# CHAPTER 6: WAVES

## 6.1 WATER WAVE REFLECTION

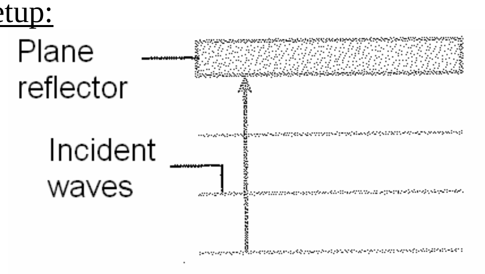
<u>Hypothesis:</u>
**The angle of reflection is equal to the angle of incidence**

<u>Aim of the experiment:</u>
**To study the relationship between the angle of incidence and angle of reflection**

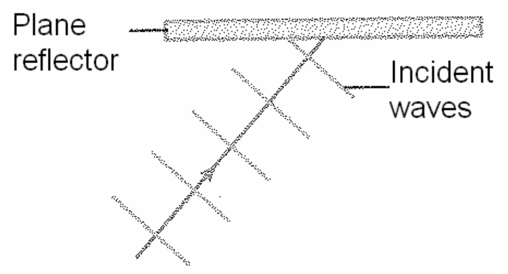
<u>Variables:</u>
Manipulated: **Angle of incidence, *i***
Responding: **Angle of reflection, *r***
Constant: **Reflector used**

<u>Apparatus/Materials:</u> **Ripple tank, reflector, stroboscope**

<u>Setup:</u>



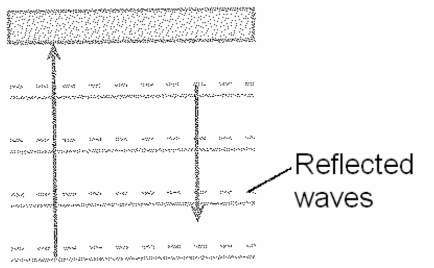

*(a)*



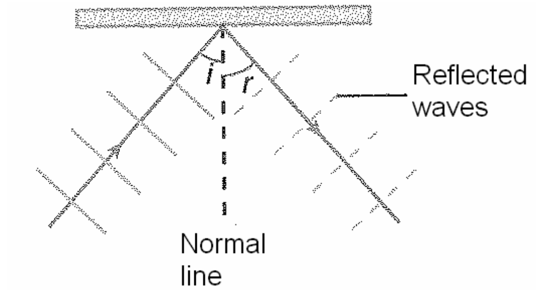

*(b)*

<u>Procedure:</u>
1. A ripple tank is set up.
2. A plane reflector is placed in the middle of the tank so that it is parallel with the incident wavefronts, as shown in the diagram (a) above. The reflected waves are observed through a stroboscope.
3. The reflector is then adjusted so that the incident waves approach the reflector at incident angles of 20˚, 40˚, 60˚ and 80˚ as shown in diagram (b). For each situation, the reflected angle is observed.
4. The wavelength of the incident and reflected waves are observed and compared.

Results:




*(a) Incident angle = 0, Reflected angle = 0*




*(b) Incident angle, i = Reflected angle, r*

| Incident angle (˚) | Reflected angle (˚) |
|---|---|
| 0 | |
| 20 | |
| 40 | |
| 60 | |
| 80 | |

Conclusion:
The angle of incidence is equal to the angle of reflection.

## 6.2 WATER WAVE REFRACTION

Hypothesis:
**When water waves propagate from deep to shallow areas, the wavelength decreases**

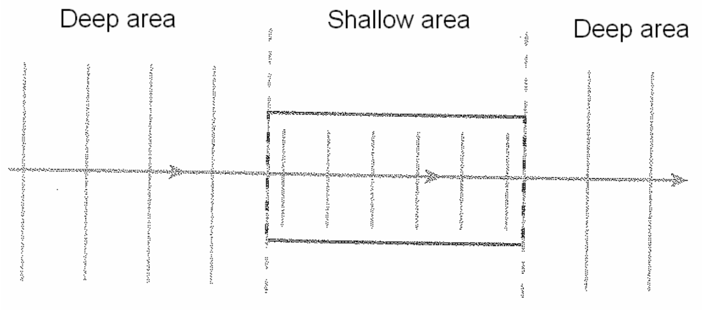
Aim of the experiment:
**To study wave refraction**

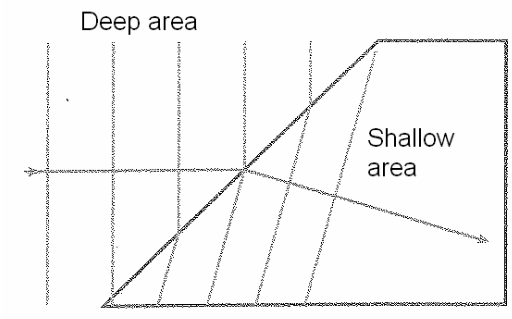
Variables:
Manipulated: **Water depth**
Responding: **Wavelength**
Constant: **Wavelength, frequency, and speed of incident waves**

Apparatus/Materials: **Ripple tank, Perspex block, stroboscope**

Procedure:
1. A ripple tank is set up.
2. A Perspex block is submerged in the middle of the ripple tank to create a shallow region. It is aligned so that one of its sides is parallel with the incident wavefronts. The wavelengths in both regions are observed.
3. The Perspex block is then rotated so that the incident angle of the incident waves is not zero. The wavelengths and the direction of the refracted waves are observed.

Results:




Conclusion:
The wavelength is shorter in a shallow area.

