Teacher Development Workshop
Senior Phase

Natural Sciences
CONTENTS PAGE

INTRODUCTION TO CAPS.........................................................................................................................3

ACTIVITY A: .................................................................................................................................................3

INTRODUCTION TO THE NATURAL SCIENCES CAPS..............................................................................5

ACTIVITY B: NATURAL SCIENCES AND TEXTBOOKS ..............................................................................5

ACTIVITY C: NATURAL SCIENCES GRADE 7............................................................................................7

ACTIVITY D: NATURAL SCIENCES GRADE 8...........................................................................................12

ACTIVITY E: NATURAL SCIENCES GRADE 9...........................................................................................18

HOW PLATINUM AND SPOT ON NATURAL SCIENCES TEXT BOOKS WILL HELP YOUR TEACHING.............................................................................................................................................23
INTRODUCTION TO CAPS

This section is an introductory section to the Senior Phase CAPS. Use your *Survival Guide to the Senior Phase CAPS* as a resource.

**Activity A:**

**Topics to be covered:**
- Generic CAPS information
- Assessment
- Generic planning

**Instructions:**
1. Participants should complete this activity in groups of three.
2. Use the *Survival Guide to the Senior Phase CAPS* as a resource to look up the answers.
3. Read each statement/question in the table and discuss the answer in your group.
4. Write down the answer in the space that has been left for discussion notes.

The questions have been developed to stimulate discussion. The facilitator will discuss the questions at the end and clarify any uncertainties.

<table>
<thead>
<tr>
<th>QUESTION / STATEMENT</th>
<th>ANSWER AND DISCUSSION NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What does CAPS stand for?</td>
<td></td>
</tr>
<tr>
<td>2. <em>CAPS is not a new curriculum.</em></td>
<td>State whether the above statement is true or false.</td>
</tr>
</tbody>
</table>
3. *The Senior Phase CAPS will be implemented in 2014.*

State whether the above statement is true or false.

4. *There are no more Learning Areas in the Senior Phase.*

State whether the above statement is true or false.

5. *The number of subjects in Senior Phase has decreased.*

State whether the above statement is true or false.

6. *The number of assessments in the Senior Phase has increased.*

State whether the above statement is true or false.

7. Which changes in the Senior Phase will have the greatest impact on planning?

*Hint:* Look at the time allocation in the Survival Guide.
INTRODUCTION TO THE NATURAL SCIENCES CAPS

This section of the workshop focuses on Natural Sciences Grades 7–9. It also provides a taste of what to expect in the Spot On and Platinum Natural Sciences textbooks and how they support teaching CAPS.

Activity B: Natural Sciences and textbooks

Topics to be covered:
- Generic CAPS information
- Criteria for choosing a textbook
- Timetabling and planning in Natural Sciences
- Assessment in Natural Sciences

Instructions:
1. Use the information provided by the facilitator to answer as many of the questions as possible.
2. Natural Sciences is organised according to four knowledge strands. For each of the knowledge strands in the table, place the number of the term in which the strand is taught in Column A.
3. Each strand prepares learners for one or more FET subjects. Match the strands to the FET subjects in Column B.

<table>
<thead>
<tr>
<th>STRAND</th>
<th>COLUMN A Term in which taught</th>
<th>COLUMN B FET subject prepared for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life and living</td>
<td></td>
<td>Geography / Agricultural Sciences</td>
</tr>
<tr>
<td>Matter and materials</td>
<td></td>
<td>Physical Sciences</td>
</tr>
<tr>
<td>Energy and change</td>
<td></td>
<td>Life Sciences</td>
</tr>
<tr>
<td>Planet Earth and beyond</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Study the list provided on the next page. The list consists of 9 criteria that are considered important to most teachers when choosing a textbook.
5. Rank the importance of these criteria for you by placing the numbers 1 to 9 in the spaces provided.
### CRITERIA

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequencing of content according to the CAPS</td>
<td></td>
</tr>
<tr>
<td>Relevant and up to date content</td>
<td></td>
</tr>
<tr>
<td>Specific tasks required for Programme of Assessment e.g. tests, projects etc.</td>
<td></td>
</tr>
<tr>
<td>Annual teaching plan according to the CAPS with term by term overview</td>
<td></td>
</tr>
<tr>
<td>Teacher’s Guide which provides guidance and answers for Programme of Assessment</td>
<td></td>
</tr>
<tr>
<td>Variety of revision activities</td>
<td></td>
</tr>
<tr>
<td>Diagrams and pictures to explain content</td>
<td></td>
</tr>
<tr>
<td>Remedial activities to support those learners that may need extra support</td>
<td></td>
</tr>
<tr>
<td>Extension activities to support those learners that need expanded opportunities</td>
<td></td>
</tr>
</tbody>
</table>

6. For each statement in the table, say whether it is TRUE or FALSE by making a tick (✓) or a cross (✗) next to it. Discuss the reasons for your choice with the person next to you.

