**University College Dublin**

**School of Mechanical & Materials Engineering**

MEEN10050 Energy Engineering 2013-14

Group Assignment

**Heating Energy Requirements for a Room over 7 Consecutive Days**

**By**

**Group 05**

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# Abstract

In no more than 200 words, describe the work so that someone could decide whether or not it would be worthwhile to read the report. It spells out the reason for the work, what was done and what the main results were. It is essentially an overview of the whole report.

Should include:

* Background – why the study was carried out.
* Method – how the study was done.
* Results – what were the main findings.

The abstract may contain bullet points but will generally be plain text divided into one or two paragraphs.

The investigation was carried out in order to find the amount of energy needed to maintain a small room in a family home at 22oC.

The process involved in carrying out the investigation was divided into the following steps:

1. Room selection - the selection of a suitable room in which to carry out the experiment.
2. Detailing and measuring of room - this involved getting dimensions and a floor plan of the room as well as documenting the material makeup of the walls, floor and ceiling.
3. Equations – equations where then used to measure the heat lost and gained by the room to its surroundings making a few assumptions, i.e. the energy input, to obtain calculations.
4. Graphing- the findings where then graphed to make interpretation of the data easier to understand.

After completing the investigation we found:

1. The room lost …… to the surrounding area, i.e. to the exterior of the building the upstairs etc.
2. That the largest contributor to heat loss was …….
3. That it takes a …….W radiator to maintain a constant temperature of 220C in the room.
4. Otherwise the room needed ……… of extra insulation to maintain a constant inside temperature of 220C.

# Table of Contents

[Abstract i](#_Toc380600468)

[Table of Contents ii](#_Toc380600469)

[1. Introduction 2](#_Toc380600470)

[2. Methodology 2](#_Toc380600471)

[2.1 Room and building description 3](#_Toc380600472)

[2.2 External surface description 3](#_Toc380600473)

[2.2.1 External wall 3](#_Toc380600474)

[2.2.2 External window 3](#_Toc380600475)

[2.3 Ambient air temperature 4](#_Toc380600476)

[2.4 Heat losses and heat gains 4](#_Toc380600477)

[2.4.1 Ventilation heat losses 4](#_Toc380600478)

[2.4.2 Internal heat gains 4](#_Toc380600479)

[2.4.3 Heat losses from the window 4](#_Toc380600480)

[2.4.4 Heat losses from the wall 5](#_Toc380600481)

[3. Results and analysis 5](#_Toc380600482)

[3.1 Heat losses 5](#_Toc380600483)

[3.2 Interior and exterior temperatures of external building elements 6](#_Toc380600484)

[3.3 Maximum heating load and radiator capacity 6](#_Toc380600485)

[3.4 Additional insulation 6](#_Toc380600486)

[4. Conclusions 6](#_Toc380600487)

[Reference 6](#_Toc380600488)

[Appendix A 7](#_Toc380600489)

[Appendix B 7](#_Toc380600490)

# Introduction

The introduction should present the objectives of the report and give a short (introductory) description of the sections that are included.

**Introduction**

This study was carried out in order to investigate the energy requirements for a room at a constant temperature over 7 consecutive days. In order to do this the internal and external dimensions of the room and where measured and then the composition of the internal and external walls as well as the ceiling and floor where discovered. The heat transfer rates through all of the construction materials in the room and the heat input to the room where then calculated. Also the difference in heat transfer rates and heating loads through the construction materials were calculated after an extra layer of insulation was added.

The room chosen had one external wall which was exposed to variations in external air temperatures and was studied over a twenty four hour period for seven consecutive days. A plan of the room and house was drawn up on C.A.D. showing the composition of the walls, ceiling and floor along with the thickness of all materials used. Measurements for volume of air in the room and surface area of the walls and windows were then taken together with the U values of the materials used.

This investigation should give you a good insight into the heating requirements to maintain a temperature of 22 degrees Celsius and the difference in these requirements when an additional layer of insulation is added for a typical Irish home in early Spring.

**Background**

Investigations such as this one are becoming more and more popular with people attempting to monitor and reduce their energy usage. The Government’s Climate Change Response Bill 2010 contains a plan to reduce Ireland’s emissions by 2.5 % annually until 2020. To do this Ireland must shift from fossil fuels to alternative renewable sources. The government also then looked at reducing our energy consumption by giving grants for insulation in homes so that there is less heat lost to the atmosphere. Recently extensive research has been carried out into improving the insulating properties of construction materials, so much so that nowadays almost all materials used in construction add to the houses’ insulating capabilities. This report give a comprehensive representation of where heat is lost in our chosen room and the materials through which the most heat is lost. It also displays the improvement in U-value of the wall after an extra layer of insulation is added.