## 6.3 WATER WAVE DIFFRACTION

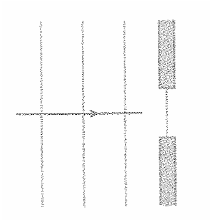
Hypothesis:
**When water waves propagate through an aperture, the smaller the aperture, the more obvious the diffraction pattern**

Aim of the experiment:
**To study the phenomenon of wave diffraction**

Variables:
Manipulated: **Aperture size**
Responding: **Diffraction pattern**
Constant: **Wavelength, frequency, and speed of incident waves**

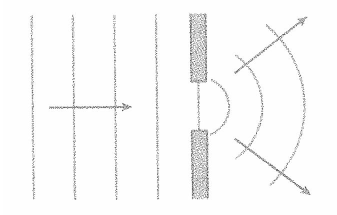
Apparatus/Materials: **Ripple tank, reflector, stroboscope**

Setup:

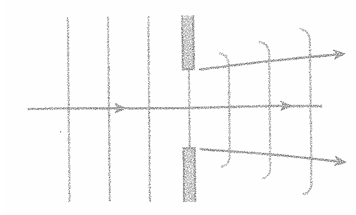


Procedure:
1. A ripple tank is set up.
2. Two barriers are placed so that they form a small aperture in the middle of the tank, as shown in the diagram above.
3. The motor is started to generate incident water waves. The shape and wavelength of the diffracted waves are observed through a stroboscope.
4. The experiment is repeated by changing the aperture size.

Results:



*Narrow aperture, more obvious diffraction*



*Wider aperture, less obvious diffraction*

Conclusion:
When the size of the aperture is smaller, the diffraction pattern is more obvious.

## 6.4 WATER WAVE INTERFERENCE

### Experiment 1: The smaller the λ, the smaller the x

Hypothesis:
**The smaller the wavelength, *λ*, the smaller the distance between two consecutive antinodal or nodal lines, *x***

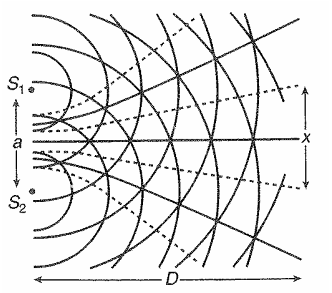
Aim of the experiment:
**To observe the change in *x* when *λ* is changed if *D* is constant**

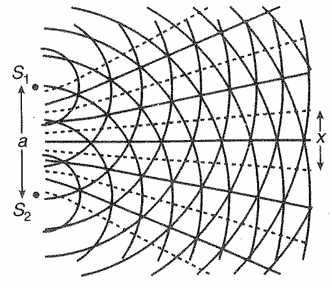
Variables:
Manipulated: **Wavelength, *λ***
Responding: **Distance between two consecutive antinodal or nodal lines, *x***
Constant: **Distance between the two wave sources, *a*; Distance between the source and where *x* is measured, *D***

Apparatus/Materials: **Ripple tank, stroboscope, ruler**

Procedure:
1. A ripple tank is set up. Two spherical dippers are placed 5 cm apart and adjusted so that they touch the water surface at the same level.
2. The motor is started.
3. The interference pattern is observed using a stroboscope.
4. The value of $x$ is observed for different values of $\lambda$ (which is modified by the rheostat).

Results:




Conclusion:
The smaller the wavelength, $\lambda$, the smaller the distance between two consecutive antinodal or nodal lines, $x$.

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## Experiment 2: The smaller the *a*, the bigger the x

Hypothesis:
**The smaller the distance between the two wave sources, *a*, the bigger the distance between two consecutive antinodal or nodal lines, *x***

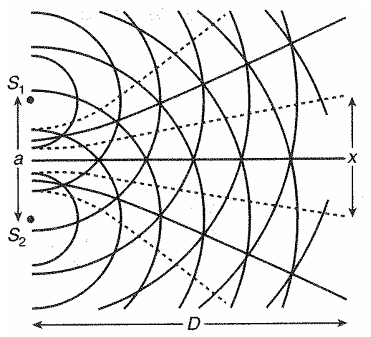
Aim of the experiment:
**To observe the change in *x* when *a* is changed if *D* is constant**

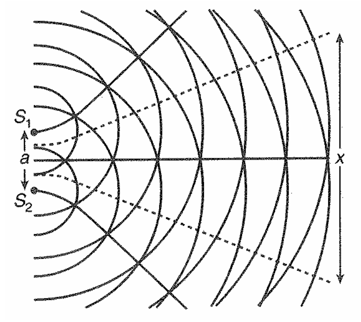
Variables:
Manipulated: **Distance between the two wave sources, *a***
Responding: **Distance between two consecutive antinodal or nodal lines, *x***
Constant: **Wavelength, $\lambda$; Distance between the source and where *x* is measured, *D***

Apparatus/Materials: **Ripple tank, stroboscope, ruler**

Procedure:
1. A ripple tank is set up. Two spherical dippers are placed 5 cm apart and adjusted so that they touch the water surface at the same level.
2. The motor is started.
3. The interference pattern is observed using a stroboscope.
4. The experiment is repeated by changing the distance between the two dippers to 3 cm.

Results:




Conclusion:
The smaller the distance between the two wave sources, *a*, the bigger the distance between two consecutive antinodal or nodal lines, *x*.

