SCIENTIFIC WRITING

PHY 207

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Introduction to Scientific Writing

- Scientific writing is a technical form of writing that is designed to convey scientific information to other people who are in the field of science.

- Examples of scientific writing are such as lab reports, grant proposals, scientific reports, research papers, literature review articles, poster presentations, oral presentations and etc.

- The importance of scientific writing is the documentation of knowledge.

The Purpose of Scientific Writing

to record the data

sharing the novel ideas and the findings

give direction of the research in a particular area

identify the potential research gap

impact can be analyzed by the number of citations

evaluate the published works of other

The Essence of Scientific Writing

Clarity

Be specific and avoid vagueness.

Precision

Accurate data, relevant references, citations and statements.

Knowledge

Should be clear, simple, and well-ordered communication to transmit.

Objectivity

Claims need to be based on facts, not intuition.

Language

Use proper language and grammar.

Expression

Write in full sentences in simple terms without metaphors.

Scientific Writing - Report

- A scientific report is a document that describes the process, progress, and or results of technical or scientific research or the state of a technical or scientific research problem.

- It includes essential parts such as Title, Abstract, Introduction, Methodology, Results and Discussion, and Conclusions of the research depending on its purpose.

Scientific Writing - Research Paper

- A scientific paper is a written and published report describing original research results.
- A scientific paper is subjected to peer-reviewed, repeatable, available to the scientific community, and subjected to screenings by independent scientific institutions.
- It includes essential parts such as Title, Abstract, Introduction, Methodology, Results and Discussion, and Conclusions of the research.

Scientific Writing

Scientific Report

more on how the experiment was performed and the outcome was evaluated

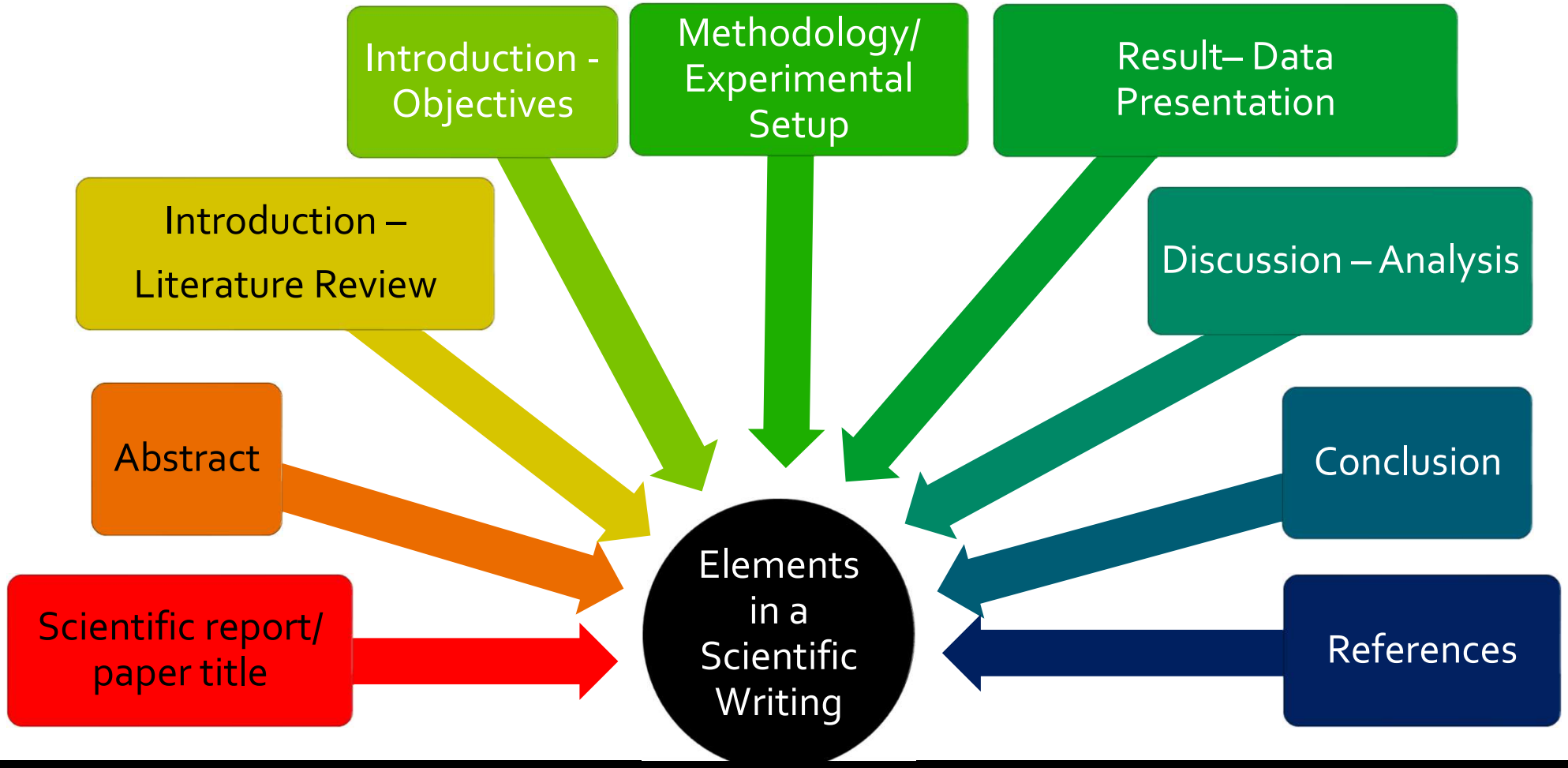
usually shorter than a research paper.

