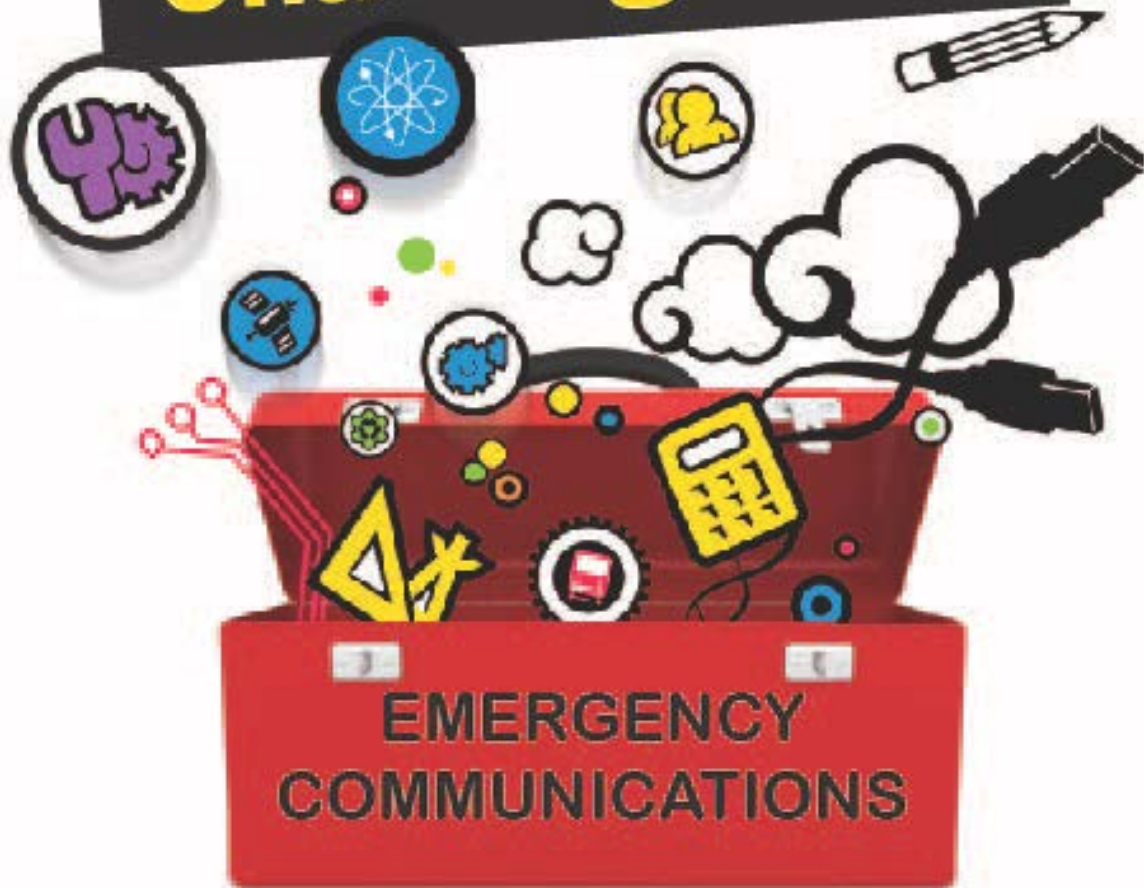


DIY Faraday Challenge Day



Teacher Booklet



The IET DIY Faraday Challenge Day 'Emergency Communications' is based on the Faraday Challenge Day of the same name, a STEM activity day written and delivered by the National Schools Partnership on behalf of the Institution of Engineering and Technology (IET).

The IET Faraday website hosts a wide range of teaching resources for science, design and technology and maths. These include classroom activities with film clips, online games, posters, careers resources and STEM activity days.

www.ietfaraday.org

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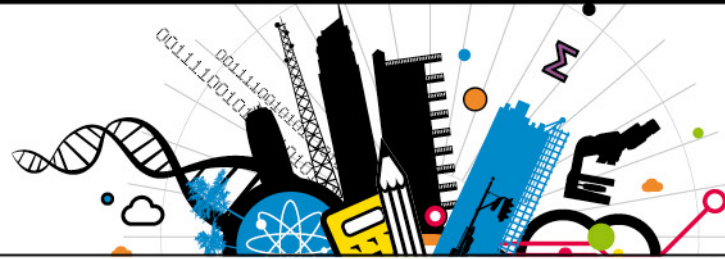


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1. Introduction

The Institution of Engineering and Technology (IET) is one of the world's leading professional societies for the engineering and technology community. As a charity we are committed to the advancement of science, engineering and technology, encouraging young people to study the Science, Design and Technology, Engineering and Mathematics (STEM) subjects and to consider careers within the engineering and technology sectors. We provide a wide range of activities, classroom materials and other learning resources, including the IET Faraday Challenge Days, to schools across the UK.

