Read this **before** you use the activities

- These translation activities have been devised to help you implement aspects of **OBE** in your teaching of science topics.
- Most of the activities, but not all, involve students working on information that is given in one form - **words**, **diagrams**, **tables**, **graphs** etc. - and turning them into another form.

- The translation activities are best carried out with the children working in **small groups**, say four to six per group, where they can spend time discussing their own ideas.
- In trials, teachers who have successfully worked with these activities get just two or three groups to **report back** the result of the group’s deliberations. Report-back from each and every group is tedious and unnecessary. After the initial reports ask the whole class if anything has not been mentioned or they can think of anything new.
- The small group activities and the whole class report-back work best if **differences in opinion** are brought out and discussed. The uncovering of such differences in opinion and interpretation provide the opportunity for your input and further teaching.
- The emphasis is less on the children having the correct answer and more on them being able to express, defend or refute ideas. That is the activities are best suited to developing **process skills**.
- Some activities are best carried out by each child working alone. These can be used for homeworks or **assessments**.

- Usually several sheets, between three and six, are grouped together on one aspect of the learning programme.
- The activities are deliberately simple in format so you can put them onto the **chalkboard** for a large class, if you have limited access to duplicating paper. Otherwise, one sheet per group does encourage group work.

**Timing** and **number of lessons** required to cover this programme will depend upon your timetable and whether you are able to do any practical work. We suggest no more than four to six weeks.
Moon Watch

Timing
If you can schedule this activity in your scheme of work so you are teaching at full Moon, so much the better. It will give the learners opportunities to make personal observations. Newspapers often carry information on the phases of the Moon with the weather reports.

• Whole class discussion
This section could start with a discussion on what people already know about the Moon. The ideas that learners offer should be collected on the chalkboard for whole class scrutiny. If you feel brave, or you have time, you can ask the learners:
“How do you know what you know?” – seen it, read about it, watched on TV etc.
“What is the evidence that convinces you of this?”

• Translation Activities MOON WATCH
*Moon Watch 1.*
There is more than one pattern:
- the shape of the visible Moon changes as the days go by;
- the visible Moon (waxes) from a crescent shape to a full circular disc and then shrinks (wanes) back to a crescent;
- the Moon waxes from the Western most side and wanes back to the East;

But there are more observations that can be made:
- the diagonal at half Moon is at an angle to the horizon;
- the diagonal for a waxing half Moon is different from that of a waning half Moon;
- from the sketches, fifteen days pass from full Moon to no Moon – this implies the cycle is about 30 days.
- In the same way, from the sketches 14 days pass from the waxing half Moon to the waning half Moon – this implies the cycle is about 28 days.

The cycle of the Moon – from full Moon to full Moon takes 29.5 days.

• Class demonstration
It would be wise to carry out the standard class demonstration of the orbit of the Moon about the Earth. There are different ways to do this. A popular way involves using two balls and a torch.

Another way involves the following.
- Ask one learner to stand up and face the window – the window being where the Sun light comes from. This learner is to play the role of the Moon.
- A second learner stands in the centre of a cleared space. This learner is to play the role of the Earth.
- The Moon-learner should move in an anti-clockwise fashion, as seen from above (the north), around the Earth-learner but – and this is important - always face the window.
- As the Moon-learner moves around the Earth-learner, the Earth-learner needs to say what they can see of the Moon-learner’s face. This will be all of the face when the Earth-learner is between the window and the Moon-learner. It will be nothing when
the Moon-learner moves between the window and the Earth-learner. Half Moon conditions occur when the Earth and Moon learners are alongside each other with respect to the window.

If you have enough space, get people to try this in pairs.

You may want to ask learners to attempt to draw their own diagrams of this before you give the groups the sheet Moon Watch 2.

**Moon Watch 2.**
The diagram is a standard textbook diagram. With experience of the class demonstration it makes much more sense. Without the class demonstration it will be very difficult to comprehend – translate into words.

**Moon Watch 3.**
Patterns include:
- as the days pass the Moon wanes (shrinks) to nothing visible and then waxes back to a full Moon;
- the Moon wanes to the East – (proceeding the rising Sun), and Waxes from the West – (following the setting Sun);
- as the days pass, the position of the Moon at a given time of night – say midnight – changes. The Moon is not at its highest point in the sky at the same time every night;

**Whole class demonstration**
Even though you will have demonstrated some model for the Moon orbiting the Earth before Moon Watch 1, it will still be useful to return to such models and allow people to think again about what might be seen from the Earth.