## 6.5 SOUND WAVES

### Experiment 1: Amplitude and loudness

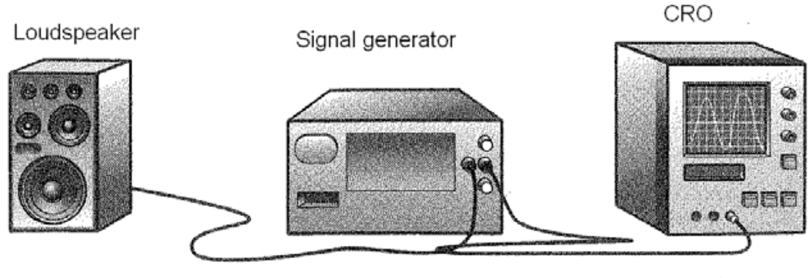
Hypothesis:
**When the amplitude of the sound wave increases, its loudness increases**

Aim of the experiment:
**To study the relationship between the amplitude and the loudness of a sound wave**

Variables:
Manipulated: **Sound wave amplitude**
Responding: **Sound wave loudness**
Constant: **Frequency of the signal generator, scale on CRO screen**

Apparatus/Materials: **Signal generator, speaker, cathode ray oscilloscope, connecting wires**

Setup:



Procedure:
1. A signal generator is connected to a speaker and to a CRO as shown in the diagram.
2. The frequency of the generator is fixed at 200 Hz. The strength of the current of the signal generator is increased slowly so that the wave amplitude shown on the CRO screen increases.
3. The loudness of the note emitted by the speaker is listened to carefully.

Results:
When the signal strength is increased, the wave amplitude increases, and the loudness increases.

Conclusion:
When the amplitude of the sound wave increases, its loudness increases.

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## Experiment 2: Frequency and pitch

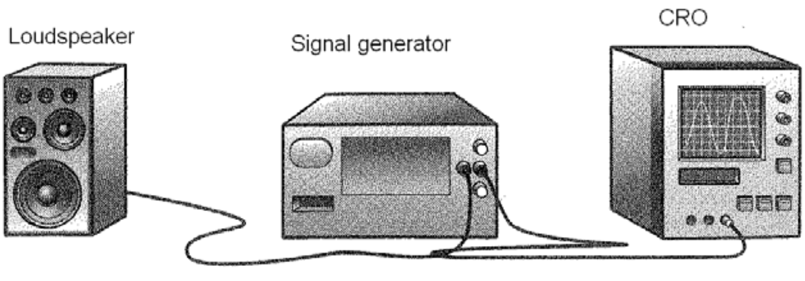
Hypothesis:
**When the frequency of a sound wave increases, its pitch increases**

Aim of the experiment:
**To study the relationship between the frequency and the pitch of a sound wave**

Variables:
Manipulated: **Sound wave frequency**
Responding: **Sound wave pitch**
Constant: **Amplitude of the signal generator, scale on CRO screen**

Apparatus/Materials: **Signal generator, speaker, cathode ray oscilloscope, connecting wires**

Setup:




Procedure:
1. A signal generator is connected to a speaker and to a CRO as shown in the diagram.
2. The frequency of the signal generator is started at 20 Hz. The frequency is increased slowly to 20 kHz.
3. The pitch of the note emitted from the speaker is listened to carefully.
4. The changes in the wave forms on the CRO screen are observed.

Results:
The higher the frequency, the higher the pitch of the note.

Conclusion:
When the frequency of the sound wave increases, its pitch increases.

## 6.6 SOUND WAVE REFLECTION

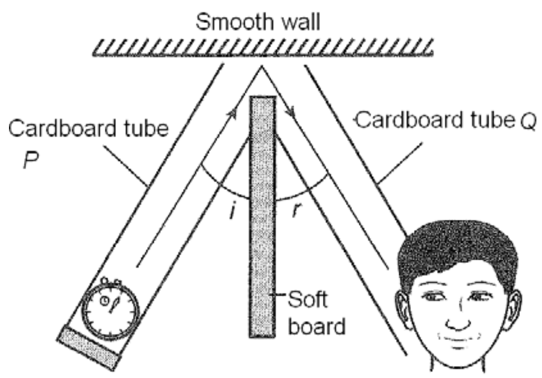
Hypothesis:
**The incident angle of a sound wave is equal to its reflected angle off a hard and smooth surface**

Aim of the experiment:
**To study the relationship between the incident and reflected angles of a sound wave**

Variables:
Manipulated: **Angle of incidence, *i***
Responding: **Angle of reflection, *r***
Constant: **Smooth wall used**

Apparatus/Materials: **Stopwatch, two long cardboard tubes, smooth wall, soft board, protractor**

Setup:




Procedure:
1. A stopwatch is placed inside cardboard tube *P* at its closed end. The apparatus is set up as shown in the diagram with incident angle of 20˚.
2. Cardboard tube *Q* is adjusted until the ticking of the stopwatch is heard most clearly.
3. The incident angle and the reflected angles are measured with a protractor and are recorded.
4. The experiment is repeated with incident angles 40˚, 60˚ and 80˚.

Results:

| Incident angle (˚) | Reflected angle (˚) |
|---|---|
| 20 | |
| 40 | |
| 60 | |
| 80 | |

Conclusion:
The angle of incidence is equal to the angle of reflection.

## 6.7 SOUND WAVE REFRACTION

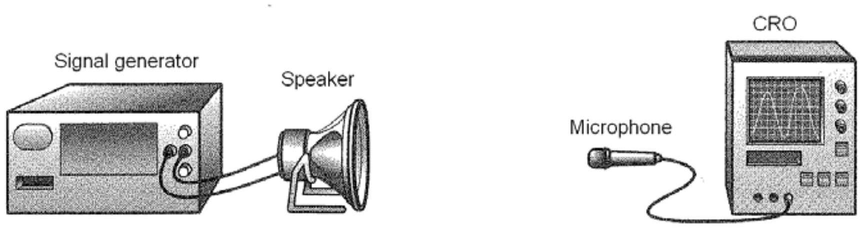
Hypothesis:
**Sound waves will refract when passing through gases of different densities**

