1

Engineering means using science, maths and technology to solve problems. It can mean improving technology that already exists or inventing something completely new.

Engineering is done by engineers – match the engineers below with their specialism.

1. Civil engineers	A. Design and build machines such as cars and trains.
2. Electrical engineers	B. Design and build systems to allow electricity to be used in everyday life.
3. Computer engineers	C. Design and build towns and cities – from bridges to buildings, road and railways.
4. Mechanical engineers	D. Design and build computers and write the software they run on.

Which of these engineers do you think were needed to help redevelop this area of the Docklands?

Now tell your teacher and swap for the next card!

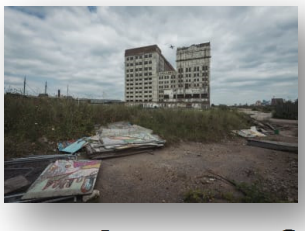
2

Most engineering projects start with a problem that needs a solution.

The engineers who had to redevelop this area of the Docklands in the 1980s and 1990s had a lot of problems they needed to find solutions to.

Pick out the real problems you think they had to solve below:

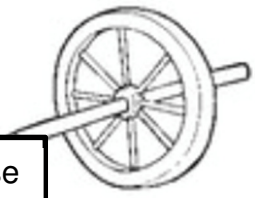
1. The area had very few transport links and was quite isolated from the rest of London. Without good transport links, no businesses would set up here.
2. There was no space to build on.
3. The old docks were still needed by the shipping industry so couldn't be knocked down.
4. The housing in the area was very run down and needed improvement if people were to be attracted to live in the area.
5. It would be hard to build large buildings on the old docks – some would need to be filled in.



Tell your teacher and swap for the next card!

3

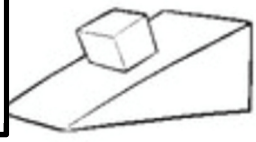
Simple machines are devices that make it easier to push, pull or lift things. There are six simple machines; here are three examples.



A wheel and axel – these make it easier to move things around. The axel (rod) attached the wheels together.

A pulley – this makes it easier to lift heavy things.

An inclined plain – this is a clever way of saying a ramp! It makes it easier to move things up and down.



Look at the view around you – can you find at least one example of each of these simple machines?

Show your teacher an example of each and swap for the next card!

4

The O2 structure was originally designed as a monument to space and time.

Can you guess what each of the following measurements represent?

- ☐ The diameter of the O2 is 365 metres.
- ☐ There are 12 tall yellow masts
- ☐ The summit of the walkway is 52 metres high.
- ☐ There are 24 scalloped cut-outs on the edge of the canopy

Why is ‘time’ so relevant in this area of London?

Tell your teacher and swap for the next card!

5

The engineers who designed the original Dome wanted this building to be iconic; and it certainly is impressive.

Which of the following facts about it do you think are true?

1. The tent structure of the O2 is the world's largest fabric structure.
2. The O2 is visible from space.
3. You could fit twelve double decker busses on top of each other under the O2.
4. The Eiffel Tower would fit inside the O2.
5. The entire roof structure weighs less than the air contained within the building.

Tell your teacher and swap for the next card!

6

The walkway you will use to climb back down to the ground has an incline of 30°.

Using your hands, show this angle to your teacher – each member of your group must be as accurate as possible.

Do you know the name of this type of angle?

Show your teacher and swap for the next card!

7

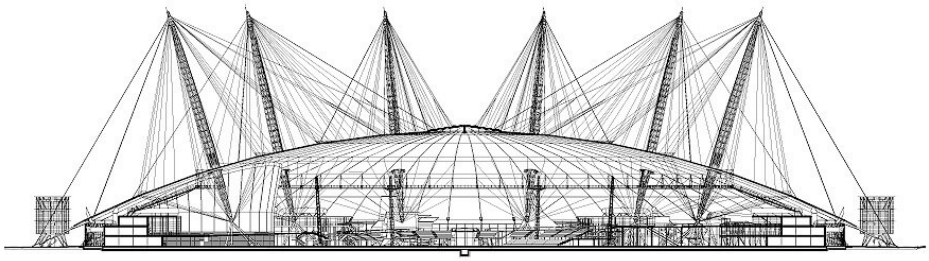
Look at the yellow masts that help to support the tent structure. Can you estimate how tall they are?

Tell your teacher and swap for the next card!

8

The cover of the O2 is suspended and supported by over 70km of steel cables attached to the tall yellow masts.

Can you and your group think why steel was chosen as the material for these cables? Try to give at least two properties of steel in your answer.



