

3 ITEMS IN THERMAL COMFORT

ENVIRONMENTAL SCIENCE



WHAT YOU UNDERSTAND ABOUT THERMAL
COMFORT

ARE YOU FEEL COMFORTABLE

WITH YOUR ROOM CONDITION

" Let's make a comfort zone for your building..."

TS.DR MARIA BINTI MOHAMMAD
FADHILLAH BINTI MOHD NASIR
AB RAZAK BIN AHMAT
NURUL AQILAH BINTI JOHAR
NOOR AINI BINTI MISTAR

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EDITORIAL

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SYNOPSIS

3 ITEMS IN THERMAL COMFORT RECOVER ONE OF THE TOPIC FROM DCA30182 ENVIRONMENTAL SCIENCE (ES) IN DEPARTMENT OF POLYTECHNIC AND COMMUNITY COLLEGE EDUCATION, MINISTRY OF EDUCATION MALAYSIA.

THIS COURSE OFFERS BASIC KNOWLEDGE CONSISTS OF FOUR TOPICS; THERMAL COMFORT, VENTILATION, LIGHTING AND ACOUSTIC.

THE COURSE PROVIDES GENERAL IDEA OF THERMAL FACTORS AND THE ACOUSTIC CONSIDERATION INTO THE DESIGN PROCESS IN BUILT ENVIRONMENT. THE STUDENTS WILL BE EXPOSED THE UNDERSTANDING OF DESIGN CONCERN IN CERTAIN TYPE OF CLIMATE AND CONDITIONS.

ACKNOWLEDGEMENT

THANK YOU TO ALL TEAM MEMBERS

THANK YOU MY STUDENTS, GAN AND DSB 1 SESSION 1
2021/2022 FOR YOUR CONTRUBUTION IN DRAWING
AND ILLUSTRATION SKILLS. HOPE THIS E-BOOK WILL
GIVE UNDERSTANDING THERMAL COMFORT
APPLICATION IN BUILDING DESIGN, ACCORDING
CLIMATE AND CONDITIONS.

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REFERENCES

COURSE LEARNING OUTCOMES(CLO)

CLO OF E-BOOK IN 3 ITEMS IN THERMAL COMFORT, STUDENTS SHOULD BE ABLE TO:

(CLO 1)

1. Apply environmental design principles to building design in tropical climate

(CLO 2)

2. Analyze data of environmental performance for selected building

ASSESSMENT:

The course assessment consists of:

- i. Continuous Assessment (CA) – 100%
- ii. Final Examination (FE) / Final Assessment (FA) – None

CLO	PLO	CLS	DT	PROPOSED TEACHING & LEARNING ACTIVITIES	CONTINUOUS ASSESSMENT WEIGHTAGE (%)				SLT (hours)	PROPOSED TOPIC
					Quiz	Theory Test	Report	Case Study		
					(1) 10%	(1) 20%	(1) 40%	(1) 30%		
CLO1 : Apply environmental design principles to building design in tropical climate.	1	1	C3	Cooperative Learning		■			39	T1,T3,T4
				Interactive Lecture	■					T1-T6
CLO2 : Analyse data of environmental performance for selected building in tropical climate.	2	2	C4	Interactive Lecture			■		41	T1/T4
				Cooperative Learning				■		T1-T6
								TOTAL SLT:	80	

Remarks/ Notes:

DT – DOMAIN TAXINOMY

/ : OR

- : UNTIL

, : AND



ITEM 1

THERMAL COMFORT

ARE YOU REALIZE



WHAT IS

THERMAL COMFORT

**ACCORDING TO THE AMERICAN SOCIETY OF
HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)**

“That condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation”. Although thermal sensitivity varies from one person to another, according to age (the very young and very old being particularly sensitive), gender, dress, activity, cultural habits, etc., the basic principles behind thermal comfort are largely universal.

FACTORS INFLUANCE;

Humidity

Air temperature

Material used

[HTTPS://MULTICOMFORT.SAINT-GOBAIN.COM/COMFORTS-AND-SOLUTIONS/THERMAL-COMFORT#](https://multicomfort.saint-gobain.com/comforts-and-solutions/thermal-comfort#)

ANGLES OF COMFORT

VISUAL COMFORT

WHEN YOU **SEE**

INDOOR AIR QUALITY

WHEN YOU **BREATHE**

ACOUSTIC COMFORT

WHEN YOU **HEAR**

DO YOU KNOW



ITEM 1

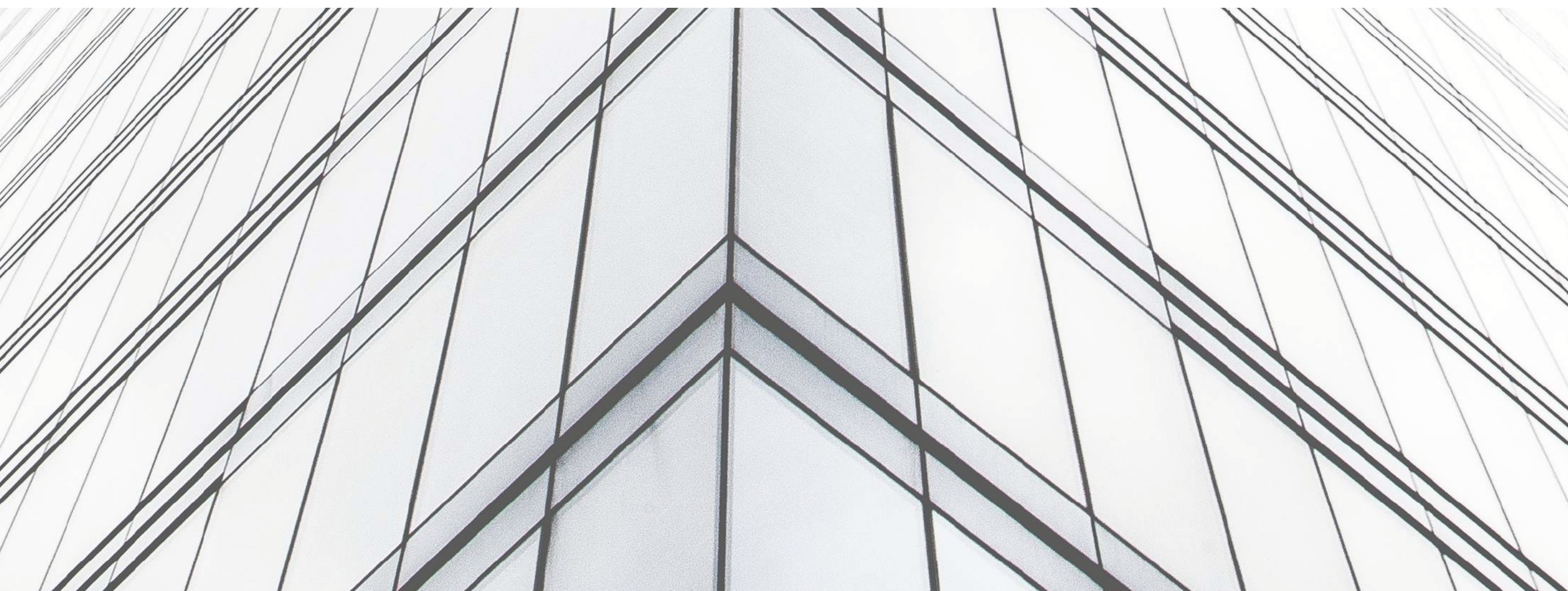
THERMAL COMFORT

1.1

- Apply thermal comfort design strategies to building design in tropical climate.



NATURAL VENTILATION IN BUILDING



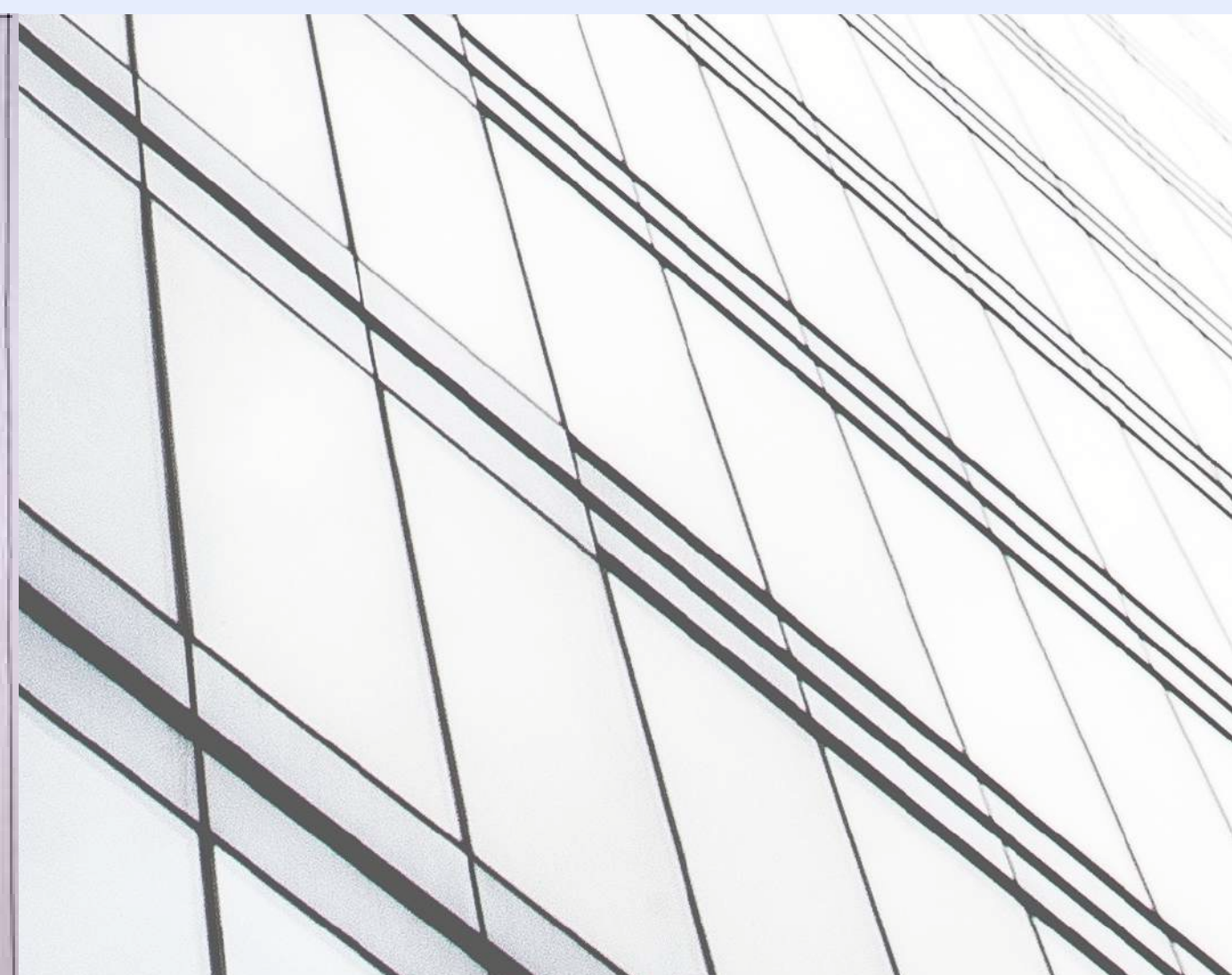
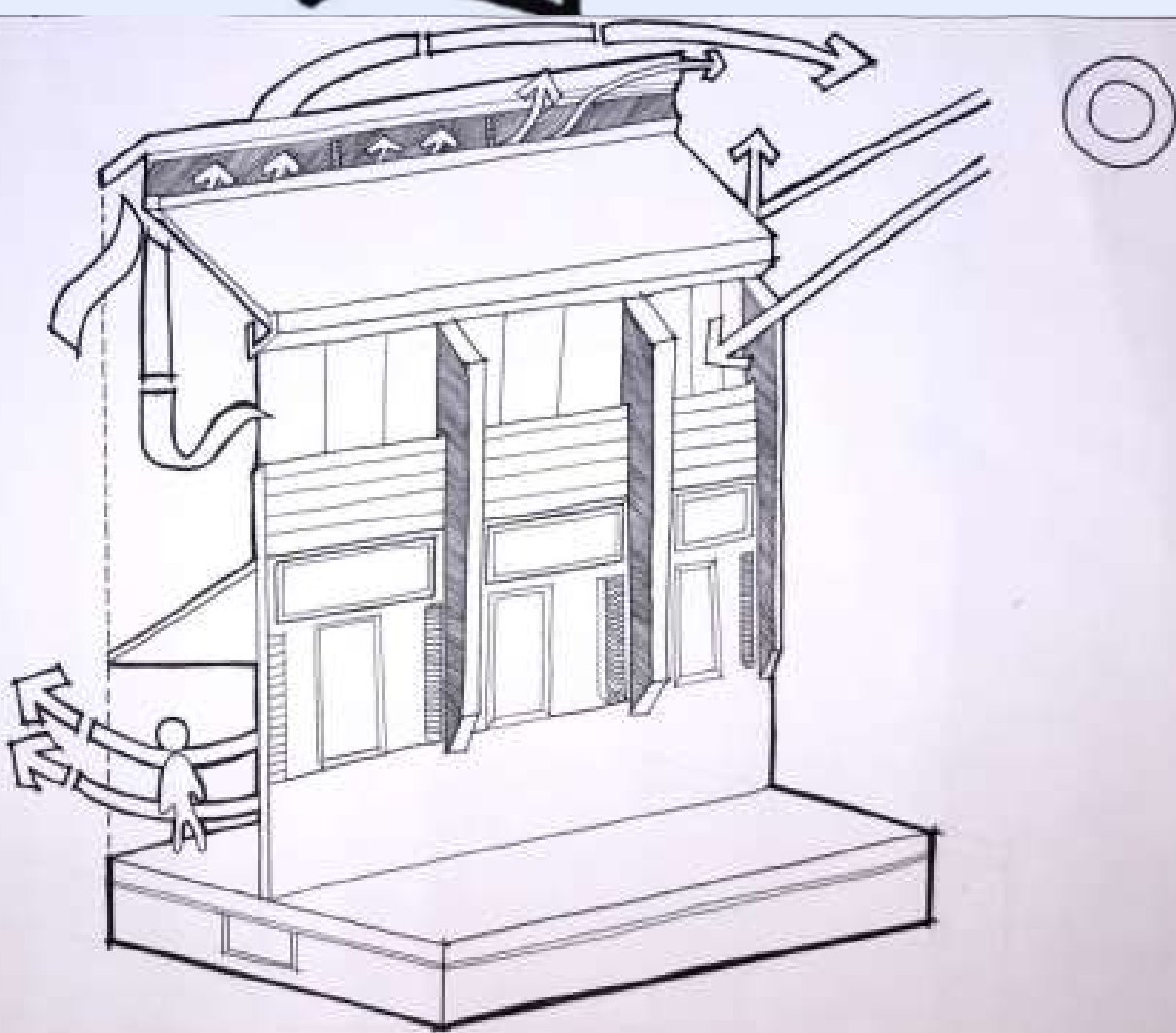
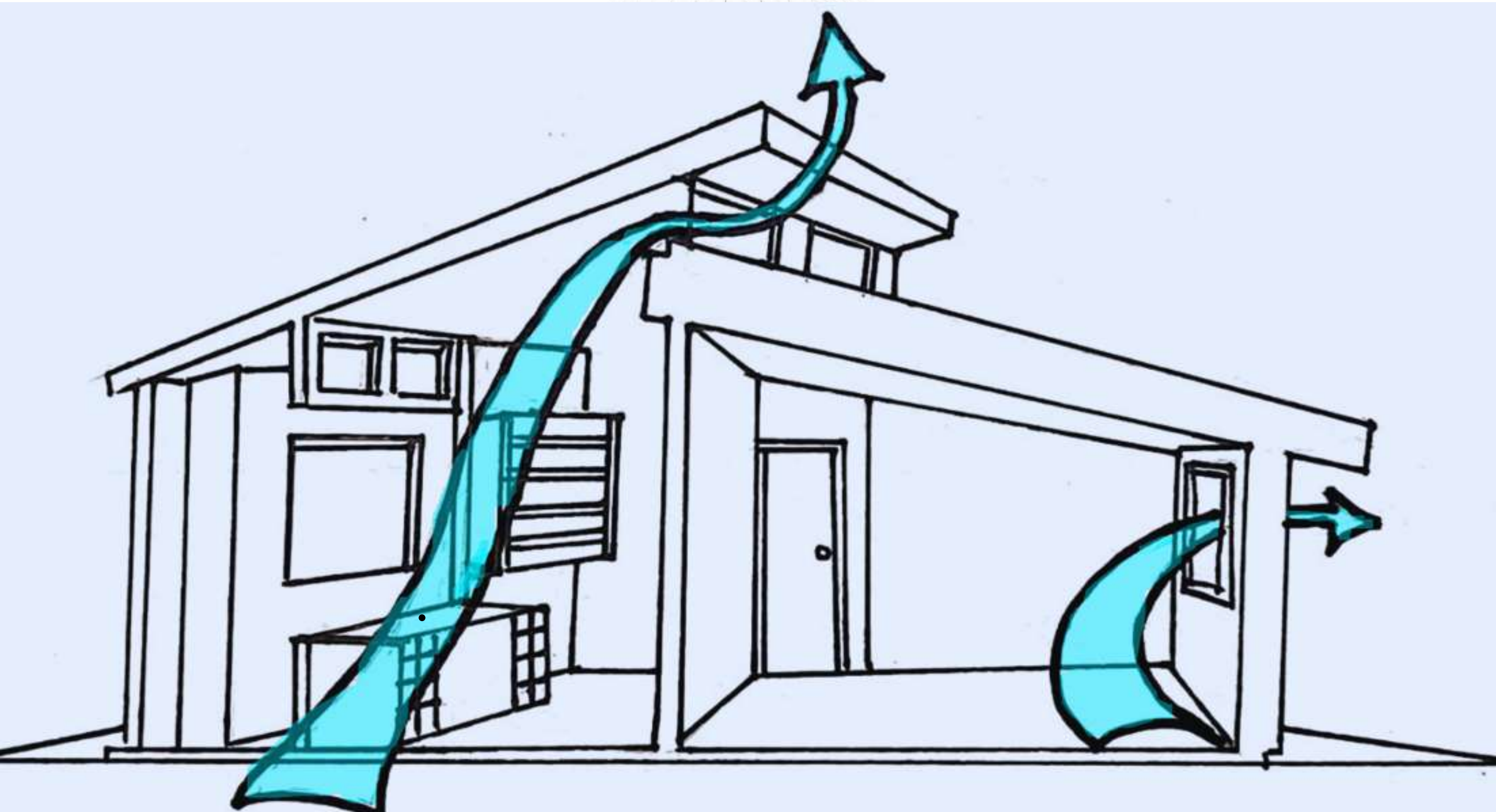
A

NATURAL VENTILATION IN BUILDING

DEFINITION

Natural ventilation is the process in which air is supplied and removed from an indoor space by natural means without using mechanical systems.