Aim of the experiment:
**To study sound wave refraction**

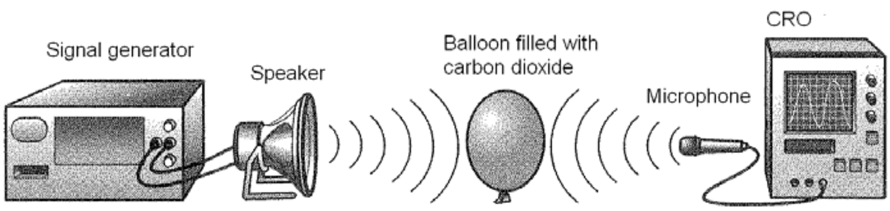
Variables:
Manipulated: **Gas density (within balloon)**
Responding: **Wave amplitude on CRO screen**
Constant: **Wave frequency**

Apparatus/Materials: **Signal generator, big balloon filled with carbon dioxide, big balloon filled with helium, microphone, speaker, cathode ray oscilloscope**

Setup:




*(a)*




*(b)*

Procedure:
1. A loudspeaker connected to a signal generator, and a microphone connected to a CRO, are set up at suitable distances as shown in the diagram (a) above. The pattern of the wave on the CRO screen is observed.
2. The balloon filled with carbon dioxide is placed between the speaker and the microphone. The position of the balloon is adjusted until the shape of the wave shown on the CRO screen has the largest amplitude. The amplitude of the waves is compared to the waves observed in Step 1.
3. Step 2 is repeated with the balloon filled with helium.

Results:
- It is observed that when the balloon filled with carbon dioxide is placed between the speaker and the microphone, the amplitude of the waves shown on the CRO is bigger.
- It is observed that when the balloon filled with helium is placed between the speaker and the microphone, the amplitude of the waves shown on the CRO is smaller.

Conclusion:
The sound waves refract when traveling through gases of differing densities.

## 6.8 SOUND WAVE DIFFRACTION

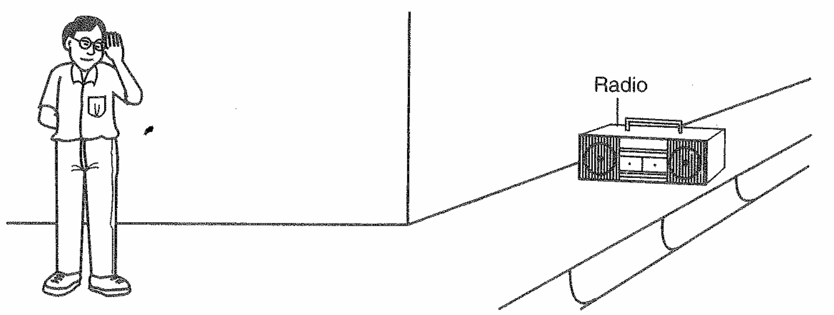
Hypothesis:
**Sound waves can be heard even though the source is blocked by a barrier**

Aim of the experiment:
**To study the phenomenon of sound wave diffraction**

Variables:
Manipulated: **Position of the sound source**
Responding: **Barrier used**
Constant: **Position of the observer**

Apparatus/Materials: **Radio**

Setup:



Procedure:
1. A radio playing music is placed at the side of the laboratory wall around a corner as shown in the diagram from the student.
2. The student is told to listen for the sounds from the radio.

Results:
Even though the radio is blocked from view by the corner, the student is still able to hear sounds from the radio. This is because sound waves is able to diffract around a corner of a barrier due its large wavelengths.

Conclusion:
Sound waves can be diffracted around a barrier.

## 6.9 SOUND WAVE INTERFERENCE

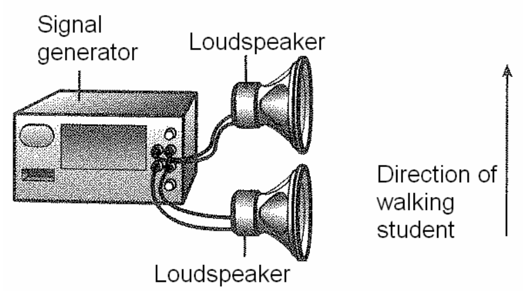
Hypothesis:
**Alternating loud and soft sounds can be heard at a distance in front of two loudspeakers playing the same sound**

Aim of the experiment:
**To study the phenomenon of sound wave interference**

Variables:
Manipulated: **Distance of observer from the loudspeakers**
Responding: **Distance between consecutive loud and soft sounds**
Constant: **Distance between speakers, frequency of signal used**

Apparatus/Materials: **Audio signal generator, cathode ray oscilloscope, two loudspeakers, microphone, metre rule, connecting wires**

Setup:




Procedure:
1. Two loudspeakers are connected to an audio signal generator and the apparatus is set up as shown in the diagram above.

2. The signal generator is started and adjusted to emit loud sounds at a suitable frequency.
3. A student is told to close one ear and to walk in front of both speakers at a distance a few metres from the speakers to detect any difference to the loudness of the sound heard.

Results:
When the student walks in front of the speakers, alternating loud and soft sounds are heard.

Conclusion:
Alternating loud and soft sounds can be heard at a distance in front of two loudspeakers playing the same sound

## 6.10 LIGHT WAVE DIFFRACTION

Aim of the experiment:
**To study the phenomenon of light wave diffraction**

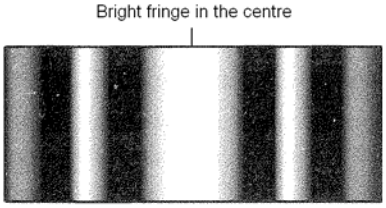
Variables:
Manipulated: **Slit size on slide**
Responding: **Diffraction pattern**
Constant: **Light source, distance from slide to screen**

Apparatus/Materials: **Laser pen, single-slit slides, screen**

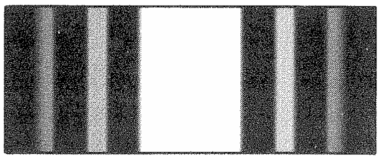
Setup:


Procedure:
1. A single narrow slit is made on a glass slide coated with aquaduk. The apparatus is set up as per the diagram.
2. The laser light is shone through the slit in the glass slide and the pattern on the screen is observed.
3. The experiment is repeated with a wider slit on the glass slide.