Scientific Paper

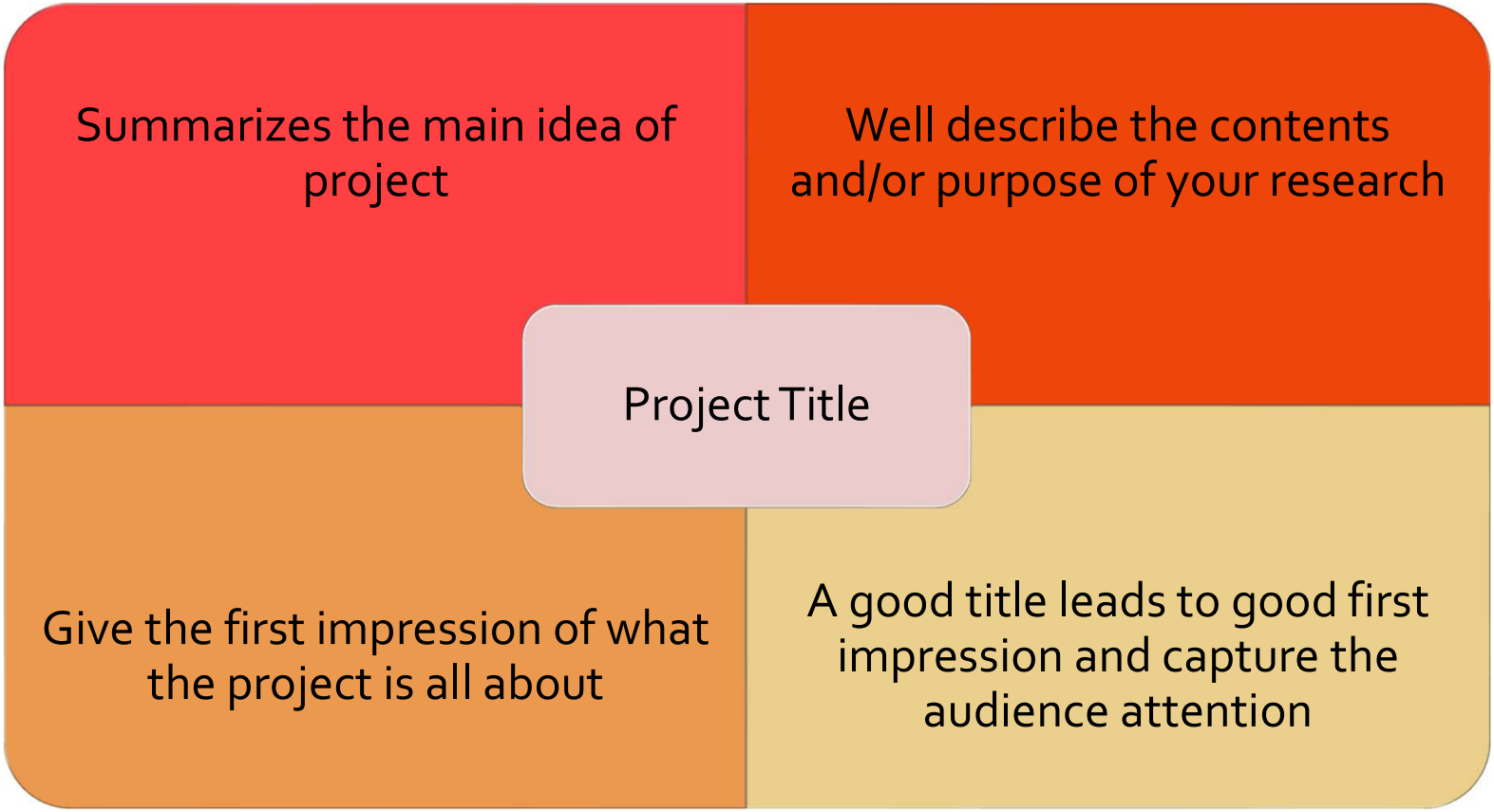
independently develop an original research project with legitimate set of data

involves more in-depth research and interpretation of sources and data

Elements in Scientific Paper/Report



Scientific Paper/Report - Title



Scientific Paper/ Report - Abstract

The main reason for the study, the primary results, & the main conclusions

summary of proposal

(>300 words)