**Moon Watch 4.**
Each time the Earth has rotated once, the Moon has moved forwards in its orbit of the Earth. Therefore for an observer to see the Moon at its highest point in the sky one has to wait for the Earth to turn that little bit more for one’s line of sight to catch up with the orbiting Moon. As the Earth turns, it actually takes 24 hours and 50 minutes for the Moon to return to the highest point in the sky.

Also, because the Earth is circling the Sun, there is yet another time delay to the Moon being at its highest point. So although the Moon would take 27.3 days to orbit a stationary Earth, in fact, it takes 29.5 days for the full Moon being at the highest point in the sky.

One can see why astronomy takes years of patient study – with lots of time in between to do other things.
Star Watch

Unlike Moon Watch, these sheets are best started when there is no Moon (two weeks after full Moon). Again you may be able to check when this will be in the newspaper by looking beside the weather reports.

If you can get star maps and charts this will add to the experience. You could ask people to look at the night sky and make observations in preparation for the activities.

• Translation Activities STAR WATCH.

Star Watch 1.
Learners should notice:
- the pattern of stars changes with the time of night;
- the pattern shifts across the sky from East to West throughout the night.

Star Watch 2.
Learners should notice:
- the patterns shift across the night sky from month to month;
- the patterns shift from East to West as the months pass.

• Home Assignment

In rural areas learners should be to make their own observations with ease. For city learners they may need to go with friends and adults to places where there is less street lighting. Observations could be made more systematic by looking for patterns in the stars and how those star patterns move across the sky both within one night and as the days pass. It is possible to see the Milky Way – our galaxy seen side on - from November through to August. It is on the Southern horizon in September and October.

Star Watch 3.
- Because the Earth moves around the Sun the stars that are on the opposite side of the Earth, away from the Sun, keep changing.
- Stars that appear on the eastern horizon one month, will be overhead some months later. They then disappear over the western horizon.
- Each night, the star patterns move from the eastern horizon to the western horizon as the Earth rotates on its axis.

• Whole Class Discussion

Feeling adventurous?
Then why not end this section of work with a discussion on the differences between ASTRONOMY and ASTROLOGY. It is best to structure the activity.

Start by asking individuals to write down what they think the differences are. Then group six or so pupils together so they can agree, as a group, what they think the differences are. Finally pick just three contrasting groups to give some whole class input.

You may want to end with some board work where you write up the key differences.

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Perhaps this is the point to recall the essence of Galileo’s statement that:
Science - ASTRONOMY – is about how the heavens go, whilst
Religion – (perhaps badly represented here by ASTROLOGY) – is about how to go to heaven.

The Solar System

Because the Star Watch activities are fairly brief, and best supplemented without outside night time observation, the work on The Solar System can follow quickly. These are definitely classroom activities as they require construction work.

You will need:
- sheets of old A4 paper with one side blank, glue sticks, scissors, rulers and pencils,
- pairs of compasses for drawing circles (Solar System 2), or circle templates cut from card.

Activities THE SOLAR SYSTEM

Solar System 1.
Do demonstrate how to do this before the learners start on their own work.
Put it up in the classroom.

Make sure that people mark the position of the Sun before they mark off the planets.
The size of the Sun, to this scale, gives some impression of how much of the solar system is just empty space.
People can make their own distance chart and then take it home.

Solar System 2.
Again, do demonstrate before you start learners on their own constructions.
If it is brightly coloured it could make a cheerful wall decoration for your classroom.

The massiveness of the Sun compared with the planets only becomes apparent with this construction exercise.

Solar System 3 and Solar System 4
You could turn this into a general exercise of creativity with the making of posters and drawings to accompany written text. How about inviting the head of year or head teacher to come and view the final display. Make it a special occasion. Science can be fun and colourful.

The Tides

Whole class discussion
Find out how many in the class have actually:
- been to the sea shore;
been on successive days;
- noticed anything about the level of the water;
- know anything about what happens to the level of the water from other work they have done (maybe in geography classes).

**Translation Activities THE TIDES.**

*The Tides 1.*
Prediction depends upon knowing some pattern in what happens in nature so that one can use the pattern to predict what will happen in the future.

