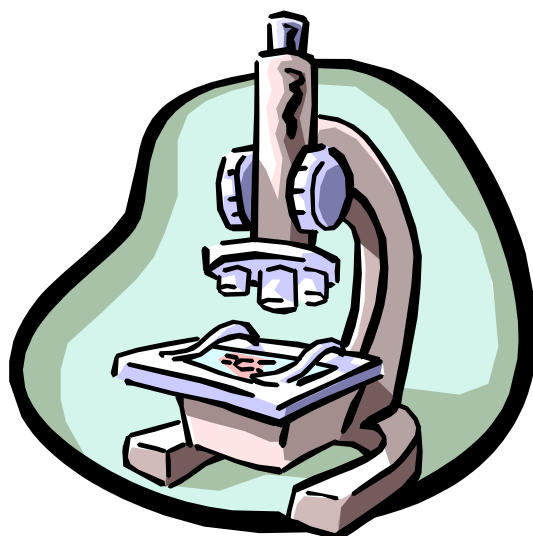




# Melbourne High School Science Year 9 Semester 2 2009



## Practical Booklet

Name: .....

Class: .....

Teacher: .....

All course information can be obtained from the Science web site:

**<http://resources.mhs.vic.edu.au/science/>**

Version: 12 June 2009

## Contents

Safety in the science rooms (Laboratory rules)	3
Analytical Chemistry	4
Burning Magnesium	15
Changing the direction of light	19
Colour & light filters	30

## Safety in the Science Rooms (Laboratory rules)

1. You must not enter the laboratory unless a teacher is present, and you must not enter any preparation room, store room or the roof top nursery except under the direct instruction of a science teacher.
2. Chemicals must not be removed from the laboratory. Theft will be dealt with severely.
3. Never attempt unauthorised experiments. You must follow instructions exactly.
4. If you see another student using an incorrect procedure, point out the error.
5. All apparatus should be examined carefully before use; it should be clean and in working order. Any damaged or dangerous apparatus must be reported immediately. Check all apparatus before putting it away. It should be undamaged and clean. Keep your work area clean and tidy.
6. Avoid waste. Use only small quantities of chemicals and make sure all gas and water taps are turned off before leaving the laboratory.
7. Most waste liquids can be poured down the sink, flush with water if this is the instructed method of disposal. Most waste solids can be disposed of in the bin. Alternative instructions will be given if required. All clean waste paper must be placed flat in the Visy recycle box.
8. If there is an accident, inform your teacher immediately.
9. Whenever you are not sure of how to handle a situation consult with your teacher.
10. Do not handle hot objects, allow sufficient time for the apparatus to cool.
11. Use matches to light a Bunsen burner, not pieces of flaming paper.
12. Be very careful with flammable liquids. Do not open or pour flammable liquids near a flame.
13. Handle glass with respect. Broken glass should be swept up immediately, wrapped and placed in the bin. All accidents must be reported to your teacher.
14. Treat ALL chemicals as poisonous. NEVER taste chemicals. Smell with care and only after being instructed to do so. Avoid skin contact or inhaling any chemicals.
15. Wash your hands thoroughly after using chemicals.
16. Do not eat or drink in the science laboratory.
17. Handle electrical equipment with great care.
18. Always leave the Science rooms looking better than you found them.



### What to do in case of accidents or injuries:

1. Inform your teacher immediately.
2. Treat splashes in the eye by irrigating the eye with water continuously for several minutes.
3. Flood spills on the skin or clothes with large amounts of water. This also applies to benches. Clean up.
4. Shower burning paper and other burning solids with water. Use the liquid carbon dioxide fire extinguisher on electrical fires.
5. If a person is on fire, shower with water or cover with a fire blanket. Do not use a fire extinguisher.

### Safety is always our first concern!

- Irresponsible and dangerous behaviour will result in your parents being informed and may result in the withdrawal of hands-on practical work.
- Careless handling of equipment causing damage or deliberate breakage will result in the student(s) responsible paying for damaged or broken equipment.
- Serious accidents can occur especially through irresponsibility, disobedience and inattention.
- Class behaviour is also important. Unruly classes will not do practical work.