introduce the physics problem

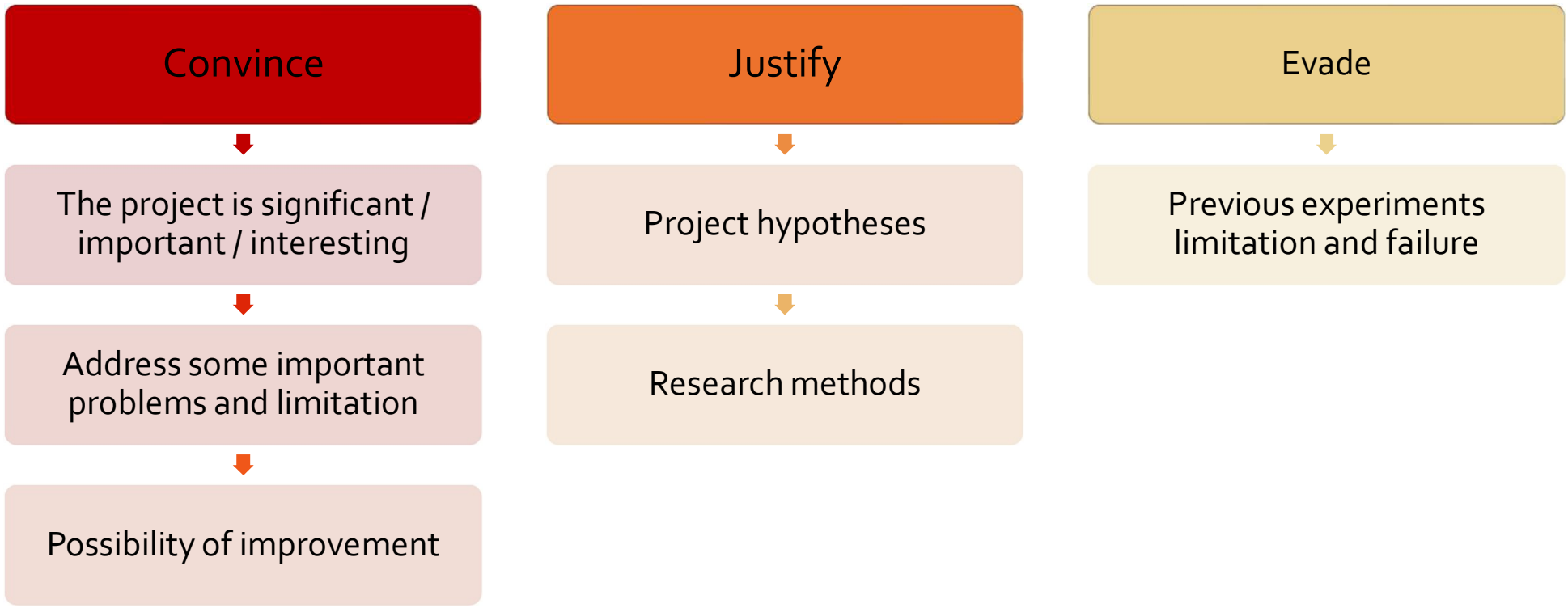
why the problem is significant

aim of project

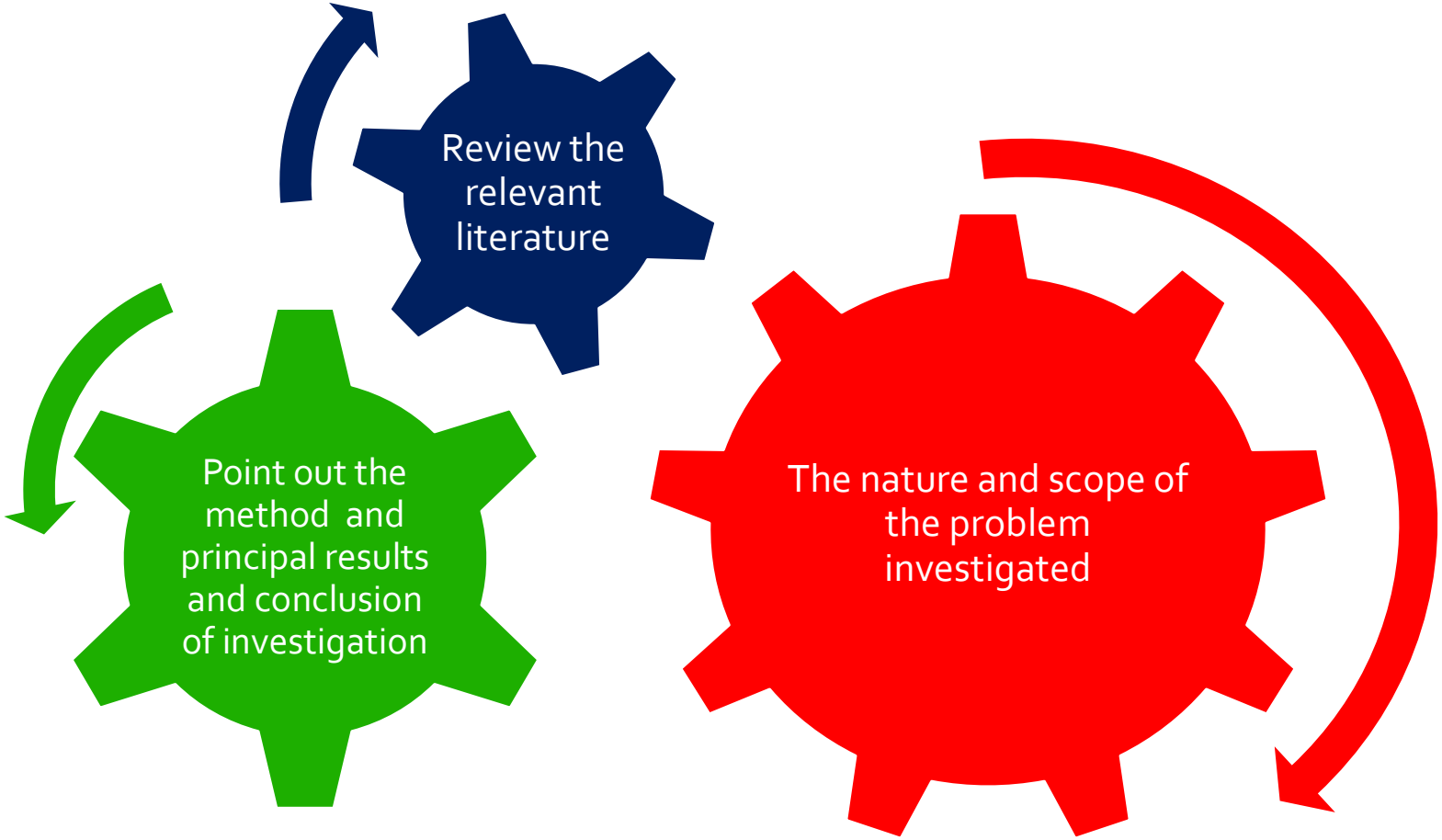
hypothesis to be tested

brief experiment summary

Introduction - Literature Review



Introduction - Literature Review



Introduction - Figure

Remove the bracket in the figure caption and may relabel the part in English.

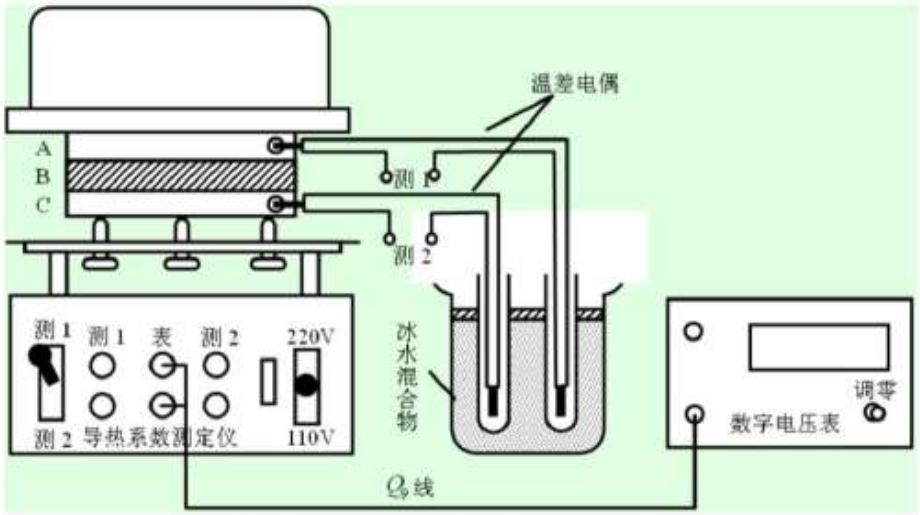
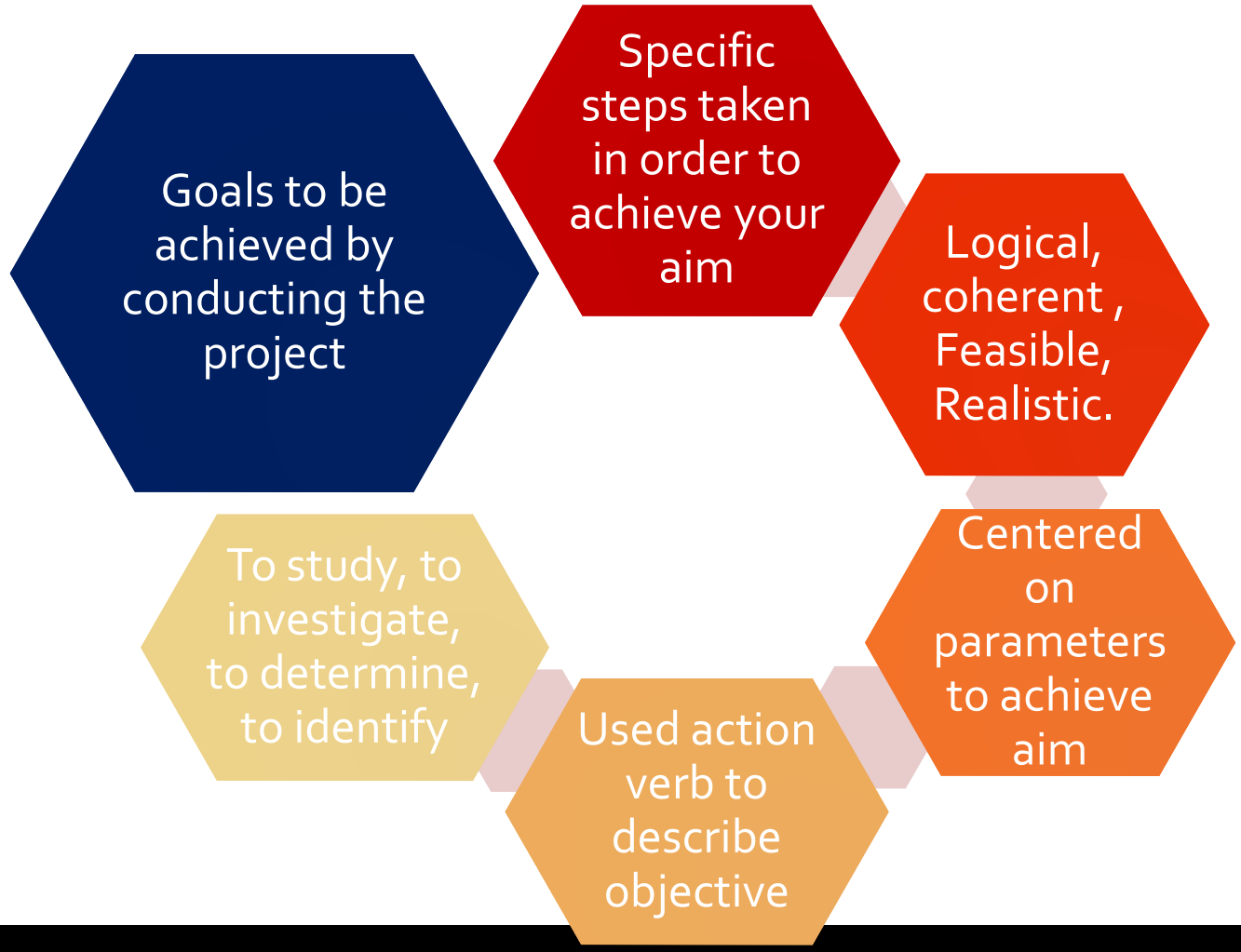