Results:




*Narrow slit*



*Wider slit*

Discussion:
- The fringe pattern observed on the screen is a result of light wave diffraction
- The light used must be monochromatic
- The slit used must be narrow enough compared to the light wave

Conclusion:
Light wave can be diffracted.

## 6.11 LIGHT WAVE INTERFERENCE

Aim of the experiment:
**To study the phenomenon of light wave interference**

Variables:
Manipulated: **Distance between the screen and the Young double-slit**
Responding: **Interference pattern**
Constant: **Light source used, size of the slits, distance between the slits**

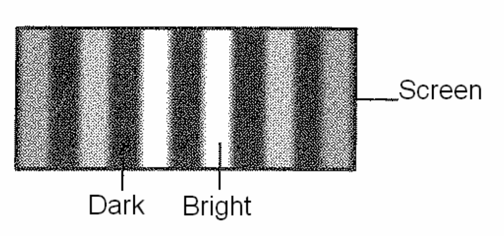
Apparatus/Materials: **Monochromatic light source, Young double-slit, screen**

Setup:


Procedure:
1. Apparatus is set up as shown in the diagram.

2. The light source is switched on and shone at the Young double-slit. The screen is adjusted until a clear interference pattern is observed. The pattern is drawn.

Results:




Discussion:

- The fringe pattern observed on the screen is a result of light wave interference
- The light used must be monochromatic
- The slits used must be narrow enough compared to the light wave
- The distance between the slits must be as close as possible for the light waves to overlap

Conclusion:

A pattern of alternating bright and dark fringes of approximately the same size is formed. Interference can occur in light waves.

# CHAPTER 7: ELECTRICITY & ELECTROMAGNETISM

## 7.1 CURRENT AND POTENTIAL DIFFERENCE

### Experiment 1: Ohmic Conductors

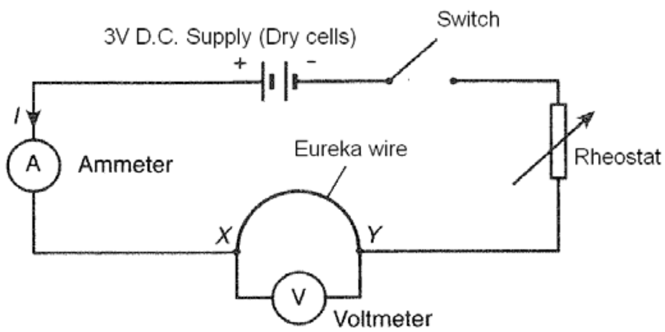
Hypothesis:
**The higher the current flowing through a conductor, the higher the potential difference**

Aim of the experiment:
**To determine the relationship between current and potential difference of a circuit**

Variables:
Manipulated: **Current, *I***
Responding: **Potential difference, *V***
Constant: **Length of conductor**

Apparatus/Materials: **Two 1.5 V dry cells, battery holder, ammeter, voltmeter, eureka wire, rheostat, press-switch, connecting wire**

Setup:

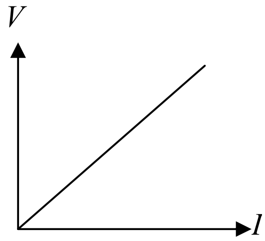



Procedure:
5. A circuit as shown in the diagram is set up.
6. A eureka wire of 10.0 cm length is connected across terminals *X* and *Y*.
7. The switch is pressed and the rheostat is adjusted until the ammeter reading, *I*, is 0.2 A. The voltage across the eureka wire, *V* is measured using the voltmeter.
8. The rheostat is adjusted to increase the value of current *I* and the corresponding voltmeter reading, *V* is recorded.
9. The values of *I* and *V* are tabulated and a graph of *V* against *I* is plotted.
10. The experiment is repeated with ammeter readings 0.3 A, 0.4 A, and 0.5 A.

Results:

| **Current, *I* (A)** | **Potential difference, *V* (V)** |
|---|---|
| 0.2 | |
| 0.3 | |
| 0.4 | |
| 0.5 | |

Analysis:
A graph of $V$ against $I$ is plotted.




A linear graph that goes through origin is obtained.

Discussion:
- The current used must not be too high to prevent the circuit from overheating. This is to maintain the temperature of the eureka wire so that the resistance does not increase.
- The slope of the $V$-$I$ graph represents the resistance of the eureka wire.

Conclusion:
The potential difference is directly proportional to the current in an ohmic conductor.