**Layout of report**

The report is laid out as follows:

1. Cover page: The opening page of report. States who completed the report and its’ title.
2. Abstract: Gives a quick description of the report and the steps taken to complete it.
3. Table of contents: Gives the page numbers of where each section is in the report.
4. Introduction: Introduces the reasons for undertaking the investigation and gives a short background to the report.
5. Objectives: Lays out the steps and goals of the report in order of completion.
6. Methodology: Tells the reader what specific objectives were set and they were met.
7. Results & Analysis: Theses are found after doing the calculations and are then interpreted and graphed.
8. Conclusions: The conclusions outline the main findings. It directs the reader to the most important findings, and as the last thing the reader sees, it helps to fix these key points in memory. It reiterates the most important points that have come up in the results section.
9. Reference: This cites all material used to help with the report.
10. Appendix A: States how much each person contributed to the report and how.
11. Appendix B: Includes any additional information on the area the report was carried out on but that is not necessary in the context of the report.

# Objectives:

1. Meet to decide type of room and delegation of roles for project.
2. Measurement of room’s internal and external dimensions.
3. Meeting with the building surveyor who designed the house to review plans and find out composition of walls ceiling and floor.
4. Drawing up of the room’s floor plan and section views of the building showing composition of the room’s walls and floor and ceiling.
5. Pictures taken of room and building showing both internal and external walls.
6. Discovery of thermal resistance values and u-values for each material.
7. Calculation of:
8. Total resistance and u-values for walls and ceiling and floor.
9. Ambient air temperature in the room.
10. Surface area of the walls, floor and ceiling.
11. Internal surface temperatures of the walls, ceiling and floors.
12. External surface temperatures of the walls, ceiling and floors.
13. Heat losses to ventilation.
14. Heat lost to external wall.
15. Heat lost to internal wall.
16. Heat lost to window.
17. Heat lost to ceiling.
18. Heat lost to floor.
19. Total amount of heat energy lost to surroundings.
20. Heat gained from electrical devices in room.
21. Heat gained from radiator.
22. Total heat gained.
23. Interpretation of results
24. Graphing of results
25. New calculations including extra insulation:
    1. Total resistance and u-values for walls and ceiling and floor.
    2. Ambient air temperature in the room.
    3. Surface area of the walls, floor and ceiling.
    4. Internal surface temperatures of the walls, ceiling and floors.
    5. External surface temperatures of the walls, ceiling and floors.
    6. Heat losses to ventilation.
    7. Heat lost to external wall.
    8. Heat lost to internal wall.
    9. Heat lost to window.
    10. Heat lost to ceiling.
    11. Heat lost to floor.
    12. Total amount of heat energy lost to surroundings.
    13. Heat gained from electrical devices in room.
    14. Heat gained from radiator.
    15. Total heat gained.
26. Interpretation of new results
27. Graphing of new results
28. Writing of the report
29. Submit report for 17:00, Monday the 24th of February.

# Methodology

The methodology should tell the reader what specific objectives you set yourself and how you went about meeting them.

Should include:

* Objectives – having explained the background, you now list the specific objectives for the study on which you are reporting. For example, the Background might have explained why new solar panel technology is necessary (in general), whereas this section will document what experiments were carried out (specifically) to test the new technology.
* Procedure – having said what you want to achieve in the Objectives (eg, find the thermal conductivity of a material) you explain how the experiment was set up to do this.

Using a work flow diagram is often quite helpful like the one depicted in figure 2.1.

**Building and Room selection**

**Ambient Air Temperature calculation**

U-values and heat transfer area

Room volume and floor area

Building heat losses

Ventilation heat losses

Internal heat gains

Radiators size and number

Interior and exterior surface temperatures

***Figure 2.1:*** *Work flow diagram of the methodology followed*

## Room and building description

The room is a north facing, ground floor music / reading room. It is part of a 1992, two storey, detached house in the suburbs of a medium sized, market town in Co. Monaghan. The room is situated at the front of the house and leads off the entrance hall. It is only ever used for recreational use and as a result is not subjected to frequent traffic. The room is x m2 (yyy x yyy). It has one exterior wall and three interior walls. It is heated by a single radiator on the external wall under the window. It is also generally quite a warm room. Also present photographs of the building and the room (depicting the external surface) and a floor plan of the room.