It refers to the flow of external air to an indoor space as a result of pressure differences arising from natural forces (passive design)

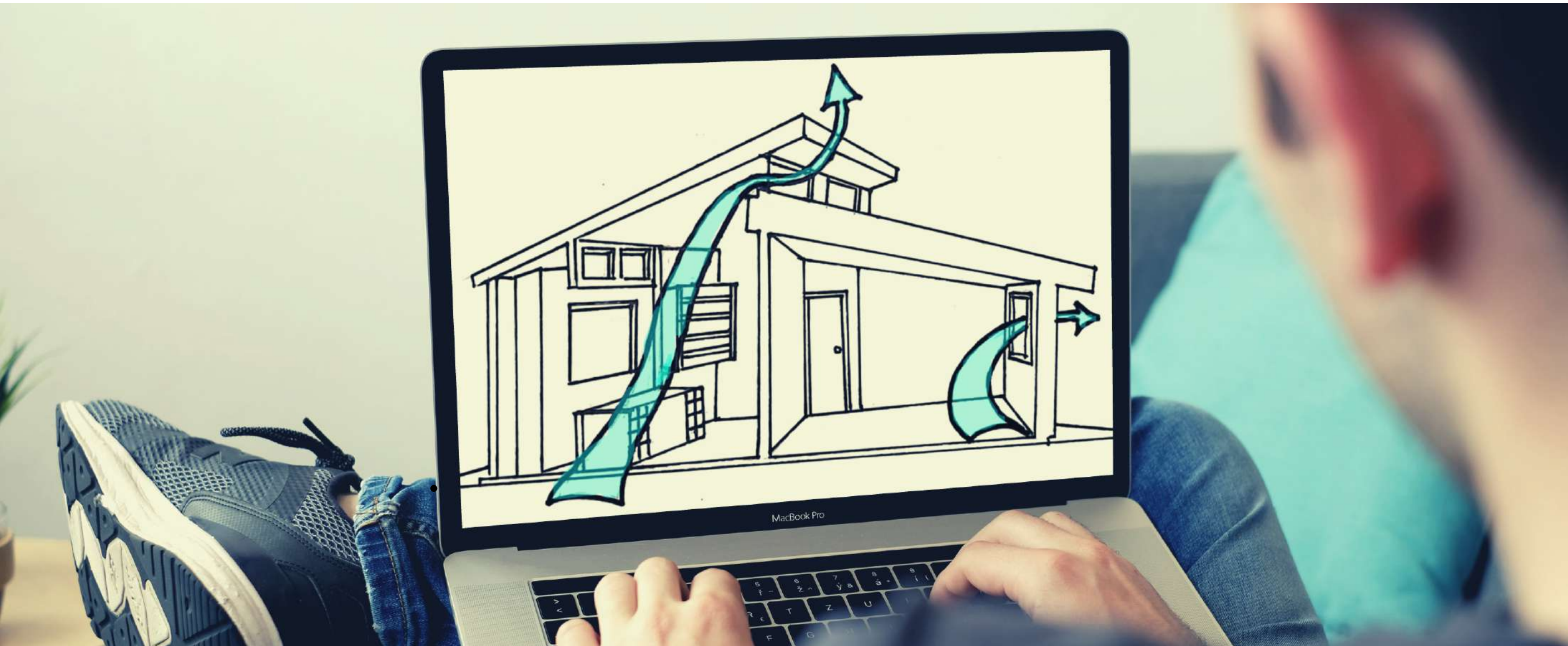


B

TWO (2) TYPES OF NATURAL VENTILATION SYSTEMS

Pressure of the fresh air in the building will move through:

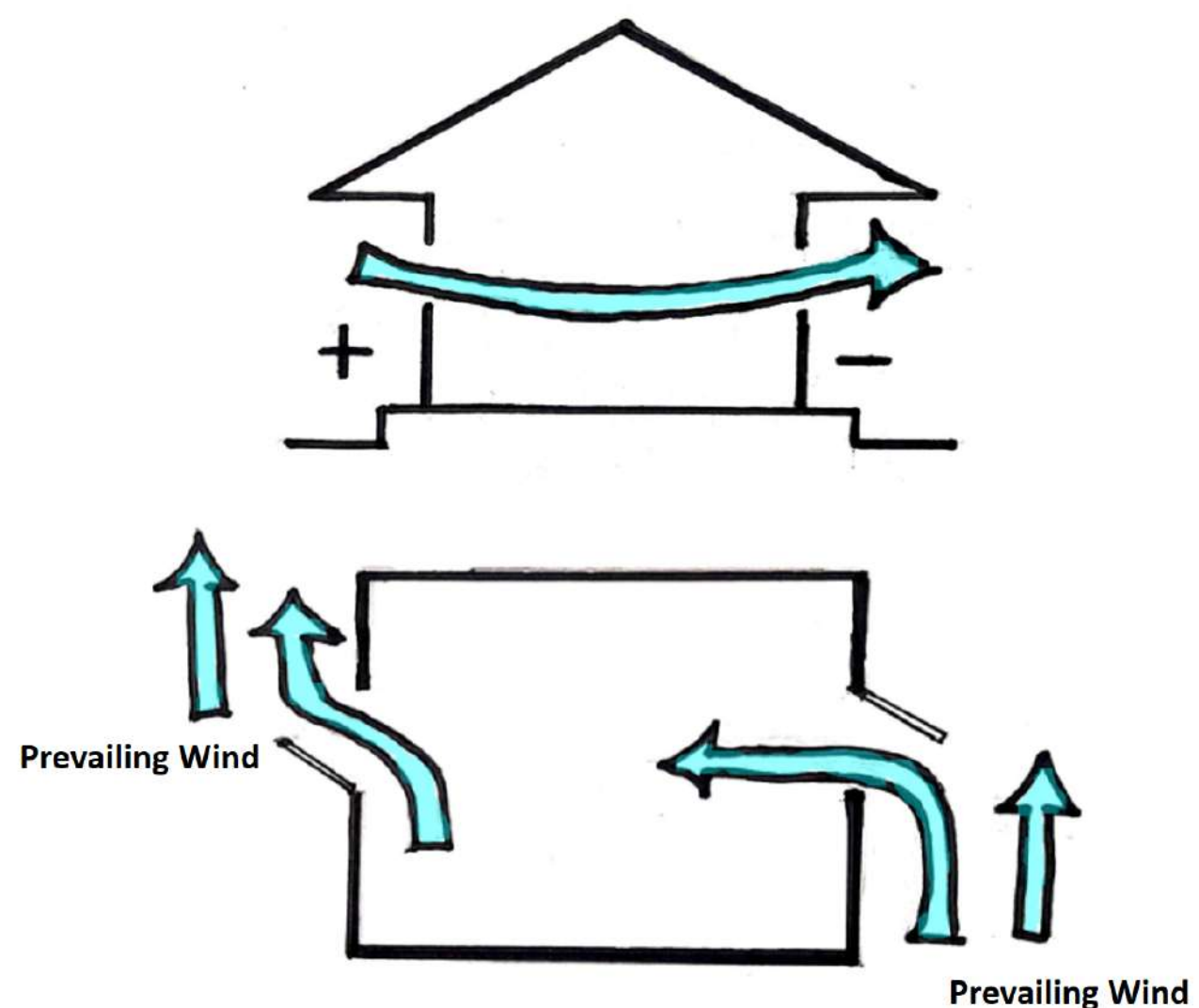
- i. **Wind effect or;**
- ii. Buoyancy effect

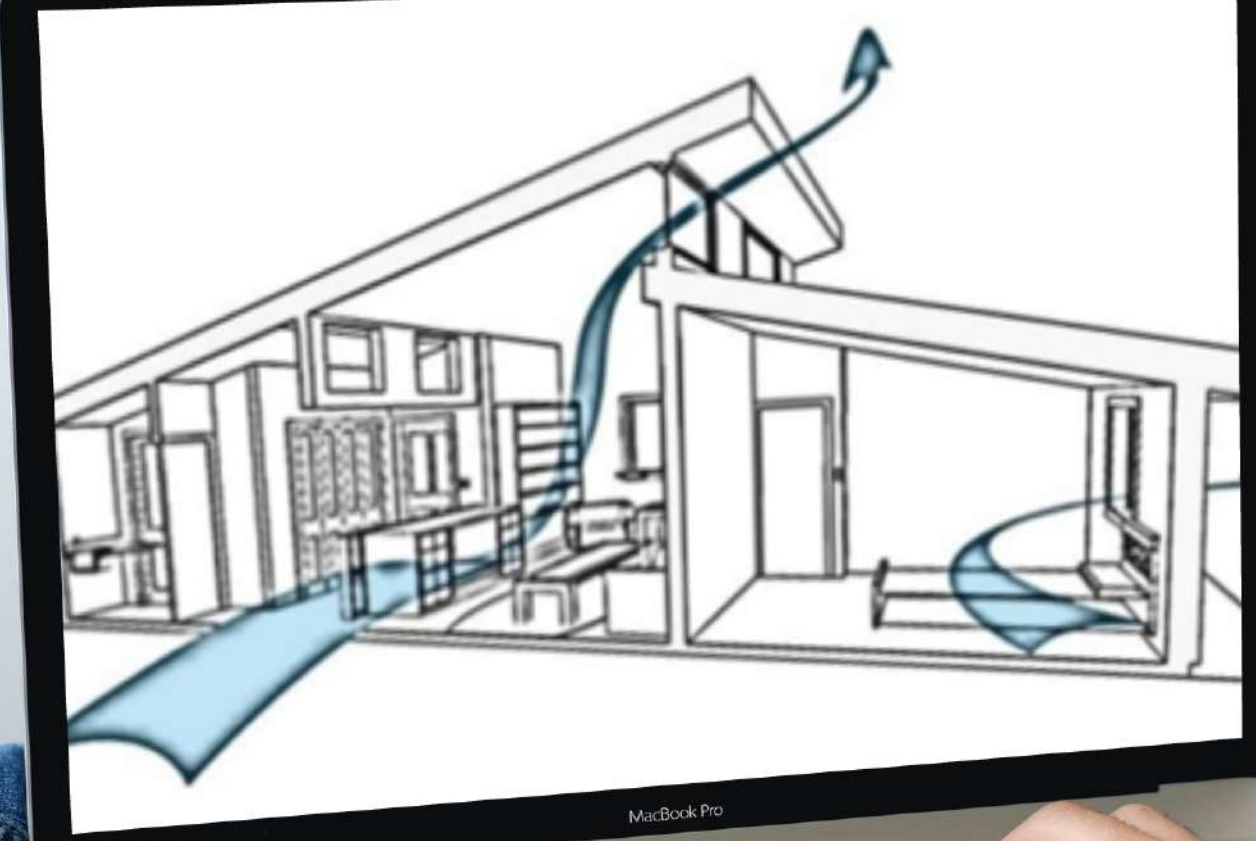


i. Wind Effect

- Natural method of cooling where it controls the air quality inside of a building environmentally and cost-effectively.
- When wind flows into the side of the building, each side of the building is hit with different amounts of pressure.
- Also known as cross ventilation

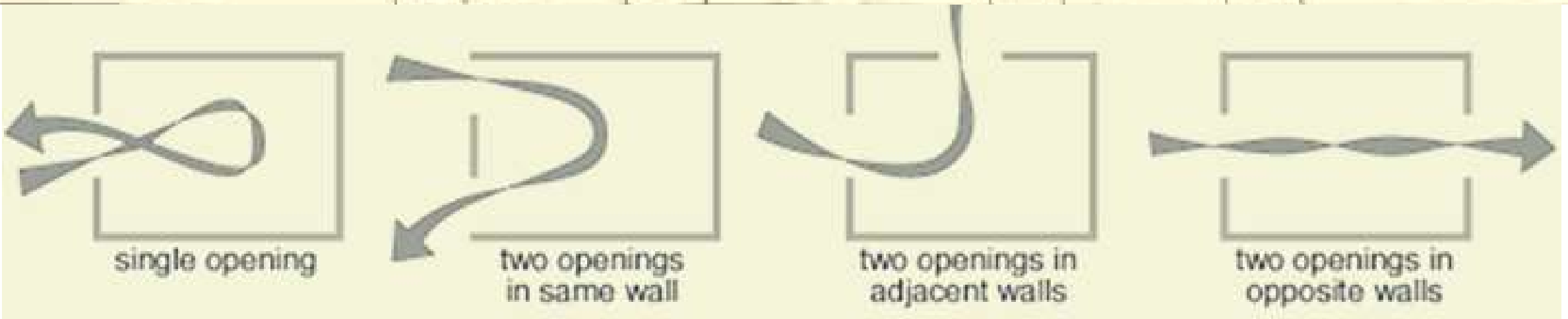
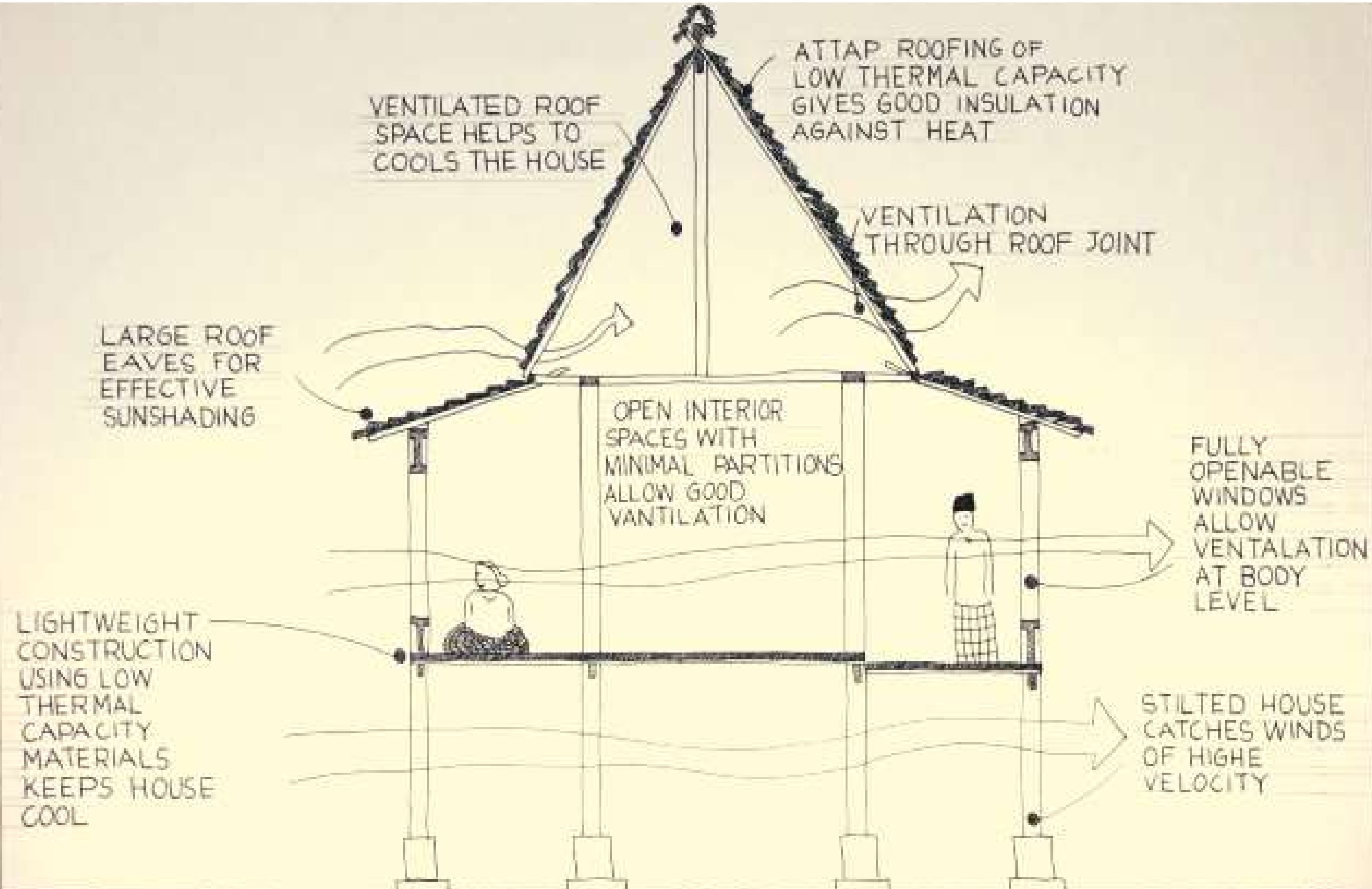
Wind Effect