Finding patterns often involves measuring. Here the obvious thing to do is to measure the height of the water in the sea. Decisions need to be made about:
- when to measure: every minute, hour, three hours, day etc.
- where to measure: out at sea, by the rock-pools, at a nearby harbour, along the coast.

Record keeping needs to be systematic with both the day, time of day and height of water all written down. This is probably best done in tables: like tide tables.

Do NOT collect ideas from all the groups. Just ask three groups, with different ideas, to report back to the whole class.

*The Tides 2.*
Obviously this is about the investigative method. So what you should be looking for are sets of cartoons where people have suggested somewhat different steps.

Again select just the three that differ most and ask a representative from each group to take the class through the procedure in the cartoons. Encourage the rest of the class to ask for clarification on how things are to be done.

*The Tides 3.*
Choices have to be made about the scales for the graph.
- As the time is the independent variable it goes horizontally.
- There does not need to be a zero for the level of the water as the heights are relative.
- The height ranges between 1.6m (10:00hrs) and 0.4m (16:00hrs) which suggests the mid-point is about 1m level.
- One may want to round the figures off to the nearest 10 cm – 0.1m. depending on the scale chosen for the vertical axis.

The shape of the graph is sinusoidal as in sheet 4.

*The Tides 4.*
The biggest problem may be in helping the learners to recognise that the graph is NOT a wave, as in waves on the sea. Waves mark out changes in height with respect to distance. Here, with the graph, the rise and fall is with respect to time.
The graph shows a cyclic pattern. The period, or time between maximum heights, is 12 hour and 25 minutes. It is impossible to get such precision from the graph. The best one might do is $12\frac{1}{2}$ hours. Going to the beach 50 minutes later each day means that the sea level will always appear much the same even though the sea level will have risen and fallen twice between such visits.

The maximum rise and fall of the water has changed over the seven days. The range of height, or amplitude – from its highest level to its lowest level, is less after seven days than it was at the beginning. At the beginning the range was from 0.4m to 1.6m. After seven days it is only from 0.6m to 0.9m.

When the amplitude is a maximum this is called a spring tide. Seven days later, the much reduced amplitude is called a neap tide.

*The Tides 5.*

One might expect learners to show the Sun, Moon and Earth to be in line with the sea on the Earth’s surface distorted (pulled) by the Sun and Moon’s gravitational force.

![Diagram](https://example.com/diagram)

Although the Sun is large it is a long way Sea distorted on Earth by gravitational force

The fact that the tides vary with the Moon’s orbit of the Earth shows that the gravitational pull of the Moon is far more influential in causing the tides.

*The Tides 6.*

At spring tides the Sun and Moon are in line and so the combined gravitational pulls on the sea causes a large distortion to the sea’s surface. The amplitude of the tide is large.
At \textit{neap tides}, at half-moon, with the Moon and the Sun acting at right angles to each other, the combined effect is much reduced and so the distortion to the sea’s surface is much less. The amplitude of the tide is lower.

\section*{The Falling Moon

\textbf{Introduction}}

People have long turned to the sky and watched the progress of the Sun, Moon, stars and wandering stars (now called planets). In a time of no radio, cinema or television, looking at the night sky was a way of passing the time and a source of entertainment, especially if the observations were accompanied by stories of the gods. In a time of no street lighting, the stars in the night sky were visible even in cities.

\textbf{• Translation activities THE FALLING MOON}

\textit{The Falling Moon 1.}

Galileo Galilei (1564-1642) is remembered as one of the fathers of modern science, if not the father. This is because he used observations and empirical data collection and combined them with a strong sense of the need for quantitative methods. He measured things in a way that few had done before. As a professional mathematician he was primarily interested in the patterns in numbers.

Galileo’s observations with his telescope led him to the conclusion that more and more evidence supported the Sun centred view of the universe as recently proposed by Copernicus (1473-1543). His work on falling objects convinced him that the established view, that of the Greek, Aristotle (384-322BCE), was wrong.

