Prism activities

What's it all about?

Activities for the prism/spectrum section of the show:

1. Make a rainbow using water spray [optional]
2. Prism used to make spectrum
3. Prism with colour filters

Objectives:

1. Sunlight contains all the colours of the rainbow
2. It is possible to separate these colours, eg using a *prism* to create a *spectrum*
3. The prism / filters are not *giving* colour to the light, nor changing its colour

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1. Make a rainbow using water spray [optional]

It is important to TEST that the demo works in this setting – if not then do not proceed! This would be the first demo in the show and so it is important that it should work well. Remember the angle of sunlight will change between test and show.

Objective:

- Sunlight / white light + water droplets can produce a rainbow

Set up:

- Drinking water in clean spray bottle
- Paper towels to wipe up potential spills
- Light source – ideally sunlight, else projector (projecting white slide)
- Positioning so that light is coming from direction of / from behind audience

Spray a fine mist into the air, taking care not to spray over electronics or create slip hazard.

You have already acknowledged that you need sunlight and rain for a rainbow. Repeat this by pointing out your source of Sun (eg "there is no Sun in here so I will be using the projector light", or "we have some Sun coming in the window here that we can use"), and saying you will use the spray for rain.

This is a quick demo – avoid getting into details about how rainbows work as this would be a complicated diversion. The only objective is to demonstrate that Sun + rain = rainbow.

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2. Prism used to make spectrum

It is highly recommended to test this demo first, to work out where the spectrum will go, the best place to project it, appropriate angles etc. But remember the angle of sunlight is always changing.

Objectives:

- Sunlight contains all the colours of the rainbow
- It is possible to separate these colours, eg using a *prism* to create a *spectrum*

Set up:

- Light source – ideally sunlight, else projector (projecting white slide)
- Prism (plastic or glass)
- White wall/surface upon which to project the spectrum (if walls coloured, ask venue if you can stick white paper onto them).

The light from the light source looks white to our eyes. But really it has all the colours of the rainbow (/lots of colours) in it. You can't see red and blue and orange and green and yellow all in the same place at the same time, and so your eye just sees bright white instead. But those colours are still there.

I could separate the colours with the raindrops because each one acts like a tiny prism. I have a big prism here. It is just a lump of glass, nothing special about it other than its shape. And I hope I can use it to show you all these colours, a little as though this was one huge raindrop*.

[Angle one of the prism's long sharp edges towards the light source. Rotate the prism until you get a good spectrum.]

Explain that the light is going from the source, entering the prism, then leaving the prism and reflecting from the wall and into their eye. Recap that light travels in straight lines, and that you see things by light entering your eye.

When it enters/leaves the prism, it *refracts* – its path bends. Different colours refract different amounts, sending them in different directions, separating them from each other. [Just explain this roughly, as you will go over it more clearly when you have the diagram on screen].

* Raindrops reflect as well as refracting, so it's not exactly the same

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3. Prism with colour filters

Objectives:

- The prism / filters are not *giving* colour to the light, nor changing its colour

Set up:

- As before, plus colour filter
- Space for volunteer to stand and move around to either side of prism

But – how do we know that the prism isn't *giving* colour to the white light? That would be a perfectly sensible way to explain what we are seeing here. I don't want you just to believe everything I say without any proof, so let's do an experiment to test this.

Here I have some red plastic in a frame. I need someone with a steady hand to help position this for the tests I want to do. Can you help me? Thanks, what's your name. Hold this by the frame – be careful as the plastic is quite delicate.

First test – Fred, please can you hold the filter so the light from our light source is going through it. Let's see what it does to the light. It goes red! What is happening do you think?

Discuss options that it could be giving red colour to the white light, or it could be filtering out the other colours and only letting red through. Maybe think about whether we think the red light is as bright as the white light was.

Let's try putting the filter in front of our rainbow spectrum. I have all the rainbow colours coming out of the prism and onto the wall. What if we put the filter there? What would we see if it gave red light to all the colours? What would we see if it was filtering out the other colours?

Test! – ask Fred to place the filter appropriately. Ask them to move it in/out of the light path so it's clear what is happening.

Think about how to ensure it doesn't look like you could have done it without help, eg by using other hand to gesticulate, having Fred too far away, asking them to verify what you are seeing, etc.

Talk out loud / ask them about what you can see. Discover that the filter is blocking all the colours except for the red end of the spectrum. Note it is letting some red/orangey colours through (avoid suggesting there is a single 'red' colour in the spectrum).

The filter is only transparent for reddish light, it blocks other colours. [This is a nice point to make ref later when we talk about materials that differentially block visible light / IR.]

Ok so now we know that the filter blocks all the colours but reds. Let's try something else.

We have white light going into the prism, and a spectrum coming out. What if Fred puts his filter so that only red light is going into the prism. What would we see the other side if the prism was giving the light those rainbow colours? What would we see if it was splitting the colours apart?

Test – ask Fred to put the filter between the prism and the wall

We see the same as before. If the prism was creating colours, then surely we'd see different colours, even if they were all a bit reddish? Or at least it would spread out on the wall like it does for white light?

Instead it looks exactly like when the filter was the other side (ask Fred to test this if necessary).
Wherever you put the filter in the path, it looks the same. This is because the colours are already there – it doesn't matter where you block the other colours, so long as the filter is between the source and the wall then we will see the same thing.

Thank volunteer, making it clear where they should put filter (eg hold out your hand to take it from them) and ask them to take their seat.

Activity extensions:

1. Seeing UV

   If you know someone has had cataract surgery, or otherwise had their lens replaced in their eye, it is fun to get them to point out the blue end of the spectrum. They should be able to see more into the UV than you can. Never ask an individual about medical things, but you can ask an audience of older adults for a volunteer who had had surgery – ie giving them the choice of whether to disclose this information.

2. Filter choice

   It would be fun to try this with more specific filters, or a range of colour filters. The provided filters were made by spray-gluing cheap plastic between picture frame mounts. See the receipt list for where these were sourced. You may wish choose to source better-quality filters which are more wavelength-specific.

3. Spectroscopic glasses

   In a more informal setting, people could see what effect the red filter had on what they see through spectroscopic glasses.

AstroBoost Project

The Royal Astronomical Society's AstroBoost project was funded by a STFC Spark Award and supported by project partners Guildford Astronomical Society, Hampshire Astronomy Group, Newbury Astronomical Society and the STFC's UK James Webb Space Telescope campaign. The project was managed and developed by Dr Jenny Shipley.