What can be observed about the objects in the water?

     The coin and ceramic spoon sink in water, while the plastic spoon and Styrofoam board float in water.

   - Explain your observation.

     The coin and the ceramic spoon are denser (heavier) than water, thus they sink in water. The plastic spoon and the Styrofoam board are less dense (lighter) than water, thus they float on water.

Experiment 2

Materials needed:

- Beaker
- Red food dye
- Dropper
- Water
- A tray / container
- Plasticine
- Tissue paper
- Cloth
- Plastic bag
- Glass marble
- Disposable wooden chopstick
- Cotton wool
- Rubber band

Steps:

1. Mix the food dye with water in the beaker.

2. Place the other objects on the tray / container.

3. Use the dropper to drip some coloured water onto each of the objects.

   - What can be observed about the objects?

     The tissue paper, cloth, wooden chopstick and the cotton wool were stained red while the plasticine, plastic bag, glass marble and rubber band were not stained red.

   - Explain your observation.

     Tissue paper, cloth, wooden chopstick and cotton wool are not waterproof, thus they absorbed the red coloured water while the plasticine, plastic bag, glass marble and rubber band are waterproof so they did not absorb the red coloured water.

WORKED EXAMPLES

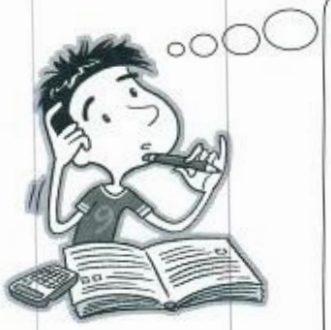
Worked Example 1

The table below shows the properties of 3 materials, A, B and C.

Property / Material	Waterproof	Flexible	Floats on water
A	Yes	No	No
B	Yes	Yes	Yes
C	No	Yes	No

(a) Based on the table above, describe Material A. (1m)

(b) Which material, A, B or C, is most suitable for making a toy boat? Explain your answer. (2m)



Thought Process:

Topic : Materials

Key Concept(s) : Materials that absorb water are not waterproof.

Materials that do not absorb water are waterproof.

Key Words / : (a) waterproof, not flexible, does not float on water
(b) B, toy boat should float on water, Material B floats on water

Process Skills : Communicating, Comparing, Analysing

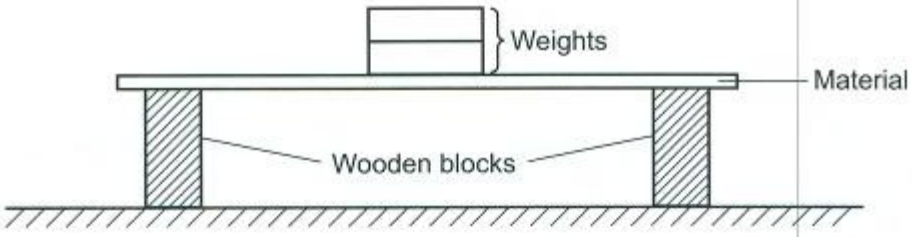
Answers:

(a) Material A is **waterproof**, **not flexible** and **does not float on water**. (1m)

(b) Material **B**. A **toy boat should float on water and Material B is the only material that can float on water**. (2m)

Worked Example 2

Jenny carried out an experiment with 4 pieces of materials, W, X, Y and Z. She placed Material W across two wooden blocks. Then, she kept adding weights to the centre as shown in the diagram below, until the piece of material broke. She repeated the experiment with Materials X, Y and Z.



The table below shows the amount of weight required to break each material.

Material	Amount of weight required to break the material (kg)
W	4
X	12
Y	9
Z	15

(a) Arrange the materials, W, X, Y and Z, according to their strength. Start from the strongest. (1m)

(b) Based on the information given in the table above, which material, W, X, Y or Z, is most suitable for making a box to carry heavy objects? Explain your choice. (2m)

Thought Process:

Topic : Materials

Key Concept(s) : Materials that can withstand tearing or breaking are strong.

Key Words / : (a) Z, X, Y, W
(b) Z, hold the most weight, strongest material, can carry heavy objects.

Process Skills : Observing, Communicating, Comparing, Analysing

Answers:

(a) **Z, X, Y, W** (1m)

(b) Material **Z**. It can **hold the most amount of weight before breaking**, so it is **the strongest material**. Thus, it can be **made into a box to carry heavy objects**. (2m)

Worked Example 3

Four pieces of similar sized materials, A, B, C and D, were weighed individually to measure their masses at the start of the experiment. The materials, A, B, C and D, were placed into four similar containers with equal amounts of water. After 5 minutes, each piece of material was weighed again. The measurements were recorded in the table below.

Material	Mass at the start of the experiment (g)	Mass after five minutes (g)
A	10	10
B	12	19
C	20	22
D	15	18

(a) Based on the table above, which material, A, B, C or D, is the most suitable material for making a bath towel? Explain your answer. (2m)

(b) Based on the table above, which material, A, B, C or D, is a piece of plastic? Explain your answer. (2m)

Thought Process:

Topic : Materials

Key Concept(s) : Materials that can withstand
Materials that absorb water are not waterproof.

Materials that do not absorb water are waterproof.

Key Words / : (a) Material B, mass of it increased the most, absorbed the most water, most absorbent, most suitable to be a towel
(b) Material A, mass did not increase, did not absorb any water, waterproof like plastic bag

Process Skills : Observing, Communicating, Comparing, Analysing

Answers:

(a) **Material B**. The **mass of it increased the most so it absorbed the most amount of water**. Thus, it is the **most absorbent material** which is **most suitable to be made into a towel**. (2m)

(b) **Material A**. Its **mass did not increase** which means it **did not absorb any water**. Thus, it is **waterproof just like a piece of plastic**. (2m)