Figure 3: (Image from heat conductivity tester(Image from [3])

Introduction - Research Objective



Introduction - Research Objective

1.2 Objective

This experiment aims to simplify the experimental model, control variables, carry out comparative experiments, and combine with computer simulation and simple solid experiments. Explore this temperature change process Through this study, practical suggestions and treatment measures are provided for the operation in production and life.

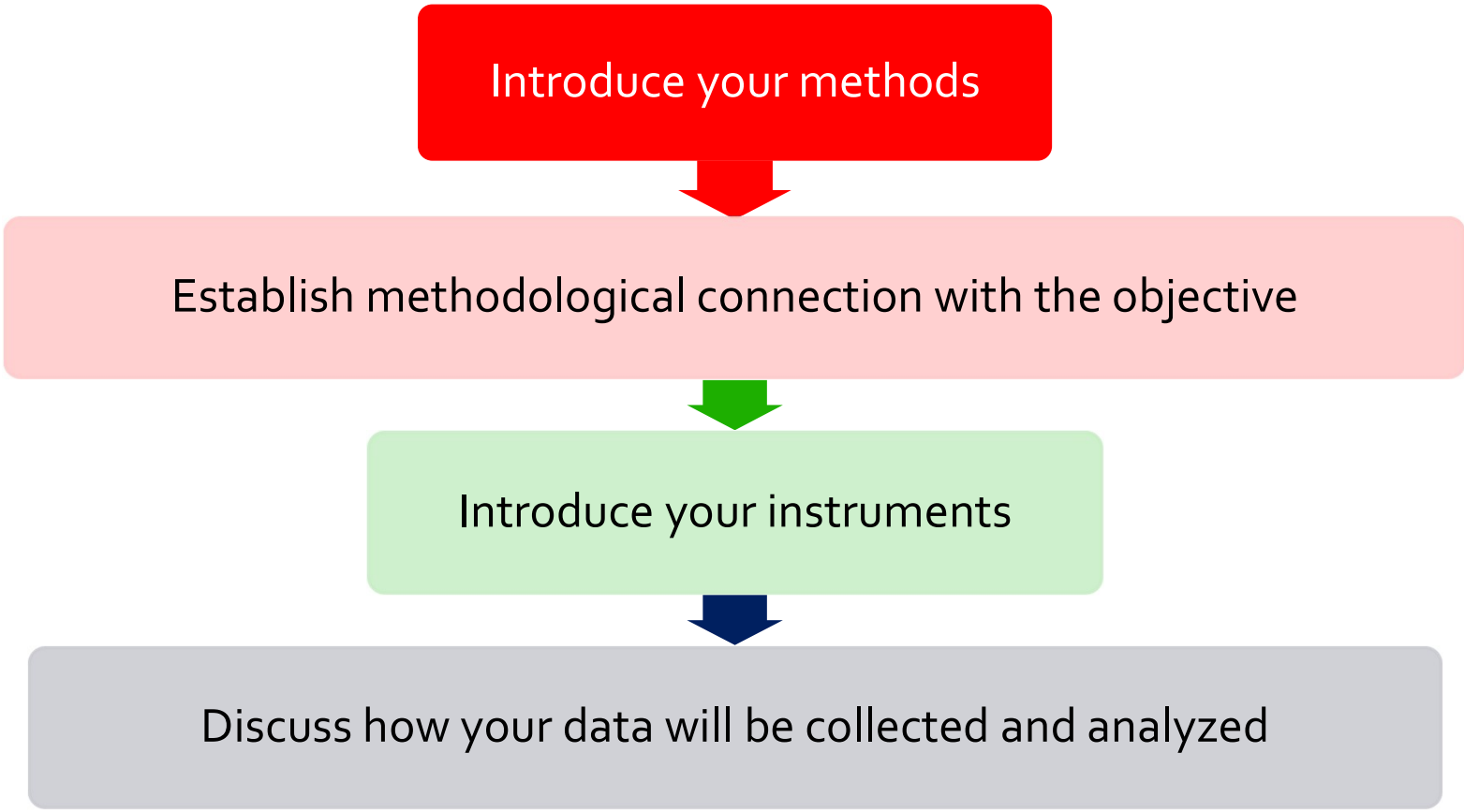
Objective is about what do you want to achieve.

Objective

To investigate the influence of mass on the velocities of the cars before and after collision.

Clear objective of what do you want to achieve.