**We expect you to work well, safely & enjoy this excellent subject.**

## Analytical Chemistry

Name: \_\_\_\_\_

Form: \_\_\_\_\_

Partner(s): \_\_\_\_\_

### Safety:



**Wear safety goggles and safety apron. Many of the compounds used in this experiment are poisonous and / or corrosive. Handle them with care and wash hands thoroughly after using them.**

**Read the general safety in the science room document at the front of this booklet.**

### ANALYTICAL CHEMISTRY OVERVIEW

During this unit, you will be introduced to various techniques used to identify particular parts of an unknown compound. The compounds that we are dealing with in this case are 'salts', or ionic compounds. The following techniques for identifying unknown compounds are widely used in a wide range of scientific fields including forensics, mining and metallurgy.

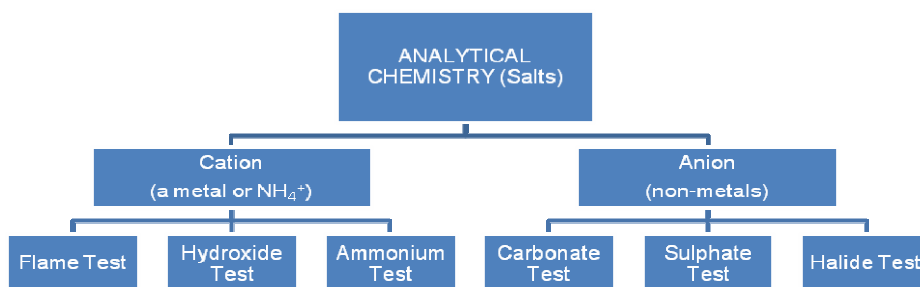
**Before beginning this practical activity you are required to read through the revision notes and complete the four worksheets on the year 9 science portal found at:**

<http://domain.mhs.vic.edu.au/student/Faculties/Science/Yr9Science/default.aspx>

There are six tests that need to be completed. You will practice each of them and become familiar with the results that you expect to obtain as you become more confident in your experimentation.

At the conclusion of the topic, you will be given three unknown compounds and you will be asked to identify each by name and chemical formulae.

Your teacher will explain the method that you will employ to identify each compound, but a flow chart illustrating this system is shown below.



**PART A – CATION TESTS****TEST 1 – FLAME TEST**

**Background:** Many compounds when introduced into a flame alter the colour of the flame. This ability is exploited in the manufacture of flares and fireworks. A good way of carrying out the test for this ability involves adding 2 or 3 small crystals on a piece of wire into a gentle blue Bunsen flame. The wire must be clean before use. If you use too much material in this test you may damage the Bunsen burner if chemical is dropped into it.



**Safety glasses must be used for this experiment**

**Procedure:**

1. Collect equipment and sand off the flame test tool with sand paper.
2. Apply heat to further cleanse the tool.
3. Now dip the tool in 0.1M HCl solution (CAUTION) and use it to pick up 2 or 3 crystals of the compound.
4. Hold the crystals in the edge of a blue flame.
5. Record the colour of the flame (if any).

**Results:**

Compound	Colour	Conclusion

**OVERALL FINDINGS: Do specific cations give unique coloured flames? Explain.**

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**TEST 2 – HYDROXIDE TEST**

**Background:** Solutions of some metals react with sodium hydroxide to produce a jelly-like (“gelatinous”) solid substance which is a new salt, the metal hydroxide. Since the substance formed is a salt that does not dissolve well in water, this substance is referred to by chemists as a precipitate. In later tests you will encounter several other types of precipitates, though they will be powdery rather than gelatinous.

**Safety Precaution: Sodium hydroxide is caustic. If sodium hydroxide solution is spilt on skin or clothes it must be washed off at once and your teacher informed of the spill.**

**Procedure:**

1. Add a small amount of the compound to a small test tube
2. Fill 1/3 of the test tube with water to dissolve the crystals.
3. Record the colour of this solution.
4. Add 3 – 5 drops of sodium hydroxide (NaOH) – CAUTION
5. Look for a gelatinous precipitate.
6. Record the colour of the precipitate if there is one.