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## Experiment 2: Non-ohmic Conductors

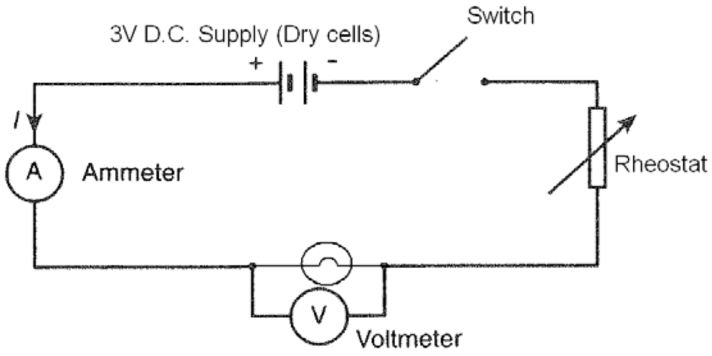
Hypothesis:
**When the current flowing through a light bulb increases, its resistance increases**

Aim of the experiment:
**To determine the relationship between current and potential difference of a non-ohmic circuit**

Variables:
Manipulated: **Current, *I***
Responding: **Potential difference, *V***
Constant: **Light bulb used**

Apparatus/Materials: **Two 1.5 V dry cells, battery holder, ammeter, voltmeter, light bulb, rheostat, press-switch, connecting wire**

<u>Setup:</u>




<u>Procedure:</u>

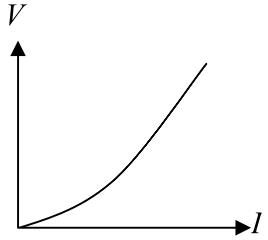
1. A circuit as shown in the diagram is set up.
2. A light bulb is connected across terminals *X* and *Y*.
3. The switch is pressed and the rheostat is adjusted until the ammeter reading, *I*, is 0.2 A. The voltage across the eureka wire, *V* is measured using the voltmeter.
4. The rheostat is adjusted to increase the value of current *I* and the corresponding voltmeter reading, *V* is recorded.
5. The experiment is repeated with current values 0.3 A, 0.4 A and 0.5 A.
6. The values of *I* and *V* are tabulated and a graph of *V* against *I* is plotted.

<u>Results:</u>

| Current, *I* (A) | Potential difference, *V* (V) |
|---|---|
| 0.2 | |
| 0.3 | |
| 0.4 | |
| 0.5 | |

<u>Analysis:</u>

A graph of *V* against *I* is plotted.




A curve graph with increasing slope is obtained.

<u>Discussion:</u>

- The resistance of a light bulb's filament increases when current increases

<u>Conclusion:</u>

A light bulb is a non-ohmic conductor because its resistance increases with the current.

# 7.2 RESISTANCE

## Experiment 1: Length

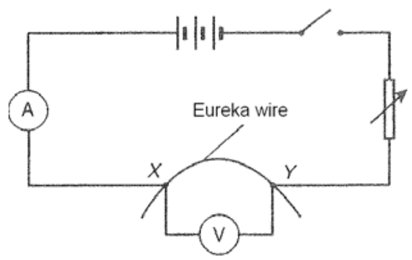
Hypothesis:
**The longer the wire, the higher the resistance**

Aim of the experiment:
**To study the relationship between the length of the wire and the resistance**

Variables:
Manipulated: **Length of the eureka wire**
Responding: **Resistance of the wire**
Constant: **Cross-section area of the wire, type of wire, temperature of wire**

Apparatus/Materials: **Battery (4.5 V), ammeter, voltmeter, rheostat, press-switch, connecting wire, eureka wire**

Setup:

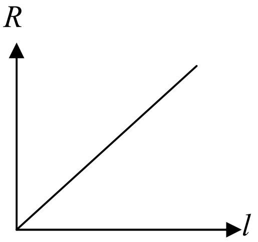



Procedure:
1. A eureka wire is connected in the circuit as shown in the diagram.
2. The length of the wire between $X$ and $Y$ is adjusted to 20 cm.
3. The switch is closed and the rheostat is adjusted until the ammeter reading, $I$ is 0.5 A. The voltmeter reading is recorded.
4. Step 3 is repeated for wire lengths 40 cm, 60 cm, 80 cm, and 100 cm.
5. The resistance, $R = \frac{V}{I}$ is calculated for each length.
6. A graph of $R$ against $l$ is plotted.

Results:

| $L$ (cm) | $I$ (A) | $V$ (V) | $R = \frac{V}{I}$ (Ω) |
|---|---|---|---|
| 20 | 0.5 | | |
| 40 | 0.5 | | |
| 60 | 0.5 | | |
| 80 | 0.5 | | |
| 100 | 0.5 | | |

<u>Analysis</u>
A graph of *R* against *l* is plotted.




<u>Conclusion:</u>
The resistance of the wire is directly proportional to the length of the wire.

---

## Experiment 2: Cross-section area

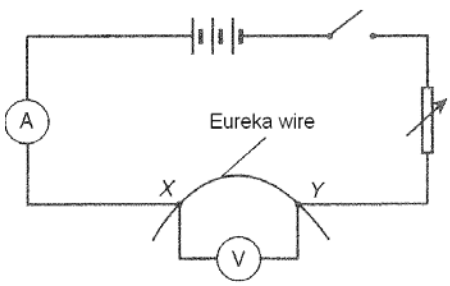
<u>Hypothesis:</u>
**The larger the cross-section area of the wire, the lower the resistance**

<u>Aim of the experiment:</u>
**To study the relationship between the cross-section area of the wire and the resistance**

<u>Variables:</u>
Manipulated: **Cross-section area of the eureka wire**
Responding: **Resistance of the wire**
Constant: **Length of the wire, type of wire, temperature of wire**

<u>Apparatus/Materials:</u> **Battery (4.5 V), ammeter, voltmeter, rheostat, press-switch, connecting wire, eureka wire (s.w.g. 22, s.w.g. 24, s.w.g. 30)**

<u>Setup:</u>




<u>Procedure:</u>
1. A eureka wire (s.w.g. 22) is connected in the circuit as shown in the diagram.
2. The length of the wire between *X* and *Y* is adjusted to 20 cm.
3. The switch is closed and the rheostat is adjusted until the ammeter reading, *I* is 0.5 A. The voltmeter reading is recorded.

4. Step 3 is repeated with eureka wires s.w.g. 24 and s.w.g. 30.
5. The resistance, $R = \frac{V}{I}$ is calculated for wire.