Research Methodology



Methodology

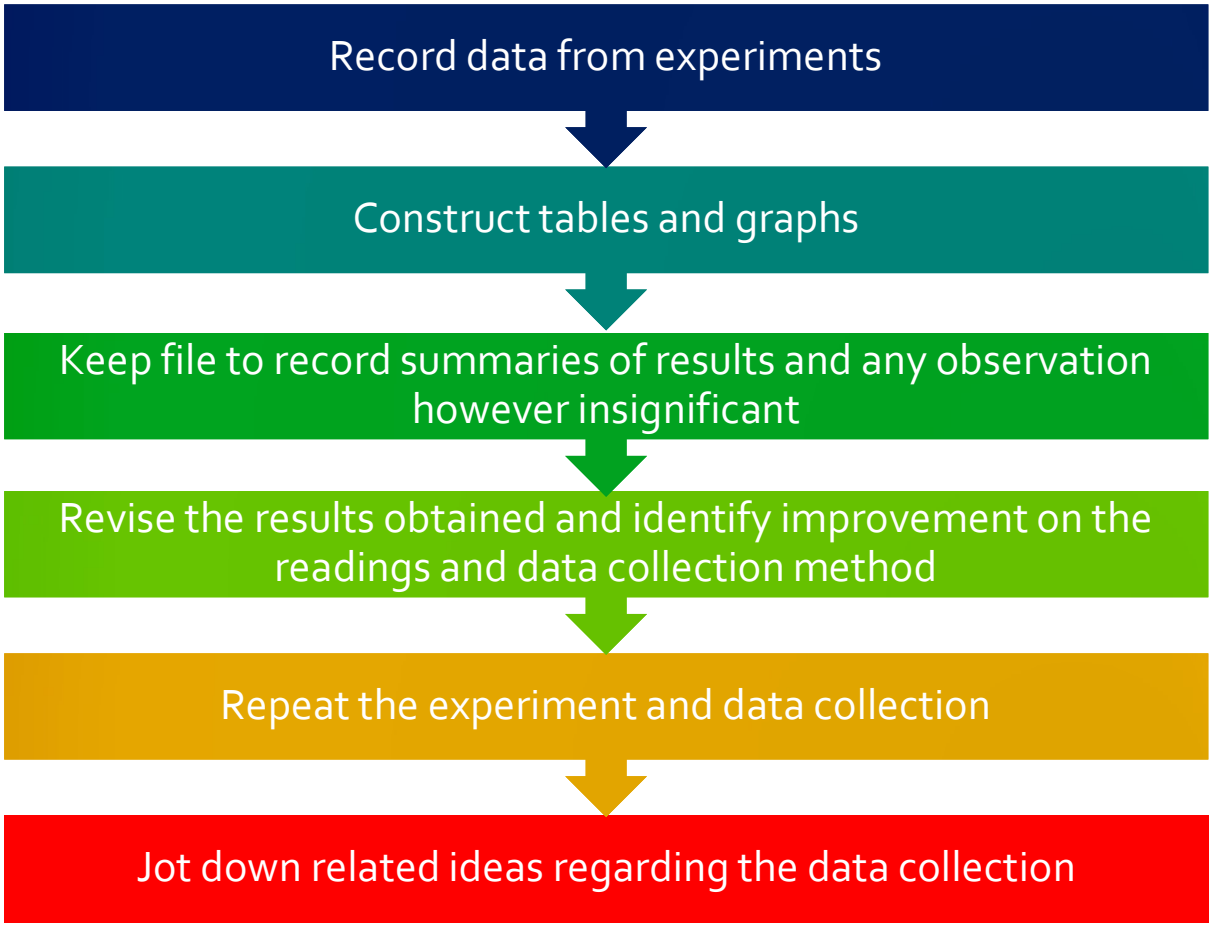
Do's

- Full details of experiments setup and design
- Organize the methods under subheadings

Don't

- Presenting results
- Write in present tense

Data Collection and Analysis



Methodology

3 Result and Data Analysis

3.1 Data Proceding Method

3.1.1 Simulation data result processing and analysis method

After the simulation data is exported through COMSOL, we intercept the data of a certain point and save it in a two-column table as needed. The first column is the corresponding time and the second column is the corresponding temperature. Through the pre-prepared script, we can obtain the maximum slope in the relevant data, the end temperature of the experiment, and the average temperature change rate of the experiment

3.1.2 Real experimental data processing and analysis method

We first used Excel to clean up the data for all collected data. Because many empty lines will be generated by datalogger, we use Excel to delete them in batches. At the same time, there may be sensors in the equipment; The output data caused by disconnection is -127. We use Excel to find and delete relevant data. Then, we delete the data existing before the beginning of the experiment according to the time stamp recorded in the experiment, classify and number the data according to the measured points and the temperature conditions, and convert them into two columns of data tables. The first column is the time and the second column is the measured temperature, which is imported into Matlab in batch and stored in MATLAB as a variables .mat file.

In proving the hypothesis, we first select the experimental group data to be compared and verified because some data are seriously affected by the environment, resulting in colossal deviation and can not be used as the experimental object. After verifying that the data conforms to the simulation results, we import it into the work area and make a diagram. Use the pre-written script to find the required experimental endpoint and automatically calculate the average change rate of the experimental temperature. Due to the randomness of the actual measurement data, we can not obtain the maximum change rate, which may be improved in future experiments.

In the experiment, we mainly compare the average temperature change rate in each data group and then use it to verify the hypothesis.

Examples of good subheadings for the methodology part.

Methodology

Detailed explanation on methodology parts.
However, this should be rearranged and organized better by introducing a relevant subheading

Methodology

Method: Control the Variables

Variables

t, falling time from release parachute to landing.

r_{out}, outer radius of each parachute.

$r_{in} = 0.05m$, inner radius of each parachute (radius of vent).

S_t, surface area of the parachute (total area in Obj.2), for Obj.1, $S_t = \pi(r_{out}^2 - r_{in}^2)$, for Obj.2, $S_i = \pi(r_{out}^2 - r_{in}^2) = \pi 0.5^2 - \pi(0.05)^2 = 0.7775 m^2$.

S_i, surface area of each parachute $S_i = \pi(r_{out}^2 - r_{in}^2) = \pi 0.5^2 - \pi(0.05)^2 = 0.7775\, m^2$. (Only in Obj.2)

v_t, terminal velocity, velocity after the vertical velocity of the parachute become 0.

h, the height the parachute will be released.

a, acceleration in the falling process, change as time changes, can be detected by MPU6050.

m, mass of the set released. In the experiment is 200g.

Shape, shape of the parachute, since parachutes are made in same way, we consider the parachutes have same shape, which is circle.

n, number of parachutes, only involved in objective 2.

k , drag constant, depends on the surface area of parachute, air density, C_d(depends on the shape you design the parachute, for our parachutes it is 1.55) the formula for k is

The graph given by the experiment can be found in the appendix part. All the analysis graph is listed below.

Experiment

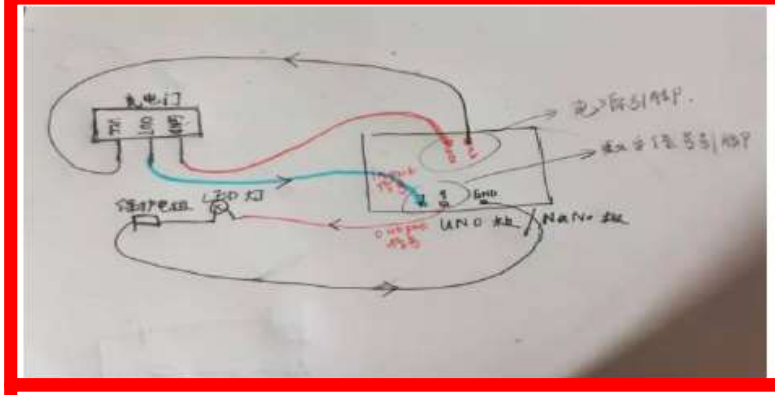
For Objective 1:

1. Setup the Arduino Module (Nano, MPU6050, SD card reader,9v battery supply). (Figure1)
2. Put the Arduino circuit into a container and tie up the container with the parachute with different surface area. (Figure 2,3,4)
3. Release the container form 10 meters high place. (Figure5)
4. MPU6050 Module will start detecting the acceleration and store in micro SD. (Figure 6)
5. After the experiment ends, the data stored will be transfer into the computer, and we will analysis it with MS Excel. (Figure 7)

For Objective 2:

1. Setup the MPU6050 Arduino Module and micro SD card. (Figure 1)
2. Put the Arduino circuit into a container and tie up the container with several numbers of the parachute but have same total surface area. (Figure 2,3,4)
3. Release the container form 10 meters high place. (Figure 5)
4. MPU6050 Module will start detecting the acceleration and store in micro SD. (Figure 6)
5. After the experiment ends, the data stored will be transfer into the computer, and we will analysis it with MS Excel. (Figure 7)

Methodology



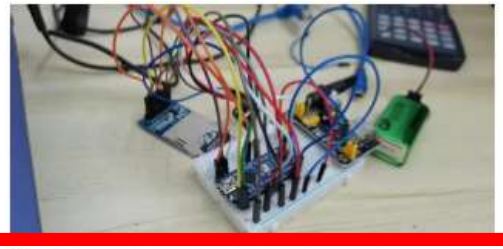
For the collision of the two cars:

Two identical Arduino programs are connected at the same time, with photogate 1 at the front end of the guide rail and photogate 2 at the back end of the guide rail. At the beginning of the experiment, the initial velocity of the leading vehicle was v1, and the initial velocity of the trailing vehicle was v2 (v2>v1), and then through photogate 1, the first two cars do not collide, and according to the time data through photogate 1, the speed can be calculated. Then the two cars collide between photogate 1 and 2, the speed changes and they collide and stick together through photogate 2, time data is obtained to calculate the speed.

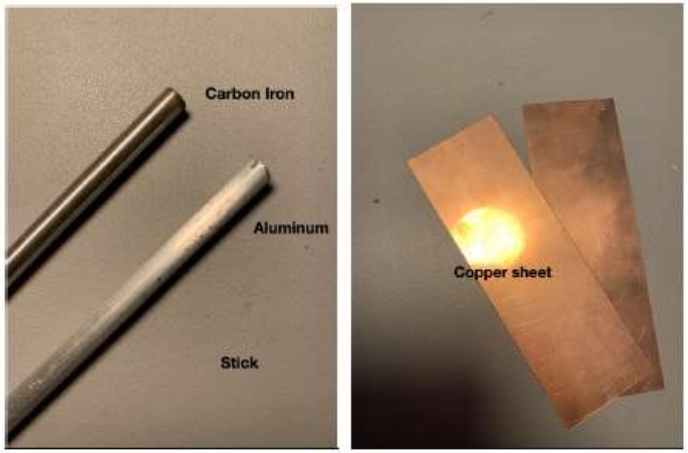
Avoid hand-drawn figures in formal reports.

Sub-heading should be properly described and labeled.

Methodology - Diagram



Rearrange the figure in the methodology according to its chronology of its the appearance in the text.
Some parts can be represented in the appendix.



(a) Metal Rod (b) Copper Sheet

Figure 5: Material

Try to group according to its purpose/role.

Programming Codes

A.1 Arduino Data Collecting Program

```
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS_2 2
#define ONE_WIRE_BUS_3 3
#define ONE_WIRE_BUS_4 4
#define ONE_WIRE_BUS_5 5

OneWire oneWire_2(ONE_WIRE_BUS_2);
DallasTemperature sensors_2(&oneWire_2);

OneWire oneWire_3(ONE_WIRE_BUS_3);
DallasTemperature sensors_3(&oneWire_3);

OneWire oneWire_4(ONE_WIRE_BUS_4);
DallasTemperature sensors_4(&oneWire_4);

OneWire oneWire_5(ONE_WIRE_BUS_5);
DallasTemperature sensors_5(&oneWire_5);

unsigned long timerecord;
float tempC_1;
float tempC_2;
float tempC_3;
float tempC_4;
float tempC_5;
float tempC_6;
float tempC_7;
float tempC_8;
void setup() {
  sensors_2.begin();  // Start up the library
  sensors_3.begin();  // Start up the library
  sensors_4.begin();  // Start up the librarySS
  sensors_5.begin();  // Start up the librarySS
  Serial.begin(9600);

}

void loop() {
  timerecord = millis();
  sensors_2.requestTemperatures();
```