### STATEMENT

<table>
<thead>
<tr>
<th>STATEMENT</th>
<th>✓ or ✗</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Natural Sciences class must have workspace and equipment for every learner to carry out investigations.</td>
<td></td>
</tr>
<tr>
<td>Reading and writing is not so important in Natural Sciences.</td>
<td></td>
</tr>
<tr>
<td>Natural Sciences is a skills-based subject. Developing learners’ skills is just as important as teaching them content.</td>
<td></td>
</tr>
<tr>
<td>There are four Specific Aims in Natural Sciences.</td>
<td></td>
</tr>
<tr>
<td>Scientific knowledge changes over time.</td>
<td></td>
</tr>
<tr>
<td>The Natural Sciences CAPS lists 15 very specific process skills that learners must master in the Senior Phase.</td>
<td></td>
</tr>
</tbody>
</table>
Activity C: Natural Sciences Grade 7

Material for this activity is taken from a Grade 7 topic in the Natural Sciences CAPS. The examples are from Spot On Natural Sciences Grade 7 and Platinum Natural Sciences Grade 7.

Topic to be covered:
• Relationship of the Moon to the Earth

Background information:
• The material for this activity comes from p. 32 of the Natural Sciences CAPS:

<table>
<thead>
<tr>
<th>Relationship of the Moon to the Earth</th>
<th>Relative positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity</td>
<td>the Moon revolves around the Earth in its orbit</td>
</tr>
<tr>
<td></td>
<td>gravity is the tendency of all objects to attract (pull) each other</td>
</tr>
<tr>
<td></td>
<td>the pull of gravity depends on how much mass each object has and how far apart they are</td>
</tr>
<tr>
<td></td>
<td>- more massive objects exert a stronger pull than smaller objects over the same distance</td>
</tr>
<tr>
<td></td>
<td>- for objects of the same mass, the closer they are to each other, the stronger the pull of gravity between them</td>
</tr>
<tr>
<td></td>
<td>the Earth is held in its orbit around the Sun by the pull of the Sun's gravity</td>
</tr>
<tr>
<td></td>
<td>the Moon is held in its orbit around the Earth by the pull of the Earth's gravity</td>
</tr>
<tr>
<td></td>
<td>the Moon also has its own gravity</td>
</tr>
</tbody>
</table>

• This is the first time that the CAPS documents for Natural Sciences and Technology (Gr 4–6) and Natural Sciences (Gr 7–9) deals with the characteristics of a force. The formal definition of “force” is mentioned for the first time in Grade 9 content. This explains the use of the word “pull”.
• The force of gravity is dependent on the masses of both objects and the distance between their centers.
• The force of gravity of one object on the other is the same for both objects. (For example, if you jump from a plane, the force that you exert on Earth is exactly the same as the force that Earth exerts on you!)
• If you want further background information, consult Newton's Law of Universal Gravitation that is taught in Grade 11 Physical Sciences.

Instructions:
1. Participants should complete this activity in groups of five.
2. Study the material taken from Spot On Natural Sciences Grade 7 and Platinum Natural Sciences Grade 7.
3. Many learners find the concept of gravity quite difficult to deal with. As you work through the material, identify at least three concepts that you think learners might find confusing or that might lead to misconception.
4. Choose one of the concepts and prepare a presentation of no longer than five minutes that you can use to “teach” this concept to the rest of the attendees. Everybody in your group must take part in the presentation.
5. Every group should now present their concept to the rest of the attendees. The “learners” should ask questions if there is something they do not understand.
Gravity keeps everything on Earth

Remember that gravity is the pull of two objects on each other. This means that you pull on Earth, and Earth pulls on you. If you jump from a plane, gravity means that you and Earth pull each other.

Earth’s mass is about $6 \times 10^{24}$ kg. That is $6,000,000,000,000,000,000,000,000$ kg. The pull of gravity that you and Earth exert on each other is not enough to move something as massive as this. So Earth does not move towards you. Because your mass is much less, the pull is enough to cause you to move towards Earth.

Nothing on Earth is nearly as massive as Earth itself. That is why everything on Earth is pulled towards Earth. Designing a space craft that can escape the pull of Earth and go into space is a great challenge for space craft engineers.

Distance and gravity

If two objects are moved closer together, the pull of gravity that they exert on each other increases. If they are moved further apart, the pull of gravity decreases. In Figure 6(a), you can see two spheres of equal mass. In Figure 6(b), the same spheres are further apart. The pull of gravity that the spheres exert on each other in Figure 6(a) is greater than in Figure 6(b).

![Figure 6 The pull of gravity is greater in (a) than in (b)](image)

Earth is held in its orbit by the gravitational pull of the Sun

The Sun is the most massive object in the Solar System, containing more than 99.8% of all the mass in it. As a result, the pull of gravity that the Sun and each of the planets exert on each other, is very strong. This keeps the planets moving around the Sun instead of flying off into space.
Earth revolves around the Sun in an almost circular orbit. Earth would not travel in an orbit like this if it were not for the pull of gravity that the Sun exerts on it. Objects tend to travel in a straight line, unless there is a push or a pull that makes them change direction.

As Earth moves forward through space, the gravitational pull of the Sun keeps pulling Earth toward the Sun. Earth’s forward movement and the gravitational pull of the Sun together keep Earth moving round the Sun in its orbit. If there were no gravity, Earth would travel away from the Sun in a straight line. Look at Figure 7 to help you understand this better.

