

Networks & Encoding



Orbeducation



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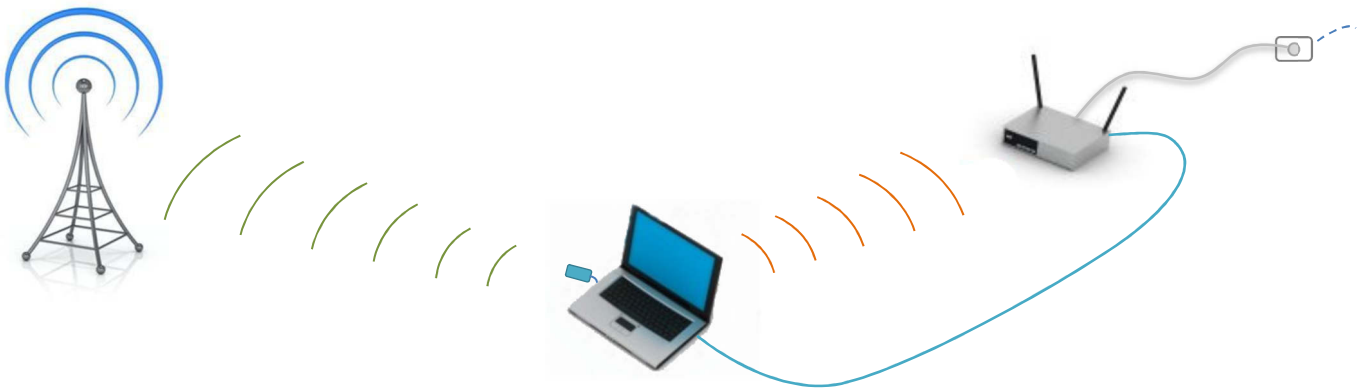


Computer data includes numbers, text, images, documents and sounds. Data can be shared between different computers via networks. To move data from one place to another, it is encoded and sent as electrical signals through wires or as radio waves in wireless connections.

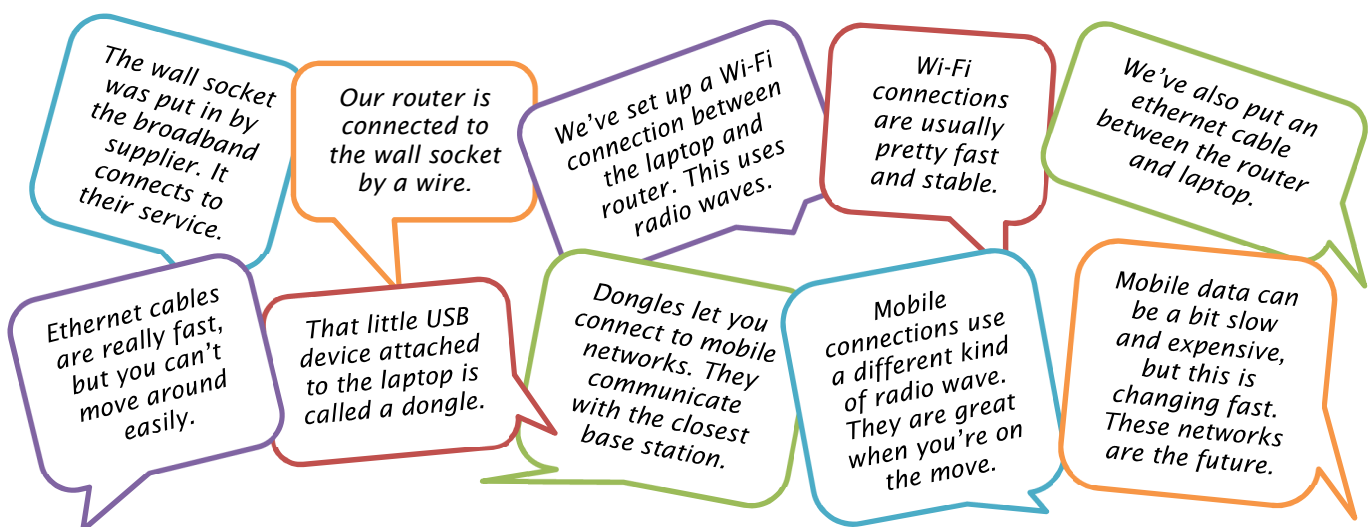
Aim: To look at how we connect to the internet and the problems with doing so.