**Results:**

Compound	Solution colour	Precipitate? (Y/N)	Colour of precipitate	Conclusion

**OVERALL FINDINGS:**


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**TEST 3 – THE AMMONIUM TEST**

**Background:** There is a group of salts that do not contain a metal ion, instead they have a charged group of nitrogen and hydrogen atoms called the “ammonium ion”. Compounds containing the ammonium ion do not produce any flame colour. Their solutions are colourless and they do not form a gelatinous precipitate when sodium hydroxide is added. However, when sodium hydroxide is added and the solution gently warmed a chemical reaction occurs, producing ammonia, a volatile base.

**Safety Precaution: Sodium hydroxide is caustic and more so when hot.**

**If sodium hydroxide solution is spilt on skin or clothes  
it must be washed off at once and your teacher informed of the spill.  
Wear safety glasses for this experiment.**

**Procedure:**

1. Place a small amount of the compound in a test tube.
2. Add 2 – 3 drops of sodium hydroxide (NaOH) (CAUTION) to the solid.
3. Warm gently and test the vapour (NOT the sides of the test tube where water may condense) with moistened red litmus paper.
4. Record your observations.

**Results:**

Compound	Observations

**OVERALL FINDINGS:**


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**PART B – ANION TESTS****TEST 4 – CARBONATE TEST**

**Background:** The carbonate ion consists of a carbon and three oxygen atoms. When metal carbonates react with an acid, one of the products is carbon dioxide gas, CO<sub>2</sub>. To verify that a colourless gas is carbon dioxide it can be bubbled through a solution of limewater (calcium hydroxide) – which will turn from clear to milky as the gas bubbles through.

**Safety Precaution:** Hydrochloric acid is corrosive, if spilt on skin or clothes it must be washed off at once and your teacher informed of the spill.  
Safety glasses must be used for this experiment.

**Procedure:**

1. Place a small amount of the solid compound into a test tube.
2. Add a 3 – 5 drops of dilute hydrochloric acid (HCl) (CAUTION).
3. Observe carefully and record your observations.  
(Fizzing may be seen and heard)

**Results:**

Compound	Observations

**OVERALL FINDINGS:**


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**TEST 5 – SULPHATE TEST**

**Background:** The sulphate ion consists of one sulphur atom and four oxygen atoms. In this test the sulphate ion retains its identity but a reaction occurs in which it “swaps partners” and barium sulphate is produced. Barium sulphate is white and it is not soluble in water. It appears as a powdery white precipitate in the test tube.

**Safety Precaution: Barium chloride is extremely poisonous.  
It must be handled with care.  
Wipe up spills immediately.**

**Procedure:**

1. Add a small amount of the compound to a small test tube
2. Fill 1/3 of the test tube with water to dissolve the crystals.
3. Add 3 – 5 drops of barium chloride solution (BaCl<sub>2</sub>) – CAUTION
4. Record your observations.

**Results:**

Compound	Observations

**OVERALL FINDINGS:**

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**TEST 6 – HALIDE TEST**

**Background:** Chlorine, bromine and iodine can all be found in the same vertical group of the Periodic Table. Salts that consist of a metal combined with an element from this group are known as “halides”. Metal halides react with silver nitrate by “swapping partners” to produce silver chloride or silver bromide or silver iodide. These products are not soluble in water and so a precipitate is obtained. You will discover the colour of each of these 3 precipitate as you carry out the experiment!

**Safety Precaution:** Silver nitrate will stain skin and clothing.



Nitric acid is corrosive. If spilt on skin or clothes they must be washed off at once and your teacher informed of the spill.  
Wear safety glasses for this experiment.

**Procedure:**

1. Add a small amount of the compound to a small test tube
2. Fill 1/3 of the test tube with water to dissolve the crystals.
3. Add 3 – 5 drops of silver nitrate solution ( $\text{AgNO}_3$ ) – CAUTION
4. Record your observations.

**Results:**

Compound	Observations

**OVERALL FINDINGS:**


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**REVISION ACTIVITIES****Part A**

Using the analysis sheet, decide the names of the following metals and non-metals that give the results below and write your answers in the spaces provided.