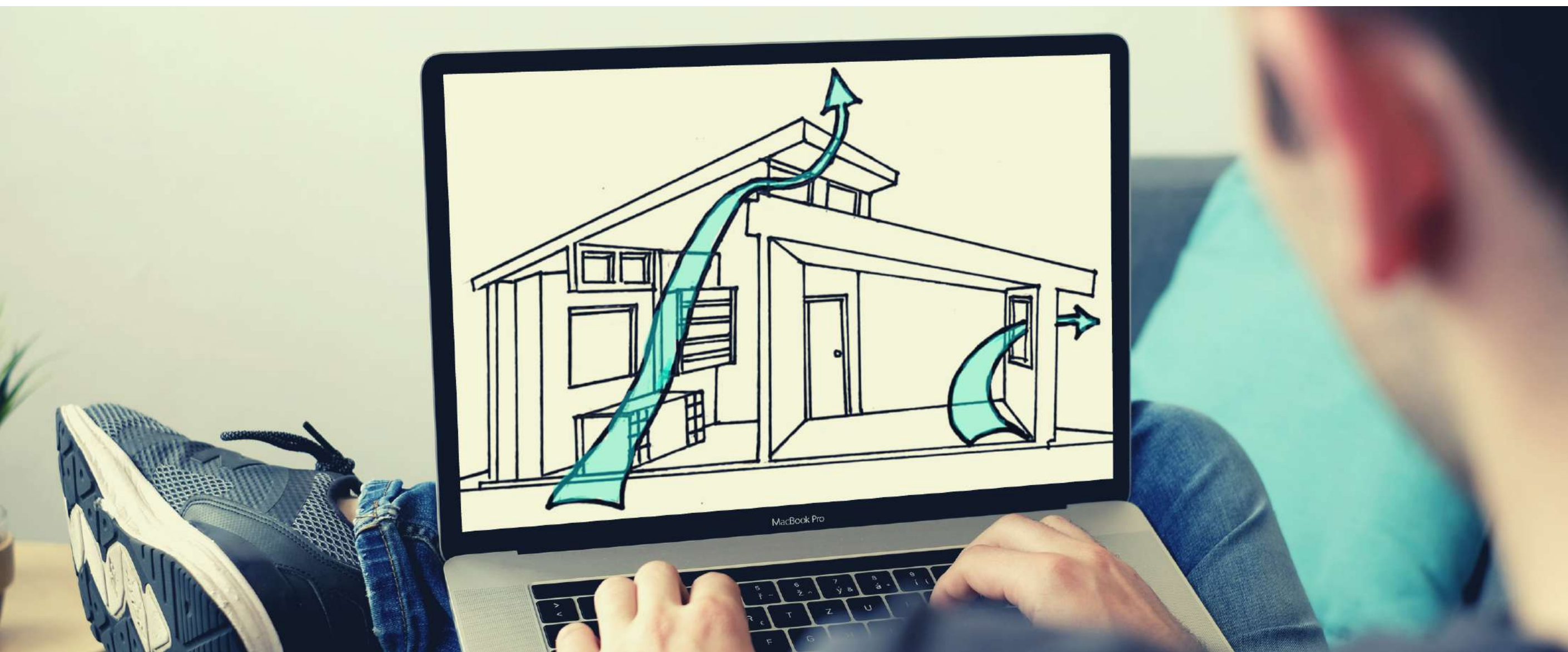




WIND FLOW MOVEMENT IN THE BUILDING ACCORDING TO BASIC BUILDING PLAN BASED ON FUNCTION OF NATURAL VENTILATION

WIND EFFECT

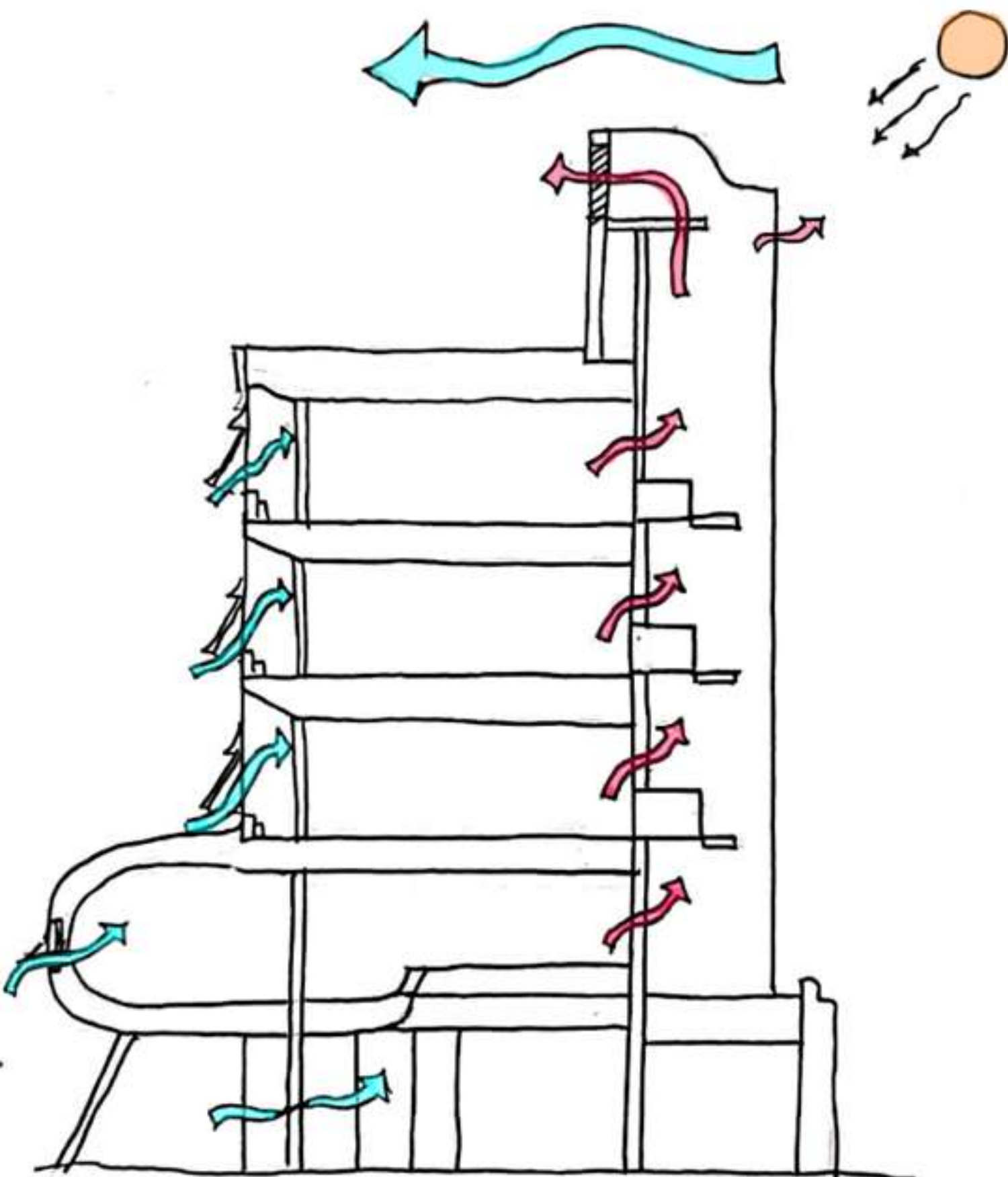




II.

Buoyancy Ventilation

- Interior and exterior air results Buoyancy ventilation in the building
- This variance causes the warm air to rise above the cold air, and create an upward air-stream in natural ventilation system.
- Also known as stack effect



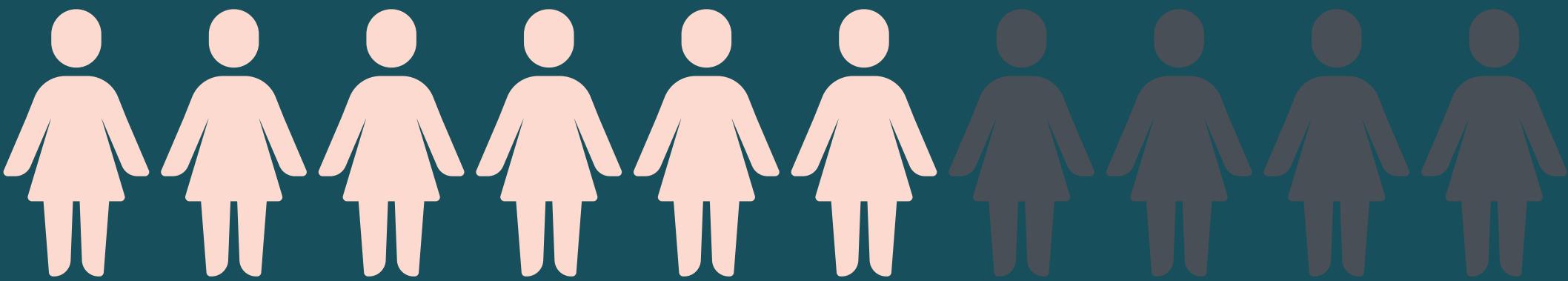


ITEM 1

THERMAL COMFORT

1.2

- Identify thermal quantity, building thermal specification in the hot and humid climate
-



WHAT YOU UNDERSTANG ABOUT THERMAL COMFORT

DO YOU FEEL COMFORT

WITH YOUR ROOM CONDITION

" Let's turn your room into your comfort zone..."



ITEM 1

THERMAL COMFORT

1.3

- Identify thermal comfort index, building thermodynamic, heat absorption and natural ventilation.
-



**WHAT DO YOU UNDERSTANG
ABOUT THERMAL COMFORT**

NATURAL VENTILATION SYSTEM RELATED TO SUSTAINABLE BUILDING DESIGN

01

NATURAL VENTILATION SYSTEM RELATED TO SUSTAINABLE BUILDING DESIGN

i. Many buildings use HVAC unit to control their thermal environment. Other buildings are naturally ventilated and do not rely on such mechanical systems to provide thermal comfort.

ii. Depending on the climate, this can drastically reduce energy consumption.



NATURAL VENTILATION SYSTEM RELATED TO SUSTAINABLE BUILDING DESIGN

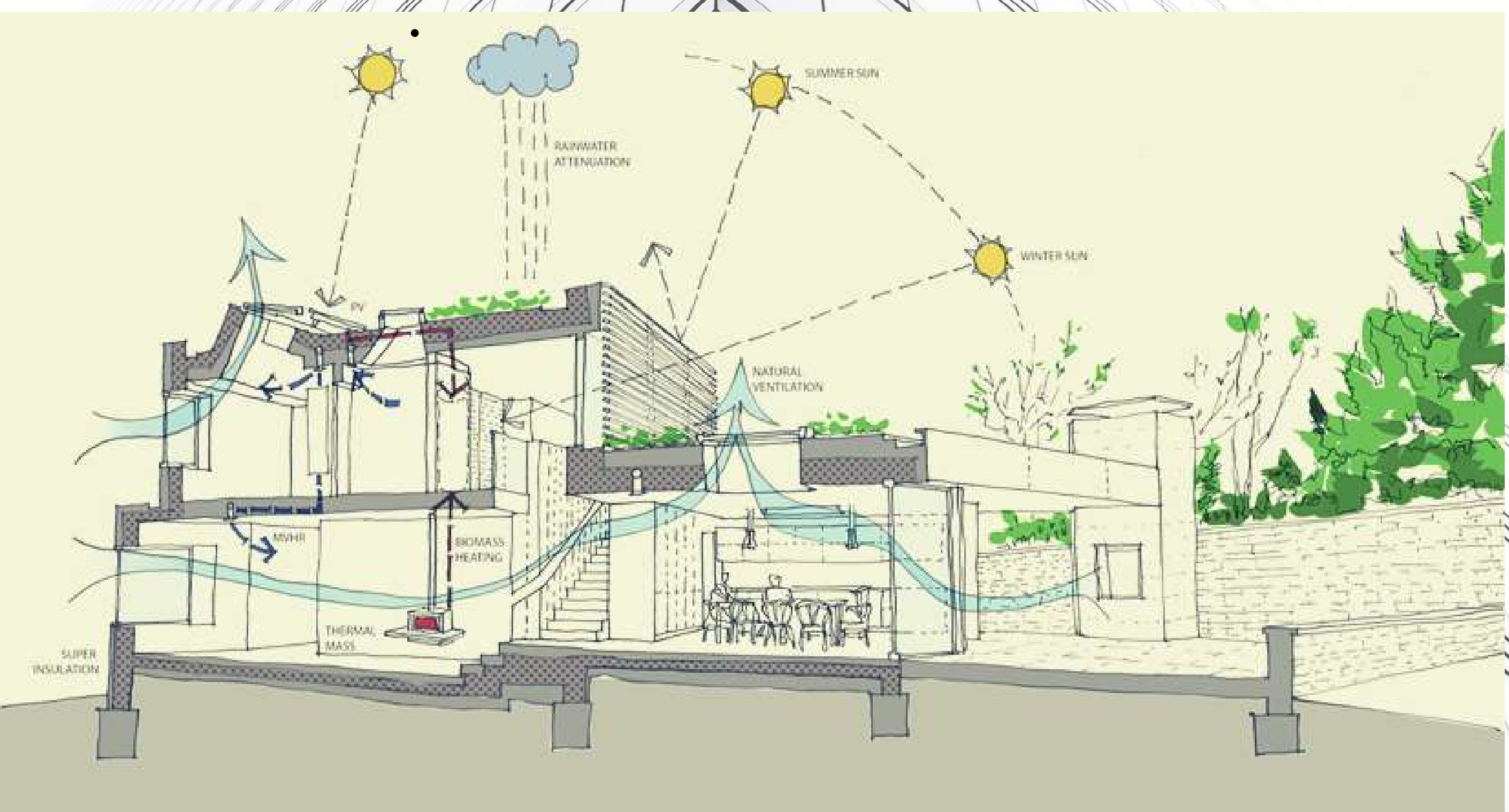
02

EFFECT

Indoor temperatures will be extreme in the building circulation effected by poorly designed.

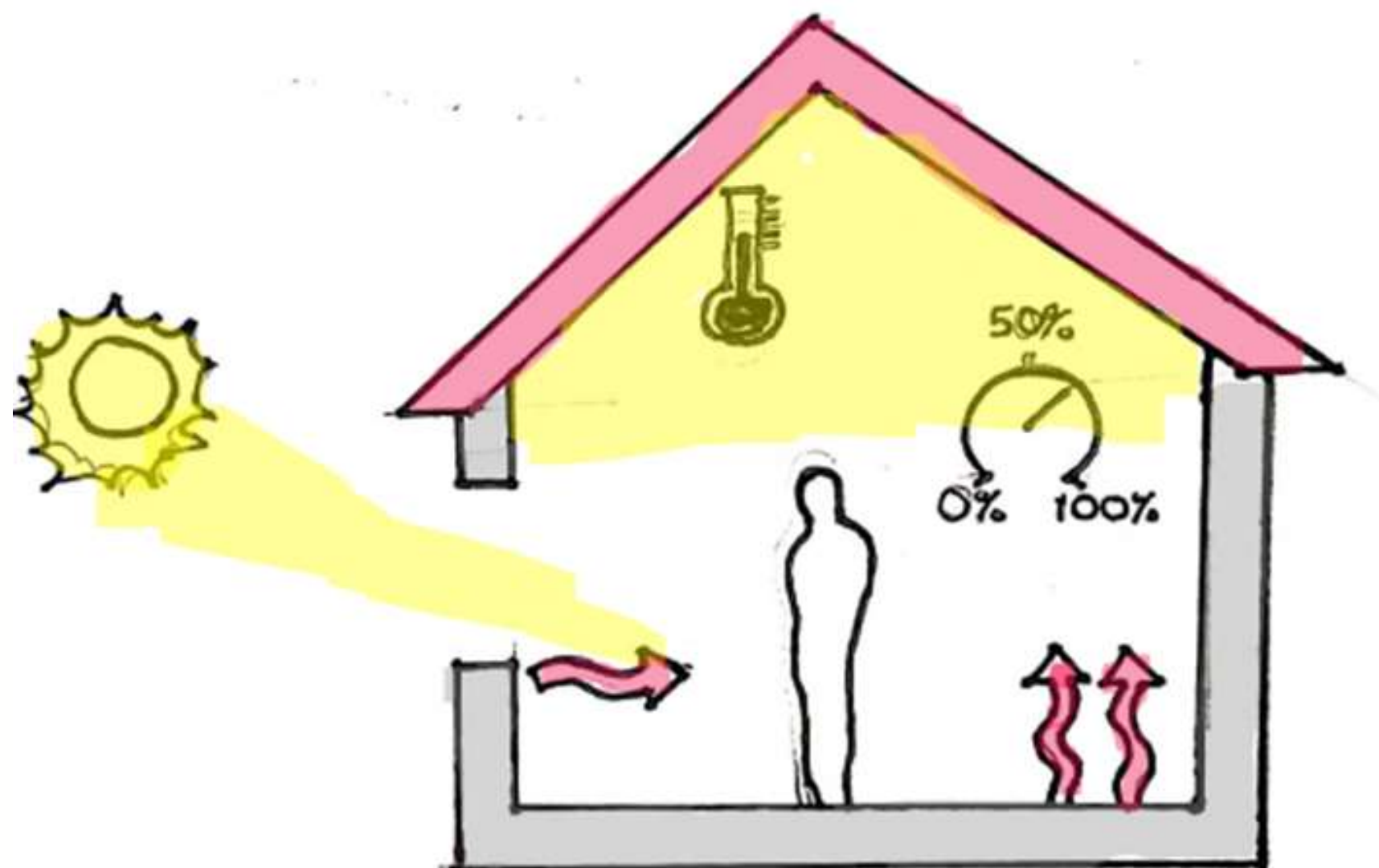
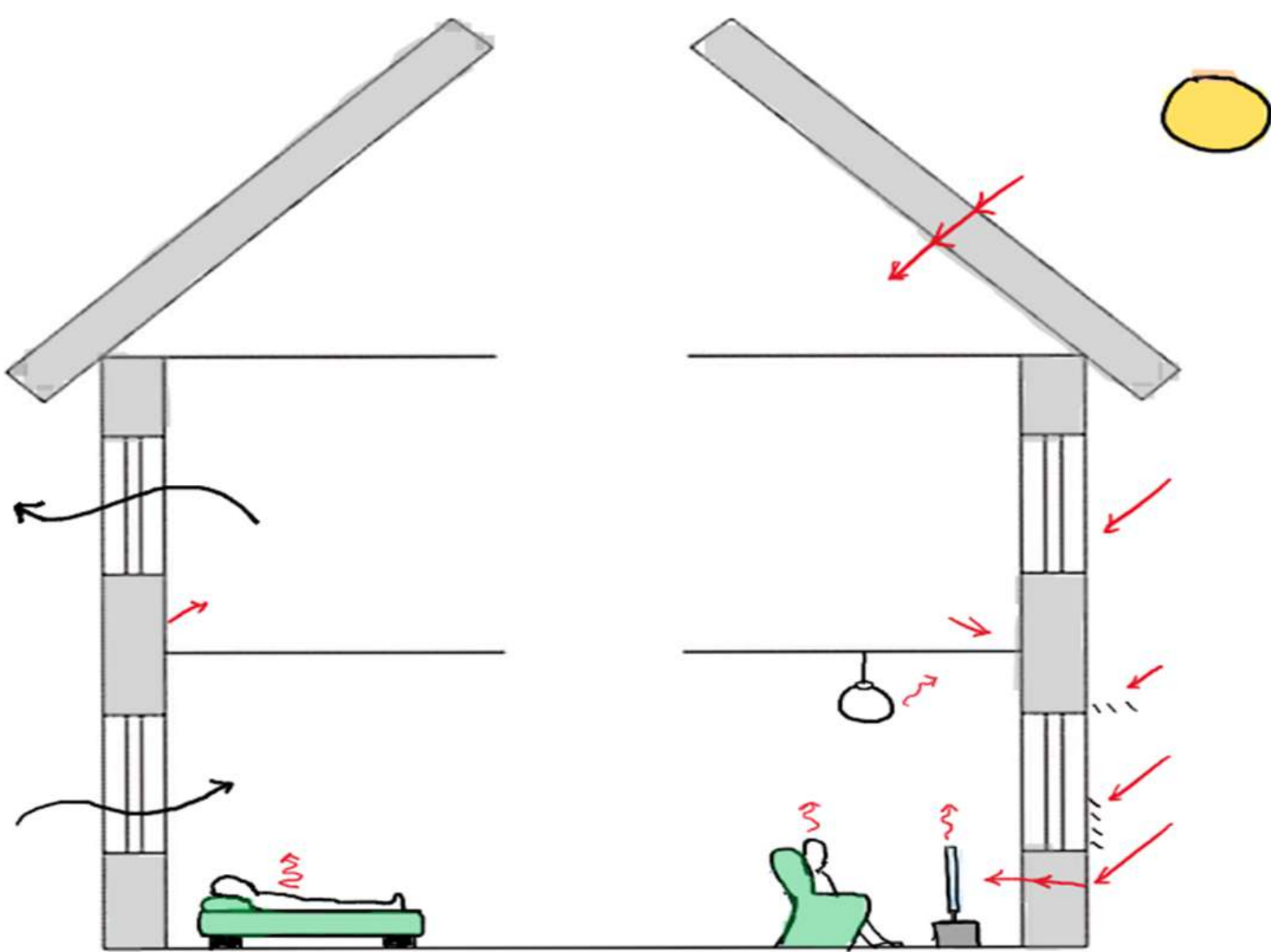
A best designed, keep indoor conditions within the range of thermally comfortable naturally.