The challenge has been specifically designed to give students the opportunity to research, design, develop and make creative solutions to genuinely tough engineering problems, independent of their level ability. This activity is therefore suitable for a range of different ability levels.



2. The Faraday Challenge: Emergency Communications

The Faraday Challenge aim is to help students to realise the ideas and knowledge they have, perhaps without realising it, are key skills in engineering and technology professions.

Engineers are vital when a disaster strikes. When there are floods, hurricanes or earthquakes, it is engineers that are needed. As the engineer rescue team, students are challenged to develop an engineering solution to ensure communications between two towns can be maintained. This challenge will develop the students' problem solving, team work and communication skills.

Who is it for?

The Faraday Challenge 'Emergency Communications' has been designed for six teams of six students (36 students in total) aged between 12-13 years.

The context

Ease of communication is part of our life, we pick up the phone, turn on the radio, TV or internet to get news and information. Wifi network work by radio signals. Your phone, TV and radio signals are transmitted by masts we hardly notice. But when all these are knocked out by natural events how do we communicate?

The scenario

Life was good in the towns of Alpha and Beta. However this year, increased solar activity brought disastrous weather. The solar activity caused radiation effects that have disrupted electricity supplies and radio signals.

Torrential rain caused flooding and mud slides on the steep mountain slopes. These brought down nearly all the radio and phone network masts and washed away roads and the telegraph poles for phone lines.

As a result of these extreme weather conditions, people in the surrounding communities have been severely affected. Beta in particular has been cut off completely and there is serious concern about the health, welfare and safety of the population.

All lines are down . . .



The brief

Students are the engineer rescue team based in the town of Alpha which has been relatively unaffected by the extreme weather.

As the engineer rescue team in town Alpha students will need to do 2 things (and quickly!):

1. Design and build a prototype device that will to send coded messages to town Beta
2. Create a code to send a message from Alpha across the mountains for decoding in Beta.

There is little time to lose, with a (simulated) helicopter arriving in a matter of hours to transport half of the rescue team to town Beta to set up the system for testing.

Constraints of your prototype device:

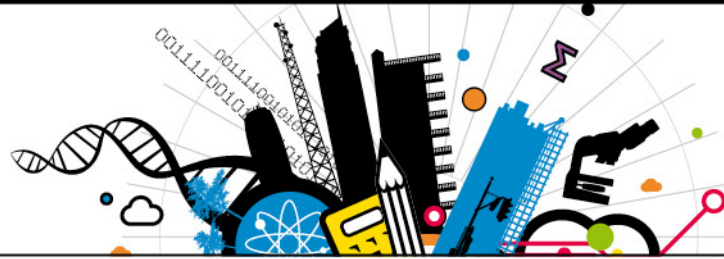
- Must include electrical component to achieve full marks.
- Must send the message over a distance of 5 metres under test conditions.
- Practice messages will be provided to test your prototype; however the message you send in the final phase will be unknown to the rescue team.



Terrain Statistics and Information

Distance between town Alpha and Beta	10 kilometres
Elevation – Height of mountain (distance between sea level and summit of mountain)	2,500 metres
Depth of mountain base	2.5 kilometres
Width of mountain base	20 kilometres
Angle of slope	110 degrees





3. Assessment Criteria

Students will be judge on in the following areas:

Criteria	Marks
1. Planning and research	15 marks
2. Development of communication solution	20 marks
3. Accounting sheet	15 marks
4. Presentation	15 marks
5. Prototype	15 marks
6. Code	15 marks
7. Safe and effective teamwork	10 marks
	Total: 105 marks

1. Planning and research (15 marks)

Using the planning sheet provided, marks will be awarded for:

- Identification of potential problems, constraints and difficulties **(5 marks)**
- Development of minimum 2 creative solutions for the prototype **(5 marks)**
- Development of minimum 2 creative solutions for the code **(5 marks)**