**Cations**

- When the flame test is carried out, the sample burned to produce:
  - a lilac flame \_\_\_\_\_
  - a yellow flame \_\_\_\_\_
  - a dark red flame \_\_\_\_\_
  - a blue-green flame \_\_\_\_\_
- When the solution and hydroxide test is carried out, the following colours are obtained:
  - a colourless solution and a white precipitate \_\_\_\_\_
  - a green solution and a green precipitate \_\_\_\_\_
  - a pale yellow solution and a rusty precipitate \_\_\_\_\_

**Anions**

- When dilute hydrochloric acid is added to a sample of the solid, the solid fizzes. Which non-metal is present?
- After adding barium chloride to a solution of this compound, a student finds a white precipitate. Which non-metal does the compound contain?

**Part B**

After reading the following information decide the name of the compound and write it in the space provided.

- Compound A produces a yellow flame and bubbles when some dilute hydrochloric acid is added to the solid in a test tube.

Compound A is \_\_\_\_\_

- Compound B gives no obvious colour in the flame test and it forms a colourless solution. When sodium hydroxide is added to the solution a white gelatinous precipitate forms. The compound was then dissolved in water. To a quarter tube of the solution, a few drops of silver nitrate was added. A white precipitate formed which turned purple in the sunlight.

Compound B is \_\_\_\_\_

- Compound C produces a lilac pink flame and forms a white precipitate when dilute barium chloride are added to a solution of the compound.

Compound C is \_\_\_\_\_

- The vapour from Compound D, turned moist red litmus paper blue after it was dissolved in sodium hydroxide solution and warmed gently. When dissolved in water, some barium chloride was added with no results and then a few drops of silver nitrate was added. A yellow precipitate formed.

Compound D is \_\_\_\_\_

## Results Summary

### CATION TESTS

<p><b>1. Flame Test</b></p> <p>No colour change</p>	<p>→</p>	<p>colour?</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Element</p> <p>= Sodium (Na)</p> <p>= Potassium (K)</p> <p>= Calcium (Ca)</p> <p>= Copper (Cu)</p> <p>= Lithium (Li)</p> <p>= Barium (Ba)</p> <p>= Strontium (Sr)</p>																		
<p><b>2. Hydroxide Test</b></p> <p>No ppte formed</p>	<p>→</p>	<table border="0" style="width: 100%;"> <tr> <td style="width: 30%; text-align: center;">Solution</td> <td style="width: 30%; text-align: center;">colours?</td> <td style="width: 40%;"></td> </tr> <tr> <td style="text-align: center;">_____</td> <td style="text-align: center;">ppte</td> <td style="text-align: center;">= Ni</td> </tr> <tr> <td style="text-align: center;">_____</td> <td></td> <td style="text-align: center;">= Fe(II)</td> </tr> <tr> <td style="text-align: center;">_____</td> <td></td> <td style="text-align: center;">= Fe(III)</td> </tr> <tr> <td style="text-align: center;">_____</td> <td></td> <td style="text-align: center;">= Mn</td> </tr> <tr> <td style="text-align: center;">_____</td> <td></td> <td style="text-align: center;">= Zn</td> </tr> </table>	Solution	colours?		_____	ppte	= Ni	_____		= Fe(II)	_____		= Fe(III)	_____		= Mn	_____		= Zn	
Solution	colours?																				
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_____		= Mn																			
_____		= Zn																			
<p><b>3. Ammonium Test</b></p> <p>No colour change</p>	<p>→</p>	<p>RED LITMUS TURNS _____ IN THE PRESENCE OF AMMONIA</p>																			
<p>→ <b>TRY AGAIN</b></p>																					

### ANION TESTS

<p><b>4. Carbonate Test</b></p> <p>No fizzing?</p>	<p>→</p>	<p>Fizzing?</p>	<p>= Carbonate present</p>
<p><b>5. Sulphate Test</b></p> <p>No ppte formed</p>	<p>→</p>	<p>_____ ppte formed</p>	<p>= Sulphate present</p>
<p><b>6. Halide Test</b></p> <p>No ppte formed</p>	<p>→</p>	<p>_____ ppte formed</p> <p>_____ ppte formed</p> <p>_____ ppte formed</p>	<p>= Bromide present</p> <p>= Iodide present</p> <p>= Chloride present</p>
<p>→ <b>TRY AGAIN</b></p>			