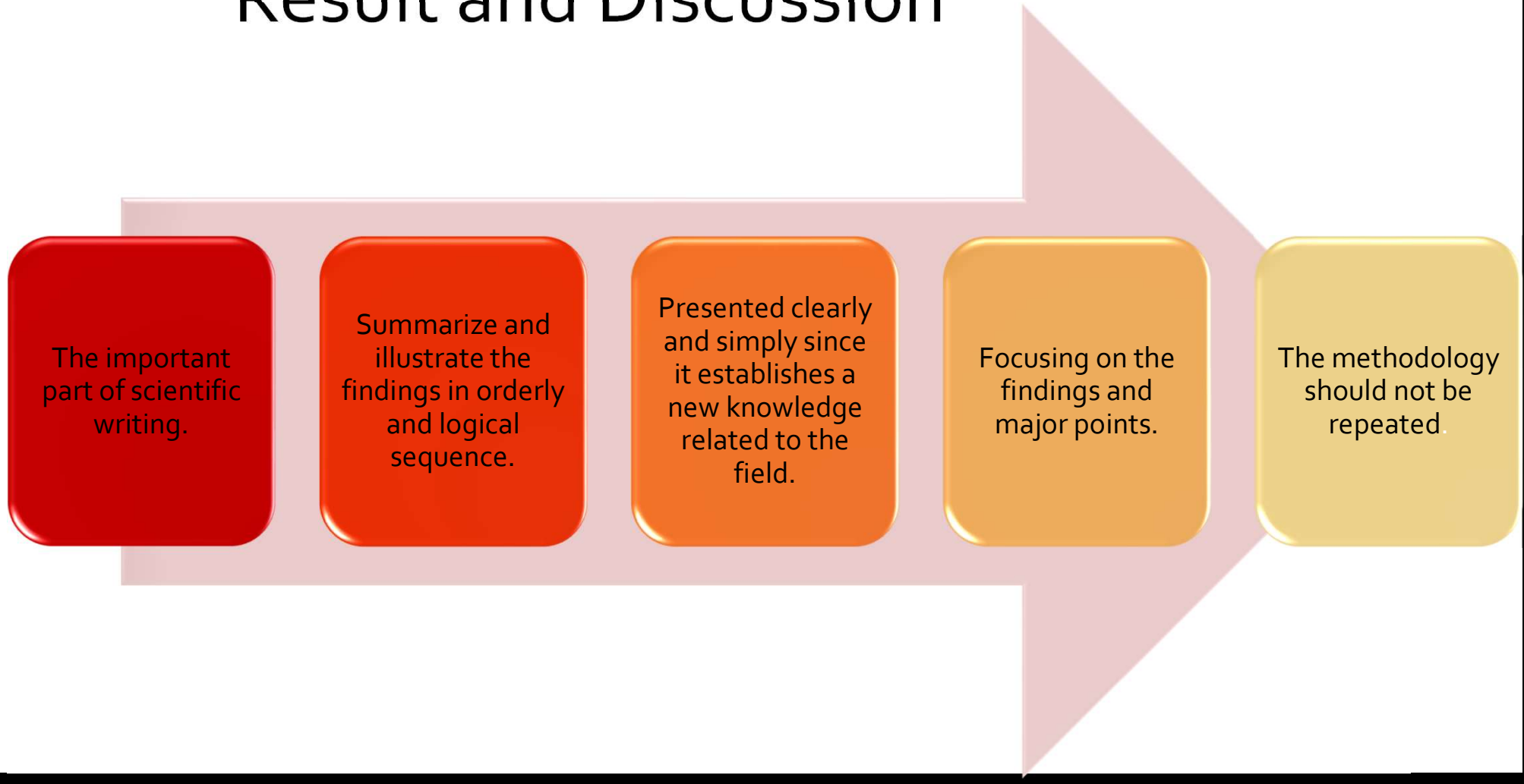
A.2 MATLAB data collecting Program

```
        function [celsius] = gettemperature(sensor,addr)
reset(sensor);
write(sensor, addr, hex2dec('44'), true);

reset(sensor);
write(sensor, addr, hex2dec('BE')); % read command - 'BE'
data = read(sensor, addr, 9);
crc = data(9);
if ~checkCRC(sensor, data(1:8), crc, 'crc8')
    error('Invalid data read.');
end
raw = bitshift(data(2),8)+data(1);
cfg = bitshift(bitand(data(5), hex2dec('60')), -5);
switch cfg
    case bin2dec('00')  % 9-bit resolution, 93.75 ms conversion time
        raw = bitand(raw, hex2dec('fff8'));
    case bin2dec('01')  % 10-bit resolution, 187.5 ms conversion time
        raw = bitand(raw, hex2dec('fffC'));
    case bin2dec('10')  % 11-bit resolution, 375 ms conversion time
        raw = bitand(raw, hex2dec('fffE'));
    case bin2dec('11')  % 12-bit resolution, 750 ms conversion time
    otherwise
        error('Invalid resolution configuration');
end
% Convert temperature reading from unsigned 16-bit value to signed 16-bit.
raw = typecast(uint16(raw), 'int16');
celsius = double(raw) / 16.0;
fahrenheit = celsius * 1.8 + 32.0;
end
```

A good example of description for appendixes part of program codes.

Result and Discussion



Result and Discussion – Data Presentation

Data presentation

- Text, Table or Figure.
- Presented table or figure must be mentioned in the result and discussion section.
- Use present tense.

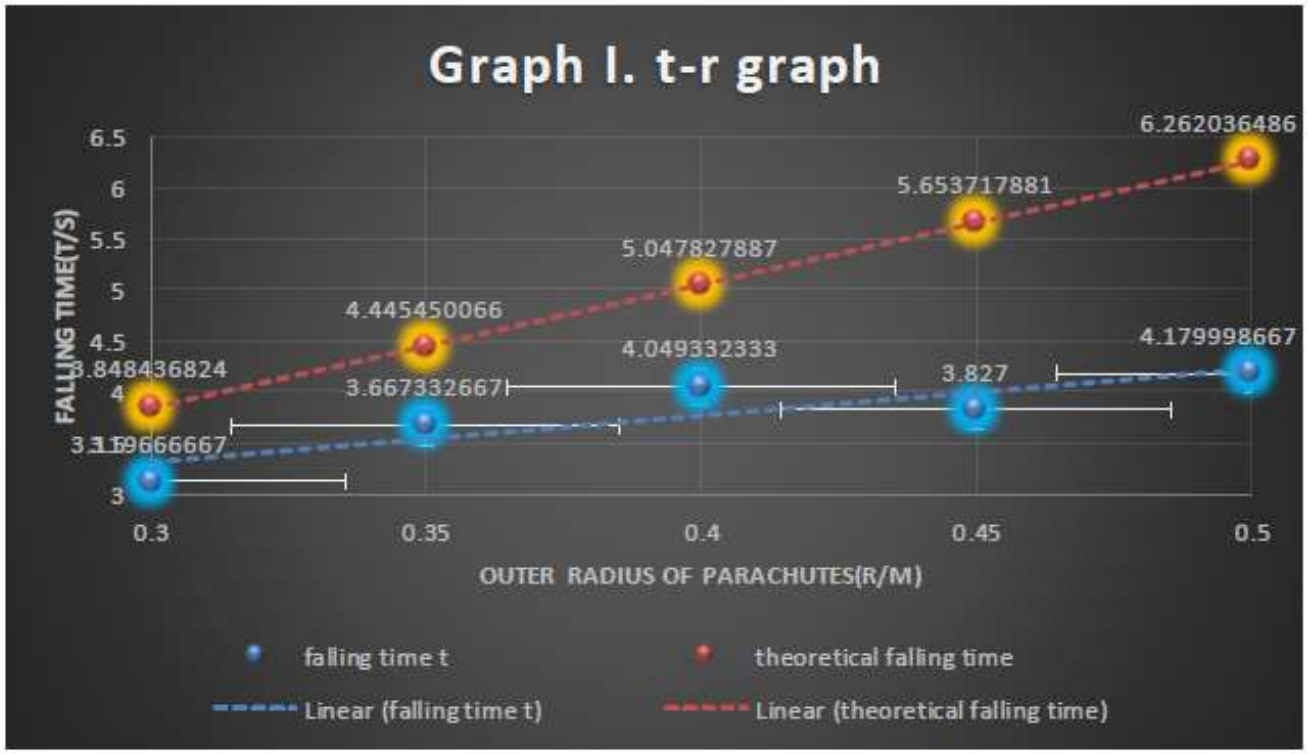
Table

- Large or complicated data sets.
- Caption represented on top of the table.

Figure

- Data sets that show trends, patterns, or connections that are better expressed visually.
- Caption represented below the figure.

Data Presentation - Graph



Fix the decimal points (up to 2 decimal point) in the graph

The graph is nicely constructed but it is better represented in white background for formal reports.
Also there is no caption for the graph

Data Presentation - Table

This part can be explained well in the report text.

