Welcome to the Tomorrow’s Engineers EEP Robotics Challenge 2019/20!

All across the world, people are working hard to find solutions to challenging environmental problems and we are delighted that this year’s Robotics Challenge is about what engineers do to help make the environment better and to create a more sustainable world.

The work that engineers do affects billions of people. Engineers have creative and hands-on jobs which involve solving problems and designing great things to improve the world. As an engineer, you could help tackle some of the world’s most important problems – from maintaining clean water and energy supplies, to finding sustainable ways to grow food, build houses and travel the globe.

We hope you have an amazing time taking part in the Challenge this year! We are really looking forward to meeting all of the teams from 575 schools across the UK who are taking part. At your Regional Final, you will showcase how successful your team has been in attempting the challenges below.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Robot Challenge Mat</td>
<td>Can you build and program a LEGO MINDSTORMS EV3 robot to complete a range of exciting mat-based tasks in preparation for your Regional Final? Here your team will have two chances to score as many points as possible on the table-top challenge in 5 minutes and 30 seconds.</td>
</tr>
<tr>
<td>Speed &amp; Control Challenge</td>
<td>Build and program your MINDSTORMS EV3 robot to cover a distance as quickly as possible and then return home! Build a fast robot and stay in control of it. At the Regional Final, you will have two attempts to race AND return!</td>
</tr>
<tr>
<td>Robot Design</td>
<td>To complete the challenges above, you will have to build and program some great robots! At the Regional Final, you will present your robots to a small group of friendly reviewers. Your team will need to explain what you have learned about robot design and programming. It’s a great chance to reflect and celebrate your beautifully raised robots!</td>
</tr>
<tr>
<td>Project Presentation</td>
<td>At the Regional Final, your team will deliver a presentation that you have prepared on an environmental topic. A team of friendly reviewers will listen to your presentation and they might even have some questions about your amazing ideas. Make sure all members of the team play a role and enjoy it!</td>
</tr>
<tr>
<td>Teamwork Challenge</td>
<td>We can’t say anything about this Teamwork Challenge as it will be set on the day of your Regional Final. It will be an exciting surprise for everyone. No preparation is needed - just be a great team!</td>
</tr>
</tbody>
</table>

Good luck!

from
The Tomorrow’s Engineers EEP Robotics Challenge Team
BEFORE YOU START…

Sorting out the pieces
Get the pieces together and make up the ramp (this is used on the Robot Challenge Mat)

REMOVE the following pieces:
(These are drawn TO SCALE to make sure you get the right ones). You will need them for use on the Robot Challenge Mat.

Next… open this bag
(REMOVE the following pieces:
(These are drawn TO SCALE to make sure you get the right ones). You will need them for use on the Robot Challenge Mat.

Really important
Take the TWO BIG TYRES and RIMS shown above and put them together like this:

Really important: Notice how the rim sticks out from the bottom of the tyre. This will allow it to slide over the surface of the Robot Challenge Mat.

Additional pieces
You will also need these pieces in the separate bag:

-- LEGO TREES, PLANTS, FROGS & FLOWERS
-- ONE PING PONG BALL
-- TWO DICE
-- STICKER FOR THE BATTERY

KEEP ALL THESE PIECES SAFE!
From the remaining LEGO pieces in your bag you can build an... ECO VEHICLE

You will need this for use on the Robot Challenge Mat!

An idea to get you started:

Every ECO VEHICLE needs a sail. Trace around a BLUE PLASTIC TEMPLATE to make your own sail out of paper or card…

In the Robotics Challenge, you will have to attach the LEGO Battery and Engineer to your ECO VEHICLE – so leave plenty of space!

Add something for your MINDSTORMS robot to ‘grab’ hold of at the front of your vehicle!

You don’t have to use four small wheels – it might look cool with three!