**IDENTIFICATION OF UNKNOWN COMPOUNDS**

UNKNOWN: \_\_\_\_\_

TEST PERFORMED	OBSERVATIONS	CONCLUSION
COMPOUND IS:		Formula:

UNKNOWN: \_\_\_\_\_

TEST PERFORMED	OBSERVATIONS	CONCLUSION
COMPOUND IS:		Formula:

UNKNOWN: \_\_\_\_\_

TEST PERFORMED	OBSERVATIONS	CONCLUSION
COMPOUND IS:		Formula:



Name: \_\_\_\_\_

Form: \_\_\_\_\_

Partner(s): \_\_\_\_\_

## Burning magnesium

Safety:



**Wear safety goggles and safety apron. Never look directly at burning magnesium. It will seriously damage your eyes. Crucibles remain very hot long after removal from heat. Do not handle the crucible until it has cooled down.**

**Aim:** (read through this prac and devise an aim for this experiment)

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**Method:**

1. Take a piece of magnesium ribbon about 5cm in length and clean the surface with steel wool.
2. Roll the magnesium ribbon into a tight coil.
3. Place the coil into the crucible and put lid on.
4. Use a clay pipe triangle to heat the crucible over a Bunsen burner. Initially ensure that the lid of the crucible is inclined slightly rather than flat during the heating process.
5. As soon as the magnesium ribbon begins to glow, use tongs to place the lid flat on the crucible.
6. After approximately 5 minutes, carefully lift the lid with the tongs to check if the magnesium is still glowing. If it has stopped glowing turn the Bunsen burner off and allow the crucible to cool.
7. After the crucible has cooled, weight the crucible, lid and contents.

**Results and Observations:**

*1. Appearance*

Before heating: \_\_\_\_\_

During heating: \_\_\_\_\_

After cooling: \_\_\_\_\_

## 2. Masses

mass of empty crucible (and lid)

g

mass of crucible (and lid) plus magnesium

g

 $\therefore$  mass of magnesium

g

mass of crucible (and lid) plus contents AFTER COOLING

g

 $\therefore$  mass of contents after cooling

g

 $\therefore$  increase in mass due to reaction

g

 $\therefore$  % increase in mass due to reaction

%

**Discussion:**

1. How do you know that a chemical change has occurred? Give two reasons.

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2. Why is it essential that the crucible and contents be cooled prior to the final weighing?

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3. There are two reasons for conducting this experiment in the way that we did rather than just holding a strip of magnesium in a bunsen flame. One relates to safety, the other to the required results. What are these two reasons?

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4. Which component of the air is reacting with the magnesium? Why is this the most likely component to react?

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5. Give a word equation for the reaction between magnesium and the gas identified in Q4. Don't forget to include symbols of state in your equation.

6. What type of strong bonding occurs in the compound produced? (Hint: Consider the types of elements involved in the reaction.)

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7. If a pipeclay triangle is used, why is it essential that the air hole in the bunsen burner be open during the heating process?

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8. What was the % increase of mass that you recorded? What % would you expect? (A hint: Mg has a mass number of 24, O has a mass number of 16.)

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**Conclusion:**

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Name: \_\_\_\_\_

Form: \_\_\_\_\_

Partner(s): \_\_\_\_\_

**Changing the direction of light  
(ref: Science Dimensions 3 ; page 74)**



**Aim**

To use the Hodson Light Box to investigate the following properties of light

- reflection in plane and curved mirrors
- refraction through a rectangular block, biconvex and biconcave lenses
- total internal reflection
- dispersion of white light through a prism

**Apparatus**

Hodson Light Box, 1 and 3 ray light screen, set of mirrors and lenses, 12 volt transformer, protractor, ruler and pencil.

**Method**

Connect the light box to the power source and place it on the edge of a plain piece of A4 paper sheet. Insert the single beam light screen and adjust the focus on the light box to produce a sharp beam of light.

**PART A: REFLECTION**

**Experiment 1: Reflection in a plain mirror.**

Place the plane mirror on the sheet below. Direct a single ray of light at an angle to the mirror's surface.

