

Topic 9e—Bulk and surface properties of matter including nanoparticles

9.35—The size of nanoparticles

As their name suggests, nanoparticles tend to be measured using the unit of **nanometres**. However, nanoparticles are much **larger** than atoms and molecules, as nanoparticles are made of these!

9.36—Properties & uses of nanoparticulate materials

A major property of nanoparticles is that they have a huge **surface area** : **volume** ratio.

For example, a cubic nanoparticle with a side length of 1 nm has a total surface area of $6 \times 1 \times 1 = 6 \text{ nm}^2$, and a total volume of $1 \times 1 \times 1 = 1 \text{ nm}^3$, giving a surface area-to-volume ratio of **6:1**.

A larger cubic particle, with a side length of 1000 nm (not considered a nanoparticle) has a surface area to volume ratio of 0.006:1—this is a 1000 times **smaller** value.

One use of nanoparticles is the use of titanium dioxide particles in **sunscreens**. The nanoparticles are used as the titanium dioxide absorbs harmful **ultra violet** radiation from the Sun, but the nanoparticles are so small they cannot be **seen** when applied to the skin.

Other uses of nanoparticles include use as **catalysts** in chemical reactions: their huge surface area to volume ratio means that very small amounts can catalyse reactions very easily. They may also be able to catalyse different reactions to the 'bulk' sized chemicals. Nanoparticles are further used in scratch-resistant spectacles, in medicine and many other fields.

9.37—The risks of using nanoparticles

The major beneficial property of nanoparticles, namely their incredibly **small** size, is also the source of the major concern regarding their use.

There are some concerns that they could be breathed **in** and, due to their small size, enter cells in the body, where they might **catalyse** harmful reactions. As well as this, silver (for example) has anti-**bacterial** properties, and silver nanoparticles are used in wound dressings. If these nanoparticles enter the body, they could destroy good **bacteria** living in the gut. There is also a concern that **toxic** chemicals may bind to these nanoparticles before they are inhaled. More work needs to be done by scientists to determine the **long-term** impact of nanoparticle use.

9.38 & 9.39—The properties of bulk materials

	Clay ceramic	Glass	Metal	Polymer
Flexibility	Low	Low	High	High
Hardness	Medium	Medium	Low	Low
Reaction with water	None	None	Very slow	None
Electrical conductivity	Low	Low	High	Low
Melting point	High	High	High	Softens

*You will be asked to compare the provided data on different types of materials, as well as making judgements, **based on the data provided**, for which material would be best to use in a given situation.*

According to the data provided, the best material to use for covering an electrical wire is **polymer** as it is **flexible** and an electrical **insulator**.

The best material to use for heating food in an oven would likely be **glass**, as it has a **high** melting point and doesn't react with any **water** that might be in the food.