Galileo published his second book, “Dialogue on the Two Chief World Systems” in 1632. From that moment he was set on a course that would lead to conflict with the Catholic Church. What probably tipped the balance of events towards a trial for heresy was that it was suggested that, in his book, Galileo had deliberately created the character of Simplicio (the simpleton) and used the character to mock the teaching of the Catholic Church. People also suggested Simplicio was supposed to be Pope Urban VIII. However, it is unlikely that Pope Urban the VIII was Galileo’s target. The next year, at the age of 69, Galileo was called to Rome to the headquarters of the Inquisition. He was asked to sign a paper which stated that his ideas were wrong. He did this. He was then kept under house arrest in Florence until he died in 1642. What probably protected him from being tortured, or burnt at the stake, was his wide fame as a natural philosopher and, ironically, that Pope Urban had been his friend and confidant.

The effects of the invention of printing by Guttenberg in the 1450s; and then the use of local languages, instead of Latin, in books; followed by the Protestant upheaval after Luther’s declaration in 1517, all combined to both make Galileo’s work possible and, at the same time, dangerous for the Catholic Church.

The people who opposed Galileo’s ideas were not silly or stupid. They were often as interested in natural philosophy as he was. However, where he thought the evidence led
to the Sun centred universe, his scientific opponents did not see the evidence as being either sufficiently strong, or conclusive. They could still point to things Galileo could not easily explain. Where he was willing to take a chance, they wanted more certainty.

_The Falling Moon 2._
The publication of Newton’s Principia in 1686 was not a great watershed in scientific thinking. In England, Newton’s work was not that much appreciated at the time. In Europe it was actively opposed by people who were followers of Rene Descartes (1596-1650). Descrates had invented a system of whirlpools and eddies in the aether (the imaginary material between the stars and planets) to account for the movement of the heavenly bodies. This quite obvious mechanical linkage was much preferred by thinkers who were trying to break with the past. For them, Newton’s idea of gravitational forces acting at a distance appeared to be a step backwards into the mysterious, rather than a step forwards to mechanical systems. The increased popularity of Newton’s ideas is often associated with the philosopher Voltaire (1694-1778) taking Newton’s side.

_The falling Moon 3._
Arrows to represent the force of gravity on the projectile can be added anywhere along the projectile’s path. The arrows should always point to the centre of the Earth as that is the source of the gravitational force.

_The falling Moon 4._
- The Moon would move in a straight line, past the Earth, if it were not for the gravitational force of the Earth.
- The pull of the Earth’s gravitational force on the Moon pulls the Moon towards the Earth.
- In being pulled by the Earth’s gravity the Moon is falling towards the Earth.
- But because the Moon is already moving sideways to the gravitational pull of the Earth, the Moon does not fall straight down to the Earth. Instead it travels in a curved path.
- Along the curved path the direction of the pull of the gravitational force is always towards the Earth, the source of the gravitational force.
- The Moon continues to travel in a curved path with the gravitational pull always acting at right angles to its immediate path of motion. Such a path is an ellipse or circle.
- Although the Moon is constantly falling towards the Earth it just orbits it.

To invent such an explanation is not a simple matter. If it were then scientific knowledge would not be so hard to produce. We celebrate the people who first make these jumps of imagination and deduction. In this case it was Newton.

*The Falling Moon 5.*
The force of gravity gets weaker the further one moves away from the Earth. This is a function of the three dimensional geometry of the situation. One can think of the imaginary lines of force radiating out as the spokes of a wheel. At the hub of the wheel the spokes are close together. At the rim the same number of spokes are more widely spread.

The independent variable, which should go on the horizontal axis is the distance from the centre of the Earth in Earth diameters. The dependent variable, which should go vertically is the force in newtons pulling on one kilogram.

*The Falling Moon 6.*
Again, if one thinks of the imaginary lines of the gravitational field like spokes, then the further away one moves from the source, the more spread out the spokes become. If one doubles the distance the same spokes pass across four times the area. So one might expect the field to be 1/4 of the strength. If one trebles the distance then the spokes pass across 9 times the area and so one might expect the gravitational force to be just 1/9th.

*The Falling Moon 7.*
Any of the following will add to a discussion.
- The force on 1 kilogram at the Earth’s surface is nearly 10 newtons.
- The gravitational force is bigger the closer one is to the surface of the Earth.
- As the distance increases the gravitational force is less
- Doubling the distance gives 1/4 of the gravitational force.
- etc.

*The Falling Moon 8.*
This should be treated as a bit of fun with people reading out their newspaper stories. Pick 3 or four people at maximum to read to the class. Other people’s work can be put on the walls of the class for display.