Decorate your sail in your team style! And then attach it…

And finally build the BATTERY CONTAINER for TASK E

You need to construct this from the elements in YOUR LEGO MINDSTORMS SET. You’ll need to place the “structure” inside the red dotted line area of the BATTERY STORAGE AREA. Remember it needs to hold the black weighted LEGO brick (the battery) and be grabbed easily by your robot!

Here is an example structure…
Robot Challenge Mat

Setting up the Mat

1. Position your eco vehicle anywhere within the red dotted lines at the eco centre.

2. Place the battery inside the structure you’ve built and place the structure in the battery store, staying within the red dotted lines.

3. At the recycling centre, use the elastic band to hold the plastic (ping pong ball) in place. Put the engineer in her position. Keep them within the red dotted lines.

4. Add the biggest tree to the tree nursery, staying within the red dotted lines.

5. Put three flowering plants, one small tree, one bush, two frogs, two leafy shrubs and two white fences in place within the nature and wildlife area – staying within the red dotted lines.

6. Roll the dice, and place your two tyres according to the two numbers rolled. Shake a ‘double’ and you can choose the positions. But stay within the red dotted lines. Remember to make sure the rims stick out of the bottom of the tyres – so they slide!

7. Set the angle of the ramp and position it within the red dotted lines of the ramp recycler. Use the dual lock tape provided to secure it. There are six guides marked in the white area to help with this.

8. Watch the setup video – it makes setting up really easy!

GOOD LUCK!

CAUTION: MIND (GET OVER) THE BUMP!
Robot Challenge Mat

A good plan...
There are 8 TASKS for you to attempt on the mat. You will have a total time of 5 minutes AND 30 seconds. You should work out a plan. Which tasks will you attempt? Maybe you will just focus on a few tasks - you don’t have to complete them all but we ask that all teams attempt TASK A. Build up your #LEGOconfidence and have fun!
You can do the tasks in any order BUT TASK A should be performed FIRST while TASK H should be attempted LAST (if you choose to do it). Remember, you can pick your robot up when it is in the ROBOT ZONE. If you pick it up outside the ROBOT ZONE you will incur a penalty point!
So let’s get started! Good Luck!

TASK A:
ROBOT SHOWTIME

Instructions
Program your robot to present a 30 second environmental message! The focus might be energy conservation, recycling, reducing pollution, etc. Place your robot in the ROBOT ZONE and have your robot ‘showcase’ its environmental message for 30 seconds (the robot should stay on the mat). The reviewers will be looking for a combination of:

- A 30 second routine
- The coordinated movement of your robot - give it a bit of style!
- The individual look of your robot – make use of the LCD display screen with your team logo or message!
- Your own team’s environmental ‘soundtrack’ or ‘voiceover’ played back through the robot speakers!
- A great name for your robot!

Task Points and Success Criteria

<table>
<thead>
<tr>
<th>Persistent (1 point)</th>
<th>Good to see your robot out there, but there were a few wobbles!! so it might need a bit of re-engineering!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert (3 points)</td>
<td>A good attempt – but a little more polish is needed…</td>
</tr>
<tr>
<td>Master (5 points)</td>
<td>What a perfectly presented robot! A showcase to be proud of - all aspects achieved!</td>
</tr>
</tbody>
</table>

Common Questions:
Q: Does the 30 seconds come out of the 5 minutes and 30 seconds allocated to the whole Robotics Challenge?
A: Yes – after this you have 5 minutes to complete the other TASKS.

We hope that first TASK goes well! You still have 5 MINUTES left - get that robot working on the remaining TASKS...
Civil engineers and construction engineers routinely assess what effect their projects have on the environment. Huge efforts are made to minimise the impact on the environment and to protect the natural habitat, including any wildlife. During the planning phase for new buildings, roads and power supplies, the team will always ensure that no unnecessary deforestation takes place. This is because trees are like the lungs of the planet - breathing in carbon dioxide and breathing out oxygen. They also provide important habitat for our birds and other wildlife, so we need to protect our precious trees and plant more trees too!