2. Development of communication solution (20 marks)

Using the planning sheet, provided marks will be awarded for:

- Recording your team's agreed solution - include the mechanical and electrical components of your device and how they work together **(7 marks)**
- Identification of the code you will be using **(7 marks)**
- Note of any changes or modifications you make as a team with the reasons you have changed the design. E.g. materials, sizes, manufacture and ease of use etc. **(6 marks)**

3. Accounting sheet (15 marks)

This is a record of all the costs the team has incurred. Marks will be awarded for:

- Accuracy of expenses **(10 marks)**
- Neatness of records **(5 marks)**

If there is a tie between teams at the end of the day, the winning team will be the one who has the most Faradays remaining.



4. Presentation (15 marks)

Summarising your learnings recorded at each stage, your presentation should communicate:

- Why and how you came up with your team's solution **(5 marks)**
- How it could be built in real life **(5 marks)**
- How Science, Technology and Maths were used in engineering your solution **(5 marks)**

There is a maximum of 3 minutes allowed. Taking more time loses marks. Use your planning and reflection sheet to help.

5. Prototype (15 marks)

Your solution will be judged on:

- Mobility - must be easily transported without connections or elements of the design breaking **(6 marks)**
- Quality - must be strong enough to continue to send messages until regular communications are back up and running **(3 marks)**
- Creativity - design must be unique **(3 marks)**
- Functionality - must function effectively, easily and as planned **(3 marks)**

Points will be deducted for not including an electrical component.

6. Code (15 marks)

The team based in Alpha will be given an unknown message to be sent in code to the team in Beta 5 metres away.

Beta will immediately need to decode the message and hand to the judges for checking.

Marks are awarded for:

- Creativity of the coding system – must be unique **(5 marks)**
- Accuracy of relaying the final message to the Judges **(5 marks)**
- Speed – must be easy and efficient to send and receive **(5 marks)**

7. Safe and effective teamwork (10 marks)

Marks are awarded for:

- How you work as a team in your allocated roles **(5 marks)**
- Ensuring that your work station and surrounding area enables safe working and is free from hazards at all times **(5 marks)**

Points will be deducted for not working as a safe and effective team.



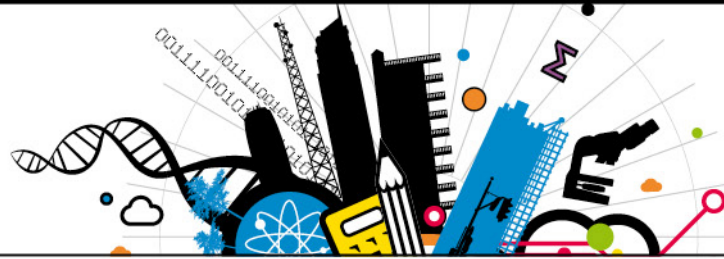
4. Snapshot and tips for the Faraday Challenge Day

SETUP:

08:00 Set up for the day	<ul style="list-style-type: none"> ▪ Student work stations, Inspiration station, Judges area (room layout and requirements, p. 16). ▪ Test area (materials and equipment, p. 22-23). ▪ Materials shop/Technician's area (materials and equipment p. 22-23). ▪ Get extra help from colleagues (at least two colleagues).
09:15-9:30 Students arrive	<ul style="list-style-type: none"> ▪ One team per table (6 teams of 6 students). ▪ Teams complete registration forms.

INTRODUCTION:

9:30 Introduction	<ul style="list-style-type: none"> ▪ Introduce the day, discuss context for the challenge, housekeeping (slide 1). ▪ Show the briefing film (slide 2). ▪ Re-cap of the challenge (slide 3). ▪ Re-cap of the final test (slide 4). ▪ Project development overview - 3 key stages (slide 5).
9:45 Electrical briefing	<ul style="list-style-type: none"> ▪ Health and safety briefing (slides 6-7). ▪ Electrical circuit activity - <i>This mini challenge has been designed to introduce/refresh students on the basic principles of circuits. Building a circuit will be crucial to power their prototype.</i>
10:05 Tools to help you	<ul style="list-style-type: none"> ▪ Provides an overview of how students can seek support throughout the challenge (slides 8-9).
10:10 How to score points	<ul style="list-style-type: none"> ▪ Overview of how students can win points. A full overview can be found in the student booklet (slide 10).
10:15 Role allocation activity	<ul style="list-style-type: none"> ▪ Each student must take on a specific role to complete the challenge successfully (slide 11). A brief overview of these roles has been provided on page 27 and full job descriptions have been provided in the Students' Pack. ▪ Students will need to choose their role within their team.