Design with circulation ventilated in the buildings



INFLUENCE OF NATURAL VENTILATION IN BUILDING

- i. Building location and orientation
- ii. Building form and dimensions
- iii. Indoor partitions and layout
- iv. Window typologies, operation, location, and shapes
- v. Other aperture types (doors, chimneys)
- vi. Construction methods and detailing (infiltration)
- vii. External elements (walls, screens)
- viii. Urban planning conditions



Influence of Natural Ventilation Building

ARE YOU REALISE



ITEM 2

HEAT TRANSFER



ITEM 2

HEAT TRANSFER

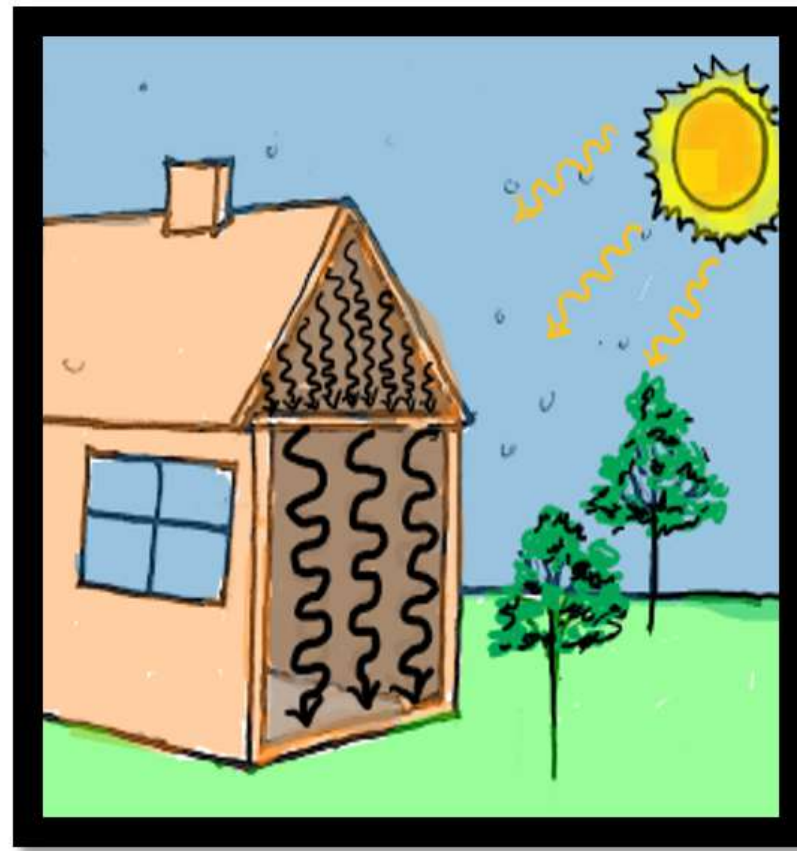
2.1

- Identify factors of heat transfer to the building: conduction,
 - convection and radiation as a factor of heat transfer.
-

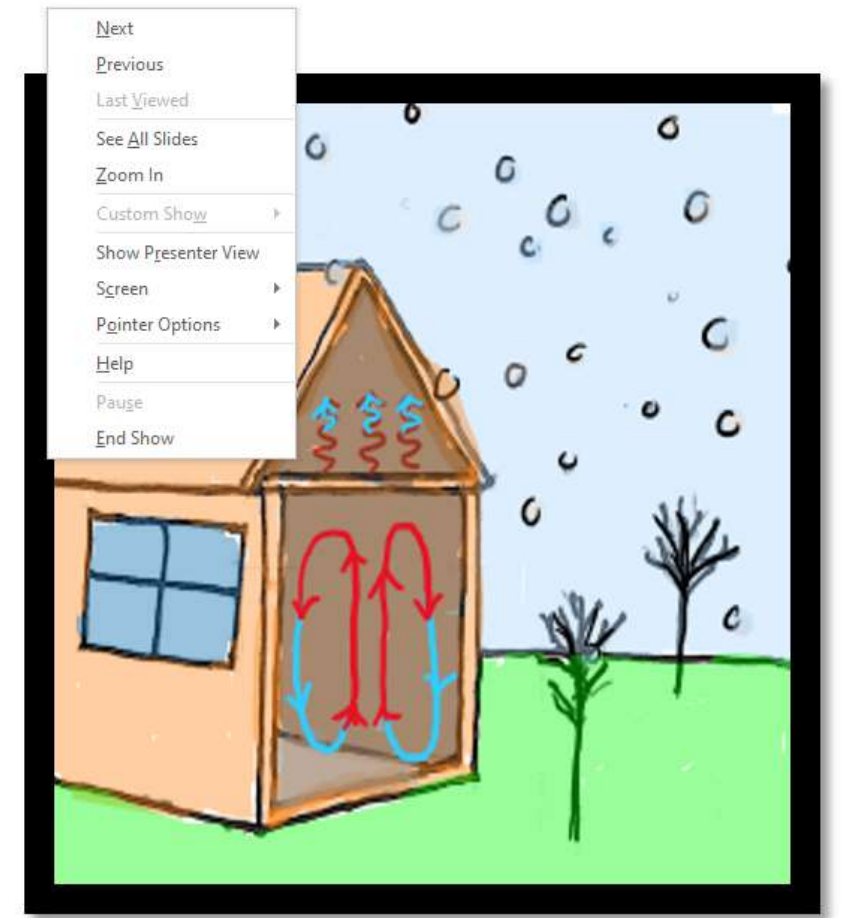
FACTORS OF HEAT TRANSFER TO THE BUILDING



CONDUCTION



RADIATION



CONVECTION

The transfer of heat between objects that are in contact

Transfer of heat from a warm object through space to a cooler object. The two objects do not have to be touching for successful heat transfer.

Heat moves through the air and the warm air is pushed out

FACTORS OF:

HEAT TRANSFER

IN BUILDING

YES...

THERMAL COMFORT

RELATED CONDITION OF INDIVIDUAL MIND

Expresses satisfaction with the thermal environment are subjective evaluation among individuals. A subjective state of satisfaction that varies with the individual and a number of circumstantial factors.



IT MAY VARY GREATLY BETWEEN

INDIVIDUALS



DEPENDING ON FACTORS SUCH AS ;

- i. Activity level
- ii. Clothing
- iii. Humidity.
- iv. Individual mind feeling either hot or cold.



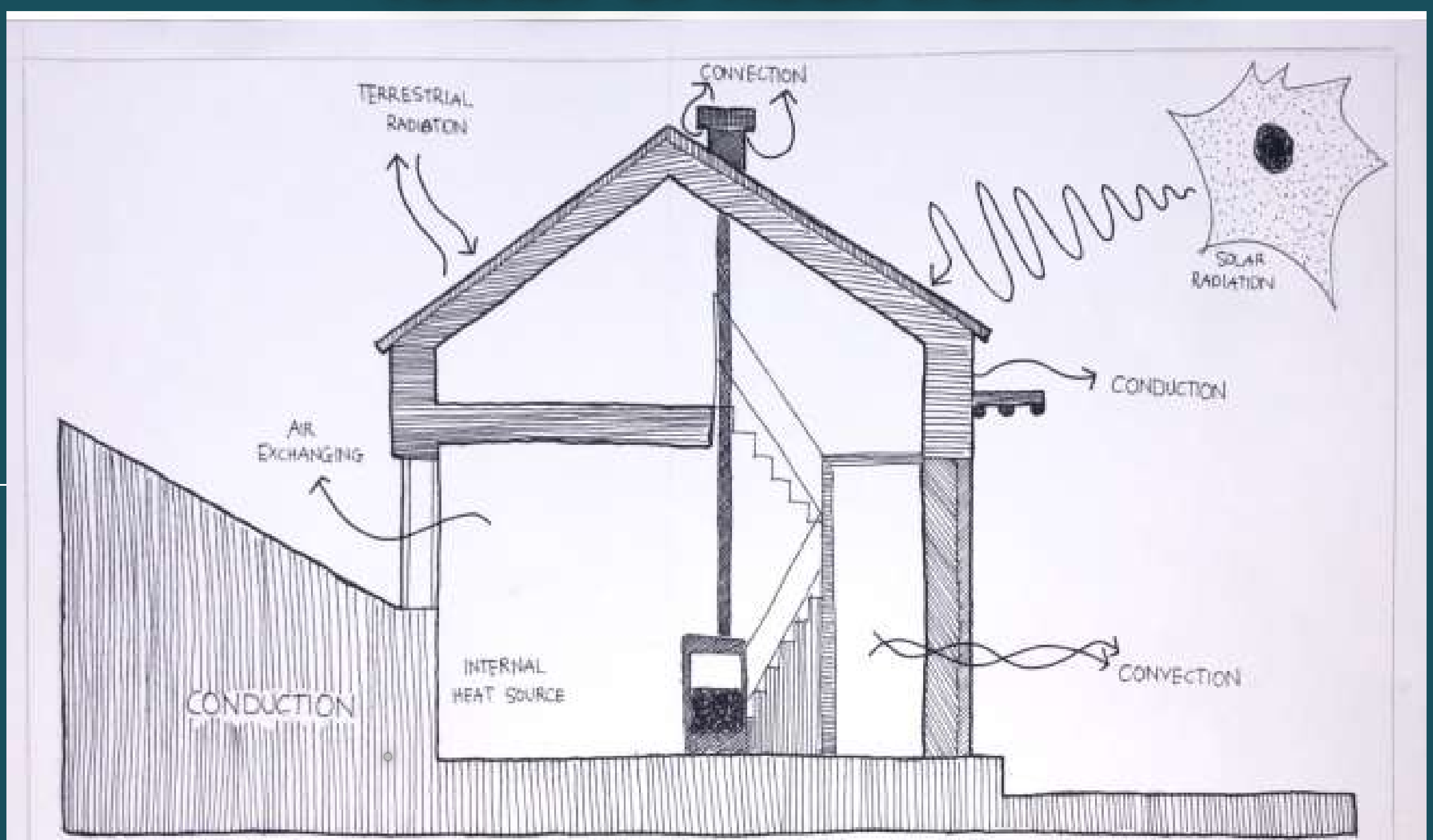
ARE YOU REALISE

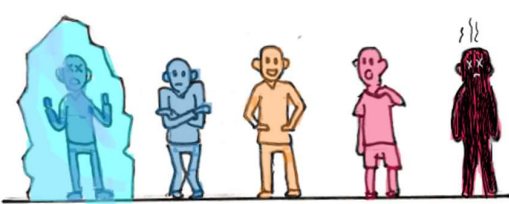
ITEM 2

HEAT TRANSFER

2.2

•Describe conduction as a factor of heat transfer.





YES...

THERMAL COMFORT

BODY HEAT TRANSFER

The body can also gain of heat exchange.

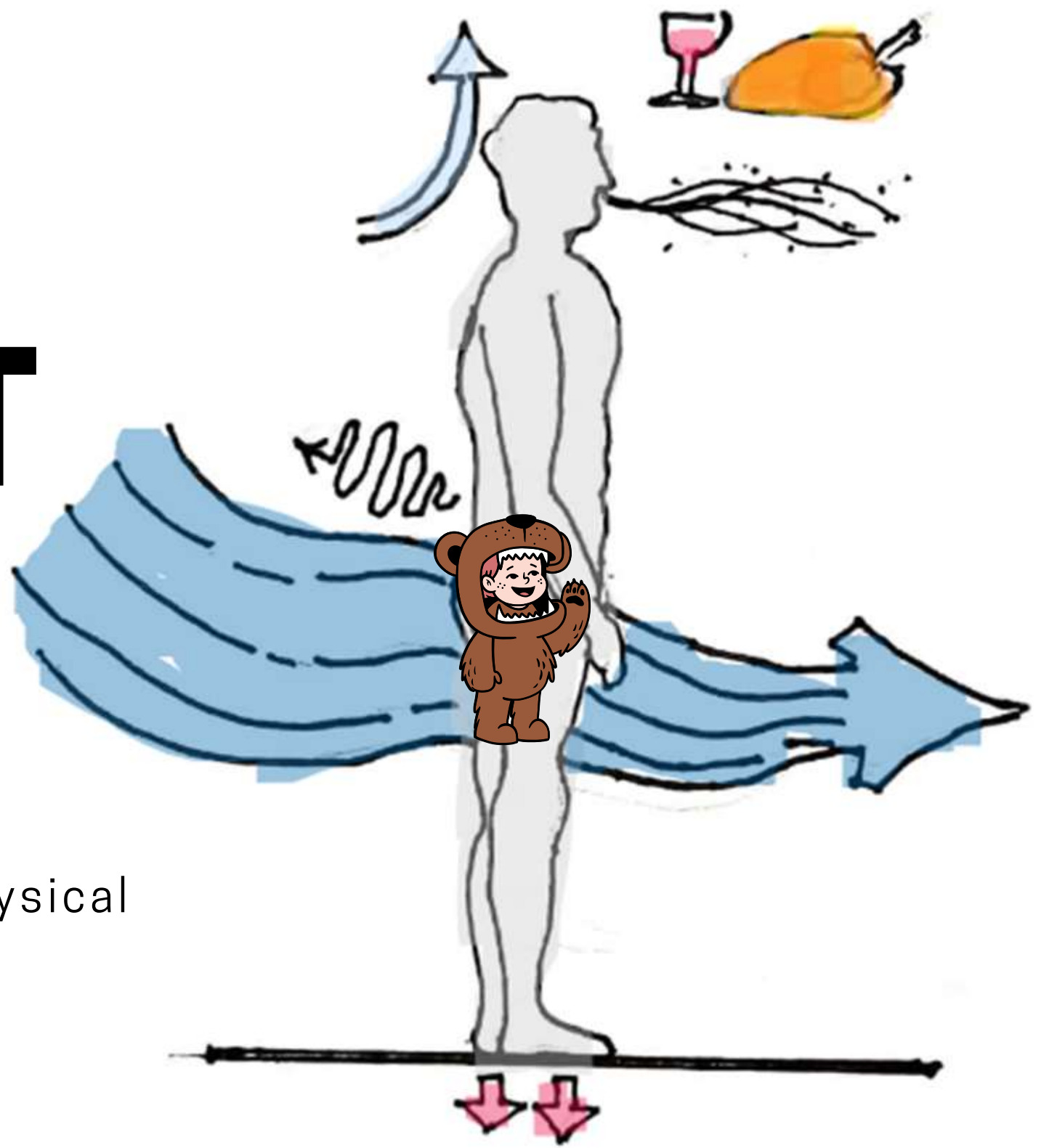
Body transfers heat through physical contact.

HEAT TRANSFER FROM HUMAN BODY

BODY HEAT TRANSFER

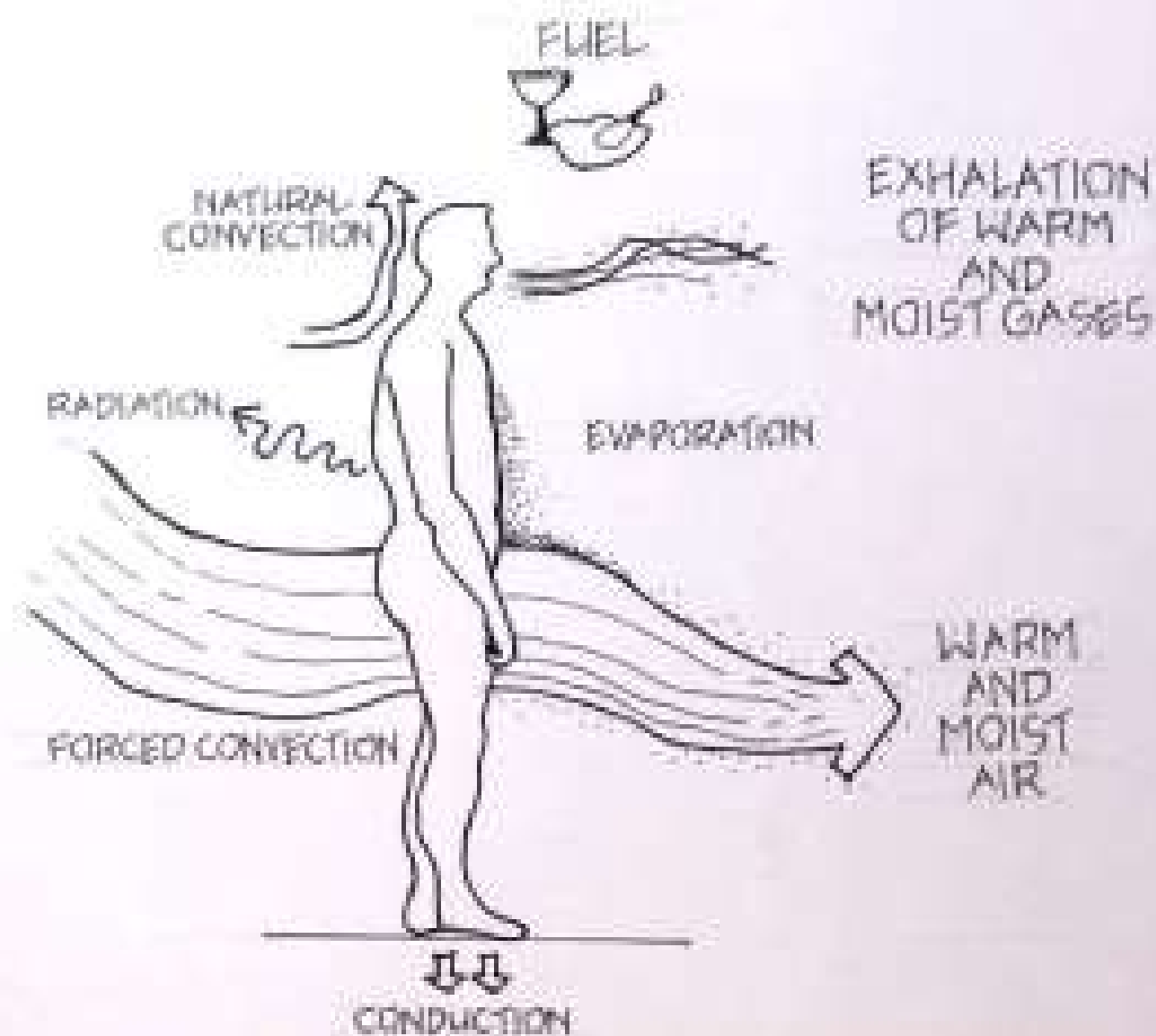
FROM;

- i. Air or
- ii. Water.
- iii. Radiation transfers heat via infrared radiation.