1. Trace the path of both the incident and the reflected ray onto the sheet of paper, also drawing the surface of the mirror which is causing the reflection. Include the normal and identify the angle of incidence. (Draw a line perpendicular ( $90^\circ$ ) to the mirror surface at the point where the light bends. This line is the normal. The angle of incidence is between the incident ray and the normal.)

2. Record this measurement in the table below. Now measure the angle between the reflected ray and the normal. This is called the angle of reflection.

Angle of Incidence	Angle of Reflection

3. What relationship appears to exist between the angle of incidence and the angle of reflection?

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4. Repeat this experiment for 2 other rays set at different angles to the mirror surface recording your measurements in the space provided below.


5. Observe closely the point in the mirror where the light beam is being reflected. Where does the reflection actually occur? Explain this with the assistance of a diagram.

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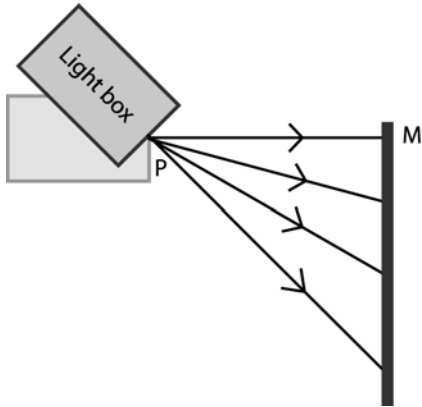


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Diagram:

**Experiment 2: Location of an image in a plane mirror.**

Place the mirror in the centre of a piece of plain A4 paper sheet and draw a line along the surface of the mirror. Pivot the light box around a fixed point **P** using the single ray screen. Direct the incident beam onto the mirror at 4 different angles starting with a ray parallel to the normal as shown in the diagram below.



1. Trace the light rays onto the page. Extend the REFLECTED rays back BEHIND the mirror surface using a ruler and a dotted line. Find the point at which the imaginary lines meet and mark this as P'.

2. Measure the distance between  $P'$  and the reflective surface of the mirror and compare that to the distance between  $P$  the mirror.

$P'M =$	$PM =$
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How do these measurements compare?

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3. Why is the image produced by a plane mirror called a *virtual image*?

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**Experiment 3: Lateral Reversal.**

1. In the space below, draw the mirror then draw the letter P about half the length of the mirror. Place the mirror in position next to the letter P and draw a line indicating the surface of the mirror. Observe the reflection in the mirror and draw the image you see.

The image you should notice is inverted left/right but not vertically inverted. This is called **LATERAL INVERSION**.

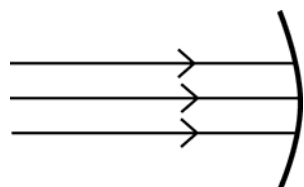
2. Try to write the mirror image of your first name. Redo with the mirror to check the accuracy of your attempt with the mirror. Show both below.

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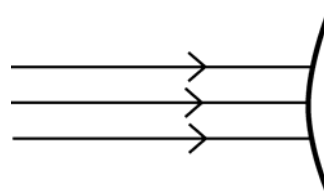
**Experiment 4: Reflection in curved mirrors.**

Replace the single ray screen with the triple ray screen and position it onto this sheet of paper (use both sides of the paper for this experiment). Direct the three parallel rays towards the mirror so the centre ray strikes the centre of the curve at  $90^\circ$  (refer to the diagram).

- Trace all three incident rays AND the resulting reflected rays with
  - the reflecting surface curving away from the light box (CONCAVE mirror)
  - the reflecting surface curving towards the light box (CONVEX mirror)



Concave Mirror



Convex Mirror

- Draw the normal at each point where the rays hit the mirror. Record the angles of incidence and reflection in the table below.

CONCAVE MIRROR

Ray	Incident Angle	Reflected Angle
1		
2		
3		

CONVEX MIRROR

Ray	Incident Angle	Reflected Angle
1		
2		
3		

- Trace the rays to where they cross over. Determine the focal lengths of the concave and convex mirrors (the distance from the mirror to where the light rays cross).

