Exploring Pressure on a Solid Surface

Many people would think that lying on a bed of nails would be very painful and dangerous. They think that the whole force of a person's weight would be acting through the sharp ends of the nails. Understanding the idea of pressure helps us to explain how such a feat is possible.

When a person lies down they can feel comfortable even on a hard surface. This is because the force of their weight (acting downward) is spread over a large surface. This reduces the **pressure** on the body.

If the force of weight is acting over a small area, the pressure is greater. Trying to lie on the point of a single nail would mean that several hundred newtons of force would be acting over an area of less than $1mm^2$ on the nail's point. The pressure would be massive and probably dangerous! The skin could not withstand such pressure and would be punctured by the nail causing damage.

Look carefully at the person lying on the bed of nails below. There are hundreds of nails, so the force of his weight is **shared** by each individual nail. The pressure on any single nail is small and he person does not suffer pain or injury.

Look at the feet of the animals below. The larger feet of the camel, elephant and polar bear prevents them from sinking into the surface that they are walking on.

ELEPHANT

CAMEL

POLAR BEAR

CHICKEN

MOUSE

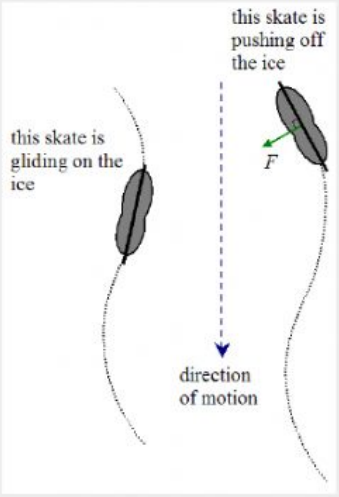
Similarly, a tractor's tyres spread the weight of the tractor over a larger area than narrow tyres would. This is also why people walking through snow wear larger snow shoes or boots and why people skiing on water or snow wear such long and large skiis—so that their weight does not cause them to sink into the water or snow.

TRACTOR TYRES

SNOW SHOES

HIGH HEELS

A blade concentrates a force over the very small area of the blade's edge. The small area of the blade of an ice skate has two benefits. Firstly, the high pressure causes the ice to melt slightly underneath the blade. The thin layer of water formed acts as a **lubricant**. Secondly, when the skate is leaned over, there is so much pressure on one edge of the blade that it cuts into the ice, allowing the skater to turn.



Engineers use the idea of pressure to improve designs for different purposes. In skiing, a downhill racer uses a different ski design than someone skiing over deep powder snow. A hand-operated tin opener uses levers to multiply the force applied. This force then acts through the narrow cutting blade. The pressure is high enough to cut through the tin.

RACING SKI

NORMAL SKI

Questions

1. What direction does the weight of a person act? _____
2. Why does a person lying on a single nail get hurt?_____
3. Why does a person lying on a bed of many nails, not sustain much damage?

   _____
4. What type of a surface are the large feet of camels and polar bears adapted for them to walk on?

   Camel _____ Polar bear _____
5. Why would a chicken or tiny mouse not be able to walk firmly on the surfaces mentioned in Question #4 above?_____
6. What do persons who walk on the snow wear to prevent them from falling into the snow? Choose three answers.

BOOTS SLIPPERS SKIS SNOWSHOES HEELS DRESS SHOES

7. Why would they wear the footwear you chose in Question #6 above?

   _____
8. What are two reasons for the blade on a pair of ice skates?

   _____
9. What is the major problem faced by persons wearing heels in sand?

   _____

Question Set 2

1 Complete the sentences using the words in the box.

Pressure is the amount of _____ acting on a certain _____ .

The size of the pressure depends on the _____ of the force and the size of the _____ it is pushing on.

area	area	force	size

2 Put a cross on the diagram to show where the pressure will be biggest when the knife is used.

3 Tick the correct answers.

a The knife blade has:

☐ a large area. ☐ a small area.

b The force pushing on a small area will make the pressure:

☐ more. ☐ less.

UNDER PRESSURE

Complete the sentences with the correct words.

The amount of _____ pushing on a certain area is the _____. For the same _____, the pressure on a _____ area will be less than the _____ on a _____ area.

Draw lines to match each picture with its description and the reason for its shape.

A camel walks on sand.

They have caterpillar tracks to make less pressure so that they don't sink into the ground.

Large bulldozers work in muddy places.

Each stud has a small area to make more pressure so they give better grip.

Football boots have studs.

It has large flat feet to make less pressure, so that it does not sink in the sand.