"UK forests currently cover 12% of our land area. This is very low compared to some of our European neighbours. For example, France and Germany have forest cover of 29% and 32% respectively. Of Europe’s total land area, forest cover makes up 47% of that. The UK is seriously lagging behind and must improve."
Source: WOODLAND TRUST

"The ‘green corridor’ [the land around a railway] is relatively undisturbed thanks to a lack of public access. For example, common lizards, grass snakes, deer and water vole make their homes close to the railway in East Anglia, while slow worms have been spotted in the south-west of England. Pipistrelle bats also often live on the railway, roosting in trees, tunnels and bridges."
Source: NETWORK RAIL

Instructions
Using your hands, take the BIGGEST TREE from the TREE NURSERY and then position it so your robot can take it from the ROBOT ZONE to the TARGET AREA of the NATURE & WILDLIFE AREA. Program your robot to ‘plant’ the tree - you can push, lift or ‘shove’ the tree into place. Just be careful not to destroy any of the current habitat (or you will lose a point)!

Task Points and Success Criteria

<table>
<thead>
<tr>
<th>Persistent (1 point)</th>
<th>Attempted the task – you got the TREE close to the NATURE &amp; WILDLIFE AREA. Who knows, it might still grow there!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert (3 points)</td>
<td>TREE FULLY in RED ZONE of the TARGET AREA and UPRIGHT. You can hear the wildlife cheering!</td>
</tr>
<tr>
<td>Master (5 points)</td>
<td>TREE FULLY in BLUE ZONE of the TARGET AREA and UPRIGHT. You could sit back and watch your tree grow but there are more TASKS to do!</td>
</tr>
</tbody>
</table>

Common Questions:
Q: If we damage the habitat during any of the TASKS do we lose points?
A: Yes, but only to a maximum of 2 points in total.

As an Environmental Engineer, the focus is to help keep the world’s population healthy. Different specialist areas within environmental engineering include: climate change, disposing of waste, dealing with water pollution (e.g. oil spills) and air pollution, flooding, recycling, deforestation and energy.

While the ultimate goal is to stop pollutants from entering the environment in the first place, clean-up projects play an important role. Sometimes rivers, oceans and land can be heavily polluted by oil, chemicals, plastics and other unwanted materials.
The cleaning up of environmental pollution involves a variety of techniques, ranging from biological processes to advanced engineering technologies. Once a body of water gets polluted, it’s difficult to clean up. Removing pollutants from a body of water is expensive and time-consuming. You now need to think like an engineer and work out the best way to complete this TASK.

**Instructions**

You need to program your MINDSTORMS robot to collect the two discarded TYRES that will have been placed on two of the 6 marked areas of the mat as part of the MAT SETUP. Their placement will have been decided by the shaking of two dice at the start of the challenge.

These tyres are polluting the environment; how you collect the tyres and return them back to the ROBOT ZONE is up to you! You might want to make use of the railway track. **Your team can get maximum marks by returning to the ROBOT ZONE only ONCE during this task.**

**Task Points and Success Criteria**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent</td>
<td>Attempted the task – looks like we might still have a pollution problem. Maybe a bit of re-engineering is needed.</td>
</tr>
<tr>
<td>Expert</td>
<td>One tyre returned to the ROBOT ZONE. Nice try – you have reduced the pollution problem!</td>
</tr>
<tr>
<td>Master</td>
<td>Both tyres returned to the ROBOT ZONE with your robot only returning to the ROBOT ZONE once. Wildlife will soon return to the unpolluted waters!</td>
</tr>
</tbody>
</table>

**Common Questions:**

Q: The tyres don’t slide over the mat very well – what can we do?
A: Make sure that you followed the instructions on the information page called ‘BEFORE YOU START…’

Q: What is the area marked ‘CALIBRATION ZONE’?
A: This is only useful if you need to use the Colour Sensor - and its use is explained in the Raising Robots’ Tutorials on the Tomorrow’s Engineers’ website. [www.tomorrowsengineers.org.uk/robotics](http://www.tomorrowsengineers.org.uk/robotics)

Q: What happens if both tyres are returned in two trips?
A: You will be awarded 4 points!