**Activity 3** Demonstrate the pull of gravity

You will need: - a ball, such as a soccer or tennis ball - a piece of rope - a string sack or bag that vegetables are often packed in, or a supermarket bag with handles

Work in pairs and follow these steps:
- Find a large clear space outside.
- Put your ball into the string bag or plastic bag. Push the ball to the end, and tie the bag so that it stays there.
- Attach the rope to the bag so that you can hold it easily.
- Swing the ball around in a circle above your head, like the girl in the picture.
- Observe what happens to the ball.

1. Think about the activity.
   a) What does the ball represent?
   b) What does the person swinging the ball represent?
   c) What does the string represent?
   d) What does the path of the moving ball represent?
   e) What would happen to the ball if you or your partner let go of the string? Look at the picture to help you.
   f) Why would this happen?
   g) What does this tell you of the role that the pull of gravity plays on Earth’s orbit?

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The Moon is held in its orbit around Earth by the gravitational pull of Earth

The Moon is kept in its orbit by the gravitational pull of Earth. Without this pull, the Moon would not follow a curved path round Earth, but would fly away from Earth in a straight line. Figure 8 will help you understand this.

The Moon also exerts a gravitational pull

The Moon has mass, and therefore there is a gravitational pull between the Moon and any other object. The Moon’s mass is much less than that of Earth. An astronaut on the surface of the Moon will experience a much smaller pull of gravity than on the surface on Earth. In fact, the pull of gravity on the Moon is six times less than on Earth!

You would be able to jump and throw balls higher and further on the Moon than on Earth. Astronauts found it was easier to jump or hop on the Moon than to walk, as they could not easily keep both feet on the ground. When they tried to walk, they often fell over!

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Key concepts:
- Gravity is the tendency of all objects to attract, or pull toward, each other because of their mass.
- The pull of gravity depends on how much mass each object has and how far apart the objects are.
- Earth is held in its orbit around the Sun by the pull of the Sun’s gravity.
- The Moon is in its orbit around Earth by the pull of Earth’s gravity.
- The gravitational pull of the Moon is less than that of Earth. This is because the Moon’s mass is much less than Earth’s mass.
**Unit 2: Gravity**

What is gravity?

Gravity is the tendency of objects to attract or pull each other. All objects have gravity—even your own body. However, you won’t notice your own gravitational pull because your mass is too small. For gravity to be noticeable, the object that is attracting or pulling other objects needs to be massive. We are pulled towards the ground because of the Earth’s gravitational pull, which pulls us and everything else on Earth towards its centre. This is one of the reasons that we can live on a planet that is shaped like a ball.

Make sure you understand the concept of mass. Mass is a measure of the amount of matter in an object and it is measured in kilograms. The mass of an object stays the same whether the object is on Earth, on the moon, or anywhere else in space.

Factors that affect an object’s gravity

The strength of an object’s gravitational pull depends on the mass of the object and the distance between the object and the object it is pulling.

The effect of mass on gravity

An object or body with a great mass will exert a stronger gravitational pull than objects with smaller masses. The circles in Figure 17A represent planets, each with a moon. Planet A and Planet B have the same mass, so the gravitational pull on their moons will be equal. Planet C has a smaller mass than the first two planets. Planet C’s gravitational pull on its moon will be less than the gravitational pull that Planets A and B exert.

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**The effect of distance on gravity**

The distance between two objects will also affect their gravitational pull. In Figure 17C, Object D and Object E will exert a strong gravitational pull on each other, because there is a relatively short distance between them. Object E, which is the same mass as the two other objects, will exert a weaker gravitational pull on Object D, because it is further away from it.

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**Pull of gravity of the sun, Earth and moon**

The sun is so massive that it holds all the bodies in the solar system in its orbit because of its gravitational pull. The Earth is one of the planets held in the sun’s orbit by its gravitational pull. There are eight planets in the solar system, as well as a range of dwarf planets, asteroids and other space material.

The moon is held in its orbit around the Earth by the pull of the Earth’s gravity. The moon also has its own gravity.

If you look at video footage of astronauts on the moon, you will see that they seem to bounce around, rather than have their feet fixed firmly on the ground. This is because the pull of gravity on the moon is weaker than the pull of gravity that we experience on Earth. But the moon is still massive enough to have some gravitational pull. In fact, the effects of its gravitational pull can be noticed on Earth. One of the most significant effects of the moon’s gravitational pull on Earth is the tides on the Earth’s oceans and seas. You will learn more about the tides in the next unit.
Activity 2.1 Demonstrate the pull of gravity

You will need:
- a large plastic ball (you can use the globes you made in the last module)
- rope or string.

Work in groups of 4 to 6. Each person in the group should have a chance to do the demonstration. Tie the rope around the ball so that it holds firmly. Make sure to leave a long end of rope – at least 1 metre in length. Hold the end of the rope and swing the ball in a circular path around you.

Discuss the answers to the following questions in your group and then write down the answers in your exercise book.

