**Skill Sheet: Tolerances**

***What You Need to Know:***

***Examiners***

***Top Tip***

*You need to be able to work out tolerances and judge if a size is within an acceptable tolerance –questions on this appear often.*

Most products are made to specific sizes (length, width, height etc.). These sizes depend on what the product is needed to do and are worked out by the designer.

The ‘target’ value for each size for a product is sometimes called the ‘nominal’ size. However, typically products can still be acceptable even if vary slightly from the nominal size. This acceptable variation is called the tolerance. If there was no tolerance, every part that was not exactly the nominal size would have to be scrapped or remade, which would be very expensive.

The reason for allowing a tolerance is that there can be variation during manufacturing – for example, tools can become worn, machines can vibrate, even the temperature of the room and material make a difference. However, parts that are within tolerance can still satisfy the needs of the design.

The tolerance is normally presented as a ± to the nominal size. For example, if a nominal length is 60 millimeters (mm) and the acceptable tolerance is 2 mm, this will be presented as 60 ± 2 mm. The largest acceptable size will be 60 + 2 = 62 mm. The smallest acceptable size will be 60 – 2 = 58 mm.

60 ± 2 mm

Many tolerances are presents as decimal numbers. A decimal point is a dot used to separate the whole number part from the part of a number that is a fraction. For example, in the number 24.6, the point separates the 24 (the whole number) from the 6 (the fractional part, which really means 6/10 or six tenths).

***Example:***

A product has an acceptable width of 18 ± 2 mm.

Calculate the maximum and minimum acceptable sizes of the product.

***Answer:***

Maximum acceptable size = 18 + 2 = 20 mm

Minimum acceptable size = 18 – 2 = 16 mm

***Now Try These:***

1. A component must be of length 2.4 ± 0.1 m.

Which of the following measurements is outside of the tolerance?

A 2.312 m B 2.54 m C 2.426 m D 2.39 m Answer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. A shaft has a design diameter of 35.5 ± 1.5 mm.

Calculate the maximum and minimum acceptable diameter.

Maximum \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Minimum \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Practice Sheet: Tolerances**

***Now Try These:***

1. A piece of material has been cut to a measurement of 150 mm x 30 mm. The tolerance allowed is ± 2 mm. Which of the following measurements are within tolerance?

A 147.6 x 29.1 mm

B 148.1 x 31.8 mm

C 150.8 x 27.9 mm

D 152.3 x 30.3 mm

1. A container has been designed to have a volume of 470 ± 25 mm3.

Calculate the maximum and minimum values for the acceptable volume.

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1. A resistor has a nominal value of 330 ohms, with a tolerance of ± 10%.

Calculate the maximum and minimum possible values of the resistor.

Maximum \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Minimum \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. A shaft must fit tightly into a hole in a wheel – if there is more than 3 mm variation in the diameters of the shaft and hole then the wheel will fall off.

Shaft

The hole has a nominal diameter of 25 mm. The maximum tolerances allowed on the hole are +1.5 mm and -0.5 mm.

Calculate an appropriate nominal size and tolerance for the diameter of the shaft.

Wheel

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**Answers:**

**Skill Sheet: Tolerances**

1. B
2. Maximum = 35.5 + 1.5 = 37 mm; minimum = 35.5 – 1.5 = 34 mm

**Practice Sheet: Tolerances**

1. B
2. Maximum = 470 + 25 = 495 mm3; minimum = 470 – 25 = 445 mm3
3. Maximum = 330 + 33 = 363 ohms; minimum = 330 – 33 = 297 ohms
4. Maximum diameter of hole = 25 + 1.5 = 26.5 mm

Hence minimum acceptable shaft diameter = 26.5 – 3 = 23.5 mm

Minimum diameter of hole = 25 – 0.5 mm = 24.5 mm

Maximum acceptable shaft diameter = minimum diameter of the hole

Hence the shaft diameter must be between 23.5 and 24.5 mm.

An appropriate size for the shaft would be 24 ± 0.5 mm.

(Accept any other combination of values which allow the specified range of shaft diameter).