**TASK D:**

**RETRIEVE THE ECO VEHICLE**

5 POINTS

The ECO VEHICLE is a wind-powered vehicle that gets its power from its sail. What a creative way of moving around! Your ECO VEHICLE can also be installed with a rechargeable battery that can be used when there is not enough wind to power your vehicle. Mechanical engineers, electrical engineers, software engineers and design engineers are all involved in developing new types of vehicles, such as electric vehicles, smart vehicles and driverless vehicles. Imagine the new and exciting types of vehicles that engineers will be designing in 10 years’ time…

**Instructions**

You need to get your ECO VEHICLE back to the ROBOT ZONE. It is currently secured behind the SECURITY GATE in the ECO CENTRE.

**IMPORTANT: YOU WILL NOT SEE THE SECURITY GATE UNTIL THE DAY OF THE COMPETITION. YOU CAN SEE ITS POSITION FROM ABOVE ON THE MAT. AND HERE ARE SOME MORE CLUES…**
There is growing demand for batteries to power cars and store energy, with the market estimated to be worth £5 billion to the UK and £50 billion to Europe by 2025.

In Coventry, a new national centre of excellence in battery technologies (aimed specifically at electric car energy storage) is seen as a stepping stone to a large-scale battery factory for electric vehicles – a ‘giga-factory’. The facility will be a huge boost in the race to lead the world in the production of electric vehicles! This is an increasingly important market as we tackle air pollution and climate change… and the fact that it’s a growing industry means there are lots of great job prospects for engineers.
Instructions
The battery for your ECO VEHICLE is in the BATTERY STORE (inside the structure you built) and you need to get it back to the ROBOT ZONE.

Program your MINDSTORMS robot to collect the structure that you created (with the BATTERY inside) from the BATTERY STORE and bring it back to the ROBOT ZONE. The structure must not make contact with the mat once it leaves the BATTERY STORE. It should only make contact with the mat again once it is safely in the ROBOT ZONE.

Once you have retrieved the BATTERY to the ROBOT ZONE, attach it to the ECO VEHICLE (if you have retrieved it).

Task Points and Success Criteria

<table>
<thead>
<tr>
<th>Persistent (1 point)</th>
<th>Attempted the task. Great to see you attempting to retrieve your structure with its BATTERY cargo. Keep trying!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert (3 points)</td>
<td>What a great effort at getting the BATTERY to the ROBOT ZONE - you almost made it! Just power up a few more of your robotics skills…</td>
</tr>
<tr>
<td>Master (5 points)</td>
<td>The BATTERY is back to the ROBOT ZONE - you did it without it touching the mat! If only we had time to celebrate…</td>
</tr>
</tbody>
</table>

Common Questions:
Q: Will we lose a mark if we don’t get the battery attached to the ECO VEHICLE?
A: No - you get full marks for getting the battery back.

TASK F: RECYCLING CENTRE

“Just 5% of plastics are recycled effectively, while 40% end up in landfill and a third in fragile ecosystems such as the world’s oceans.”
Source: theguardian.com (January 2016)

Recycling centres play a key role in our communities. At our Recycling Centre (on the mat), there is a Materials Engineer who is carrying out some research on plastic recycling. Materials engineers work in different industries and they look at how to combine or change materials. They want to improve the performance, durability, renewability, and cost-effectiveness of the materials.

It is great that we are recycling and reusing materials and we need to continue to move away from single use materials in the future.

Instructions
You need to program your MINDSTORMS robot to go to the RECYCLING CENTRE and retrieve both the ‘PLASTIC’ (PING PONG BALL) and the ENGINEER and then return them to the ROBOT ZONE. Your robot can get them back to the ROBOT ZONE using any method (push, pull, drag, lift, scoop, etc).
Common Questions:
Q: Do we need to collect the ENGINEER and the PLASTIC at the same time?
A: No, but you can do!