HEAT TRANSFER FROM HUMAN BODY

BODY HEAT TRANSFER

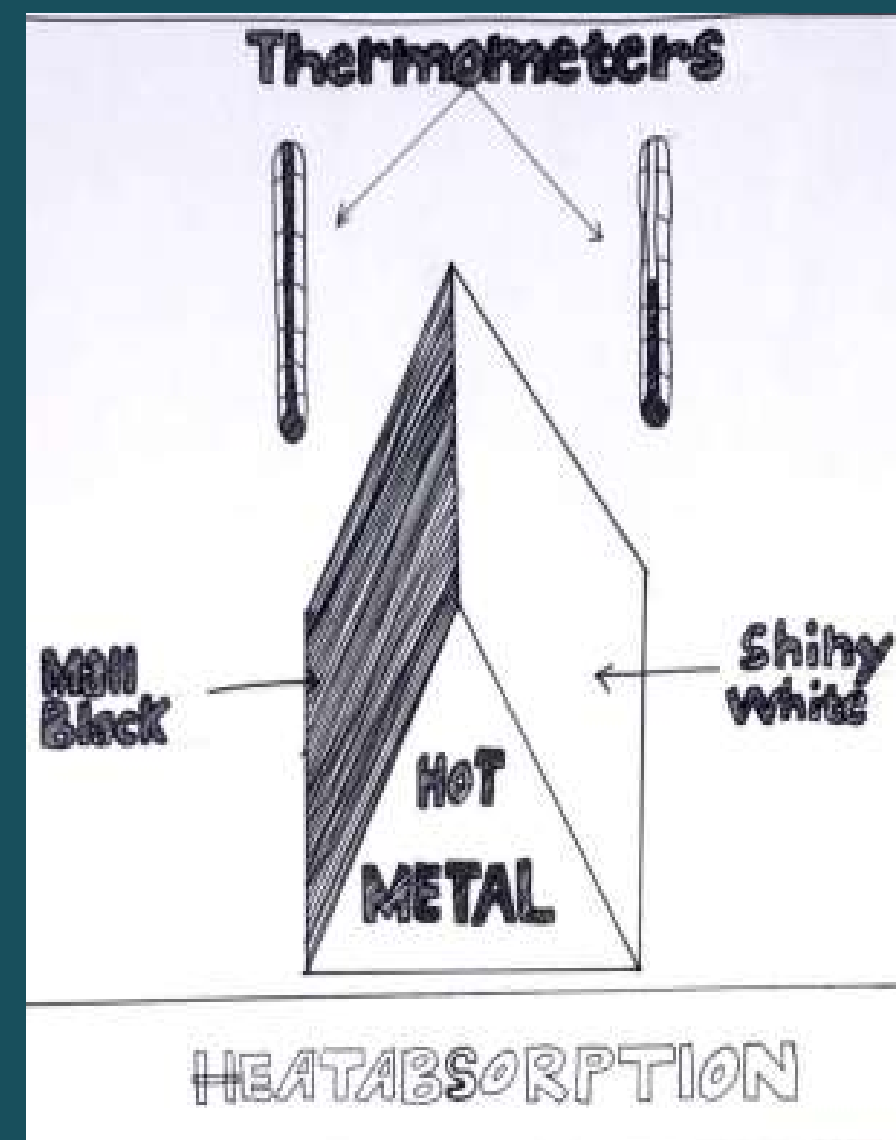
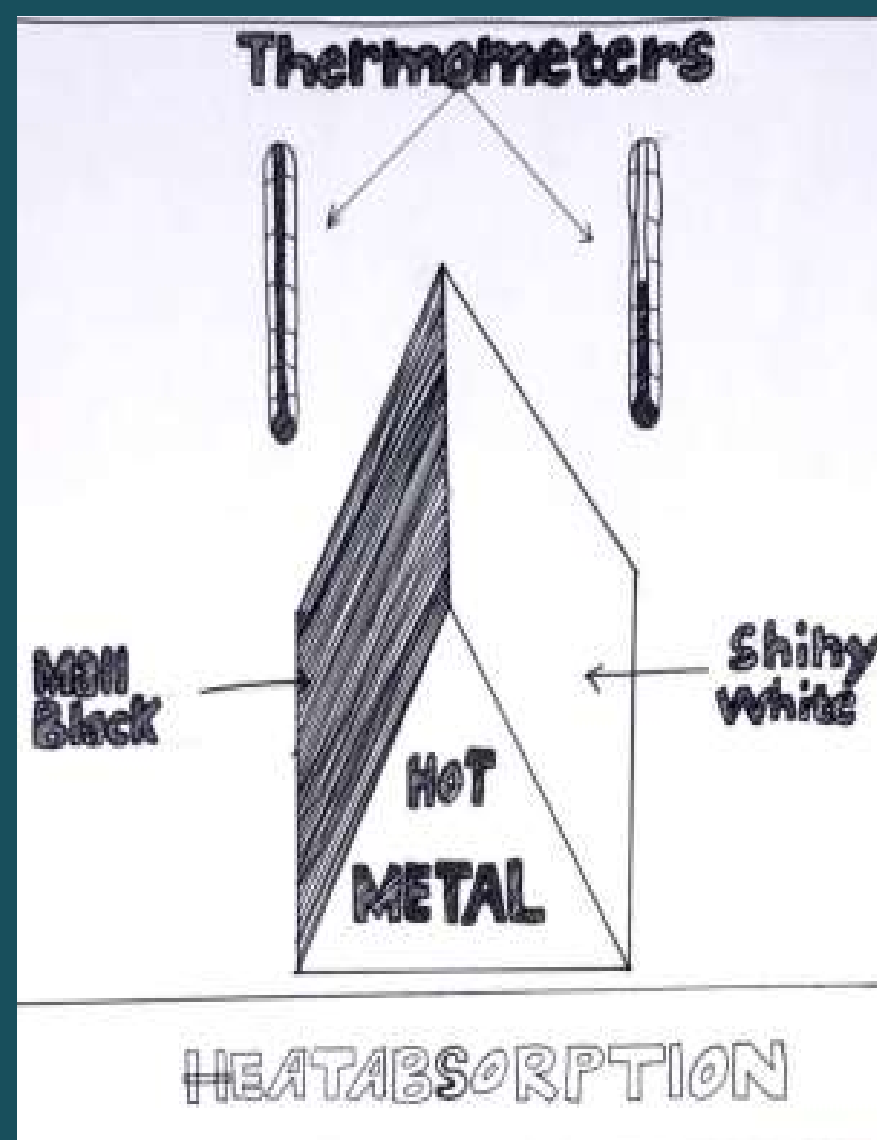
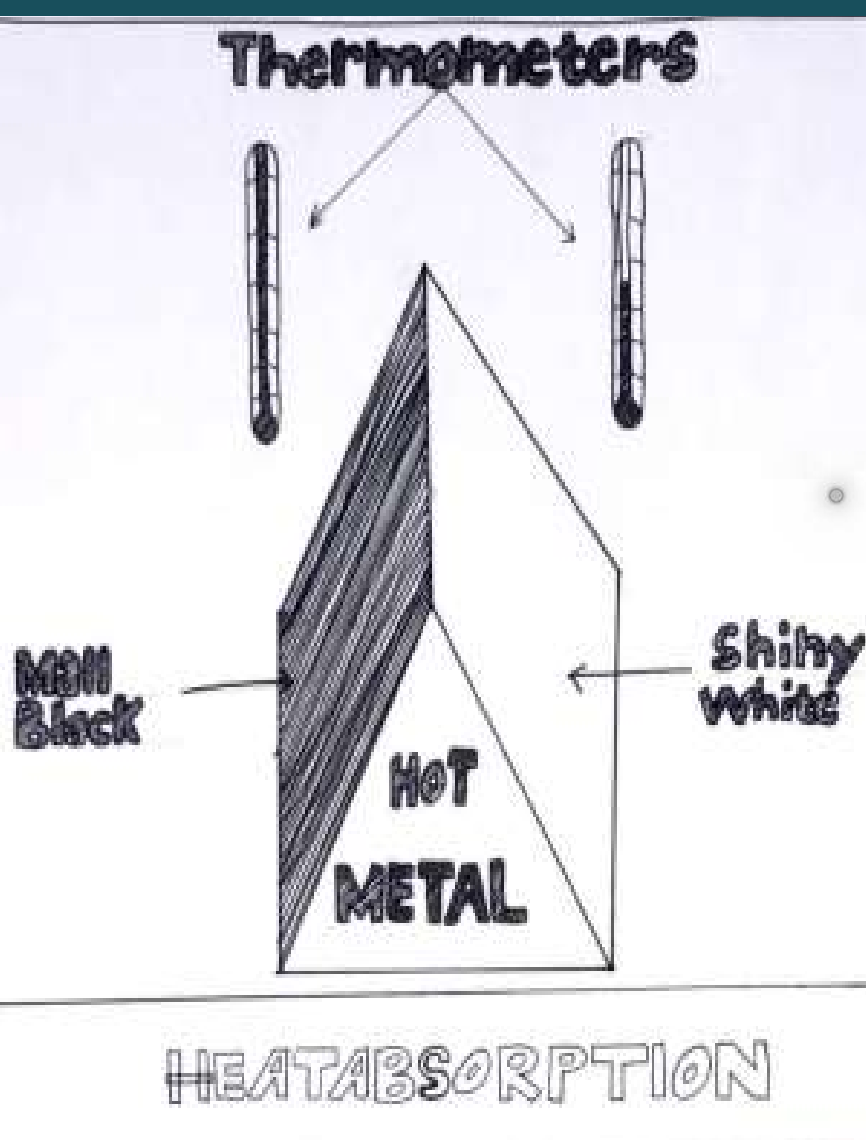


2.3

- Describe convection as a factor of heat transfer.

ITEM 2

HEAT TRANSFER



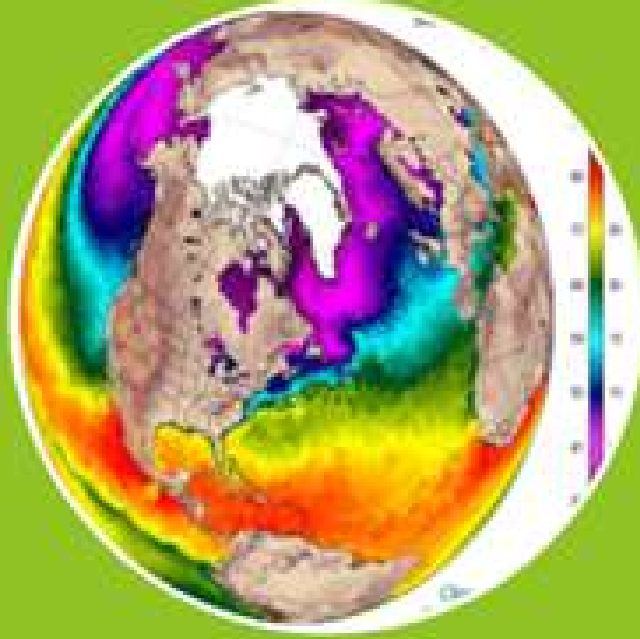
1.USER
FACTOR

**2.ENVIRONMENT
AND CLIMATE**
FACTOR

**3.BUILDING
DESIGN**
FACTOR



USER



ENVIRONMENT
AND CLIMATE



BUILDING
DESIGN

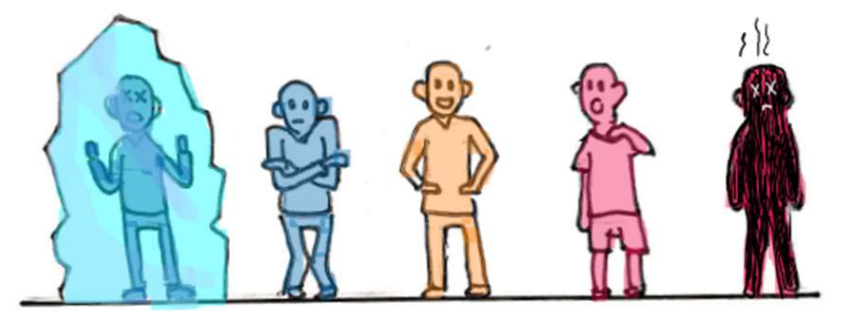
THERMAL COMFORT FACTORS

2.3

•Describe convection as a factor of heat transfer.

3 FACTORS OF:

**AFFECTING
THERMAL
COMFORT**



AFFECTING THERMAL COMFORT

FACTORS ONE(1):

The body can also gain or lose heat through mechanisms of heat exchange. Conduction transfers heat from one object to another through physical contact.

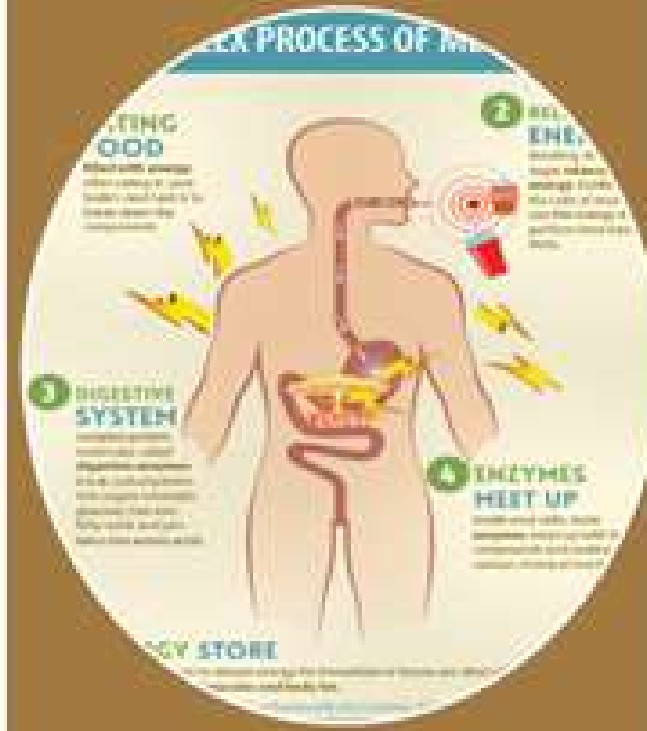


Activity



Clothing

- The amount of thermal insulation the person is wearing



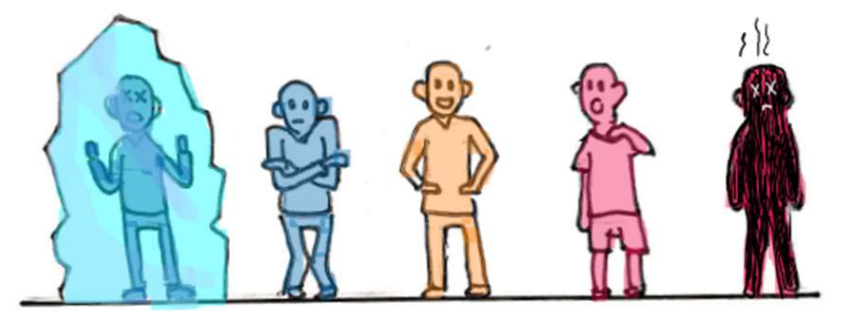
Metabolism

- The energy generated from the human body

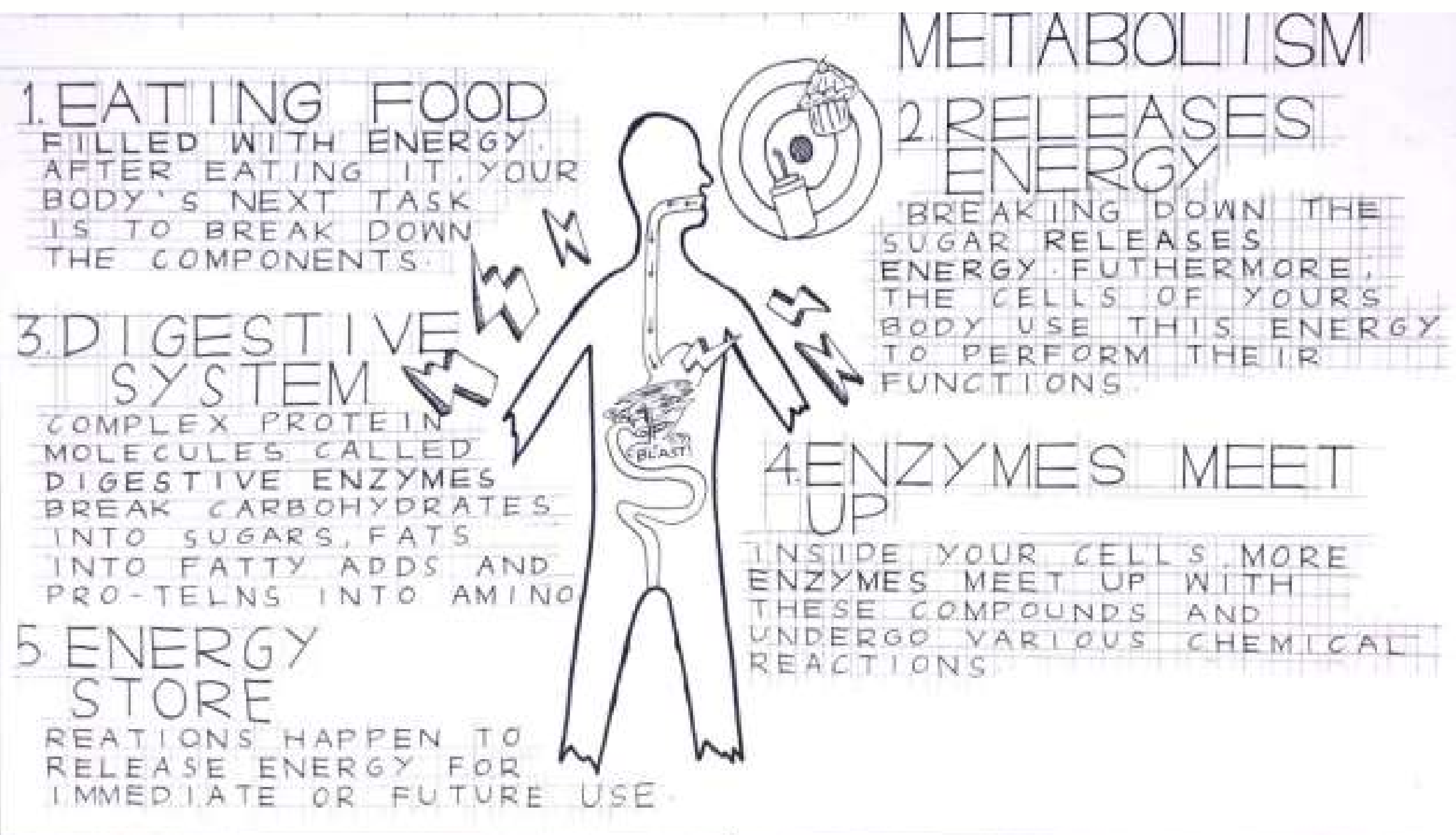


Well being and sickness

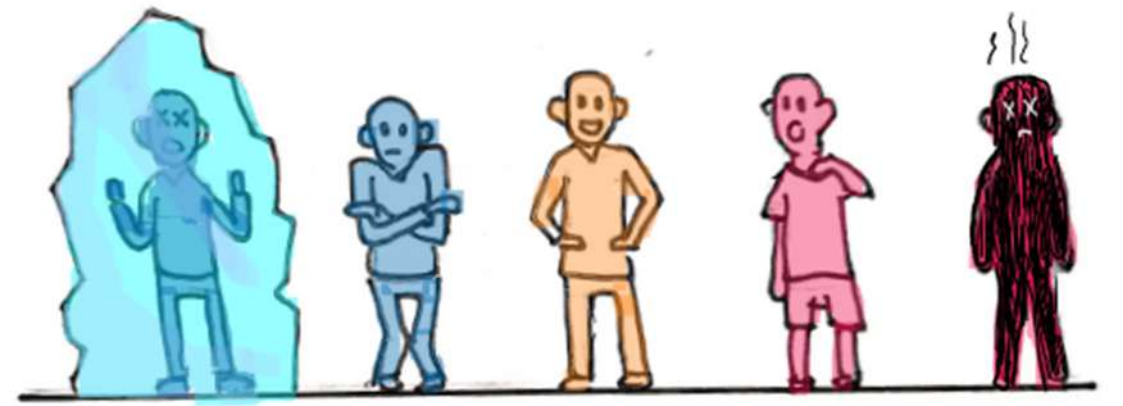
← USER →



THE COMPLEX PROCESS OF BODY METABOLISME



AFFECTING THERMAL COMFORT

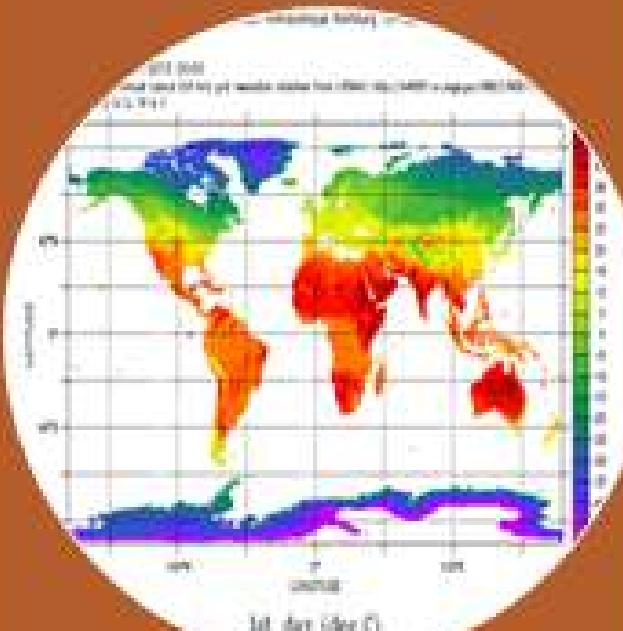


FACTORS TWO (2):




AIR TEMPERATURE

- The air temperature is the average temperature of the:
- i. air surrounding the occupant, with respect to location and time




SURFACE TEMPERATURE

- Surface temperature of the earth is the combined:
- temperature of the near-surface air temperature and the sea surface temperature. Important measured quantity in analysing global climate change.