Task 1 – Signal Transmission

The laptop in the diagram below is connected to the internet using three different methods. Two of these connections use a cable broadband service (one via Wi-Fi and the other via an ethernet cable). The last connection uses a mobile network. **Note:** If you set things up like this at home, your laptop would select and use only one of the internet connections at any time.



- a. Use the explanations below to label as many parts of the diagram as you can.



- b. From the information given, which type of network is usually the fastest? Which is probably the slowest?



Task 1 – Designing a Network

Your task is to design the layout for a small room with a network of computers. All users need a connection to shared files on a server. They must also be able to print documents and access the internet.

Aim: To look at how computers are joined together to form networks.

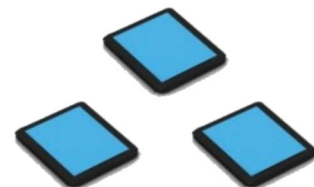
If you have the editable version of this resource, you can work digitally. Otherwise, cut out the parts below, sort them, stick them down and then draw on the cables and radio waves. The rules for your network are as follows:

- The desktops, tablets and printer should be arranged as they might be in a small classroom.
- Your teacher needs easy access to the server. This one has its own screen and keyboard.
- The wall socket is the link to the internet. The router must be connected to this using the coaxial cable.
- The tablets only have Wi-Fi. They must communicate with the router using radio waves.
- The desktops also need to be connected to the router. You can use ethernet cables for this. The computers can be arranged in a single chain, a ring, or have separate wires all the way to the router.
- The desktops and tablets must all be able to communicate with the printer and server. The easiest solution is probably to connect these two components to the router as well, although you might connect the printer to the server instead.

Note: Don't worry if your network isn't perfect; it's good to think about the issues.



Desktop Computers



Tablets / iPads



Server



Router



Printer



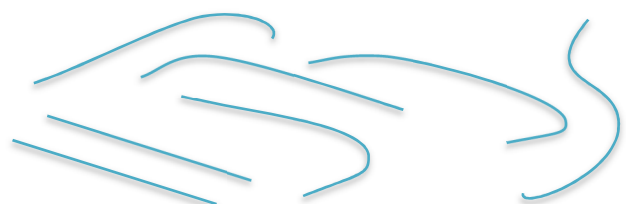
Wall Socket



Radio Waves



Coaxial Cable



Ethernet Cables



Most of the time, we like to count in base 10. Historically, this probably occurred because we have ten fingers and people used them to add up. When counting in base 10, if any digit goes past 9, we add one to the column on the left and start again. Adding 1 to 9 makes 10; adding 1 to 39 makes 40; adding 1 to 99 makes 100 etc.

Aim: To consider how computers use binary to store and transfer data.

Computers don't have fingers, but they do have switches. Switches can only be on or off; 1 or 0. Computers can therefore really only count in base 2, or binary. There isn't a number 2 in binary, so when a digit goes past 1, we add one to the column on the left and start again. Adding 1 to 1 makes 10 and adding 1 to 11 makes 100.

Task 1 – Binary Computing

Complete the passage using the words in the box.

transistors

binary

ON

base

billions

OFF

Modern computers are built using _____ of tiny electronic switches called _____. Each switch can either be ON or OFF. If the switch is turned _____, it is represented by the digit 1. If it is turned _____, then it is represented by the digit 0. As data is stored on the computer using these two digits, operations must be carried out using the _____ system of counting. The binary system involves working with numbers in _____ two.

Task 2 – Binary Counting

Complete the table below showing how to count in binary. Remember that any time a digit goes past 1, you add one to the column on the left and start again. Find help online if required.

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	
6	
7	

Decimal	Binary
8	1000
9	1001
10	1010

Decimal	Binary
16	10000

Decimal	Binary



Task 3 – Digital Data

Computer data includes numbers, text, images, documents and sounds. Because of the way it is stored and processed, all digital data is made up of 1s and 0s. If you take a photo on a phone, you are actually storing thousands, or perhaps millions, of 1s and 0s. If you send an email to a friend, you are sending them a stream of 1s and 0s.