**TASK G: CHARGE UP THE ECO VEHICLE**

“All we estimate [in London] there are 360 primary schools and 78 secondary schools located in areas exceeding legal pollution limits for nitrogen dioxide. This is based on analysis using the London Atmospheric Emissions Inventory 2013.”
Source: MAYOR OF LONDON

All of those cars waiting outside schools have a negative impact on the environment. You can see that the forward-thinking school on the mat has built an ECO CENTRE for young engineers to develop new and innovative forms of transport.

The good news is that sales of electric cars are rising which is great news for the environment! But electrification of vehicles is not just about developing amazing electric cars. We are all familiar with the idea of electric trains, but other forms of transport are embracing electrification too. For example, Rolls-Royce is leading a highly specialised challenge to build the world’s fastest all-electric aircraft. This zero-emissions, electric-powered aeroplane will have the most powerful battery ever built for flight. Exciting times for future engineers!

**Instructions**

You need to get your amazing ECO VEHICLE charged up at the CHARGING STATION but it needs to be taken there by your MINDSTORMS robot. You will need to attach the BATTERY to the ECO VEHICLE and it would be great to have the ENGINEER onboard too! Go and get powered-up!

Program your MINDSTORMS robot to deliver the ECO VEHICLE (with the ENGINEER and the BATTERY onboard) to the ELECTRIC VEHICLE CHARGING STATION, keeping the ECO VEHICLE within the bay lines.

**Task Points and Success Criteria**

<table>
<thead>
<tr>
<th>Persistent (1 point)</th>
<th>Attempted the task – but neither the ENGINEER nor the ‘PLASTIC’ made it back to the ROBOT ZONE. Keep trying!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert (3 points)</td>
<td>Either the ENGINEER or the ‘PLASTIC’ made it back to the ROBOT ZONE. Good job!</td>
</tr>
<tr>
<td>Master (5 points)</td>
<td>Both the ENGINEER and the ‘PLASTIC’ made it back to the ROBOT ZONE. You are a top recycler!</td>
</tr>
</tbody>
</table>

**Common Questions:**
Q: We didn’t collect the BATTERY or the ECO VEHICLE so I suppose we can’t complete this TASK?
A: Yes, you can – if you didn’t get the items back to base, just grab them so you can have a go at this one.
Let’s carry on working hard to reduce the amount of plastic waste we create in our lives by reusing, recycling and upcycling – it’s a great way forward!

- Around 15 million plastic bottles per day are used in the UK which are classed as ‘single use’.
- The average household in the UK uses 480 plastic bottles each year, with only 270 being recycled which means 44% are being sent to landfill.
- 1 recycled plastic bottle would save enough energy to power a light bulb for 3 hours.

Source: recyclenow.com and recyclingbins.com

**Instructions**

You need to program your MINDSTORMS robot to climb the RAMP RECYCLER, starting from the ROBOT ZONE. When it gets to the ‘YOU MADE IT’ LINE, it should attempt to get the ‘PLASTIC’ (PING-PONG BALL) into the recycler.

GO ON… attempt the Recycle Ramp Challenge!

**Task Points and Success Criteria Example**

**Recycle Ramp Challenge Multiplier:**

You start with 4, 3, or 2 points, depending on the position of the ramp that you set before the start.

Multiplied by 0 if it fails to get to the ‘YOU MADE IT’ LINE.

+1 point for depositing the plastic into the hole.

-1 point if the robot falls off the top of the ramp! Whoops!

Note: The front-facing side of the MINDSTORMS Intelligent Brick must be at least partially over the ‘YOU MADE IT’ LINE.