1. If your demonstration represented the gravitational pull between the sun and the Earth, then which piece of equipment represented the following?
   a) The sun
   b) The Earth
   c) The gravitational pull between the sun and the Earth

2. Could you use this demonstration to represent the gravitational pull between the Earth and the moon? Explain how.

3. Copy the following table into your exercise book and fill in what this demonstration teaches you about gravity.

<table>
<thead>
<tr>
<th>Observation from demonstration</th>
<th>What does this teach you about gravity?</th>
</tr>
</thead>
<tbody>
<tr>
<td>As the person swings the ball, the ball makes a circular path around the person.</td>
<td></td>
</tr>
<tr>
<td>As long as the person is holding the rope, the ball doesn’t get thrown into the air.</td>
<td></td>
</tr>
<tr>
<td>The person can feel a slight pull back on the rope as he or she swings the rope.</td>
<td></td>
</tr>
<tr>
<td>If the person extends the length of rope, it is more difficult to swing the ball and it may even fall to the ground.</td>
<td></td>
</tr>
</tbody>
</table>

4. Imagine you replaced the plastic ball with a ball filled with sand.
   a) Would it be easier or more difficult to swing the ball? Describe how swinging a ball filled with sand would be different to swinging the plastic ball filled with air.
   b) What does this demonstrate about gravity?

NOTES:
Activity D: Natural Sciences Grade 8

Material for this activity is taken from a Grade 8 topic in the Natural Sciences CAPS. The examples are from Spot On Natural Sciences Grade 8 and Platinum Natural Sciences Grade 8.

**Topic to be covered:**
- Visible light

**Background information:**
- This is the first and last time in Intermediate Phase Natural Sciences and Technology and Senior Phase Natural Sciences that learners deal with the characteristics of light.
- It is a long topic with many new concepts and teachers might find it quite challenging to get through the topic in the three weeks allocated by CAPS.
- CAPS pp. 49–51 divides the content and concepts into seven main ideas. The ideas do not always follow smoothly on each other, and sometimes terminology is used in an earlier section that is only explained in a later section. This diagram is one way that you can use to find your way through this section:
**Instructions:**
1. Participants should complete this activity in pairs.
2. Study the material covering different aspects of the topic “Visible light”, taken from *Spot On Natural Sciences Grade 8* and *Platinum Natural Sciences Grade 8*.
3. Work through the content and concepts and then do **Activity 3.1** on p. 137 of *Spot On Natural Sciences Grade 8* and **Activity 8** on p. 175 of *Platinum Natural Sciences Grade 8*.
4. Discuss the following with your partner:
   - Did you teach the topic “Visible light” before? If so, for how long? If not, how do you feel about teaching this topic?
   - Do you think your learners will understand the specific concepts covered in this material after they worked through it? If not, what else is needed?
   - Do you think your learners will be able to do the activities that you did after they worked through the material? If not, what else is needed?
   - Would you be able to do **Practical activity 3.2** on p. 139 of *Spot On Natural Sciences Grade 8* and **Activity 9** on p. 175 of *Platinum Natural Sciences Grade 8* with your learners? Give reasons if your answer is “no”.

**ANSWERS for ACTIVITY 3.1 on p. 137 of *Spot On Natural Sciences* and ACTIVITY 8 on p. 175 of *Platinum Natural Sciences*:**

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Unit 3  Opaque and transparent substances

There are three types of objects depending on the amount of light they allow to pass through them (see Figure 10.9):

- Opaque objects do not let light pass through them, such as metal, clay, bricks, wall paint and cardboard. The light is either absorbed or reflected. Most objects or materials are opaque.
- Transparent objects allow all the light to pass through them such as glass, clear plastic, cellulose and clean water. Some of the light is absorbed, some of the light is reflected, but most of the light is transmitted. This means that the light passes straight through the object.
- Translucent objects allow some of the light to pass through them such as an X-ray, stained glass and waxed paper.

Activity 3.1 Classify opaque, transparent and translucent objects

1. Draw a table with three columns titled opaque, transparent and translucent.

2. Decide which the following objects belong to and write them in the correct column:
   - cloth, plastic wrap, aluminium foil, toilet paper, coloured plastic lids, bubble packing material, Styrofoam cup, tissue paper, clear glass, laminating material, wood, frosted glass, clear plastic container, white T-shirt

Shadows

Have you noticed that when you walk in the sun, your shadow seems to be close to you? Your shadow has an identical shape to your body. It may be a different size to your body. Sometimes it may be in front of you, sometimes behind you and sometimes to the side of you.

Facts about shadows:

- Light is needed to make a shadow.
- A shadow is made when an opaque object blocks the light.
- A shadow only shows the shape of an object. The shape is formed by light rays passing around the edge of the object.
- The position of the light source changes the size, length and shape of the shadow.

Ray diagrams

Ray diagrams are used to show the path of light from the person to a point on the object being viewed.

- They are drawn with straight lines using an arrow to show the direction.
- They can be used to show how the size of a shadow depends on the size of the object blocking the light source.
- They can be used to show the distance of the object from the light source.
Practical activity 3.2 Drawing diagrams to show how shadows are cast by opaque objects

Your teacher will demonstrate the following investigation.

You will need:
- a bright torch or an overhead projector
- a square shape cut from cardboard
- a retort stand and clamp
- tape
- pencil
- material to represent light rays such as straws/diagonal sticks/metre ruler
- sheet of white paper on the wall.