Results:

| Eureka wire | Cross-section area | $I$ (A) | $V$ (V) | $R = \frac{V}{I}$ (Ω) |
|---|---|---|---|---|
| s.w.g. 22 | Large | 0.5 | | |
| s.w.g. 24 | Medium | 0.5 | | |
| s.w.g. 30 | Small | 0.5 | | |

Conclusion:
The larger the cross-section area of the wire, the lower the resistance

---

## Experiment 3: Type of wire

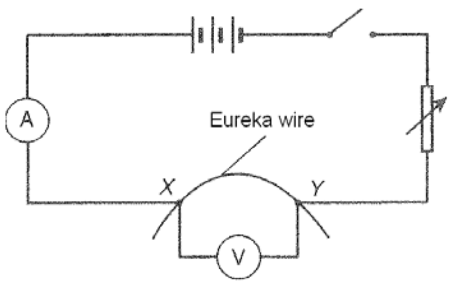
Hypothesis:
**Different types of wires have different values of resistance**

Aim of the experiment:
**To study the relationship between the type of wire and the resistance**

Variables:
Manipulated: **Type of wire**
Responding: **Resistance of the wire**
Constant: **Length of the wire, cross-section area of wire, temperature of wire**

Apparatus/Materials: **Battery (4.5 V), ammeter, voltmeter, rheostat, press-switch, connecting wire, eureka wire (s.w.g. 30), nichrome wire (s.w.g. 30), copper wire (s.w.g. 30)**

Setup:




Procedure:
1. A eureka wire (s.w.g. 30) is connected in the circuit as shown in the diagram.
2. The length of the wire between $X$ and $Y$ is adjusted to 20 cm.

3. The switch is closed and the rheostat is adjusted until the ammeter reading, $I$ is 0.5 A. The voltmeter reading is recorded.
4. Step 3 is repeated with nichrome and copper wires with the same cross-section area.
5. The resistance, $R = \frac{V}{I}$ is calculated for wire.

Results:

| Type of wire | $I$ (A) | $V$ (V) | $R = \frac{V}{I}$ (Ω) |
|---|---|---|---|
| Eureka | 0.5 | | |
| Nichrome | 0.5 | | |
| Copper | 0.5 | | |

Conclusion:
Different types of wires have different resistance values

---

## Experiment 4: Temperature

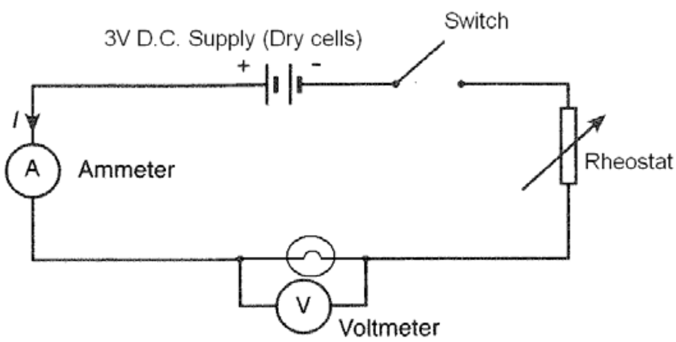
Hypothesis:
**The higher the temperature of the filament in a light bulb, the higher the resistance**

Aim of the experiment:
**To study the relationship between the temperature of the filament in a light bulb and the resistance**

Variables:
Manipulated: **Temperature of the filament in the light bulb**
Responding: **Resistance**
Constant: **Light bulb used**

Apparatus/Materials: **Battery, ammeter, voltmeter, rheostat, press-switch, connecting wire, light bulb**

Setup:

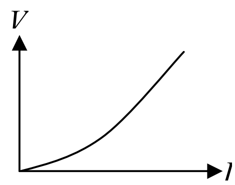


Procedure:
1. A light bulb is connected in the circuit as shown in the diagram.
2. The rheostat is adjusted to the maximum value so that the light bulb does not light up.
3. The ammeter and voltmeter readings are recorded.
4. Steps 2 and 3 are repeated by adjusting the rheostat until the light bulb lights up dimly, and then until it lights up brightly. The corresponding ammeter and voltmeter readings are recorded.
5. The resistance, $R = \frac{V}{I}$ is calculated for each instance and graph $V$ against $I$ is plotted.

Results:

| **Light bulb condition** | **Filament temperature** | ***I* (A)** | ***V* (V)** | $R = \frac{V}{I}$ **(Ω)** |
|---|---|---|---|---|
| Does not light up | Very low | | | |
| Very dim | Low | | | |
| Dim | Medium | | | |
| Bright | High | | | |
| Brighter | Higher | | | |
| Very bright | Very high | | | |

Analysis:
The brightness of the light bulb increasing shows the temperature of the filament increasing. This also shows the increase in current flowing through the filament. Based on the graph, it is found that the resistance increases with the temperature.




## 7.3 E.M.F. AND INTERNAL RESISTANCE

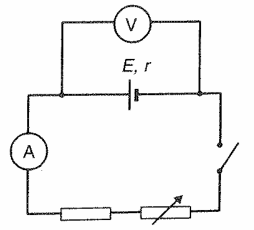
Hypothesis:
**The potential difference across the terminals of dry cells decrease when the current supplied by the cells increase**

Aim of the experiment:
**To study the relationship between the potential difference and current of the dry cells**

Variables:
Manipulated: **Current, *I***
Responding: **Potential difference across the terminals, *V***
Constant: **Dry cell used**

Apparatus/Materials: **Dry cells, ammeter, voltmeter, rheostat, resistor, switch, connecting wires**

Setup:




Procedure:

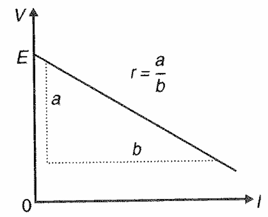
1. A circuit as shown in the diagram above is set up.
2. The switch is started. The rheostat is adjusted until the ammeter reading shows 0.2 A. The voltmeter reading is recorded.
3. Step 2 is repeated with current values of 0.3 A, 0.4 A, and 0.5 A.
4. A graph of *V* against *I* is plotted. The slope of the graph is calculated and the *V*-crossing is extrapolated.