<table>
<thead>
<tr>
<th>Example A</th>
<th>The ramp is set to position 4 but our robot doesn’t get to the ‘YOU MADE IT’ LINE.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RESULT: 4 x 0 = 0</td>
</tr>
<tr>
<td></td>
<td>TASK ATTEMPTED = 1 POINT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example B</th>
<th>The ramp is set to position 3 and we get our robot the whole way up and deposit the ‘PLASTIC’.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RESULT: 3 + 1 = 4 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example C</th>
<th>The ramp is set to position 4 and we get our robot the whole way up but it falls off the top of the ramp after depositing the ‘PLASTIC’.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RESULT: 4 + 1 - 1 = 4 points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example D</th>
<th>The ramp is set to position 4 and we get our robot the whole way up and it deposits the ‘PLASTIC’.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RESULT: 4 + 1 = 5 points</td>
</tr>
</tbody>
</table>

**Common Questions:**

Q: There is a bump (where the ramp meets the mat) – what can we do about it?

A: Design your robot so it can get over the bump!
An Electric Revolution?

It might soon be the norm to plug in an electric vehicle, in the same way that we have all become used to plugging in our mobile phones to charge them with power.

Electric vehicles still make up a small percentage of car purchases and they also present some environmental challenges themselves. However, electric vehicles are now becoming a real choice for consumers over the internal combustion engine, after 140 years of dominance! It is time for you to channel your inner electrical engineer, using your robotics engineering skills to create an electric vehicle of your own, then put it through its paces...

Speed is part of this challenge. The Royal Air Force, working with the likes of Rolls-Royce, has announced that it is developing hypersonic planes which will fly at more than 3,000 mph! Incredible speeds that will need to utilise amazing engineering and technology in order to stay in control of the plane. It is a fine balance between speed and control. Can you get this balance right when developing and programming your electric vehicle? Good luck.

Instructions

Use MINDSTORMS to develop your own ELECTRIC VEHICLE. This challenge is about speed AND controlling your vehicle. You need to program your ELECTRIC VEHICLE to...

- START in the YELLOW ZONE (your vehicle needs to fit inside this area). The timer will START as your vehicle exits the YELLOW ZONE.
- Get the WHOLE of your vehicle (including all cables, etc) into the WHITE ZONE as fast as you can.
- THEN get your vehicle to RETURN to the YELLOW ZONE. The timer will STOP as your vehicle re-enters the YELLOW ZONE.
- There is a 10cm high LEGO DUPLO WALL at the end of the track – try not to let your vehicle crash into it!

Penalties

- NO TIME RECORDED if NONE of the vehicle enters the WHITE ZONE.
- 3 SECOND PENALTY if not all of the vehicle enters the WHITE ZONE.
- 4 SECOND PENALTY if the vehicle hits the DUPLO WALL!
- NO TIME RECORDED if your vehicle fails to get back to the YELLOW ZONE, where it will STOP the Timer.

Notes

- You can only use LEGO MINDSTORMS parts
- You can only use ONE LEGO MINDSTORMS EV3 Intelligent Brick
- You must stay within the confines of the track – it has a solid black border round the edge
- You will get TWO attempts on the day and your best time will be the one that counts. We will have a ‘Top Gear’ style scoreboard that will track your position!

Points will be awarded as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Winner</td>
<td>20</td>
</tr>
<tr>
<td>In the top 25%</td>
<td>17</td>
</tr>
<tr>
<td>In the second 25%</td>
<td>13</td>
</tr>
<tr>
<td>In the third 25%</td>
<td>10</td>
</tr>
<tr>
<td>In the final 25%</td>
<td>7</td>
</tr>
<tr>
<td>Failed to compete</td>
<td>0</td>
</tr>
</tbody>
</table>

Tips

Go fast but stay in control – think about your stopping distance! The material of the track will be the same material as the one used on your Robot Challenge Mat.

Q: Can we nudge our vehicle to stay on the track?
A: Yes.

Q: Can we physically turn our vehicle around or physically stop it from hitting the wall?
A: No.
In this part of the Robotics Challenge, your team needs to work together to be able to explain the thinking behind your robotic creations to a group of friendly reviewers at your Regional Competition Final. Good luck!