1. Set up the light source about 2 metres from the wall. Shine the light towards the paper that is taped on the wall.
2. Cut a square from the cardboard. Calculate its area (length x breadth).
3. Mount the shape on the retort stand. Place it between the light and the wall, 1 metre from the wall as shown in Figure 10.12.
4. Trace the shadow of the square that is projected onto the wall. Calculate the area of the shadow that you have traced.
5. Create four straight simulated light rays using straws that you have taped together. These must extend from the light source to the corner of the shadow of the square. Calculate the lengths of these light rays.
6. Sketch the arrangement of the light source, simulated light rays, shape and shadow.
7. Move the shape closer to the wall. Adjust the "light rays". They must still touch the edges of the shape. Predict whether the shadow size will increase or decrease based on the new locations of the rays.
8. Test your prediction by turning on the light.
9. Move the shape further away from the wall. Adjust the "light rays". They must still touch the edges of the shape. Predict whether the shadow size will increase or decrease based on the new locations of the rays.
10. Test your prediction by turning on the light.
11. What can you conclude about the distance between a light source and an object and the shadow it casts?
12. Would the same result be achieved if the object's position stayed the same but the position of the light source changed? Explain your answer.

Figure 10.12: Using a ray diagram to predict the shadow of a shape such as a square or triangle

Safety
Do not shine bright light into anyone's eyes.

Unit 4 Absorption of light

Do you remember investigating the absorption of heat by a dull black surface in Grade 7? Black surfaces look black because they absorb the light which falls onto it. If you get into a black car on a hot day, you will notice that it is a lot hotter than a white car because it absorbs heat far better. A black car is also a bad reflector of heat. A silver, shiny, light coloured motorcar is a good reflector and bad absorber of heat. The same principles that apply to heat also apply to light.

Light can be absorbed by surfaces of some materials. Black, dull surfaces are bad reflectors of light and good absorbers of light. Light is absorbed differently by different materials.

Light can be reflected by surfaces of some materials. Silver, light surfaces are good reflectors of light and bad absorbers of light.

Light is reflected differently by different materials.

Practical activity 4.1 Investigate what happens to light when it strikes different objects

You will need:
- piece of white and red cardboard
- a mirror
- red plastic
- a torch.

1. Put the piece of cardboard in front of the beam of light. Do you see anything happening to the light? Is it absorbed, reflected or transmitted by the object? Write down your observation in a table as the one shown.

<table>
<thead>
<tr>
<th>Object</th>
<th>Light is:</th>
<th>absorbed</th>
<th>transmitted</th>
<th>reflected</th>
</tr>
</thead>
<tbody>
<tr>
<td>cardboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>red plastic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mirror</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Do the same with the other objects.

Did you see that the beam of light was stopped by the white and red cardboard? We say the cardboard absorbed the light. Light was not transmitted through the white or red cardboard. They are opaque substances because no light is able to pass through them. The light is not absorbed and some reflected.

Colours and absorption of light

A material has colour because it absorbs some of the colours in the spectrum (some of the frequencies) and reflects other colours.
Reflection of light

Light is reflected off most surfaces, which is why we can see the objects around us. While you read this book, light is radiated from a light source, onto the page where it is reflected back to your eyes. But, light is not reflected from the black ink on the page, so all the words appear black. Your brain interprets the absence of reflected light as black.

Key words:
- normal
  - imaginary line on a reflective surface that is perpendicular to the surface
- incident ray
  - light ray that travels to the reflective surface
- reflected ray
  - light ray that is reflected by the reflective surface
- angle of incidence
  - angle between the normal and the incident ray
- angle of reflection
  - angle between the normal and the reflected ray
- plane
  - imaginary flat surface that only has length and width, but no depth or height
- scattered light
  - light that reflects in different directions, with no regular pattern apparent in the reflection

1 and 2: Light from a light source reflects on you and shines on the mirror. When light is reflected, it always changes direction.

2 and 3: Light shines on the mirror and is reflected back to your eye.

4: Your brain "sees" that the light ray that just entered your eye travelled the distance equal to the length of rays 2 and 3 together. Therefore, the brain forms an image a distance away (the sum of the distance that rays 2 and 3 travelled).

Figure 16: The reflection of light from a book.

Figure 17: How a mirror works.

Sometimes when you look at a mirror at an angle, you see an image of another object. The next diagram how this happens: in this diagram the red light that shines on the mirror is radiated at an angle. When it is reflected, it is also reflected back at the same angle.

When the reflected ray reaches your eye, your brain receives a message that a light ray that travelled a distance equal to the size of arrows 1 and 2 combined, entered your eye. Your brain then forms an image this same distance away from the eye.

In order to explain how reflection works in scientific language, it is important that we use the following terminology:

- Normal: The normal is an imaginary line on a reflective surface that forms an angle of 90° to the surface.
- Incident ray: This is the light ray that travels to the reflective surface. You can think of the incident ray as the incoming ray.
- Reflected ray: This is the light ray that is reflected by the reflective surface. You can think of the reflected ray as the outgoing ray.
- Angle of incidence: This is the angle that is measured from the normal to the incident ray.
- Angle of reflection: The angle that is measured from the normal to the reflected ray.

The laws of reflection can be summarised as follows:

1. The incident ray, the reflected ray and the normal (to the reflection surface at the point of incidence) lie in the same plane. A plane is an imaginary flat area that only had a length and width, but no depth.
2. The angle which the incident ray makes with the normal is equal to the angle which the reflected ray makes to the same normal.
3. The reflected ray and the incident ray are on the opposite sides of the normal.