Results:

| **Current, *I* (A)** | **Potential difference, *V* (V)** |
|---|---|
| 0.2 | |
| 0.3 | |
| 0.4 | |
| 0.5 | |

Analysis:

A graph of *V* against *I* is plotted.




Internal resistance, *r* = slope value
Electromotive force, *E* = *V*-crossing

Conclusion:

From the experiment, the potential difference across the dry cells when the current supplied increases.

# CHAPTER 8: ELECTROMAGNETISM

## 6.12 ELECTROMAGNETIC STRENGTH

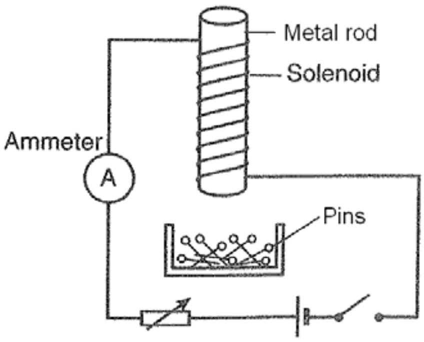
Hypothesis:
**The higher the current flowing through the solenoid, the stronger the electromagnet**

Aim of the experiment:
**To study the relationship between the current and the strength of the electromagnet**

Variables:
Manipulated: **Current**
Responding: **Number of pins stuck to the electromagnet**
Constant: **Number of coils, type of pins used**

Apparatus/Materials: **Metal rod, ammeter, rheostat, pins in a dish, power supply, insulated copper wires, retort stand, wooden clamp**

Setup:




Procedure:
1. The metal rod is wrapped with 10 turns of the insulated copper wire and both ends are connected to a circuit as shown in the diagram.
2. The circuit is started and the rheostat is adjusted to get 1.0 A current.
3. One end of the electromagnet is inserted into the dish of pins, and then removed. The current is switched off. The number of pins that were stuck to the electromagnet is counted.
4. The experiment is repeated with current values of 2.0 A, 3.0 A, 4.0 A, and 5.0 A.

Results:

| Current (A) | Number of pins stuck to electromagnet |
|---|---|
| 1.0 | |
| 2.0 | |
| 3.0 | |
| 4.0 | |
| 5.0 | |

Analysis
From the results, the number of pins stuck to the electromagnet increase when the current increases. This shows that the strength of the electromagnet increases with the current.

Conclusion:
The increase in current flowing through the solenoid increases the strength of the electromagnet. Hypothesis proven.

Note: The experiment can be modified to study the relationship between the number of turns on the coil and the strength of the electromagnet.

## 6.13 INDUCED FORCE

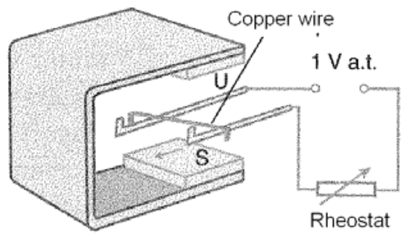
Hypothesis:
**When the current in the conductor increases, the magnitude of the induced force increases**

Aim of the experiment:
**To study the relationship between the current in the conductor and the magnitude of the induced force**

Variables:
Manipulated: **Current**
Responding: **Speed of the movement of the wire**
Constant: **Number of magnets**

Apparatus/Materials: **Four magnadur magnets, U-shaped metal piece, non-insuloated copper wire (s.w.g. 26), wooden block, connecting wires, press pin, rheostat**

Setup:




Procedure:
1. The rheostat is adjusted to the maximum resistance to get a small current flowing through the short copper wire. The movement of the short copper wire when the power supply is started.
2. The rheostat is adjusted to the minimum resistance so that a bigger current flows through the short copper wire. The speed of the movement of the short copper wire is compared.

Results:
The speed of the movement of the copper wire increases when a bigger current flows through.

Conclusion:
The speed of the movement of the copper wire increases when a bigger current flows through the conductor.

Note: The experiment can be modified to study the relationship between the speed of the movement of the copper wire and the strength of the magnet

## 6.14 INDUCED CURRENT

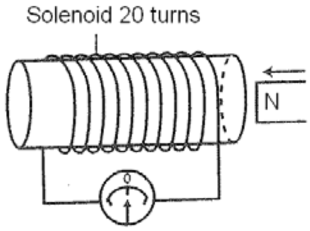
Hypothesis:
**The faster the relative movement of the magnet with the solenoid, the higher the induced current**

Aim of the experiment:
**To study the relationship between the relative movement of the magnet with the solenoid and the induced current**

Variables:
Manipulated: **Speed of relative movement of the magnet with the solenoid**
Responding: **Deflection of the galvanometer**
Constant: **Type of magnet, type of wires, solenoid size, galvanometer used, number of magnet bars, number of turns on the solenoid**

Apparatus/Materials: **Insulated copper wire, galvanometer with zero in the middle, magnet bar, cardboard tube**

Setup:




Procedure:
1. A magnet is placed into the solenoid slowly. The deflection of the galvanometer is observed.
2. The speed of movement of the magnet is increased. The deflection of the galvanometer is observed.

Results:
The faster the magnet bar is moved, the higher the deflection of the galvanometer.

Conclusion:
The faster the magnet bar is moved, the higher the current induced

Note: The experiment can be modified to study the relationship between the number of turns on the coil and the value of the current induced