STAGE 1:

<p>10:20 STAGE 1: Planning and research</p>	<ul style="list-style-type: none"> ▪ Brainstorming, planning and research (slides 12-14). ▪ At the end of this stage, teams should complete stage 1 on their planning and reflections sheet.
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STAGE 2:

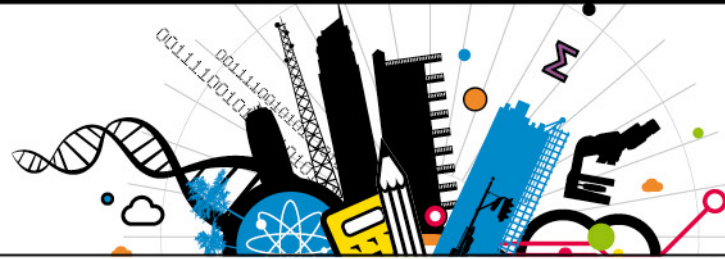
<p>10:50 STAGE 2: Development and modifications</p>	<ul style="list-style-type: none"> ▪ The shop opens – you may like to suggest that only the Accountant role is able to go to the shop to purchase materials in avoid the shop manager becoming inundated. ▪ Students commence development and build of solution (slides 15-16).
---	---

11:10	Short break
--------------	--------------------

<p>11:20 STAGE 2: Development and modifications continued...</p>	<ul style="list-style-type: none"> ▪ In this session students will continue the build and development of their solution. ▪ They must also discuss and implement modifications of their solution. ▪ At the end of this stage, teams should complete stage 2 on their planning and reflections sheet.
--	--

<p>12:00 Testing</p>	<ul style="list-style-type: none"> ▪ Teams should be at a stage where they can start testing their solution (slide19). ▪ Teams can use the practice messages provided on the Cryptographers job description to help.
---------------------------------	--

12:30	Lunch - tools down
--------------	---------------------------



STAGE 3:

<p>13:00 STAGE 3: Final build and testing</p>	<ul style="list-style-type: none"> ▪ Teams are to make final amends to their prototype and ensure that they have everything required to send and decipher a code (slides 21-22). ▪ Teams to complete final reflections and prepare for 3 minute presentation which focuses on the science, engineering, technology and mathematics skills, knowledge and understanding they have used in developing their communications system.
<p>13:30</p>	<ul style="list-style-type: none"> ▪ Slide 24 ▪ Shop closes! ▪ Sell back unused items. ▪ Get teams to submit accounting and planning and reflection sheets to Challenge Leader.

STAGE 4 - FINAL TEST:

<p>13:45 STAGE 4: Presentation and sending/receiving of final message</p>	<ul style="list-style-type: none"> ▪ Team's present planning and reflections from stages 1, 2 and 3 to the Judges – teams should have a maximum of 3 minutes to present (slides 26-27). ▪ Demonstration of each team's communications system using an unknown message – teams should have a maximum of 5 minutes to present.
---	--

WRAP-UP:

<p>14:45 Award ceremony</p>	<ul style="list-style-type: none"> ▪ Highlights strengths and areas for improvement on each teams' solution. ▪ Announcement of winning team (slide 30).
<p>15:00 Finish</p>	<ul style="list-style-type: none"> ▪ Students depart.