As Robotics Engineers, you have designed and developed amazing robots by continuously testing, evaluating, tinkering and improving them so that your robots can complete the Robotics Challenge. This is what the engineers at Rolls-Royce do too:

“Each year at Rolls-Royce, we invest heavily in research and apply our engineering expertise to maximise performance, efficiency and reliability so that we continually reduce the environmental impact of our products and services. We harness the skills and knowledge of our 16,500 engineers to deliver more efficient products and services; we are particularly committed to lowering fuel consumption, emissions and noise.”

Source: ROLLS-ROYCE

Robot Design – Steps to Success…

The engineering process includes really important steps such as: communicating well to generate ideas, selecting and building the best idea, testing and analysing it, then revising the ideas. These are the kind of discussion points you could have with your reviewers about your robot design:

**STEP 1** = Introduce your team and your robots.
**STEP 2** = Describe the key features of your robots – point out all the best bits of your designs! What do you think are the strengths and weaknesses of your robots?
**STEP 3** = Explain what you have learned about the hardware that you have used to build your robot. You might talk about the different motors you have used, or possibly the sensors.
**STEP 4** = Take time to explain some of the programs that you have written. Explain how they bring your robot to life!
**STEP 5** = Explain some of the key challenges you had when building and programming your robots – how did you overcome them?
**STEP 6** = If you were given more time, what other changes would you make to your robot designs and your programs? Why would you make these changes?

Remember:

You don’t have to create a presentation – but you can do if it helps. Encourage all members of the team to be part of the discussion. Take your robots and your programs into the discussion – then the reviewers can see the robots for themselves. Good luck in your Robot Design ‘Show and Tell’!
In this part of the Robotics Challenge, your team needs to work together to prepare a short presentation of around five minutes. You will make this presentation to a group of friendly reviewers at your Regional Competition Final. Good luck!

**Finding Solutions to Global Challenges**

All across the world, people are working hard to find solutions to challenging environmental problems such as: climate change, plastic pollution, air pollution, loss of biodiversity and deforestation. By 2050, it is predicted that you will be one of 9 billion people living on the Earth and this means that the demand for energy, food, fresh water and land will greatly increase. Engineers are having a really positive impact by designing and developing sustainable solutions such as designing carbon capture technology, finding creative ways to harness renewable energy and even building giant recycling robots!

Your mission, as Research Engineers, is to find a solution to this important question:

**How could engineers help future-proof the world?**

You can present a new idea or your own improvements to a current engineering solution.

As Research Engineers, you need to work together to come up with creative and effective solutions to the global challenge that you choose. You then need to be able to communicate your research findings clearly to a team of reviewers – some of them may be engineers themselves. They will be excited to hear all of your team’s great ideas!

**Research Topics**

You can pick one research topic from the grid below or come up with your own!

**What type of engineer do you want to be?**

<table>
<thead>
<tr>
<th>RECYCLING ROBOTS</th>
<th>RETHINKING ROADS</th>
<th>RE-USING MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building robots to clean up the land or sea</td>
<td>Roads that harness kinetic energy, solar panel roads, roads made from plastic waste</td>
<td>Animal-friendly road crossings made from recycled materials</td>
</tr>
<tr>
<td>Robotics engineer</td>
<td>Civil engineer</td>
<td>Civil engineer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RETHINKING MATERIALS</th>
<th>CLEANER ENERGY</th>
<th>CLEANER WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothes, packaging and technology built from environmentally friendly resources</td>
<td>Clean energy for transport: new plane fuels, hydrogen trains</td>
<td>Solutions for clean water</td>
</tr>
<tr>
<td>Materials engineer</td>
<td>Transport engineer</td>
<td>Water engineer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FARMING IN THE FUTURE</th>
<th>SPACE-BASED SOLAR POWER</th>
<th>STORING OUR ENERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming, robotics and food production</td>
<td>Powering the Earth from space</td>
<td>Microgrids – storing energy from various energy sources: solar, wind and hydro</td>
</tr>
<tr>
<td>Agricultural engineer</td>
<td>Aerospace engineer</td>
<td>Systems engineer</td>
</tr>
</tbody>
</table>