Figure 18: How an image forms in a mirror when you look at the mirror at an angle.

Figure 19: A ray diagram showing how light is reflected off a reflective surface.

Figure 20: A protractor and laser pointer can be used to show how and where the angle of incidence and the angle of reflection can be measured.
Activity 8: Understand the scientific terminology used for light reflection

Study Figure 20 on page 74 and Figure 21, below, and answer the questions that follow.

1. How big is the angle of reflection? Explain how you arrived at this answer.
2. Give the scientific terminology for BC, AB and BD.

Activity 9: Investigate how images form on different surfaces

You will need: piece of tin foil - torch - mirror
1. Place the mirror flat on a table and shine the torch in the mirror. (Do not look at the image of the light directly.)
2. Place the piece of tin foil on a table and shine the torch on the tin foil. How does the image that forms differ from the image formed in the mirror?
3. Crumple the tin foil and straighten it again. Place the tin foil on the table and shine the torch on the tin foil. What can you conclude about the relationship between the texture of a surface and the reflection on that surface?

The reflection of light from smooth and rough surfaces

A mirror has a very smooth surface. On a smooth surface, all the light is reflected in the same direction.
On a rough surface, different light rays will shine on different parts of the surface, so some might shine on relatively flat parts, and some might shine on parts that are at a greater angle away from the flat surface.

Activity 10: Draw a ray diagram

1. Draw a labeled ray diagram to illustrate how it is possible to 'see' around a corner with the aid of a mirror. Use Figure 24 to help you.

2. Explain the following with the aid of a ray diagram: Although a piece of white paper is able to reflect all the light that shines on it, it is not possible to form an image of a reflection.
Activity E: Natural Sciences Grade 9

Material for this activity is taken from a Grade 9 topic in the Natural Sciences CAPS. The examples are from Spot On Natural Sciences Grade 9 and Platinum Natural Sciences Grade 9.

Topic to be covered:
- Reactions of acids with bases Part II (acids and metal oxides and metal hydroxides)

Background information:
- Acids and bases were also dealt with in Grade 7.
- CAPS pp. 67–69 presents the reactions of acids and bases as three parts and allocates two weeks for all three parts. The relationships between the different reactions are not always clear and the order in which content and concepts are dealt with might be confusing. The diagram below might be useful.
- Note that the reaction between metals and acids is not an acid-base reaction.

Instructions:
1. Participants should complete this activity in groups of five.
2. Study the material covering certain sections of the reactions of acids with bases. Choose one of Activity 5 or Activity 6 from Platinum Natural Sciences Grade 9, or Practical activity 3.1 from Spot On Natural Sciences Grade 9 to focus on in your group.
3. Answer the following in your group. Appoint one person to write down the answers:
   - What is the aim of the activity? How does it support the content? List all the process skills that learners develop in the activity.
   - Make a list of all the chemicals and apparatus you need to do the activity in a class of at 40–50 learners. Include exact quantities. Say where you will find each item or how you are going to prepare it.
   - Make a list of precautions you have to take or measures you have to put in place to prevent accidents when the activity is done in a class of 40–50 learners. Specifically pay attention to how you are going to keep the class under control.
4. Each group should give feedback to all the attendees about their answers to one of the above points.
Reactions of acids with metal oxides and metal hydroxides

Key words
- metal hydroxide: compound consisting of a metal and a hydroxide, for example Mg(OH)₂ can be formed when a metal oxide reacts with water

Acids and metal oxides
Metal oxides tend to react as bases, they have the ability to make an acid less acidic.

When an acid reacts with a metal oxide, a salt and water forms. The type of salt that forms depends on the acid and metal oxide that is used in the reaction.

The general word equation for such a reaction is: metal oxide + acid → salt + water

For example:

Word equation: magnesium oxide + hydrochloric acid → magnesium chloride + water
Symbol equation (balanced): MgO + 2HCl → MgCl₂ + H₂O

Word equation: calcium oxide + sulfuric acid → calcium sulfate + water
Symbol equation (balanced): CaO + H₂SO₄ → CaSO₄ + H₂O

Word equation: sodium oxide + nitric acid → sodium nitrate + water
Symbol equation (unbalanced): Na₂O + HNO₃ → NaNO₃ + H₂O
Symbol equation (balanced): Na₂O + 2HNO₃ → 2NaNO₃ + H₂O

Acids and metal hydroxides

Formation of hydroxides
When metals react with water, they tend to form metal hydroxides. A hydroxide ion consists of an oxygen atom and a hydrogen atom held together by a bond. The ion carries a negative electric charge and has the chemical formula OH⁻.

Metal hydroxides are bases. When they dissolve in water, they form alkaline solutions, with a pH greater than 7. The solutions turn red litmus blue. If colourless phenolphthalein indicator is added to a metal hydroxide solution, it turns pink (see Figure 12).

Figure 12: When sodium reacts with water, sodium hydroxide is formed. Phenolphthalein indicator turns pink because the hydroxide is alkaline.

Figure 13: Sodium hydroxide (NaOH) is also called caustic soda. It is used in drain cleaners.