Focal length of convex mirror	Focal length of concave mirror

- The headlights of a car use concave mirrors in their headlights. Using a diagram show how headlight mirrors can produce light beams with parallel rays of light.

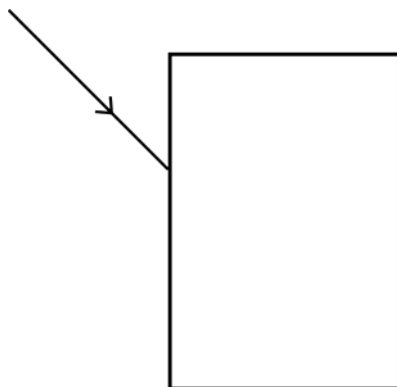
**PART B: REFRACTION**

Using the same set up as for part A (experiment 4) but replace the mirrors with the perspex blocks and lenses. The shapes of the lenses should be outlined on the paper where the ray tracings are completed.

**NOTE:** Light rays should be drawn so that a complete path **through** the lens being investigated is shown.

**Experiment 5: Refraction of light through a perspex rectangular block.**

Position the rectangular block in the centre of the paper (as shown below) below and trace around its edges. Place the single ray slide in the light box and direct the ray at an angle to the block.



1. Trace the path of the incident ray and the ray emerging from the opposite side of the block (ignore any less intense reflected rays that may occur both inside and outside the block).

Remove the plastic block and connect the two light paths.

At the two points where the ray moves from one medium to the next (air to plastic and plastic back to air) draw a line at a right angle ( $90^\circ$ ) to the interface. These lines are the NORMALS.

2. Using a protractor measure the angle between the incident ray and the normal. This is the angle of incidence. Now measure the angle between the refracted ray and the normal. This is the angle of refraction.

Angle of incidence	Angle of refraction

3. Where exactly does the bending occur?

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4. Complete the table below.

Medium Change	Incident Angle	Refracted Angle
Air $\rightarrow$ Plastic		
Plastic $\rightarrow$ Air		

5. How does the direction of the final emergent light ray compare to that of the original incident light ray? Explain in terms of bending towards or away from the normal.

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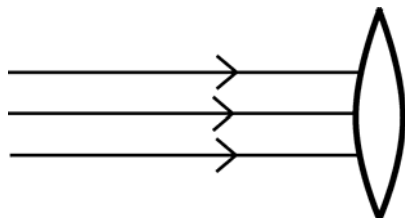
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**Experiment 6: Converging and Diverging Lenses.**

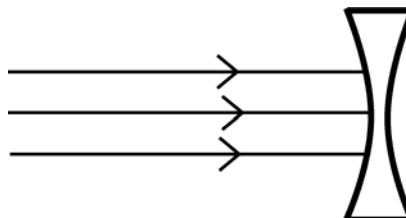
(ref: Science Dimensions 3 ; page 83)

Using the triple parallel ray screen place a) the biconcave lens and then b) the biconvex lens on the paper and direct the rays so that the middle ray strikes the centre of each lens at  $90^\circ$  (refer to the diagram below).

- Trace the outline of each lens and remove it. Draw the passage of the rays through the lenses and beyond.



Biconvex Lens



Biconcave Lens

You should find the rays passing through the biconvex lens converge to a point. This point is called the **focal point**. Measure the distance from the focal point to the centre of your lens. This is the **focal length** of the lens.

- Record the focal length.

	cm
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The rays passing through the biconcave lens diverge and do not meet at a focal point. However if we **extend the rays backwards** they will meet at a point in front of the lens.

- Using a ruler and dotted lines extrapolate the emergent rays backwards until they meet.
- Record the focal length of the lens.

	cm
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5. Describe the behaviour of the emerging light rays from the

a) biconvex lens: \_\_\_\_\_

b) biconcave lens: \_\_\_\_\_

6. Which type of lens could be used to focus parallel light rays?

\_\_\_\_\_

7. Why is the image formed by a biconvex lens called a real image?

\_\_\_\_\_

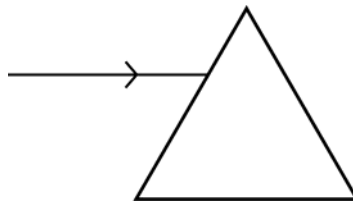
\_\_\_\_\_

8. Name a device that uses biconvex lenses.

\_\_\_\_\_

**Experiment 7: Dispersion of white light through a prism.**

Direct a single ray at various angles through the equilateral perspex block. You should find that at some point the ray splits up and spreads into a rainbow. This splitting up of the light is called dispersion.