5. Checklist for running the Faraday Challenge Day

Student tables	Quantity	Note
Team station label (1-6)	1 per table	See Teachers' Pack.
Student team registration form	1 per table	See p. 26.
Student Booklet	1 per table	See Students' Pack.
Roles and responsibilities – Project Manager, Mechanical Engineer, Electrical Engineer, Accountant and Cryptographer	1 per role per table	See Students' Pack. Each team will require 2 Cryptographers.
Planning and Reflections sheet	1 per table	See Planning Sheet.
Blank paper	1 per table	Provided by your school.
Starter Pack	1 per table	See p. 22.
Faraday branded currency	Each team should have F100 with the following breakdown: <ul style="list-style-type: none"> ▪ 2x F20 ▪ 3x F10 ▪ 4x F5 ▪ 10x F1 	See p. 24 and Teachers' Extras Pack.
Teacher	Notes	
Teachers Booklet		Current document.
PowerPoint Presentation with notes		See Teachers' Pack.
AV pack		See Teachers' Pack.
Audio visual equipment – projector and sound		Provided by your school.
Assessment Matrix		See p. 20.
Final messages reference sheet		See Teachers' Pack.
Final messages in envelopes	Message sheets will need to be printed and put in envelopes	See Teachers' Extras Pack.
Certificates	1 per student	See Teachers' Extras Pack.