Hydroxides can neutralise acids

Hydroxides have the ability to make an acid less acidic. When an acid reacts with a metal hydroxide, a salt and water forms. The type of salt that forms depends on the acid and metal hydroxide that is used in the reaction.

The general word equation for such a reaction is: metal hydroxide → salt + water

For example:

Word equation: sodium hydroxide + hydrochloric acid → sodium chloride + water
Symbol equation (balanced): NaOH + HCl → NaCl + H₂O

Word equation: potassium hydroxide + sulfuric acid → potassium sulfate + water
Symbol equation (unbalanced): KOH + H₂SO₄ → K₂SO₄ + H₂O
Symbol equation (balanced): 2KOH + H₂SO₄ → K₂SO₄ + 2H₂O

Word equation: magnesium hydroxide + nitric acid → magnesium nitrate + water
Symbol equation (balanced): Mg(OH)₂ + HNO₃ → Mg(NO₃)₂ + H₂O
Symbol equation (balanced): Mg(OH)₂ + 2HNO₃ → Mg(NO₃)₂ + 2H₂O

Activity 5: Investigate the neutralisation of a metal hydroxide

You will need: sodium hydroxide solution + dilute hydrochloric acid + a test tube or small beaker + a test-tube or a measuring cylinder + a dropper + universal indicator solution

1. Place about 13 ml (two teaspoons) of sodium hydroxide solution in the test tube or beaker.
2. Add a drop of universal indicator solution. Use the colour of the indicator to determine the pH of the sodium hydroxide.
3. Use the dropper to add hydrochloric acid to the sodium hydroxide. Swirl the beaker or test tube after a few drops.
4. When the indicator turns light blue, add the acid one drop at a time. Stop when the indicator turns green.
5. Explain the meaning of the green colour of the indicator.
6. Write a word equation and a balanced symbol equation for the reaction in the test tube.

Figure 14: (a) Add the hydrochloric acid drop by drop. (b) The sodium hydroxide is neutralised.
Activity 6  Recover table salt from a neutralised solution

You will need: hydrochloric acid + sodium hydroxide + a watch glass or saucer

1. Make a neutral solution by carefully adding hydrochloric solution to sodium hydroxide solution. Pour some of your solution into the watch glass or saucer.
2. Leave the watch glass in a sunny spot until all the water evaporated. This may take a day or two.
3. Record your observations.
4. Write down the formula, chemical name and everyday name of the substance in the watch glass.
5. Explain what happened when the watch glass was left in the sunny spot.

Figure 15 Result after the watch glass was left in sunny spot

Activity 7  Predict reactions between hydroxides and acids

Write word equations and balanced chemical equations for each of the following reactions,
1. Sodium hydroxide and nitric acid
2. Calcium hydroxide, Ca(OH)₂ and hydrochloric acid
3. Magnesium hydroxide, Mg(OH)₂ and sulfuric acid
4. Potassium hydroxide and hydrochloric acid
5. Aluminium hydroxide, Al(OH)₃ and hydrochloric acid

Key concepts
Metal oxides and metal hydroxides can neutralise acids. When acids react with metal oxides or metal hydroxides, the products are a salt and water. The salt can be recovered from the neutralised solution.
Unit 3 The general reaction of an acid with a metal carbonate (base)

General reaction
Muriatic acid and lime water are made up of calcium carbonate. Cement also contains carbonates. Carbonates are used by people as anti-acids. People take these when they have heartburn as a result of too much stomach acid. Carbonates are also found in sea shells.

Metal carbonates are bases. When an acid reacts with a metal carbonate, the products formed are a salt, carbon dioxide and water.

The general equation for this reaction is:

\[ \text{acid} + \text{metal carbonate} \rightarrow \text{salt} + \text{carbon dioxide} + \text{water} \]

The type of salt formed will depend on the acid and carbonate that is used in the reaction.

To test for carbon dioxide you can use lime water. This is a clear liquid that turns milky or cloudy when carbon dioxide is present.

Examples
Calcium carbonate can be made by grinding up chalk into a powder. If it is added to dilute hydrochloric acid the products will be calcium chloride, a salt, carbon dioxide and water.

The word equation for this reaction is:

Hydrochloric acid + calcium carbonate → calcium chloride + carbon dioxide + water

The chemical equation is as follows:

\[ 2\text{HCl} + \text{CaCO}_3 \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O} \]

Figure 8.6: The changes that occur in lime water when carbon dioxide is present

Figure 8.7: Chalk reacting with hydrochloric acid

Practical activity 3.1 Reaction of calcium carbonate with hydrochloric acid

You will need:
- beaker
- calcium carbonate - obtained by grinding up a piece of chalk
- dilute hydrochloric acid
- dropper
- teaspoon
- evaporating dish
- tripod stand
- Bunsen burner or heat source
- Universal indicator
- lime water

Procedure:
1. Grind up a piece of white chalk and place about 1 teaspoon of the calcium carbonate in a test tube.
2. Add a few drops of UI to the test tube.
3. Use the medicine dropper to carefully drop the hydrochloric acid over the calcium carbonate. Observe what happens.
4. Continue adding hydrochloric acid until all the calcium carbonate has reacted – until the UI has turned green.
5. Collect the gas that is given off during the reaction – as shown in Figure 8.0.
6. Test the gas using lime water.