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<tr>
<th>FIGHTING WASTE</th>
<th>ECO-BUILDING</th>
<th>DID YOU PICK ONE RESEARCH TOPIC FROM THIS GRID? OR WILL YOU COME UP WITH ONE OF YOUR OWN? WHAT TYPE OF ENGINEER DO YOU WANT TO BE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-engineer</td>
<td>Sustainability engineer</td>
<td>Aerospace engineer</td>
</tr>
</tbody>
</table>

DID YOU PICK ONE RESEARCH TOPIC FROM THIS GRID? OR WILL YOU COME UP WITH ONE OF YOUR OWN? WHAT TYPE OF ENGINEER DO YOU WANT TO BE?
Once your team has carried out lots of research on your chosen topic, this might be a good starting point for organising your presentation for the reviewers:

**Step 1** = Introduce the team and the environmental challenge you chose.

**Step 2** = Explain what your new or improved engineering solution is and what impact it could have on the environment if it is successful.

**Step 3** = Explain what type of engineering the solution relates to. In what ways does it involve engineering skills and expertise?

**Step 4** = Outline how you got your information – what were your research sources? (Extra points for a range of sources or if you contacted a specialist or expert in that area for information!)

**Step 5** = Evaluate your teamwork and communication skills – how did they develop while preparing the research project presentation?

It is entirely up to you as to how your team wants to deliver the presentation. Using presentation software (e.g. PowerPoint) is fine, but we also love creative approaches to presentations! Here are some creative ideas...

**Teamwork Challenge**

A maximum of 40 points are available. We can’t say anything about the Teamwork Challenge as this will be set on the day of your Regional Final. It will be an exciting surprise! We wish you the best of luck!
## Checklist

<table>
<thead>
<tr>
<th>THE CHALLENGES…</th>
<th>WHAT YOUR TEAM NEEDS TO BRING ON THE DAY OF THE REGIONAL FINAL…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robot Challenge Mat</td>
<td>Robot Challenge Mat - if you want to practise! Bring your ECO VEHICLE to use on the Robot Mat. All the other parts will be provided. Ideally bring a laptop/tablet device, just in case you have to tinker with (or replace) your programs! Don’t worry if you haven’t completed tasks. Remember, you get two goes!</td>
</tr>
<tr>
<td>Speed and Control Challenge</td>
<td>Bring your programmed and fully charged MINDSTORMS robot. You will get two goes!</td>
</tr>
<tr>
<td>Robot Design</td>
<td>Have both your programmed MINDSTORMS robots ready to show the reviewers. You might want to bring some notes so you don’t forget your great ideas!</td>
</tr>
<tr>
<td>Project Presentation</td>
<td>Bring your presentation and all the resources associated with it. If you have created a presentation that requires a laptop, please bring a laptop or have it on a USB pen. There will not always be internet connectivity at Regional Events. You will present to between 1 and 3 reviewers.</td>
</tr>
<tr>
<td>Teamwork Challenge</td>
<td>Just bring your great team ready to work together on an exciting and unseen challenge!</td>
</tr>
</tbody>
</table>

There will always be people around to help you on the day. The Regional Final is about highlighting all the things you have done, not focusing on what you haven’t done. If things are still a little imperfect come the day of the Regional Final – don’t worry. Just put your best foot forward and you will learn lots on the day!

### Resources & Support

"We are really excited to have developed this year’s environmental challenge with Tomorrow’s Engineers. Here at Raising Robots, we are now focused on making sure that your team makes great progress with your LEGO MINDSTORMS robots. We can’t wait to see you and your robotic creations at your Regional Final! And who knows? Maybe at the UK Final in Birmingham too!"

At Raising Robots, we have developed some easily accessible learning resources and videos to support you with the challenges…

[www.tomorrowsengineers.org.uk/robotics](http://www.tomorrowsengineers.org.uk/robotics)

GOOD LUCK!

AND DON’T FORGET TO WATCH THE SUPPORT VIDEOS!