Description for the table is missing

	vertical distance/cm	possibility	
room temperature/23℃	10	100%	
horizontal distance/20cm	20	100%	
	30	40%	
	40	10-20%	do 15 times 2 detected
	10	100%	
temperature 180℃	20	100%	
horizontal distance/20cm	30	100%	we do 25 times only one time cannot detect

Data Presentation - Table

Table 2

Table caption is missing

Pay extra attention to the unit used and their font.

outer radius of parachute r/m	theoritical value v/ms^-1	terminal velocity test 1 v/ms^-1	terminal velocity test 2 v/ms^-1	terminal velocity test 3 v/ms^-1	mean value ms^-1	relative error
0.3	2.736	2.658	2.885	2.571	2.705	-0.011
0.35	2.336	2.286	2.277	2.316	2.293	-0.019
0.4	2.039	1.991	2.114	2.093	2.066	0.013
0.45	1.810	1.579	1.875	3.791	2.415	0.334
0.5	1.627	1.731	1.611	1.731	1.691	0.039

Result and Discussion

The temperature of the heat source has an arresting effect on the PIR sensor detection rate.

The higher the temperature of the heat source, the greater the PIR sensor detection rate.

The vertical and horizontal distance of the heat source has a noteworthy effect on the PIR sensor detection rate.

The greater the vertical and horizontal distance of the heat source, the lesser the PIR sensor detection rate.

The speed at which the heat source must move for the PIR sensor detection rate to decrease is dependent on the temperature of the heat source.

The higher the temperature of the heat source, the faster the speed must be before PIR sensor detection rate can be noticeably affected/impacted.

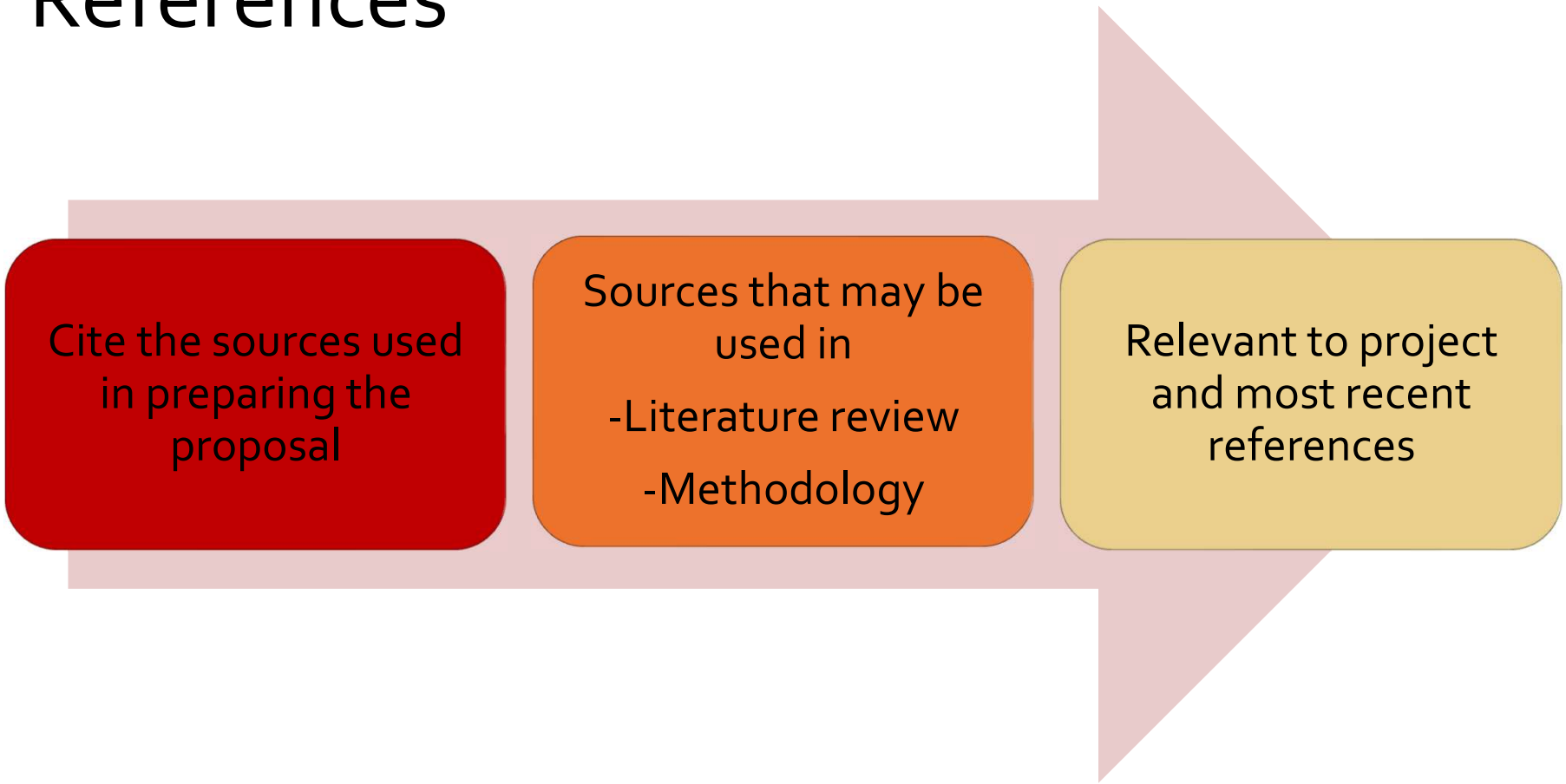
And for the speed upper limited, with all the data we got, we believe that when you reach a speed at 4.20m/s (90cm) you almost cannot get any detection (if the upper limit of the temperature is 180℃, because the hottest thing we can get can only up to 180 ℃)

Discussion should be in paragraph.

Conclusion


Recap back the research topic or issue raised.
State the significance of results.
Validate the importance of research approach in tackling the research problem.
Summarizing ideas and express the implications of the study.
Introducing possible new approach or suggestion in improving the research problem.

References


Cite the sources used in preparing the proposal
Sources that may be used in
-Literature review
-Methodology
Relevant to project and most recent references

Reference

3.3 Hypothesis 1

In hypothesis 1, we need to prove the material and rate of temperature change. Through the analysis of textbooks and COMSOL software, we can find that the rate of temperature change is mainly affected by the change of the variable heat conductivity.

Before discussing the results of hypothesis 1, it is necessary to clarify the concept of thermal conductivity rate.By Wikipedia [5] , thermal conductivity rate could be simply defined by [3.1]:

$$q = -k \cdot \frac{T_2 - T_1}{L} \tag{3.1}$$

The thermal conductivity of a material measures its ability to conduct heat. Generally speaking, metals have better thermal conductivity, which means that metals can transport more heat simultaneously. By consulting the metal thermal conductivity data in COMSOL, we can find the following data :

Metal type	Thermal Conductivity Rate($Wm^{-1}K^{-1}$)
Aluminum	237
Steel	80

Here, we first take the temperature change data of $250mm$ aluminum and iron at $1/8$ of the whole length at the room temperature of $22°C$, $22°C$ at one end, and $100°C$ at the other end, and compare it with the Fe in the same situation and same sampling point.

Here we can present the data collected in the physical experiment [20].

State the source of reference. In this case, the textbooks name.