Your computer is very good at switching between these two digits and other more useful things. For example, your screen changes the 1s and 0s into a picture. Your speaker changes them into sound. Your mouse is an input device, so it works the other way around; it translates movements into a stream of 1s and 0s.



1	0	0	1	0	0	0	1

The screen on the left will display a simple image. There are 64 squares (or pixels) altogether. The 64 bits of data below show you how to complete the picture.

Moving from left to right, top to bottom, shade any square that will hold a 1. Leave blank any square that will hold a zero. We have got you started with the first 12 bits of data.

**1001 0001 1001 0101 1001 0001 1111 0101 1001 0101 1001 0101
1001 0100 1001 0101**

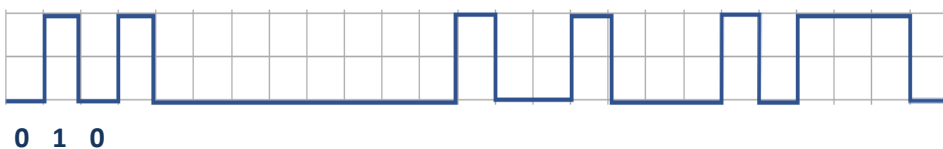
What is the hidden message?

Extension

Create an image in digital code for one of your friends to decipher. For a more difficult task, try and think of a way of including more than one colour but still only using 1s and 0s. You may use as much code as you need, but you'll need to explain the method you have used to your partner before they can start decoding.

Task 4 – Digital Signals

Our digital data can be converted into a signal that can be sent through a network. Using a similar method as before, create an image from the signal below. You should start by converting each part of the signal to a 0 or 1.



0	1	0		

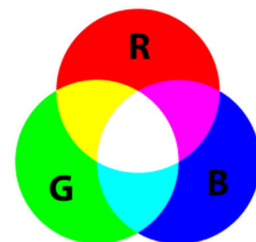
These ideas are a simplification of real life, but they give you an idea of how binary data is stored and transferred as digital signals. We will look more closely at different types of data in the following tasks.



When you were young, you were probably told that red, yellow and blue are the three primary colours and that you could make all the other colours by mixing these three paints. This isn't quite true. Paint absorbs light. If you add more colours to a mix, it will absorb more and more light until you end up with a smudgy brown colour. You wouldn't be able to make black paint, though, however hard you try. Or white. This is called the *reflective colour model*.

Aim: To investigate how colours are encoded by computers.

TVs and computer screens work differently. In these devices, we can consider red, blue and green to be the primary colours. As you add more colours together, the mix gets brighter and brighter and you may form white light. By mixing red, blue and green, it is indeed possible to get all the other colours except black, which can be achieved by removing the light altogether (black is the absence of light). This is called the *additive colour model*.

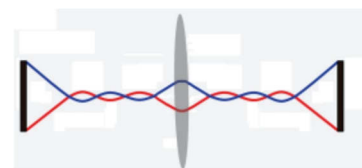


Task 1 – Newton's Disc

You can test the additive colour model with a simple Newton's disc. Draw a circle on a white piece of paper and fill with colours from the rainbow as shown below. You then need to get the disc spinning fast. Try either of the following methods:



1. Stick the coloured disc to some card, cut it out, poke two holes through and use string as shown on the right. Plastic tubing makes great handles, but these aren't necessary. Get the disc spinning a little, then pull the handles rhythmically to speed it up;



2. Stick the coloured disc to an old CD and cut the centre out of the paper. Glue a marble over the hole with super glue (it should poke through a little) and use it to spin the disc.



If you spin your disc fast enough and your colours are well balanced, you should see something approaching white.

Task 2 – RGB Colour

As we have said, on a screen, you can make any colour from the primary colours of light - red, green and blue. In the RGB model, each of these three colours can be given an intensity between 0 and 255. Try and complete the missing sections of the table below.