AIR MOVEMENT / VELOCITY

- The rate of motion of air in a given direction;
- usually expressed in meters per second. Measured conducting a vane anemometer traverse over a selected cross section, the area of which is also measured.

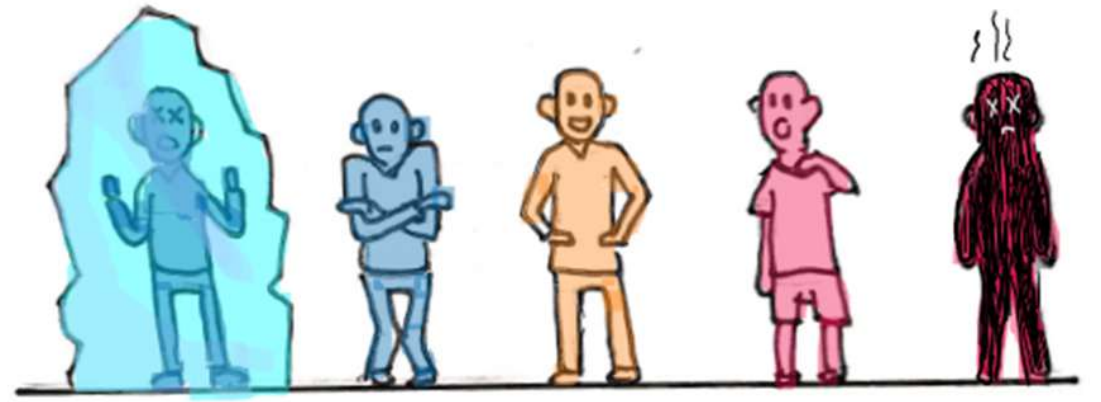


RELATIVE HUMIDITY

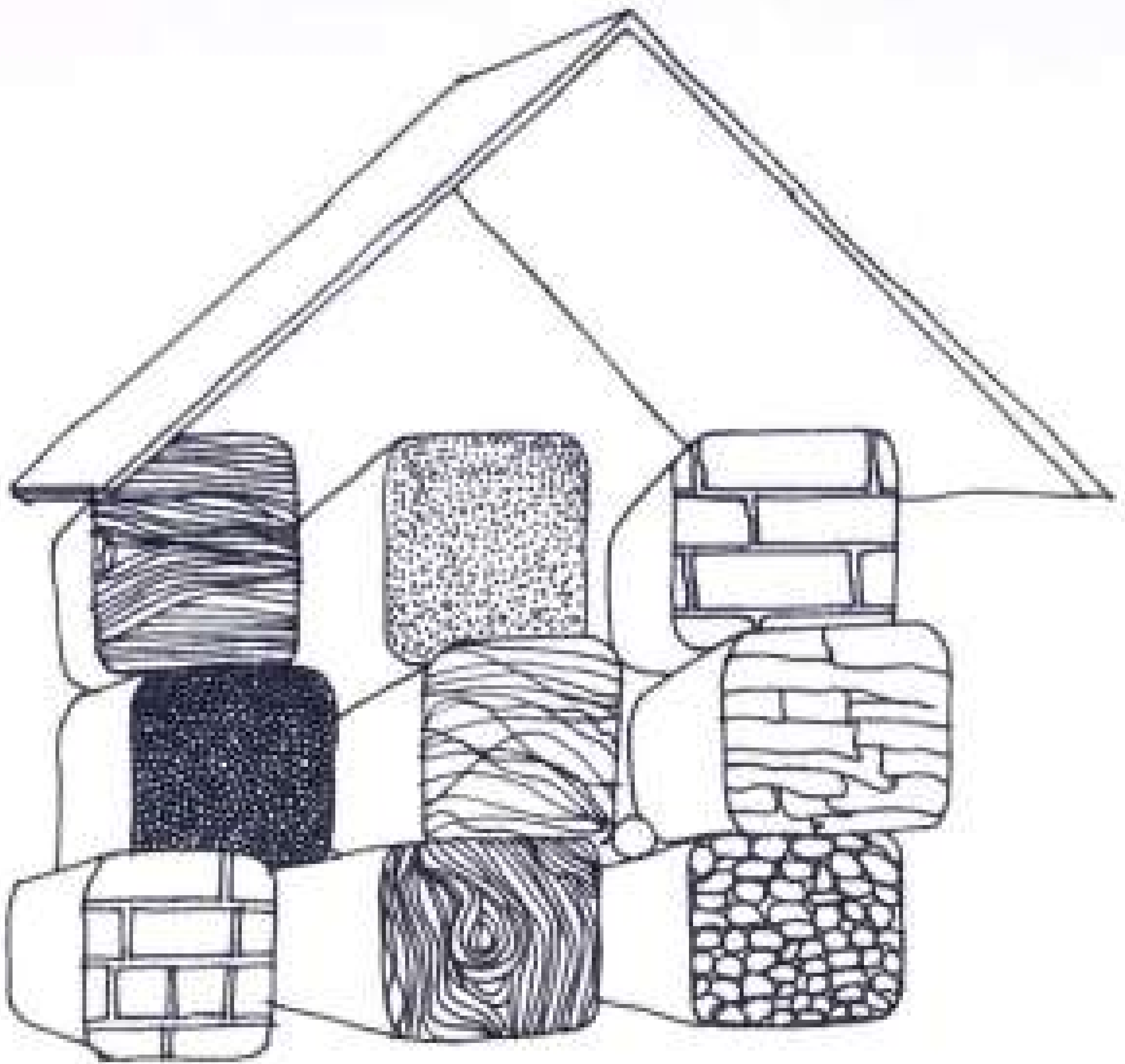
- Ratio of the amount of water vapour in the air to the amount of water vapour that the air could hold at the specific temperature and pressure.
- The recommended level of indoor humidity is in the range of 30-60% in air conditioned buildings

← ENVIRONMENT AND CLIMATE →

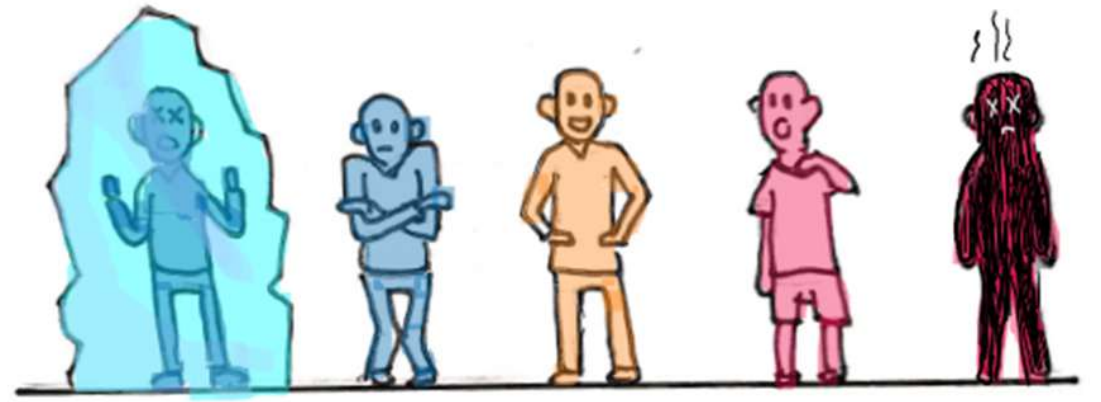
AFFECTING THERMAL COMFORT



FACTORS THREE (3):



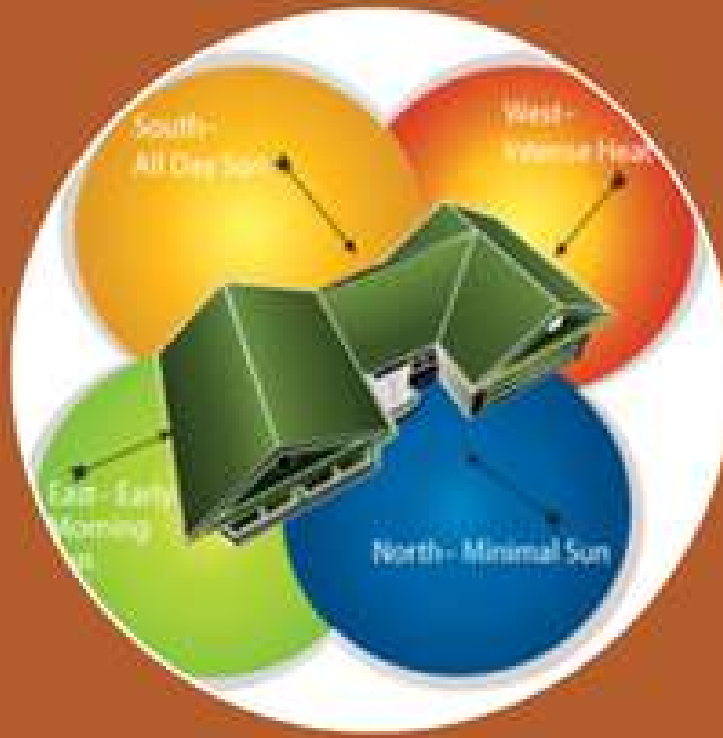
AFFECTING THERMAL COMFORT



FACTORS THREE (3):



MATERIALS



ORIENTATION



**SPACE
PLANNING &
DESIGN**

BUILDING DESIGN



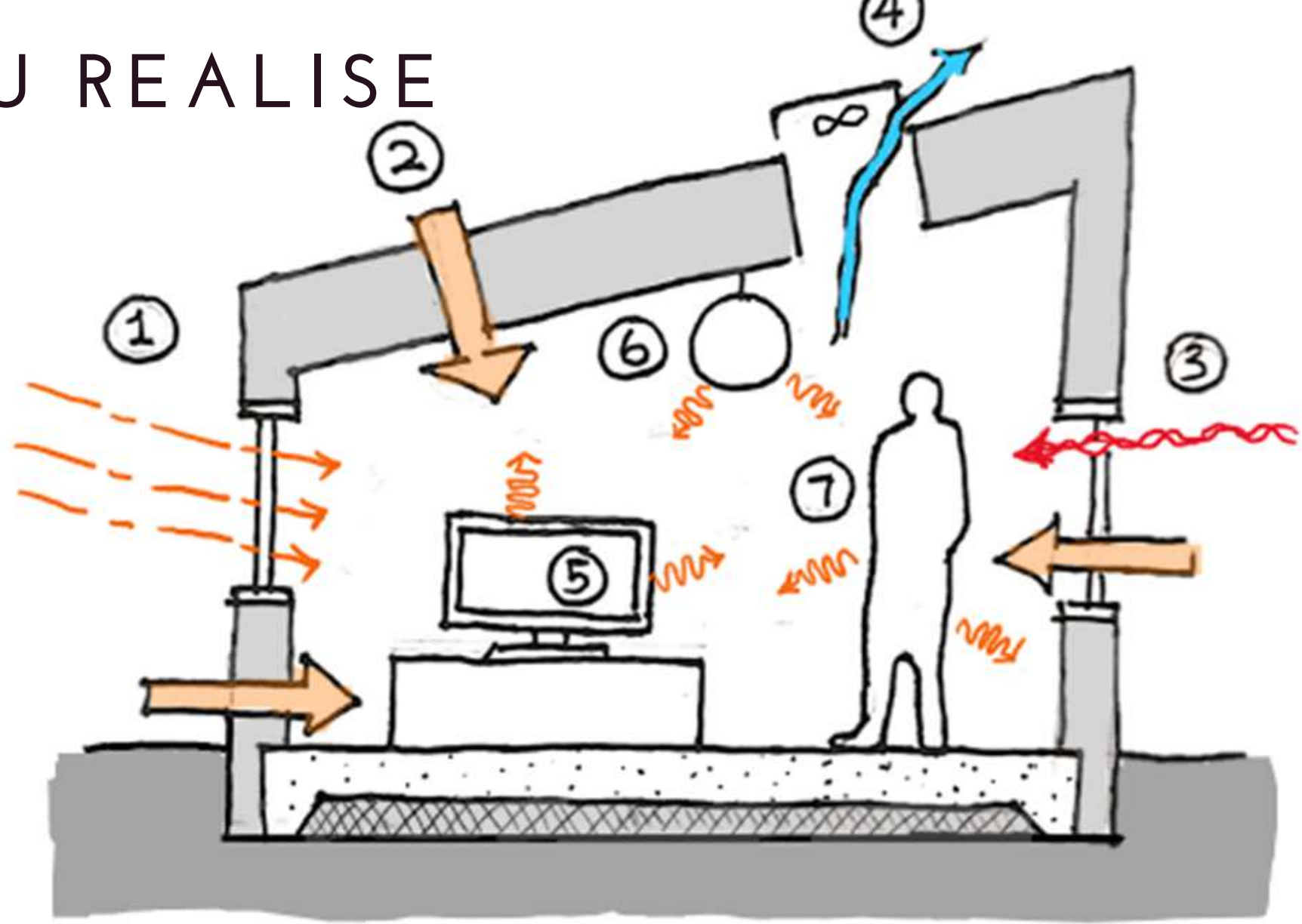
ITEM 2

HEAT TRANSFER

2.4

- Describe Radiation as a factor of heat transfer.
-

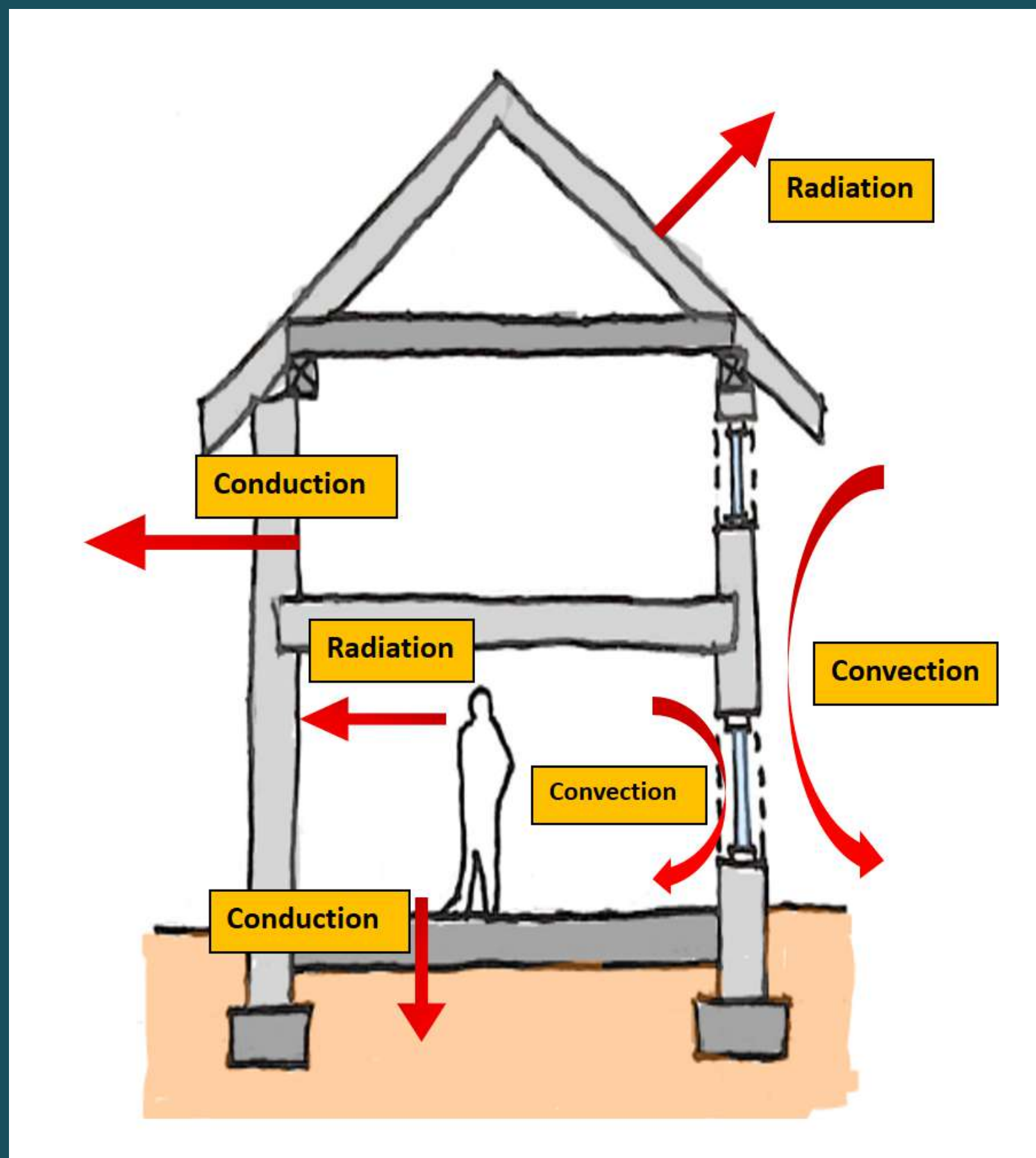
ARE YOU REALISE

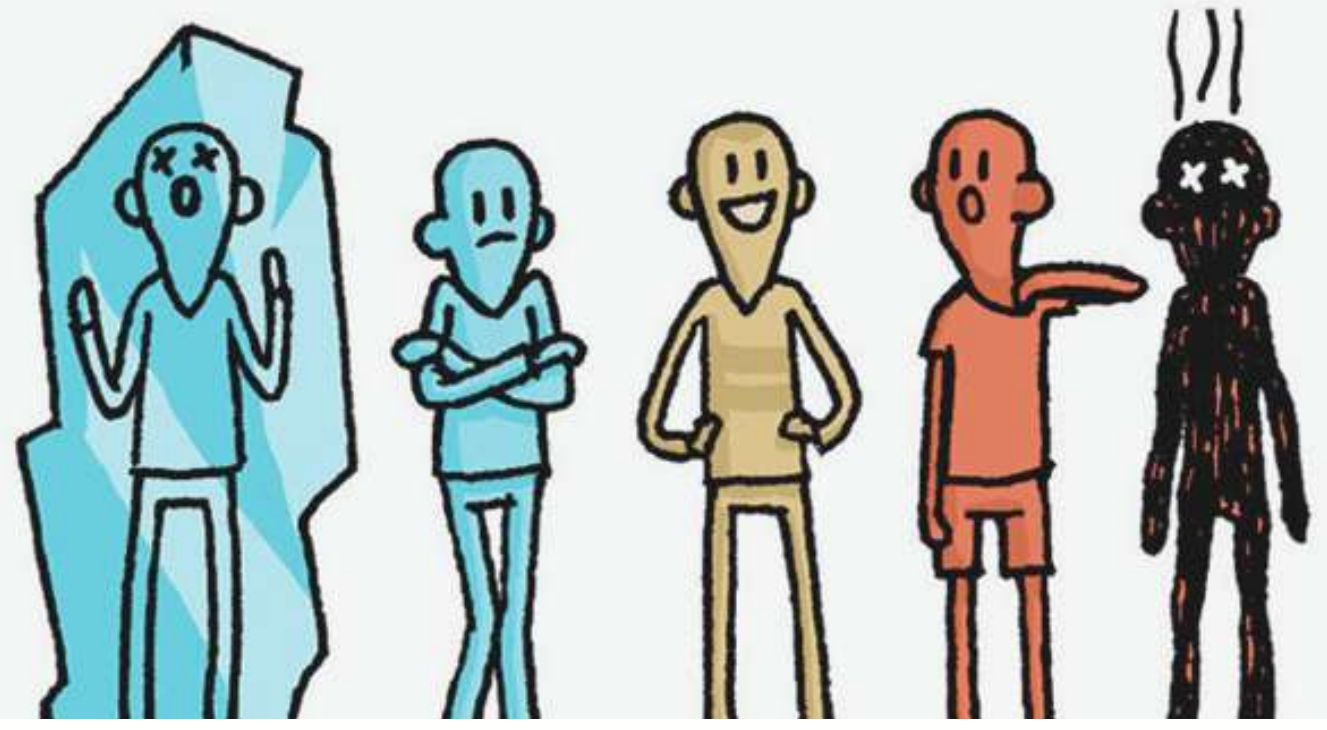


A quantity of heat transferred and measured that affected by heat conduction, convection and radiation.