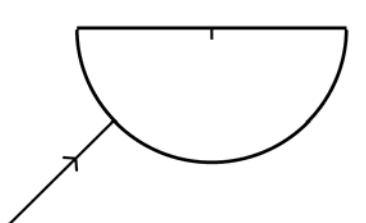


1. Trace the outline of the prism below and draw the path of the light ray showing an enlarged portion of the dispersed ray indicating the order of the colours observed (you should use coloured pencils). Also write down these colours on your results sheet indicating the order of the colours produced by the dispersal of the ray of white light?

**Experiment 8: Total internal reflection**

You may have observed in Experiment 5 that when light passes from a dense material to a less dense material a little light is always reflected at the boundary but most continues through. As we increase the angle to the normal at which the ray hits, the refracted ray bends progressively away from the normal. This continues until the refracted ray leaves *along* the boundary of the two materials. The angle of incidence between the ray and the normal is called the **critical angle** when it produces a ray **refracted at  $90^\circ$** .

For any angles larger than the critical angle there is no refracted ray at all, but instead all of the incoming light is reflected. This phenomenon is called **total internal reflection**.



1. Using the semi-circular lens as shown in the diagram above, draw the passage of a single ray that  
 a) passes through the lens and b) is totally internally reflected

a)	b)
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2. Using a protractor measure the critical angle of your semi-circular lens and record it below.

Critical angle: \_\_\_\_\_

## CONCLUSIONS

1. State what you think would be an appropriate **law of reflection**.

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2. What general conclusion can you draw about the location and appearance of an image in a plane mirror compared to the object that forms the image?

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3. State what you think would be the appropriate law of refraction for

- a) light passing from a medium of low density to high density:

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- b) light passing from a medium of high density to low density:

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4. Which lenses are used to:      a) converge light?

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- b) diverge light?

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Name: \_\_\_\_\_

Form: \_\_\_\_\_

Partner(s): \_\_\_\_\_

**Colour & light filters**

(ref: Science Dimensions 3 ; page 92)

**Aim**

To investigate the mixing of colours using colour filters.

**Apparatus**

- Hodson light box
- Coloured filter set
- Coloured card set

**Part A: Adding colours****Method**

Connect the light box to the power supply and place it in front of a piece of white paper. Place the three filters in the slots and angle the rays to overlap on the white sheet. Record your observations in the table below.

**Results**Primary filters

	red	blue	green	red + blue + green
red				
blue				
green				

Secondary filters

	yellow	cyan	magenta	yellow + cyan + magenta
yellow				
cyan				
magenta				

**Part B: Subtracting colours****Method**

Connect the light box to the power supply. Place the coloured filter in the front slot and shine the appropriate coloured light onto the coloured card. Record your observations in the table below. As any additional light will cause interference then record both the observed and expected results.

	red filter	blue filter	green filter	yellow filter	cyan filter
red card					
blue card					
green card					

**Discussion**

- How do the results obtained adding the secondary filters differ from those obtained using the primary filters?

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- What would be the effect of shining green and red spotlights on to a white surface so that the beams partly overlap?

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- Explain how it could be possible for an object to have a red shadow.

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- What primary colour(s) does a yellow filter absorb?

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- What primary colour(s) does a green filter absorb?

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6. Gina and Claire decide to wear their new clothes to the disco. Gina has a new red top and Claire has a yellow skirt and a pair of green shoes. Inside the disco, the light is alternating red and blue. What colour(s) do the 3 items of clothing appear to be?

	red light	blue light
top		
skirt		
shoes		

### Conclusion

1. Adding any combination of 2 primary coloured lights gives \_\_\_\_\_ and all 3 primary colours gives \_\_\_\_\_.
2. Explain, with the assistance of a diagram, the difference between shining two colours of light together (adding) and shining light onto a coloured object (subtracting).

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