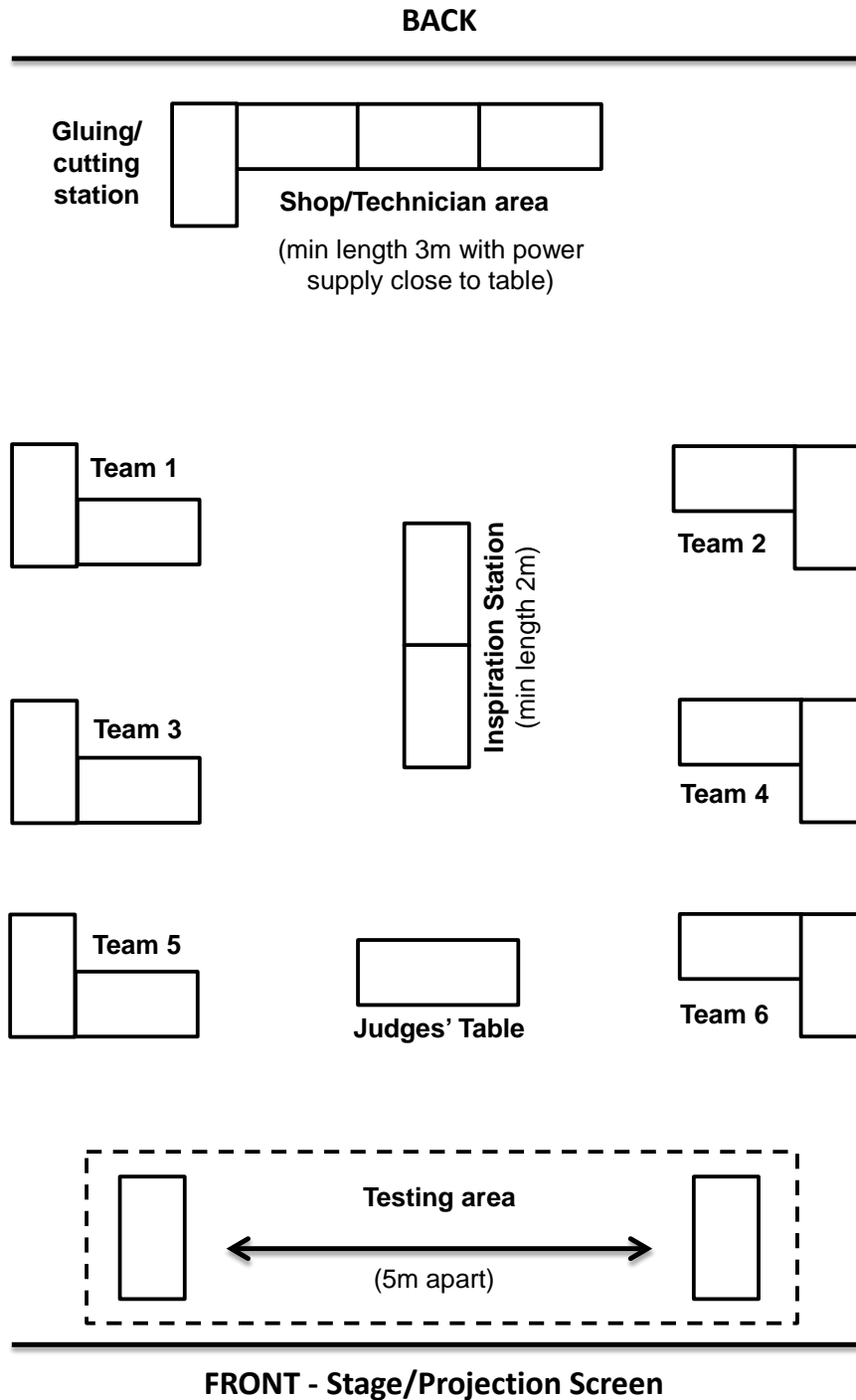
Continued....Challenge Leader checklist

Shop		
Materials list for shop manager/technician		See p. 22-23.
Materials price tags		See Teacher's Pack.
Shop manager/technician balance sheet		See Teacher's Pack.
Faraday branded currency	Shop change kitty: <ul style="list-style-type: none"> ▪ 20x F20 ▪ 20x F10 ▪ 20x F5 ▪ 40x F1 	See Teacher's Pack.
STEM Consultant name tag		See Teacher's Pack.
STEM Consultant card		See Teacher's Pack.
Signage	Notes	
Inspiration station	1	See Teacher's Pack.
Shop	1	See Teacher's Pack.
Alpha/Beta towns	1 for each town	See Teacher's Pack.
Judges table	1	See Teacher's Pack.
Cutting station	1	See Teacher's Pack.
Gluing station	1	See Teacher's Pack.
Inspiration Station		
Physical items (i.e. megaphone, torches, print outs (Morse code, semaphore) or images (lighthouses, periscopes, coloured lenses etc.) to inspire pupils and get their creative minds working.		



6. Room layout

Each team table requires 6 chairs and the Judges' table requires 3 chairs.





7. Schedule for the day

0930	Introduction to the Challenge
0945	Electrical briefing <ul style="list-style-type: none"> ▪ Health and safety briefing ▪ Electrical circuit activity
1000	Role allocation activity
1020	STAGE 1 - Planning and research <ul style="list-style-type: none"> ▪ Brainstorming ▪ Planning research
1050	STAGE 2 – Development and modifications <ul style="list-style-type: none"> ▪ Development/build of solution ▪ Modification of solution
1110	Short break
1120	Continued STAGE 2 – Development and modifications <ul style="list-style-type: none"> ▪ Development/build of solution ▪ Modification of solution
1230	Lunch - tools down
1300	STAGE 3 - Final build and testing
1330	<ul style="list-style-type: none"> ▪ Shop closes! ▪ Sell back unused items ▪ Submit accounting and planning sheets to Challenge Leader
1345	STAGE 4 - Presentation and sending/receiving of final message <ul style="list-style-type: none"> ▪ Team's present reflections from Stage 1, 2 and 3 to the Judges ▪ Demonstration of each team's communications system using an unknown message
1445	Award ceremony <ul style="list-style-type: none"> ▪ Announcement of winning team ▪ Final feedback and evaluation of the day
1500	Finish



8. Risk assessment example (page 1 of 2)

Risk Assessment and Operating Procedure - IET

Activity: Faraday Challenge Days 2012 – 13

Persons at risk	Students taking part in the Faraday Challenge Day		
Maximum Group Size	36 students	Recommended Staffing/Student Ratio	1:6

Risk Assessment

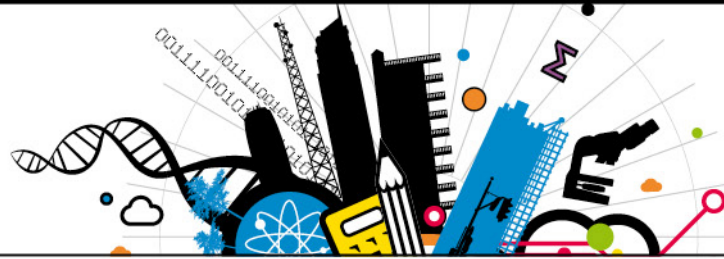
Hazards	Control Measures
1. Basic use of hand tools (files, screwdrivers, scissors, hole punches) – risk of cutting or abrasion.	The use of all cutting materials will be supervised by a school technician/teacher at all times and performed in a designated area.
2. Use of craft knives – risk of cutting.	A member of staff will supervise the use of craft knives to cut any materials. A safety ruler will be provided and safety notes at the designated cutting station.
3. Use of glue guns – risk of burning.	The use of glue guns will be supervised by a school technician/teacher at all times and performed in a designated area. Glue guns will be low melt which reduces the risk of severe burns.
4. Use of electrical equipment – risk of electric shock.	All electrical equipment is low voltage.
5. Use of electrical equipment – short circuit causing heating.	Warn students of the possibility of burns when connecting and disconnecting components. All pupils will receive a briefing about correct use of electrical components.



