

# TEACHER ANSWERS

## SOUTH SITE Key Stage 3

### Activity Different Types of Light

**Go to the infrared camera and place your hand under the plate. Describe what happens.**

Can't see hand under plate but can see hand on the monitor as seen by the camera.

**Who discovered infrared radiation and how was it done?**

William Herschel – he passed light through a glass prism (taken from his chandelier!) to create a spectrum. He used a 'burning lens' to focus the light and he measured the heat produced across the spectrum with thermometers. He found the red end of the spectrum had the highest temperature.

**Choose an object and move the dial to see it in different wavelengths. Describe what you see.**

Sun, Andromeda, Saturn, Crab Nebula

**What type of light was used to explore this astrophysical phenomenon?**

Black holes: X-rays

Star Nursery: infrared

The Big Bang: microwave

### Activity Exploring the Universe

**Select a topic and write down how scientists explored this part of the Universe – think about what was used to gather information.**

Astronomical tools: terrestrial telescopes, space telescopes, space probes, artificial satellites, particle colliders

**When was the orrery made?**

1780

### **How many planets can you see? Explain this.**

6 planets can be seen - the telescope was built before the discovery of Uranus and Neptune.

### **Why does the Earth orbit the Sun and not the other way round?**

The Earth is significantly less massive than the Sun so the common centre of mass of the Earth-Sun system lies within the Sun. If the masses were similar they would orbit each other.

### **Explain how the spectroscope helped us explore the Universe.**

Spectroscopes produce a spectrum from visible light – by looking at absorption and emission lines in a spectrum we can find out what stars are made of, how hot they are and whether they are moving towards us or away from us.

## **Activity** Space Probes

### **Where is your probe going?**

Options are: Venus, comet and Ganymede (moon of Jupiter)

### **Do you think we should send people instead of probes? Why?**

#### **Points to consider:**

- Cost of sending people into space
- Safety and health concerns
- Advancement of human exploration
- Mission duration

### **Do you think we should be spending billions of dollars on building space probes? Why?**

#### **Points to consider:**

- Exploring the Solar System helps us understand its formation and evolution
- We may want to extract minerals and other resources from other planets and moons
- We could focus all financial resources to the Earth and improve our standard of living here
- It's part of the intrinsic human desire to explore and discover new things – this expands our knowledge and may help us do things better on the Earth

### **How did we explore this planet/moon and what did we find out?**

The Cassini-Huygens space probe explored the gas giant Saturn and its largest moon Titan. Titan is  $-190^{\circ}\text{C}$  and rains liquid methane. There are pebbles and boulders on the surface made of ice.

# SOUTH SITE

## Key Stage 4

### Activity Multi-Wavelength Astronomy

#### **Write down a few things we have discovered about the Universe.**

The birth of the Universe, the formation of the Solar System, properties of the planets and moons, the existence of other solar systems (extrasolar planets), the structure of the Milky Way, the presence of other galaxies and their properties.

#### **Put these types of light in the correct order starting with the highest energy radiation: X-ray; infrared; radio; gamma-ray; ultraviolet; microwave; visible.**

Gamma-ray, X-ray, ultraviolet, visible, infrared, microwave, radio

#### **What are they part of?**

The electromagnetic spectrum

#### **Why do we use infrared telescopes to look at objects in space?**

Infrared light can penetrate dust allowing us to see more of the object.

#### **What do you think might affect an infrared telescope on Earth?**

The atmosphere absorbs a lot of infrared light.

#### **Who discovered infrared radiation and how was it done?**

William Herschel – he passed light through a glass prism (taken from his chandelier!) to create a spectrum. He used a 'burning lens' to focus the light and he measured the heat produced across the spectrum with thermometers. He found the red end of the spectrum had the highest temperature.

#### **Choose an object and move the dial to see it in different wavelengths. Describe what you see.**

Sun, Andromeda, Saturn, Crab Nebula

#### **How can we see this emission from the objects above (where are the telescopes?)**

They are in space above the atmosphere (the atmosphere blocks high energy light from extreme UV to gamma-ray and a large part of the infrared spectrum).

## **Activity** Elements in the Universe

### **Where did all of the elements we see on Earth originally come from?**

They were made in a star many times more massive than our Sun which underwent a supernova explosion releasing the matter into space. Some of this matter clumped together under gravity to form the Sun and planets, including the Earth.