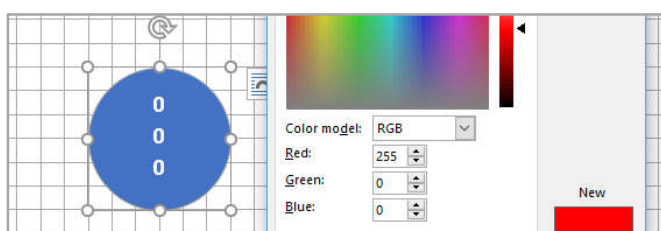
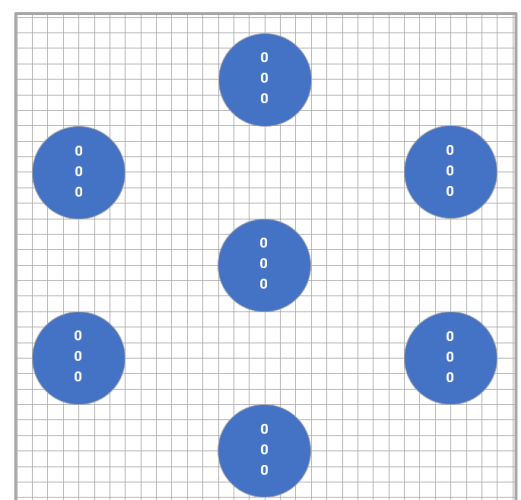
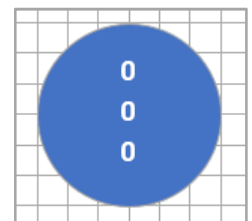
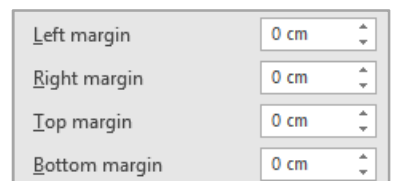
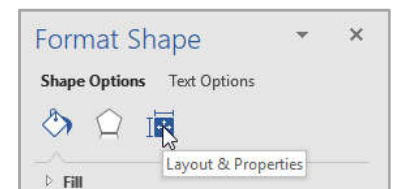
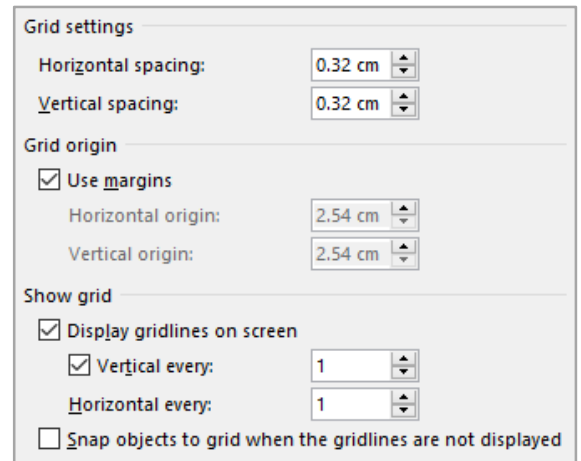
Primary Colours			Secondary Colours			
Red	Green	Blue	Yellow	Magenta	Cyan	White
Pure red		Pure blue	Red & Green		Green & Blue	Red, Green, Blue
R: 255 G: 0 B: 0	R: 0 G: 255 B: 0		R: 255 G: 255 B: 0	R: 255 G: 0 B: 255		



Task 3 – Creating an RGB Colour Chart

A good way to get to grips with the RGB colour model is to have a go at making a colour chart. We are going to use the colour tools in MS Word for this. We will also learn to format shapes and place text in them.

