

# TUNNELWORKS

## KS3 SCIENCE LESSON 2 WORKSHEET

### SAFE & STABLE: FORCES & PRESSURE

**Construction Engineer's Note: Battersea**

The crane position is critical for site planning and safety. We need to calculate the maximum safe distance we can locate the crane from the edge of the shaft.

Mark on this crane where the load, effort and pivot are. Show the direction of each force:

How would you describe the forces on the crane when it is stable?

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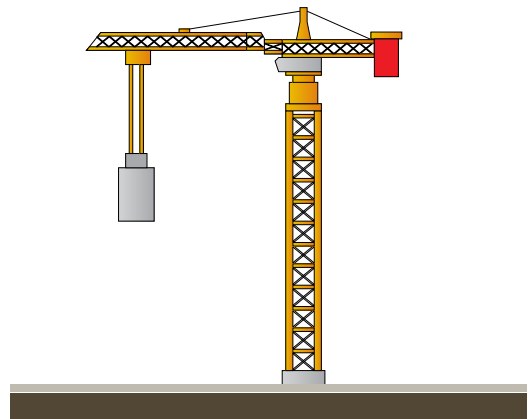
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Why is this important when calculating the position of the counterweight?

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**Challenge 1: Safety table**

This table shows important safety information for the crane operator. They will use this table to ensure their crane is always stable. **Fill in the missing data. Remember 1kg mass acts with a force of 10N.**

Load (kg)	Distance (m)	Load turning moment (Nm)	Counterweight turning moment (Nm)	Counterweight (kg)	Distance (m)
e.g. 4,000	25	1,000,000	1,000,000	10,000	10
6,000	40		1,000,000	10,000	10
				20,000	10
10,000	15	1,500,000		10,000	

**Challenge 2: Crane location**

The site engineers need to know where to locate the crane when it is lowering the first Tunnel lining segments one at a time, before a permanent gantry crane is installed that can lower many segments at once. **How far outside the edge of the shaft can the centre of the crane be?**

- Each Tunnel lining segment has a mass of 5.5 tonnes
- The crane's 20 tonne counterweight can be up to 15m from the crane's centre column

The crane must lower the load at least 15m from the inside edge of the shaft.