THERMAL QUANTITY

AFFECTED BY HEAT CONDUCTION, CONVECTION AND RADIATION





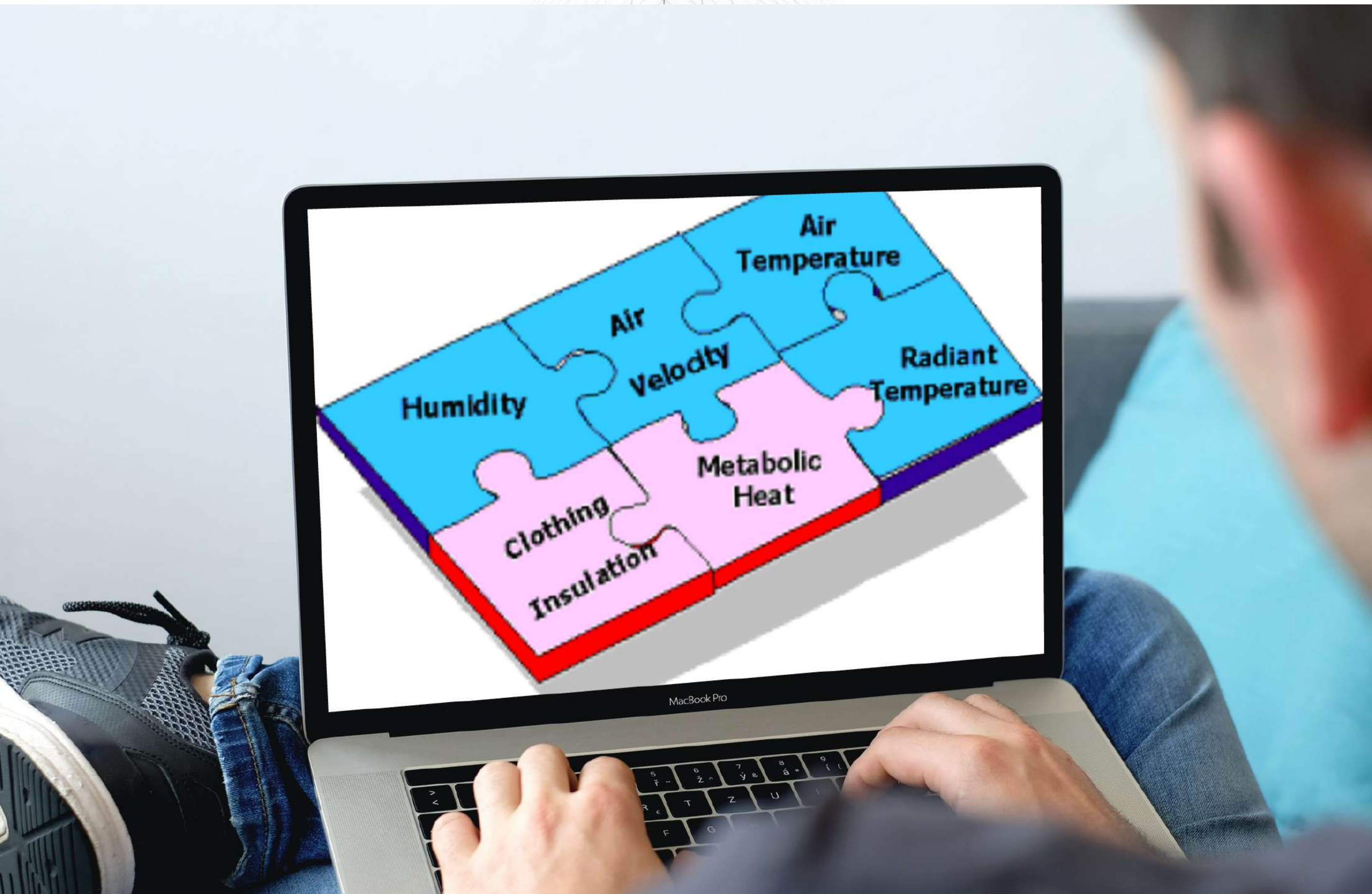
MATERIAL OF BUILDING CONSTRUCTION AFFECTING THERMAL COMFORT

THIRD (3) FACTORS OF:



BUILDING THERMAL IN THE HOT AND HUMID CLIMATE

RELATIVE HUMIDITY (RH) EFFECTED THERMAL COMFORT



BUILDING THERMAL IN THE HOT AND HUMID CLIMATE

ENVIRONMENTAL FACTORS

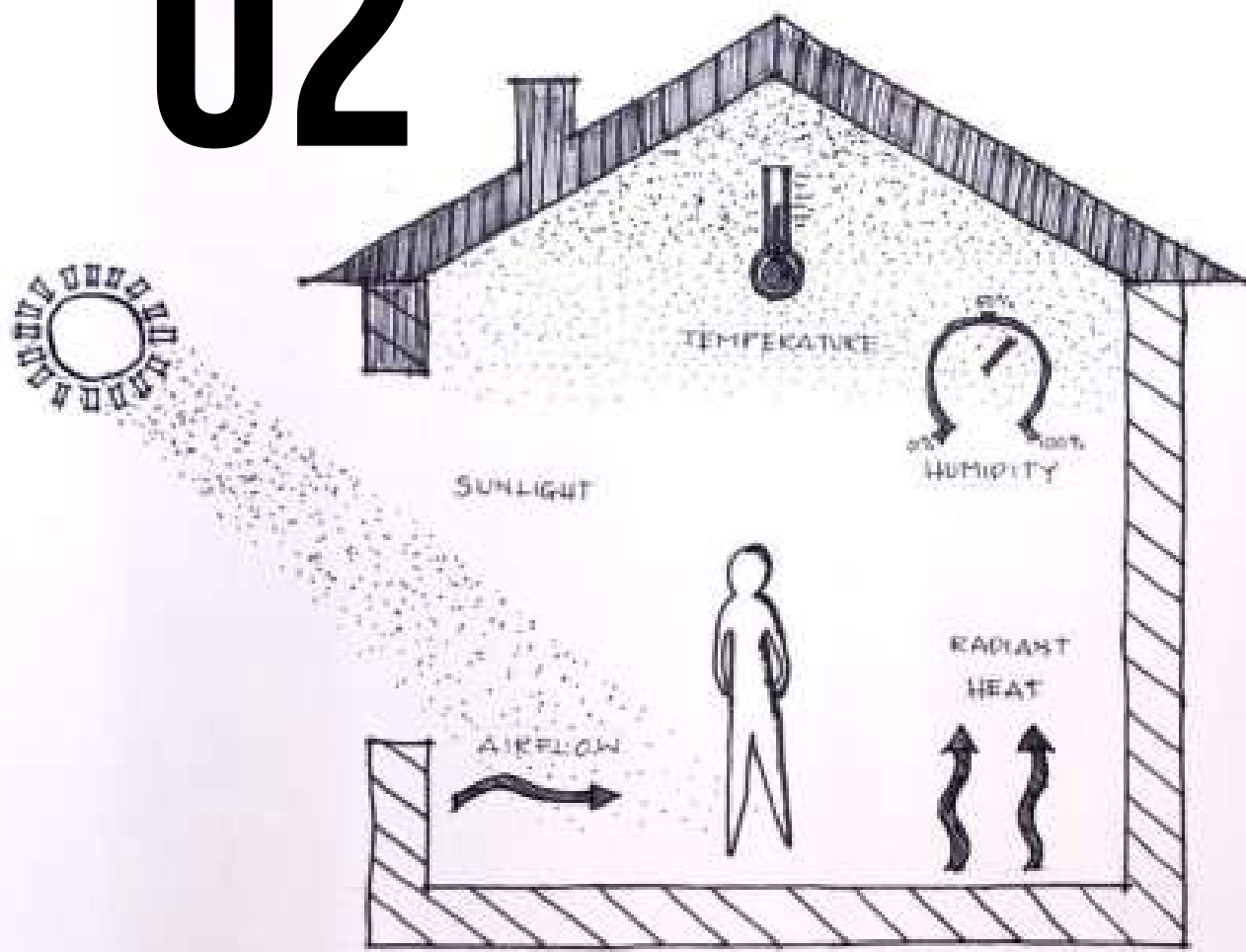
01

- i. Air temperature – The air contact temperature measured by the dry bulb temperature (DBT)
- ii. Air velocity (AV) – The air contact velocity measured in m/s
- iii. Radiant temperature (RT) – The temperature of a person's surroundings; generally expressed as mean radiant temperature (MRT) which is a weighted average of the temperature of the surfaces surrounding a person and any strong mono-directional radiation, such as the solar radiation
- iv. Relative humidity (RH) – The ratio between the current amount of vapor in the air and the maximum amount of water vapor that the air can hold at that air temperature, expressed as a percentage