Tell your teacher and swap for the next card!

9

Engineers covered the O2's tent structure with Teflon.
Teflon is a chemical coating.

Can you think why they might have covered the fabric of the tent with this?

Try to come up with a sensible guess.

Tell your teacher and swap for the next card!

10

This part of London used to be the world's largest port – the river was busy with ships carrying cargo from all over the world, the river edges were crowded with factories and warehouses and people flocked here looking for work on the docks.

When the docks closed the area became derelict and was largely abandoned. In the late 20th century planning began to transform the area into something that was desirable to both live and work in. But before they could build anything, engineers had to make sure people could access the area. Good transport links were vital.

Over 70% of the O2's visitors now travel with public transport; this helps the O2 to function sustainably.

Look at the view around you. Come up with a list of at least five different ways visitors can travel to the O2 that you can see from the top.

Show your teacher and swap for the next card!

11

Look at the view around you. See if you can find Canary Wharf, an area of office buildings built on what was once docks. Thousands of people now work in the offices there.

Canary Wharf in 1934

Canary Wharf now

Approximately 20,000 people travel down the 23 escalators at Canary Wharf Underground station each hour in the morning rush!

Can you and your team work out how many people travel on Canary Wharf's escalators each minute?

Give your answer to the nearest integer (whole number).

Tell your teacher and swap for the next card!

(Hint: remember, if you are expecting a larger number as your answer, multiply. If you are expecting a smaller number, divide.)

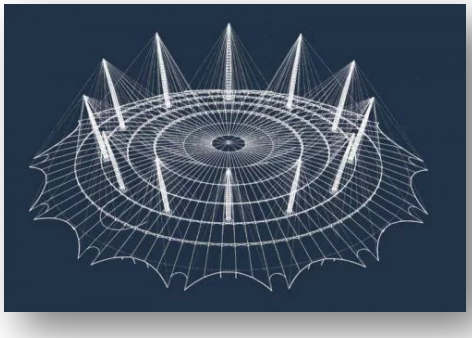
12

Engineering is about making ‘things’ that work and making ‘things’ work better.

Look at the amazing buildings, equipment and machines around you.

What skills and habits of mind do you think engineers need?
Try to think of at least three more to add to the list.

- ☐ Problem-finding
- ☐ Problem solving
- ☐ Ethical consideration
- ☐ ……..
- ☐ ……..
- ☐ ……..



Tell your teacher and swap for the next card!

13

The higher you climbed up the walkway today, the more **potential energy** you gained.

As you climb back down at the end of your visit, the potential energy you have stored from being higher up will change into **kinetic energy** – the energy of movement.

What will stop you from zooming downwards?

Can you think of one way you could *slow* your descent to the ground and one way you could *speed up* your descent to the ground?!

Use your imaginations, creativity and your understanding of forces and energy.

Tell your teacher (in a scientific way if you can) and swap for the next card!

14

Engineers have to work together – this is called collaboration.

Can you and your team work together to spell O2 with your bodies?!

Show your teacher and swap for the next card!

15

Engineers typically work together to solve problems that face society. Below are the usual steps in an engineer's design process, but they are muddled up.
Put them in the correct order:

A. **Picking the best solution** – the final decision will need to meet all the criteria (engineers will need to consider costs, practicality, materials, time-scales etc.)
B. **Researching possible solutions** – coming up with ideas to address the problem.
C. **Identifying a problem** – observing and seeing a need for a solution.
D. **Building a prototype** – building a working model of the chosen design.
E. **Improving the design** – engineers usually repeat some of the 5 steps until they are happy with the finished plan.
F. **Testing the prototype** – making sure the working model solves the problem that was first identified.

Tell your teacher and swap for the next card!

16

Skyscrapers are buildings that have over 40 floors and are taller than 150 metres. Buildings above 300 metres are called **supertall skyscrapers**, and those over 600 metres are known as **megatall skyscrapers**.

Buildings can be built this tall because they are strengthened with steel rods and beams, making the 'skeleton' of the skyscraper. They also need strong bases and foundations.

Have a look around you. Point out the tallest skyscraper you can see.

Using the information panels, find out the address of the skyscraper and decide what type of skyscraper it is.

Tell your teacher and swap for the next card!

(Clue: it is 235 metres tall and has 50 storeys).

17

When you climbed up the walkway to reach the top of the O2, you were climbing an incline of 28°. Many forces were at work to help you reach the top.

Can you and your team think of which forces were acting on you as you climbed the walkway?

NOTE: A side-on view of someone climbing up the walkway would be better here – with arrows coming outwards from them forwards and backwards (a force diagram) to encourage children to think of forces acting against them and forces helping them to move.