Risk assessment example (page 2 of 2)

<p>Location issues (to be completed by Host School)</p> 	
<p>Further Action Required: 1. Ensure all persons staffing the Faraday Challenge Days are aware of and competent to comply with this risk assessment and the control measures.</p>	

Working Practice	
Group structure	One Faraday Challenge Day Leader and one member of staff from the host school present during the whole day to oversee use of equipment and to keep order.
Restrictions	Unknown premises.
Emergency Procedure	Follow the lead from the Host School. Faraday Challenge Day Leader to be fully briefed on risk assessment procedure prior to the day or on arrival.
Safety Equipment	First aid kit and fire extinguisher (electrical fires) to be provided by Host School.
Name and role of IET Faraday Challenge representative	Keira Sewell Challenge Day Leader
Name and role of school representative	
Signature of the school representative	
Date of this Review	July 2012



9. Assessment matrix

Assessment Criteria		Team 1	Team 2	Team 3	Team 4	Team 5	Team 6	Team 7
Planning and research	15							
Development of solution	20							
Accounting Sheet	15							
Presentation	15							
Prototype	15							
Code	15							
Safe and effective teamwork	10							
Total Score	105							

Team	School/Team name
1	
2	
3	
4	
5	
6	
7	



10. Final test messages – Judges reference sheets

‘Secret’ messages to give to each team in the final test stage.

1	Food Arriving
2	Transport Now
3	Engineer Help
4	Helicopter OK
5	Help Tomorrow
6	Solution Done
7	Rescue Coming
8	OK Communicate

Two spare messages have been provided.

Message sheets to be printed and put into envelopes to hand out to students may be found in the Teachers’ Extras Pack.



11. Student certificates

To celebrate success, certificate templates have been provided in the Teachers' Extras Pack to award your students.

12. Full list of materials available to purchase, cost and units

STARTER PACK:

Item
1 x stick of White Tak
10 x Elastic bands
1.5 Volt battery D size
1.5 Volt bulb
2 pieces x 30cm of black copper wire
2 pieces x 30cm of red copper wire
Wire strippers
Blue Pen

AVAILABLE TO BUY:

Item	Measurement	Cost	Min/event
Masking tape	30cm	5 Faradays	1 roll
Double-sided tape	30cm	8 Faradays	1 roll
Plastic cups	1 cup	1 Faraday	10
Tin cans	Each	5 Faradays	4
A4 plain paper	Each	1 Faraday	30 sheets
Coloured card A4	Each	1 Faraday	2 sheets of at least 3 colours
Foil 30cm x 30cm	Each	5 Faradays	1 roll
Neoprene Sheets	Half sheet	5 Faradays	2 sheets of at least 2 colours
Bubble wrap 25cm x 25cm	Half sheet	2 Faradays	2 sheets
Acetate red 35 x 310mm	Half sheet	5 Faradays	2 sheets
Acetate blue 35 x 310mm	Half sheet	5 Faradays	2 sheets
Mirror 150 x 100mm	1 mirror	5 Faradays	4
Straws	10 straws	10 Faradays	30 bundle
Cardboard tubes	Each	10 Faradays	4
Thin sponge	Each	2 Faradays	2
String	Per Metre	1 Faraday	1 roll
Paper fasteners	5 fasteners	1 Faraday	20
Paper clips	5 paper clips	1 Faraday	20



Elastic bands	10 bands	2 Faradays	50
Steel nail - 10cm	2 nails	10 Faradays	3
Binoculars	Each	30 Faradays	2
Stopwatch	Each	30 Faradays	3
White Tak	Stick	5 Faradays	2 packs
Polyfoam	A4 size	10 Faradays	3x A2

ELECTRICAL COMPONENTS:

Item	Measurement	Cost	Min/event
Copper wire - red	Per metre	10 Faradays	1 roll
Copper wire - black	Per metre	10 Faradays	1 roll
Bare copper wire	Per metre	10 Faradays	1 roll
Croc leads - black	Each	5 Faradays	10
Croc leads - red	Each	5 Faradays	10
Croc clips	Each	5 Faradays	15
Terminal blocks	Each	2 Faradays	10
1.5 Volt bulbs	Each	5 Faradays	24
3.5 Volt bulbs	Each	5 Faradays	24
1.5/3.5 Volt bulb holder	Each	10 Faradays	15
Batteries - AA size	Each	2 Faradays	35
Batteries - D size	Each	5 Faradays	15
Battery holder – 1 D cell	Each	2 Faradays	15
Battery holder - 3 AA cells	Each	1 Faraday	15
Watch battery	Each	1 Faraday	3
Buzzers 3 Volt	Each	5 Faradays	10
Switches	Each	5 Faradays	10
Magnet	Each	5 Faradays	2

AVAILABLE TO HIRE:

Item	Measurement	Cost	Min/event
Consultancy Time	5 minutes	10 Faradays	3 cards
Hole punch	5 minutes	5 Faradays	1
Stapler	5 minutes	5 Faradays	1
Screwdriver small	5 minutes	1 Faraday	4
Calculator	5 minutes	10 Faradays	1
Craft Knives + Technician	n/a	FREE	4
Glue guns	n/a	FREE	2



13. Shop Managers balance sheet

An account sheet for the Shop Manager/Technician has been provided in the Teachers' Pack.

14. Price tags

These should be used at the materials shop to label prices of items available for purchase. These can be printed and folded in half so that the price is displayed in a way that both students and the shop manager can see the price clearly.

The price tags have been provided in the Teachers' Extras Pack.

15. Currency

Faradays are provided in denominations of one (F1), five (F5), ten (F10) and twenty (F20) Faradays – students use these as their currency for the day to buy materials and resources.

Each team will need F100.

The 'materials shop' will need plenty of F1, F5 and F10 notes to provide change for students purchasing materials.

The currency denominations have been provided in the Teachers' Extras Pack.

You can photocopy these pages to create the amount needed to run the day.

16. Student booklet

Student Booklets can download online under Student Resources. We recommend you print 6 copies, one for each team.

The Student Booklet outlines the challenge context and brief, assessment matrix, timings for the day and all other information and worksheets needed by each team to complete the challenge.



17. Student Planning and Reflections

Planning and Reflections sheets can also be downloaded online under Student Resources. Each team should complete this learning log as they progress through the challenge. It will help students to prepare for the presentation as part of the final stage of the day also.



18. Student team registration form

Student Team Registration Form

Team No: ...

Faraday Challenge Date:

Your School Name:

Your Teacher's Name:

Team Member Names (please print clearly)

1

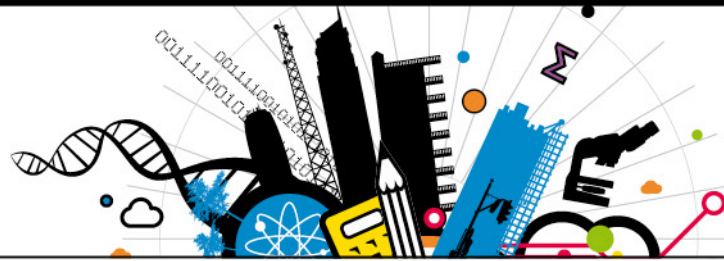
2

3

4

5

6



19. Student roles and responsibilities

The team that wins will work together in the most effective and efficient way.

It is crucial that each and every member of the team understands what their role is and what they are responsible for.

When you discuss the roles and responsibilities at the start of the day, students must think about what they are good at and which areas they are responsible for.

An outline of all the roles and responsibilities within the team has been provided below. More in-depth job descriptions have been provided in the separate Roles and Responsibilities document.

1 x Project Manager

You need to have a clear overview of what the team is trying to achieve in the time you have available.

1 x Accountant

To set up a communications system needs not just clever engineering but great accounting, to make sure you don't go over budget.

1 x Electrical Engineer

Your role is to ensure power and the correct voltage is supplied to the prototype. Understanding what will work and what won't is key to solving the problem.

1 x Mechanical Engineer

You will lead the team in design and construction work. Your device must be able to send an encoded signal across a distance of 10 km in the real situation in the mountains, but 5 metres in testing. Your solution must be free of the interference caused by the solar radiation disrupting radio and phone signals and its effects on the power supply grid.

2 x Cryptographers

This role requires 2 people and is crucial in ensuring that important messages are sent to and received by the isolated town. You will be responsible for coding and decoding your team's messages.