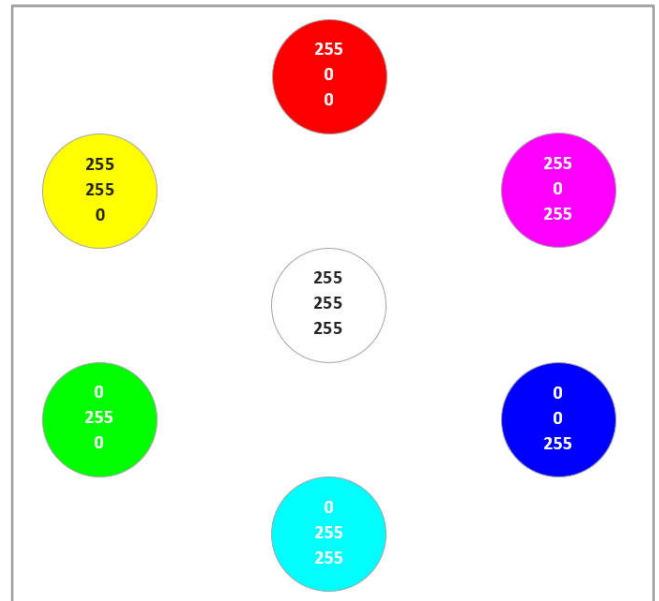
- a. Open a new blank MS Word document.
- b. Turn on the grid by clicking 'View / Gridlines'.
- c. Select 'Layout / Align / Grid Settings' and check the grid settings are as shown on the right.
- d. Select 'Insert / Shapes / Oval' and draw a circle with a diameter of 6 squares. The grid will help you control the shape, so it should be a perfect circle.
- e. With the circle still selected, click 'Format / Shape Outline' and select a grey border with a weight of ½ point.
- f. Right-click on the circle and select *Format Shape*. In the panel on the right, open the 'Layout & Properties' tab.
- g. Set each of the four margins to '0 cm'. This will allow us more space for text in the circle.
- h. Right-click on the circle and select *Add Text*.
- i. Place the cursor inside the circle and type a '0'. Hold down the *Shift* key and press *Enter* to start a new line (rather than a new paragraph). Type another '0', then one more '0' on a new line. The last zero will probably be cut off.
- j. Select all the text and change it to size 9, bold.
- k. Use the copy and paste functions to lay out circles in a wheel as shown on the right. The grid should help you align the circles neatly.
- l. Select the top-centre circle and click 'Format / Shape Fill / More Fill Colours'. Click on the *Custom* tab.
- m. Make sure that the *RGB* model is selected and enter the values '255' for Red, '0' for Green and '0' for Blue, as shown below. Click *OK*.





Task 3 – Creating an RGB Colour Chart (cont)

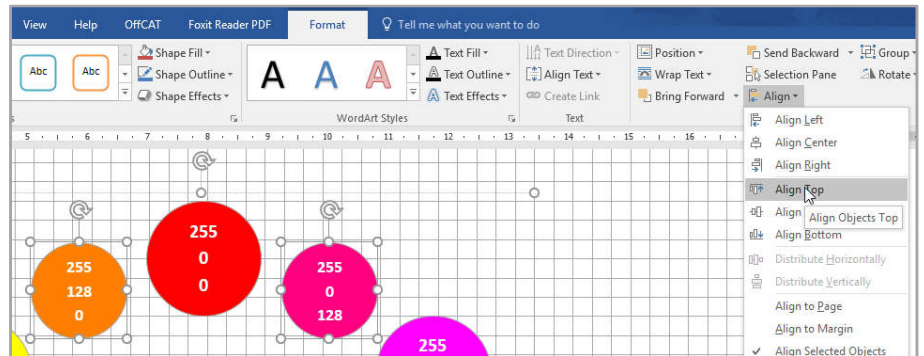
- n. Edit the text inside your red circle to display the RGB values, 255, 0 and 0. You can turn the grid off at this point if preferred.
- o. Repeat this process for the other circles. The blue circle has a blue intensity of 255, and 0 for the other settings. The green circle has a green intensity of 255. The secondary colours are formed by setting two of the intensities to 255 and leaving the last one as 0. The white circle in the centre has a value of 255 for each component.
- p. You may need to change the text colour if it becomes difficult to read.



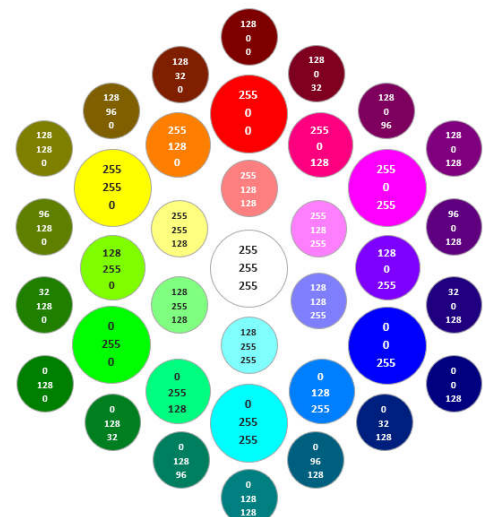
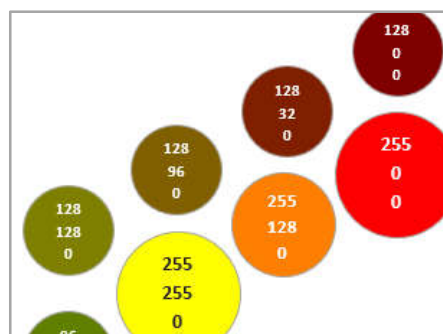
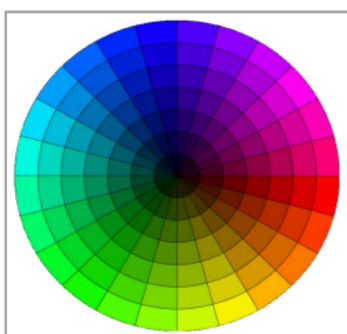
Task 4 – Extending your Colour Chart