### **Look at the Allende meteorite. Shade in the correct elements in the periodic table below.**

Magnesium (Mg), calcium (Ca), silicon (Si), iron (Fe), aluminium (Al)

### **Which part of the Solar System do you think meteorites come from?**

The asteroid belt

### **How can we find out the composition of stars?**

We look at the spectrum of a star – we can measure the wavelengths of spectral lines and compare them to existing spectra of atoms and molecules to identify what is in the star.

### **What type of star is Betelgeuse?**

M2 – red supergiant

### **What type of star is Bellatrix?**

B2 – blue giant

### **Why are these stars different colours?**

They have different surface temperatures

## **NORTH SITE** **Key Stage 3**

### **Activity** Observing with the 28 Inch

#### **What does the measurement 28 inches refer to:**

The diameter of the lens. This is still the case for today's commercially available telescopes with mirrors or lenses (reflecting or refracting). For instance reflecting telescopes 8 inches plus are recommended for viewing planetary details such as the great red spot on Jupiter and the rings of Saturn.

### **Why switch to red lights?**

To help night vision while still being able to see the telescope to move it.

### **Why did the dome have to change?**

The older telescope was the 12 inch Mertz – it was significantly smaller. The previous 'barrel' dome was fit for purpose, but had to be replaced with the onion dome to fit the newer telescope. Also this telescope at lower altitudes still pokes out of the open slit! A lot of care is taken when moving the telescope left and right at low altitudes with the dome.

- 1** Check the wind speeds so the dome doesn't blow off! (Wind speed indicators are to the left and up when you come through the door).
- 5** Switch off the bright white lights and switch on the very dim red lights to keep your night vision.
- 2** Take off the dust cap at the top of the telescope. It's bigger than the size of a dustbin lid!
- 4** Open the dome slit so the telescope has a gap to see through. Warning! Dust and dirt may fall into the room at this point.
- 6** Move the telescope dome around so that the gap in the dome is facing your chosen star or planet.
- 3** Move the telescope away from the dome slit to prevent dust and dirt falling onto the lens.
- 7** Move the telescope to the right part of the sky to point at your chosen star or planet and look through it.

### **Activity** Communicating Time

#### **What is the imaginary line around the Earth that divides the world into the Northern and Southern hemisphere?**

The equator.

**How many degrees are in a circle?** 360 degrees

**How segments are there around the globe?** 24

**Move 15 degrees East from Greenwich (along the same latitude). Which country are you now in?**

- X Poland
- Germany
- Sweden
- Czech Republic

**Move 37.5 degrees East from Greenwich (along the same latitude). Which country are you now in?**

- X Russia
- Ukraine
- Belarus
- Finland

**Long ago people used a timepiece with no moving parts that uses light and shadow to tell their local time. Do you know what it was?**

A sundial.

**Travel from Dover to Reykjavik in Iceland. Which direction did you need to travel in (East/West)? Are you behind or ahead of Greenwich Time? And by how many minutes?**

- East, Ahead, 60 mins
- East, Behind, 40 mins
- X West, Behind, 90 mins
- West, Ahead, 60 mins

**Travel from Dover to Seoul in South Korea. Which direction did you need to travel in (East/West)? Are you behind or ahead of Greenwich Time? And by how many hours?**

- West, Behind, 9.5 hours
- East, Behind, 8.5 hours
- West, Ahead, 9.5 hours
- X East, Ahead, 8.5 hours

## **Activity** Forces and Harrison's Timekeepers

**Can you name the forces acting on the pendulum bob?**

F1: Gravity

F2: Tension

**When stationary on land, what force will slow the pendulum down and eventually stop it?**

(Think of how brakes on a car or bike work)

Friction

**Can you identify two ways he did this in his clocks (H1, H2, H3, H4) and learn more about them using the interactives?**

- 1 Springs (This was unnecessary for the small movements in H4)
- 2 Bimetallic Strip. Harrison used this to curb the effect of temperature on the balance spring of H3.