## External surface description

The external surface is a red brick external leaf on a cavity wall. The inner leaf is block work with an insulated panel with cavity full fill insulation. There is a veranda overlooking the external surface and as a result it is not usually subjected to direct sunlight.

## External wall

A cross section of the wall is essential reporting all the material layers. You should cite all the sources you have used to determine the thermal conductivities of the wall materials. Tables like table 2.1 can be useful to illustrate the data used for the calculation of U-values.

**Thermal Resistance**

The thermal resistance was calculated by measuring the thickness of the material in metres (x) and dividing it by the thermal conductivity (k).

Rt = Thermal resistance (m^2k/W)

X = thickness (m)

k = Thermal conductivity

***Table 2.1:*** *(Sample) Calculation of the U-value for the external wall*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Material** | **Thickness d (m)** | **Thermal Conductivity k (W/m\*K)** | **Thermal Resistance R (K/W) R=d/A\*k(1)** | | **U value** | |
| Red Brick | 0.103 | 0.87 | | 0.1184 | 8.446 | |
| Concrete blocks | 0.10 | 0.55 | | 0.1818 | 5.50 | |
| Gypsum plaster board :split into |  |  | |  |  | |
| 1. Polyurethane insulation | 0.25 | 0.03 | | 8.33 | 0.12 | |
| 2. Plaster board | 0.12 | 0.20 | | 0.6 | 1.667 | |
| Polystyrene bead cavity full fill insulation | 0.10 | 0.03 | | 3.33 | 0.3 | |
|  |  | | | | |  | |
|  |  | | | | |  | |
| **Total Thermal Resistance RT (m2K/W)** | RT=Rsi+R1+R2+…+Rn+Rse | | **12.5602** | |  | |
| **Thermal Transmittance U(W/m2K)** | **U=1/A\*RT** | | 0.0796 | |  | |

*(1): for a heat transfer area of 1 m2*

## External window

The window is double glazed UPVC 1.8m x 1.2m, split into five different sections. 2 (0.25x46.5) m, 2 (0.61x46.5) m and 1 (110x46.5) m. The outside sill is made of a concrete block ledge. A cross section of the window is essential reporting all the material layers. You should cite all the sources you have used to determine the thermal conductivities of the window materials. A table such as that shown in Table 2.1 is useful here also.

## Ambient air temperature

Report the formula used to perform your calculation explaining every variable.

Inside room it was 22.50C

Outside window it was 7.80C at 17:48 on Sunday evening

**The External Ambient Temperature (˚C)**

The external ambient temperature is calculated by:

T = The external ambient temperature

A = The average of the last digit of the UCD student numbers of all students in the group (excluding any numbers ending in zero).

h = Hour of the day

d = Day of the week

## Heat losses and heat gains

Report the formula used to perform your calculation explaining every variable.

**Thermal Transmittance (U-value**)

Rt = Thermal resistance of the material

**Heat Transfer Rate**

Heat transfer rate through the wall, window, ceiling and floor:Top of Form

Bottom of Form

U = U-value of the material

Av = room temperature (22˚C)

T = External ambient temperature

**Losses**

Through outside wall.

Window

Door to hall

**Gains**

Radiator

From internal walls

From door to hall

To ceiling

Radiator behind one of the walls it’s in the hall

## Ventilation heat losses

Only through the door and windows if open

Report the formula used to perform your calculation explaining every variable.

## Internal heat gains

Radiator single radiator 1.2 x 1.7 ( at least about 70 %)

Through heat from walls, ceiling (whatever there is left)

Back boiler from fire is to the inside of one of the internal wall increases temp through that wall slightly

Report the formula used to perform your calculation explaining every variable.

## Heat losses from the window

Not sure but curtain is usually pulled which lets less heat out through window most to walls the ventilation from door and light to upstairs as the heat is zoned upstairs and downstairs upstairs rarely turned on.

Report the formula used to perform your calculation explaining every variable.

## Heat losses from the wall

Most of the heat that lost is through this wall but not a lot of heat is ever lost room is well insulated and sealed very little lost to ventilation.

Report the formula used to perform your calculation explaining every variable.

# Results and analysis

This section is being used to tell the reader what you found.