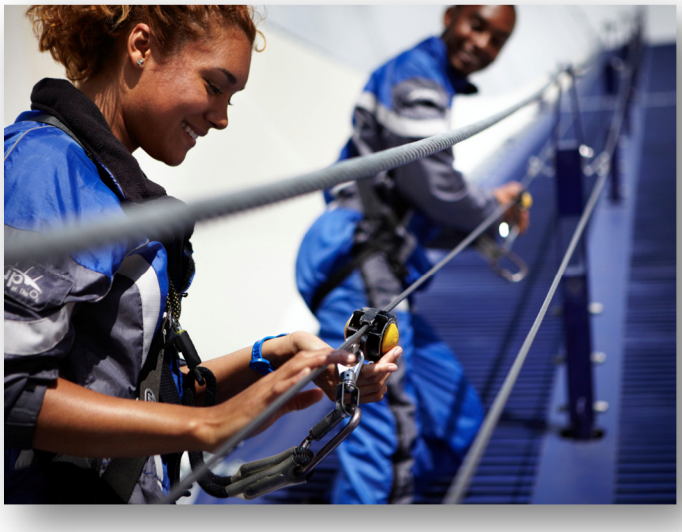
Tell your teacher and swap for the next card!

18

Friction is a force between two surfaces that are moving against each other. Friction always works in the opposite direction to the movement of the object; it slows a moving object down.

Friction has been very useful to you today!

Can you name three examples of friction you have encountered since you have been here at Up At The O2 (think about all the things that stopped you slipping as you climbed)?



Tell your teacher and swap for the next card!

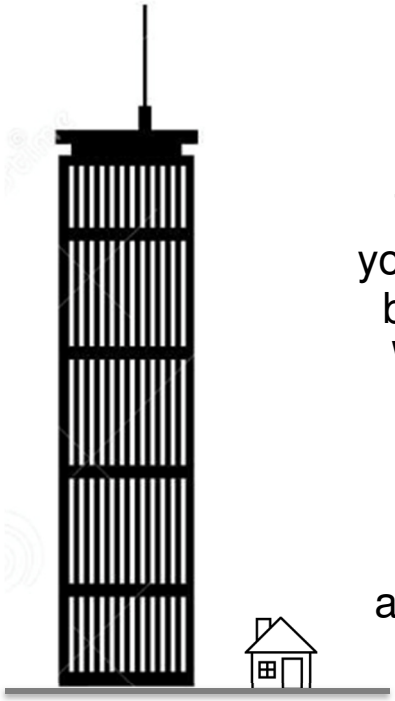
19

From the top of the O2 you have awe-inspiring views of London.

The base of the O2 is a circle.
So how many degrees wide is your view?

The diameter of the base is 365m.
Can you and your team work out the radius?
Can you explain to your teacher what the circumference of a circle is?

Tell your teacher and swap for the next card!



20

There are a variety of buildings in the area you can see around you – some older low-rise buildings, some huge, modern skyscrapers. Which do you think would be more likely to topple over in strong winds?

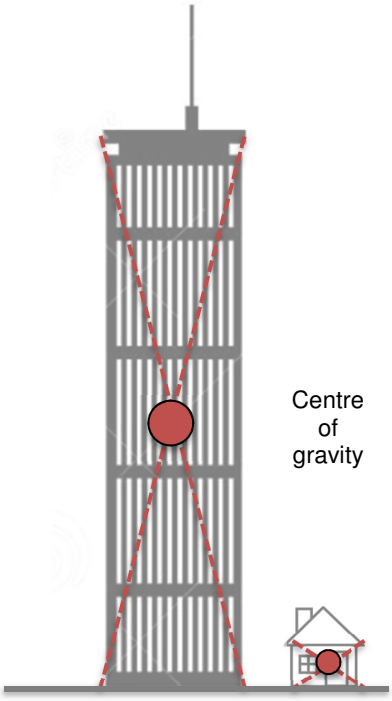
That's right – the tall skyscraper. This is because the weight of a building balances around an imaginary point called a CENTRE OF GRAVITY. All objects have one – including you!

<u>The taller the building, the higher the centre of gravity.</u>
<u>The lower the centre of gravity, the more stable the building.</u>

Engineers have to find ways to lower the centre of gravity to make skyscrapers stable. Can you think of how they might do this?

Discuss this as a team.

Tell your teacher and swap for the next card!



Hint: Adding weight to the *top* of a building *raises* its centre of gravity…you need to do the opposite…