Questions:
1. What do you observe when the acid is added to the calcium carbonate?
2. What is the name of the salt that has been formed?
3. What is the name of the gas that is given off during the reaction?
4. How do you know this?
5. The word equation for the reaction is as follows:

\[ \text{calcium carbonate} + \text{hydrochloric acid} \rightarrow \text{calcium chloride} + \text{water} + \text{carbon dioxide} \]

Write a balanced chemical equation for this reaction.
Topic: Reactions of acids with bases

When the dilute hydrochloric acid reacts with the calcium carbonate, a bubbling reaction is seen. This bubbling is called effervescence. The bubbles that are given off are carbon dioxide. This can be seen as the lime water changes from clear to milky. The calcium chloride which is formed is soluble and the solution in the first test tube stays clear.

Applications

Antacids
Carbonates can be found in ‘antacids’ or ‘anti-acids’. Remember that the stomach contains hydrochloric acid to help with the chemical digestion of food. Sometimes there is too much acid and a person feels uncomfortable and may complain of heartburn. By drinking a fizzy glass of Eno, the carbonate in the Eno which is basic, neutralises the stomach acid.

Changing the pH of soil
Agricultural lime is a substance that can be added to soil to make the soil less acidic. It is made from crushed up limestone or chalk. The main ingredient of lime is calcium carbonate.

Activity 3.2 Uses of carbonates

15 minutes

Figure 8.10: The Ingredients of Eno

Answer the following questions:
1. After drinking an antacid such as Eno you usually burp. What is the name of the gas that forms?
2. What would you use to test the gas and determine what it is?
3. What do we call the type of reaction taking place when we use antacids or agricultural lime?

NOTES:
How *Platinum* and *Spot On* Natural Sciences text books will help your teaching

At the beginning of the workshop, you were required to rank the importance of the criteria that are considered important to most teachers when choosing a textbook.

*The Platinum and Spot On Grade 7, 8 and 9 Natural Sciences text books cover all of these criteria!*

**Sequencing of content according to the CAPS**
The books follow the exact sequence of the CAPS. Teachers are able to follow the sequence of the textbook and be confident that they have covered everything required by CAPS, in the order required by CAPS.

**Relevant and up to date content**
The authors and publishers have ensured that the latest CAPS requirements are covered. The most recent subject content is used in text and activities. Career opportunities, indigenous knowledge and the application of subject content in everyday life are addressed throughout the Learner’s Books, making the books relevant to South African learners. Assessment tasks are designed to be relevant to the ages of the learners.

**Specific tasks required for Programme of Assessment**
The Learner’s Books and Teacher’s Guides follow the required tasks for the Programme of Assessment, as specified by CAPS, precisely. The Teacher’s Guides also include assessment guidelines and relevant answers. Learners cannot be successful in Natural Sciences without developing specific process skills. *Platinum Natural Sciences* Learner’s Books include special “Skills Focus” pages that can be used to develop the process skills mentioned in CAPS. *Spot On Natural Sciences* Learner’s Books clearly lists the skills that must be developed in each section at the beginning of every module.

**Annual teaching plan according to the CAPS with term-by-term overview**
The books follow the exact sequence of the CAPS. The Teacher’s Guides provide various planning tools to assist with annual and quarterly planning.

**Teacher’s Guide which provides guidance and answers for Programme of Assessment**
The Learner’s Books are accompanied by Teacher’s Guides that provide the answers to all activities, as well as guidelines on how to use the assessments and how to mark them. Rubrics, memoranda and checklists are provided where appropriate. Support and extension opportunities are provided where necessary.
Variety of revision activities
Many different activities test newly acquired content, concepts and skills at a variety of levels, as required by CAPS. All the Learner's Books also have a revision activity at the end of each chunk of content. These can be used for homework assignments, class tests or opportunities for learners to test themselves. Platinum Natural Sciences provide practice tests and examinations in the Learner’s Books.

Diagrams and pictures to explain content
The way that colour is used to make the understanding of content easier is shown clearly in some of the extracts provided in this manual. Senior Phase Natural Sciences teachers are strongly advised to buy full-colour text books when they make a choice. Colour makes the subject far easier and more accessible for learners. All the Learner’s Books have clear, up to date diagrams to support the text. In addition, real-life, colourful photographs make the subject matter more accessible to all learners.

Remedial activities to support those learners that may need extra support
Suggestions for remedial activities are provided in the Teacher’s Guides. The Platinum Natural Sciences Teacher’s Guides come with remedial worksheets for each topic. Colourful posters that can be used to aid weaker learners accompany the Spot On Natural Sciences Teacher’s Guides.

Extension activities to support those learners that need expanded opportunities
Suggestions for extension activities are provided in the Teacher’s Guides. The Platinum Natural Sciences Teacher’s Guides come with extension worksheets for each topic. Extension opportunities are indicated as special features in the Spot On Natural Sciences Learner’s Books.

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<th><strong>Spot On Natural Sciences components</strong></th>
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<tr>
<td>• Learner’s Book</td>
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“Education is the most powerful weapon which you can use to change the world.”
(Former president Nelson Rolihlahla Mandela)