**What other (astronomical) method of finding longitude at sea was used alongside Harrison's timekeepers?** (*HINT Find the panel nearest the largest 90 degree instrument in the gallery.*)

The Lunar Distance Method. This used accurate observations of the Moon and the stars to use the Moon like a hand on a clock and the background stars as the dial. Mariners could use a set of tables to work out their longitude using this method. It did take a long time for the calculations to be reduced for ease of use, by which time Harrison's chronometers were proven to be a much faster method of calculating longitude at sea

**In the 21st century we have used our skills in timekeeping and space exploration combined to tell our position accurately. What do we use?**

Global Positioning Satellites (GPS)

## **NORTH SITE**

### **Key Stage 4**

**Activity** Mapping the Night Sky

**How are the instruments aligned?**

North-South

**In which directions can these telescopes move?**

Up-Down

**What two properties could you measure using such telescopes?**

- Time (using nearby accurate clock) of the stars passage over the meridian (North-South line).
- Altitude. How high or low the star is in the sky when crossing the meridian.

**If the instruments could only move in one set of directions how could you map the whole sky?**

Simply allow the Earth to spin and watch the stars cross the local meridian.

**As you move from oldest to newest telescope in this building what two improvements can you see in the way they are mounted?**

Suggested answers include: mounting on both sides, larger mounting blocks for greater stability and more freedom of movement (from wall mounted quadrant to transit 'circles' allowing both North and South-facing positioning).

**If the Sun passes over the Airy Transit Circle at local noon, how far will the Sun have appeared to move in the sky when the ball is dropped?**

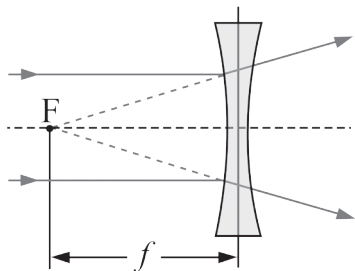
24 hours in a day. Earth spins 360 degrees. That is 15 degrees movement for each hour. The Sun will have appeared to move 15 degrees west along the ecliptic.

## Activity Telescope Optics

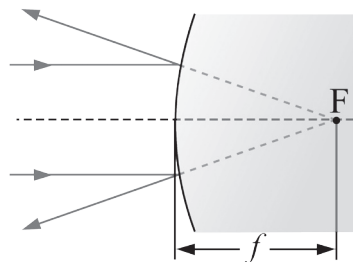
**Fill in the blanks:**

A lens REFRACTS light and light passes through it.

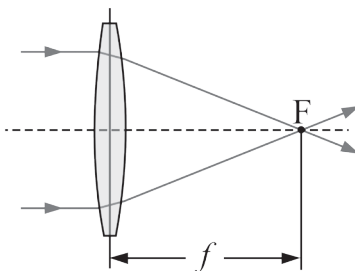
A mirror REFLECTS light and light does not pass through it.



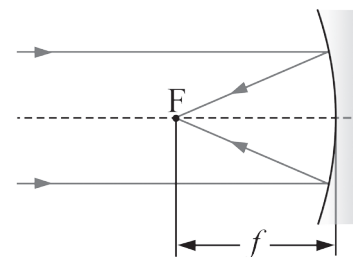
◀ **CONCAVE LENS**



◀ **CONVEX MIRROR**



◀ **CONVEX LENS**



◀ **CONCAVE MIRROR**



## Refracting Telescope

Object Lens: Convex  
Eyepiece Lens: Convex

## Newtonian Reflecting Telescope

Primary Mirror: Concave  
Eyepiece Lens: Convex

## Activity The Power of the Sun

### Can you name three things that extreme solar activity can affect in our daily lives?

Navigation, communications, power surges, power outages, aurorae

### From the panels in this building can you choose the correct star type for our star the Sun as it will be in approximately 4.5 billion years time?

White Dwarf

### The field in which the inside of the Sun is studied is called:

Helioseismology

### Can you find out how much more massive the Sun is compared to Earth on the panels?

300,000 times more massive than the Earth

### Use the following equation to find out the density of the Earth compared to the Sun.

Density = Mass / Volume = 300,000 / 1,000,000 = 3/10 (Sun is three tenths Earth's density)

### What is the unit of density? (Mass in kilograms and volume in metres cubed)

Kilogram per metre cubed ( $\text{kg}/\text{m}^3$ )

### Why is the Sun more/less dense per metre cubed than the Earth?

The Sun is less dense than the Earth per metre cubed. The Sun is composed of mainly hydrogen and helium gases (heated to the state of plasma). This composition is less dense than the rock and iron composition of most of the Earth.