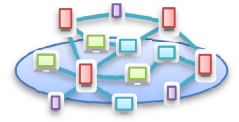
Use all the same tricks to create a set of smaller circles positioned in between the original ones. The values should be an average of the circles on either side. The orange circle below has a *Red* value of 255 and a *Blue* value of 0, the same as the red and yellow circles either side. The *Green* value is set at 128, about half way between the 0 in the red circle and the 255 in the yellow one.

Hold down the *Shift* key and click on two circles that need aligning. Use the 'Format / Align' tools to achieve this. Repeat until all your circles are arranged tidily.



You may build on the chart in lots of different ways. Ours has white in the centre and increasingly dark colours as you move outwards. Others, such as the one below-left, are designed the opposite way. Our outer colours have half the average of the one(s) inside.



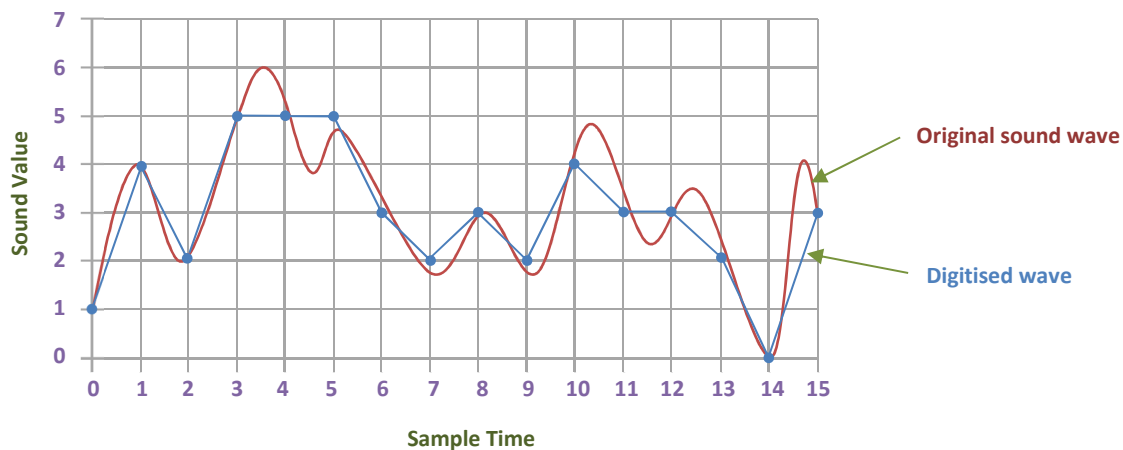


As with images, sound must also be encoded as binary so that it can be processed by, and transferred between, our digital devices. To encode sound, a sample is recorded at regular intervals.

Aim: To investigate how sound is encoded as binary and the effect of sample rates.

Task 1 – Sampling Sound

The diagram below shows how a sound wave can be changed into a digital signal represented by numbers. The original sound is the very wobbly (analogue) red line. The digital sound is the blue line. The blue dots show the sample points. They are rounded off to the nearest whole value.



- a. The blue dots show the samples that have been taken. There are sixteen altogether, taken at regular intervals (shown on the horizontal axis). The values for each sample are shown on the vertical axis. Complete the table showing the sound values for each sample.

Sample Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sound Value	1	4	2													

- b. What is the highest sound value for the digital signal? What appears to be the highest value of the original analogue signal?

- c. The two waves are shown separately on the right. Describe some of the other differences between the two waves.