Should include:

* Results – graphs and statements of key findings.
* Analysis – interpretation for the reader of what these findings mean.
* Discussion – explanation of errors or uncertainties that might limit these findings.

It is important to realise, when you are writing a report, that you are performing a service for the reader, you are helping them to understand. It is not good enough to just fill the report with graphs, you should prioritise these graphs, explain what each means and what conclusions they can lead to.

For example, on election night data streams into a TV studio but to most viewers it doesn’t mean anything until the experts explain the significance of each count and their overall implications. In that section visualisation of the results is very important. However, be careful to include results that are useful to the reader and do not cause confusion.

## 3.1 Heat losses

A pie chart like that of figure 3.1 provides useful information to the user. Every time you are inserting a table or a figure in your text you should introduce the reader to its contents. Of course you are expected to comment on each figure. You should discuss the findings that are presented in every graph. For example in this particular project you should – based on the results – comment on how well thermally protected is the room you have selected.

Presenting output is mainly done by charts and graphs (and not by tables). Especially for time depended variables – like most of the questions require in your project – graphs is the straightforward solution.

***Figure 3.1:*** *Heat losses (left) and heat gains (right) breakdown*

## 3.2 Interior and exterior temperatures of external building elements

## 3.3 Maximum heating load and radiator capacity

## 3.4 Additional insulation

# 4. Conclusions

The conclusions should outline the main findings. This does two things:

* it directs the reader to the most important findings, and
* as the last thing the reader sees, it helps to fix these key points in memory.

It should include several statements, one for each of the key findings. You should never introduce new material in the conclusions. They simply reiterate the most important points that have come up in the results section.

# 

# Reference

Kenneth D. Lonergan & Associates Ltd. (Building and Quantity surveyors) designed the house

The UCD Library website contains a very useful citing tutorial:

<http://www.ucd.ie/library/supporting_you/support_learning/cite_tutorial/>

<http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html> (u values)

<http://www.foe.ie/download/pdf/understanding_the_targets_in_the_climate_bill_compared_to_irelands_eu_obligations_jan_2011.pdf>

[www.wikipedia.org](http://www.wikipedia.org) for research on particular construction materials and formulae

MEEN 10050 Energy Engineering classes and notes for calculations formulae etc.

# Appendix A

Appendix A of your report should include a summary of the contribution made by each member of the group.

Aaron Collier – in charge of: calculations and construction of formulae and data  
 assisted in: research, choice of room, and compilation of report

Eibhan Joyce – in charge of: background research for project, compilation of report

Assisted in: calculations and construction of formulae and data, choice of room

Fergal Lonergan - in charge of: measuring photographing drawing and finding out composition of room

Assisted in: research, compilation of report and calculations and construction of formulae and data

# Appendix B

Any additional appendix should be used to show useful (but not vital) extra material with the main report. It should include anything that is not necessary for a reader to follow the content of the report, but which could be useful for certain readers if they wished to know more about a particular item.

For example, if you were doing a report on emission testing of cars, you may include a figure from an EU regulation on vehicle emission standards. This EU regulation could then be reproduced in full in the appendix allowing the reader to look through the rationale for the figure cited.

A REPORT ON AVERAGE ENERGY CONSUMPTION OF HOUSES IN IRELAND AND THE COUNTRIES PROJECTED ENERGY TARGETS IN THE COMING YEARS

<http://www.seai.ie/News_Events/Press_Releases/Energy_in_the_Residential_Sector_FNL.pdf>

IRISH BUILDING REGULATIONS 2013

<http://www.environ.ie/en/Legislation/DevelopmentandHousing/BuildingStandards/FileDownLoad,33646,en.pdf>

IRISH ENERGY STANDARDS AS OF 2008

<http://www.environ.ie/en/Legislation/DevelopmentandHousing/BuildingStandards/FileDownLoad,17763,en.pdf>

Ventilation standards

<http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,1647,en.pdf>

Heat producing appliance standards

<http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,1650,en.pdf>

Conservation of energy in dwellings standards

<http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/FileDownLoad,27316,en.pdf>

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**Note:** The completed report should be converted to Portable Document Format (i.e. into a “pdf” file) prior to submission through UCD Blackboard.

Pdf writing is normally offered as a “print” option. Free pdf writing software can be downloaded from several sources, including;

* <http://www.cutepdf.com/products/cutepdf/writer.asp>
* <http://www.primopdf.com/>
* <http://www.pdf995.com/>