BUILDING THERMAL IN THE HOT AND HUMID CLIMATE

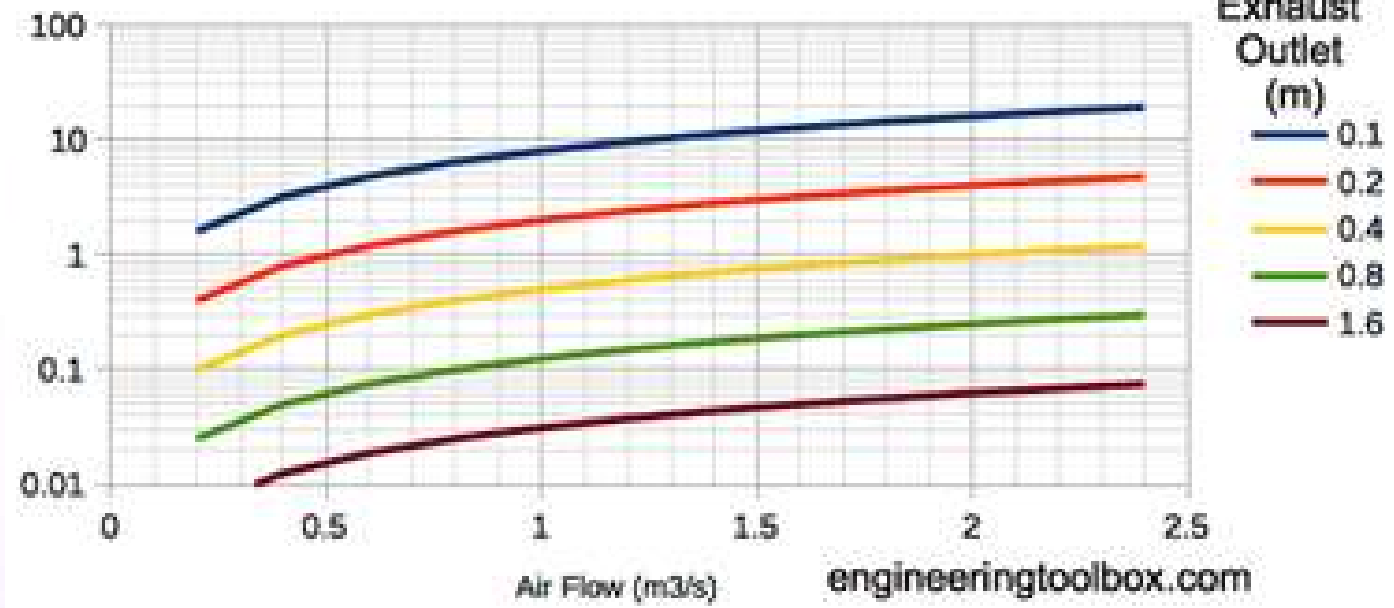
PERSONAL FACTORS

02

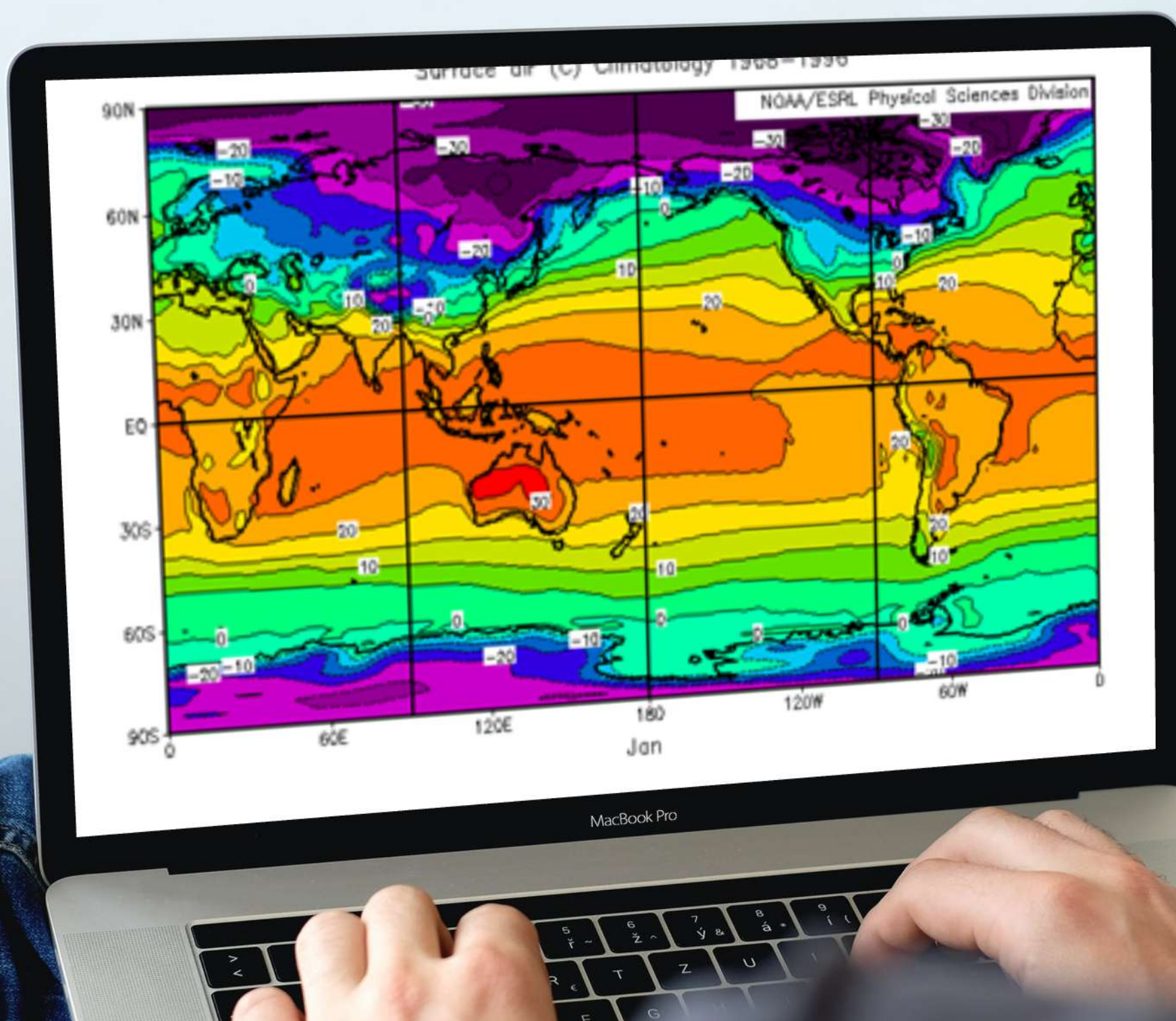


Small Exhaust Outlet

Capturing Air Velocity

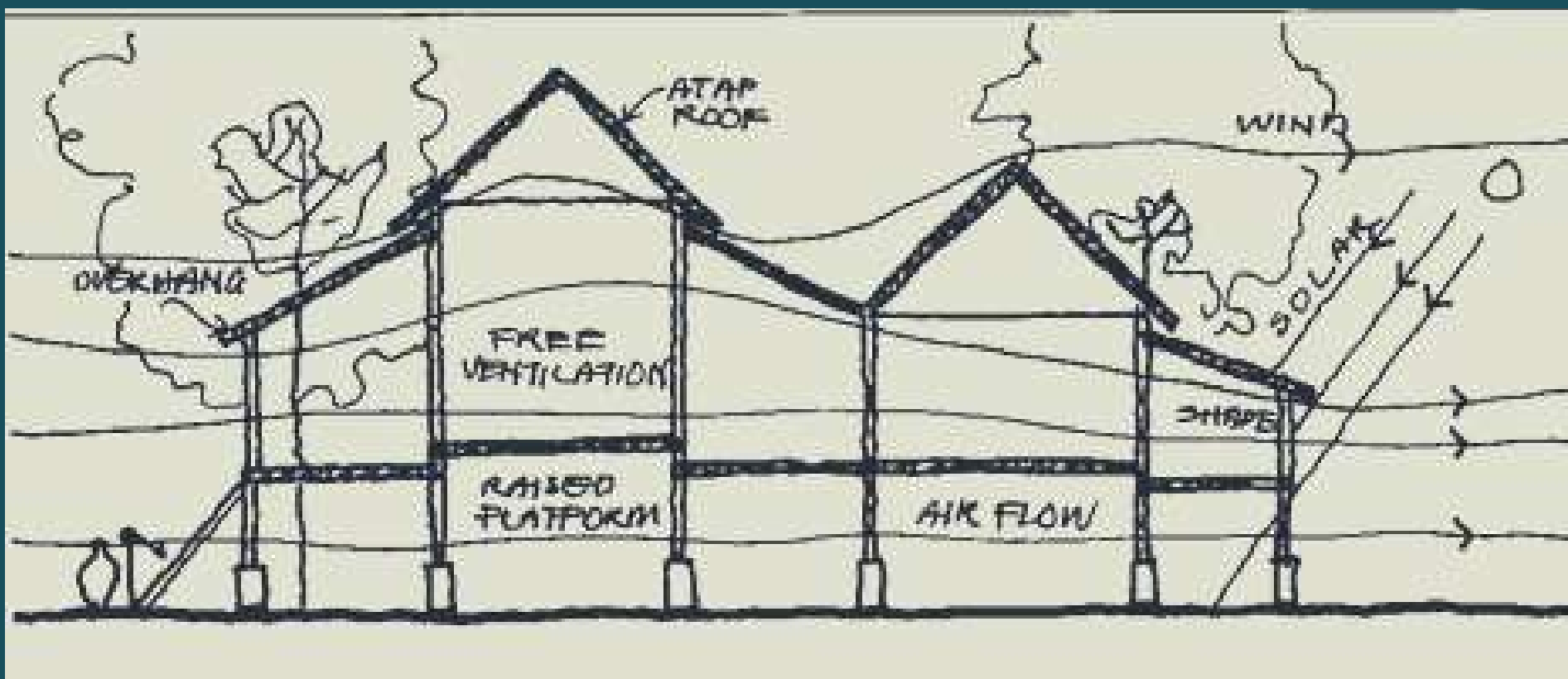


AIR TEMPERATURE



HEAT TRANSFER

HOW



NATURAL VENTILATION IN BUILDING



PSYCHOLOGICAL EFFECTS

ITEM 3





ITEM 3

PSYCHOLOGICAL EFFECTS

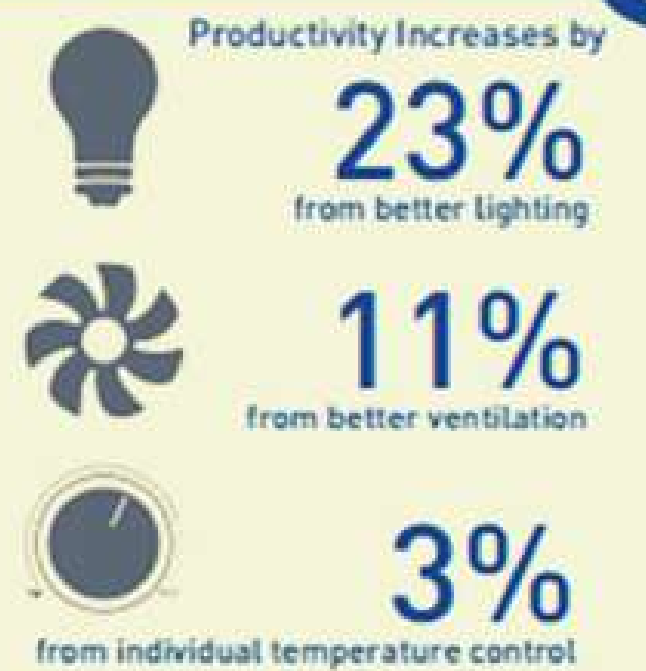
OUTSIDE VIEWS



DAYLIGHT



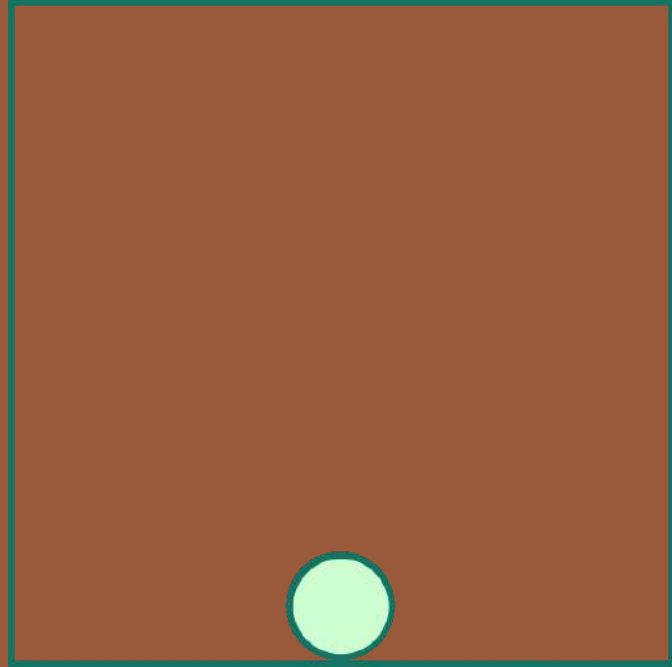
SYSTEMS





ITEM 3

PSYCHOLOGICAL EFFECTS





ITEM 3

PSYCHOLOGICAL EFFECTS

3.1

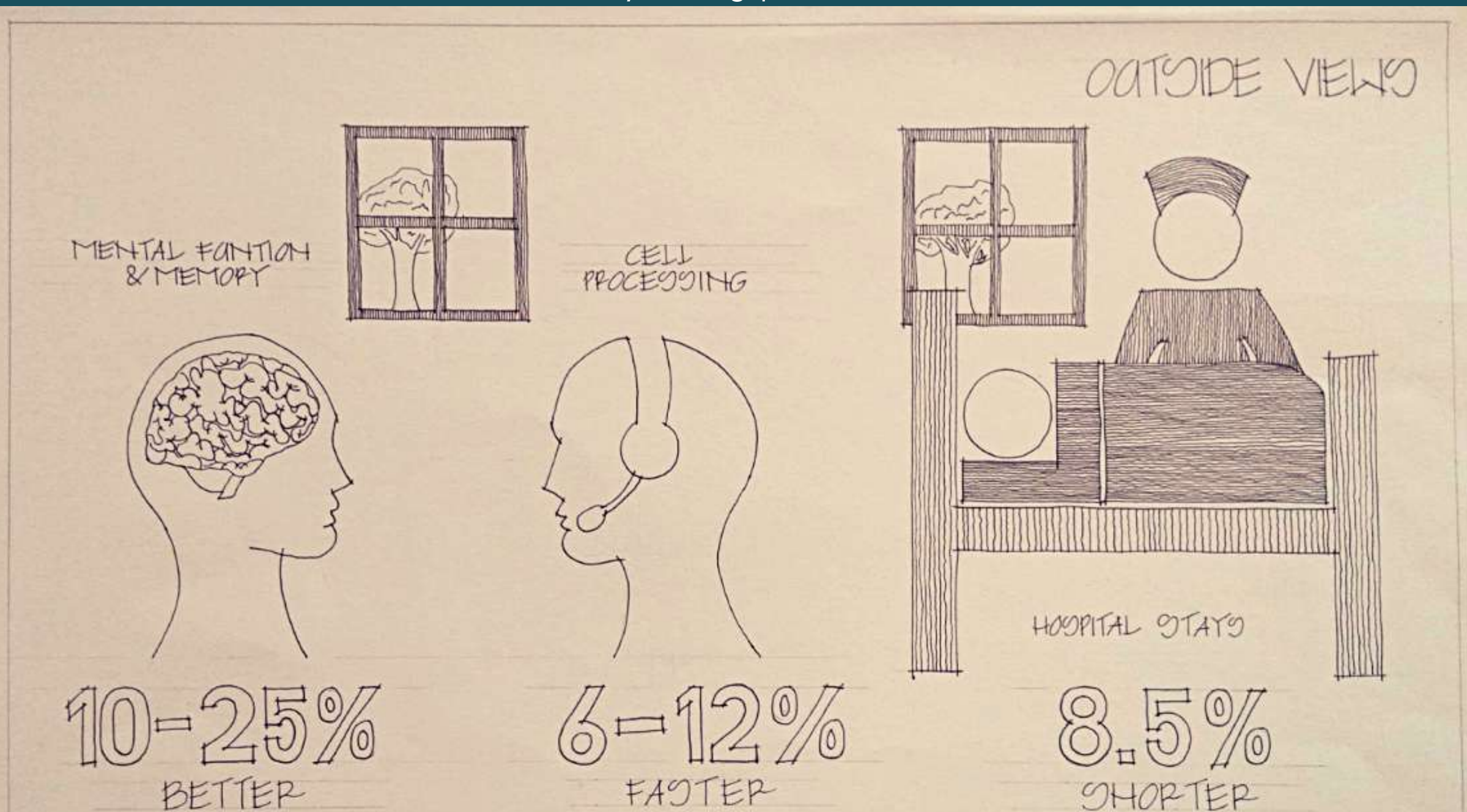
- Determine the psychological effects of thermal comfort by using portable thermal comfort meter
-



ITEM 3

PSYCHOLOGICAL EFFECTS

Effects of thermal comfort by using portable thermal comfort meter

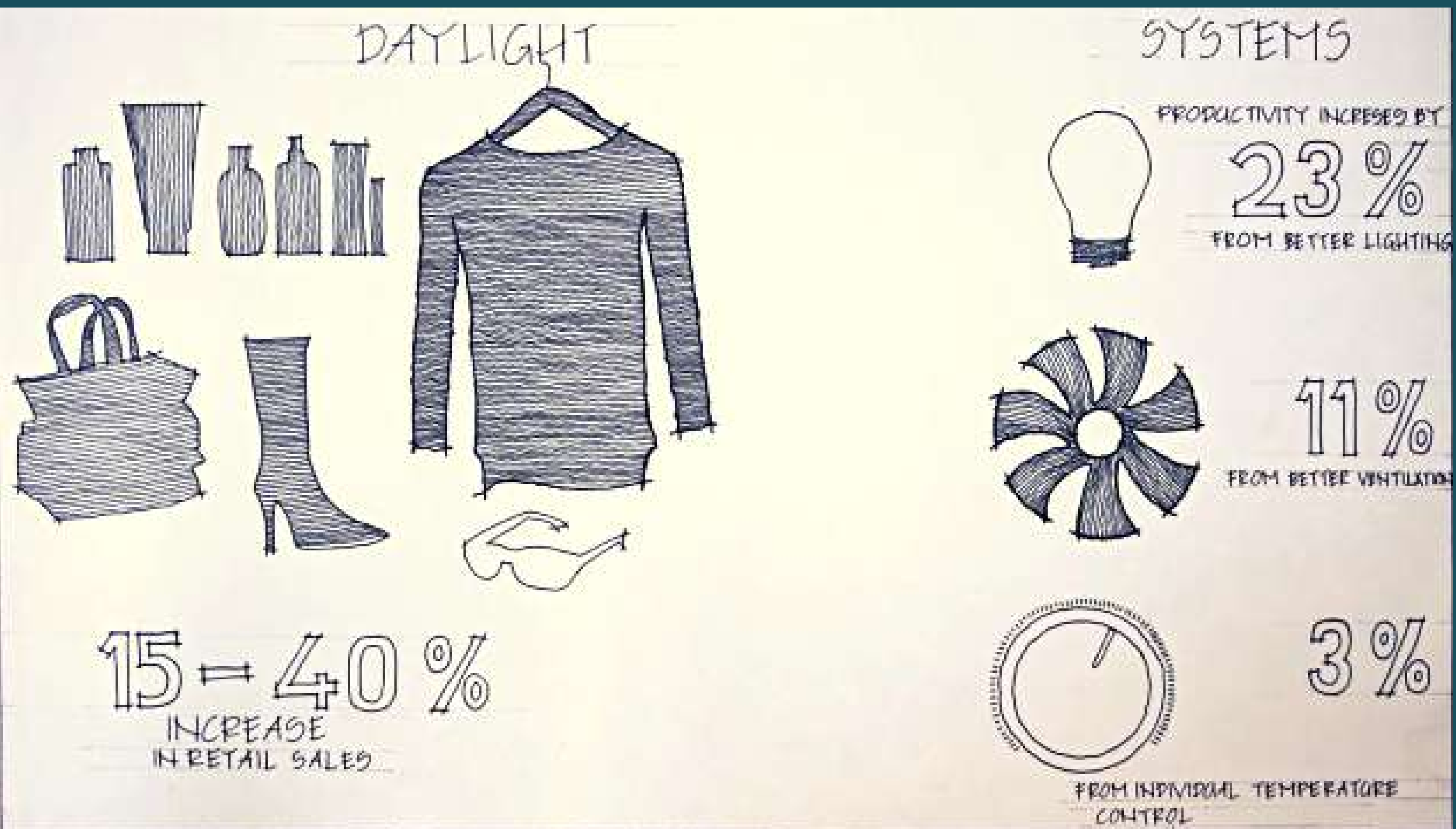




ITEM 3

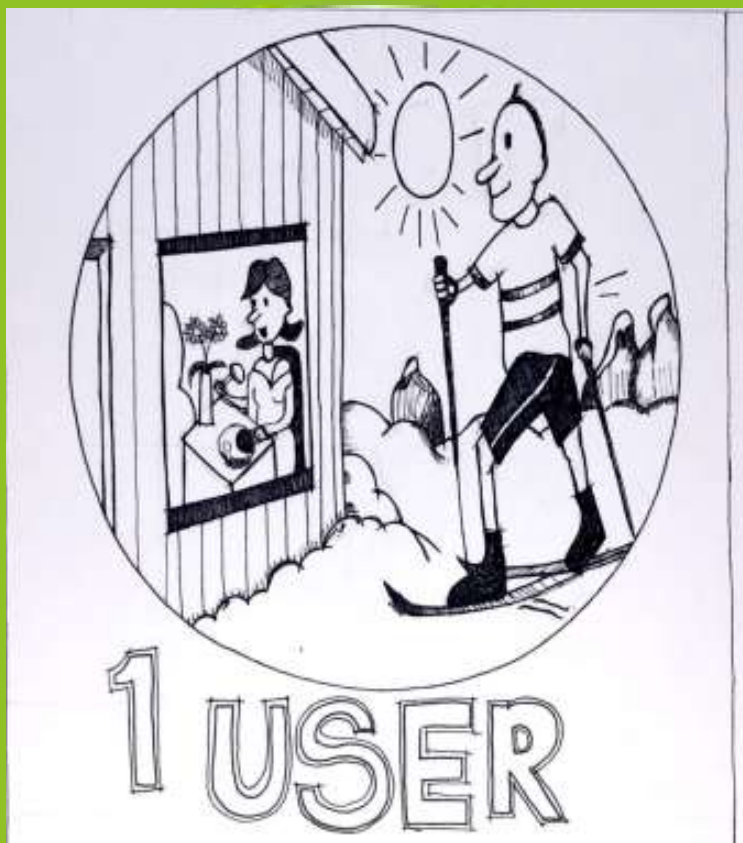
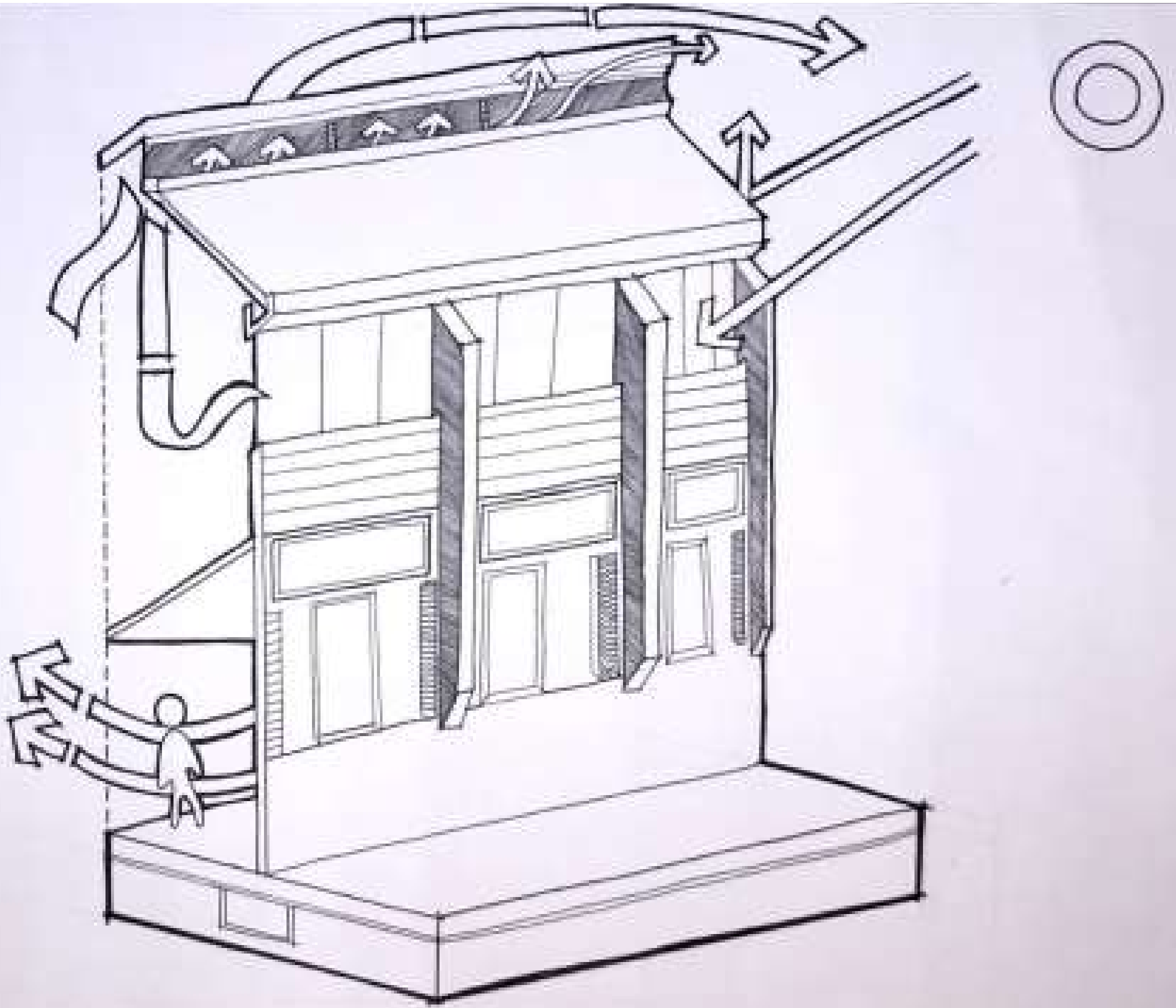
MORE PSYCHOLOGICAL EFFECTS

Effects of thermal comfort by using portable thermal comfort meter

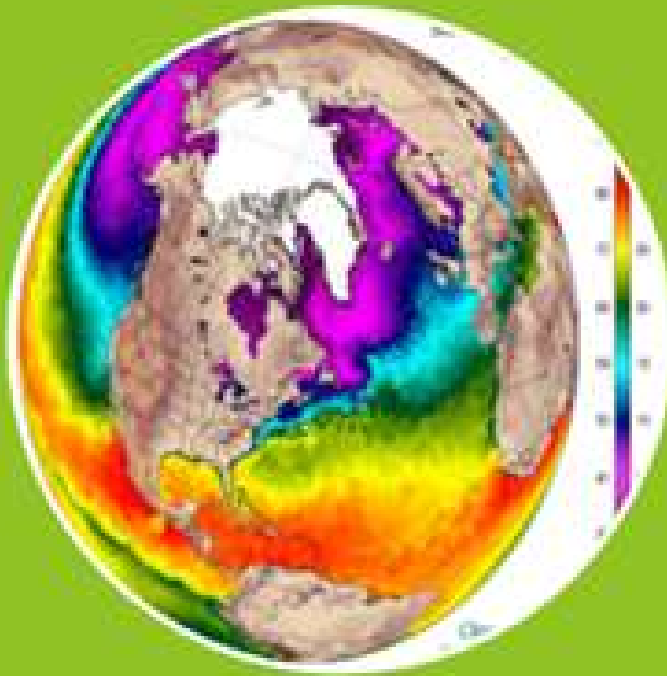


PSYCHOLOGICAL EFFECTS

3.1



USER



ENVIRONMENT
AND CLIMATE



BUILDING
DESIGN



ITEM 3

PSYCHOLOGICAL EFFECTS

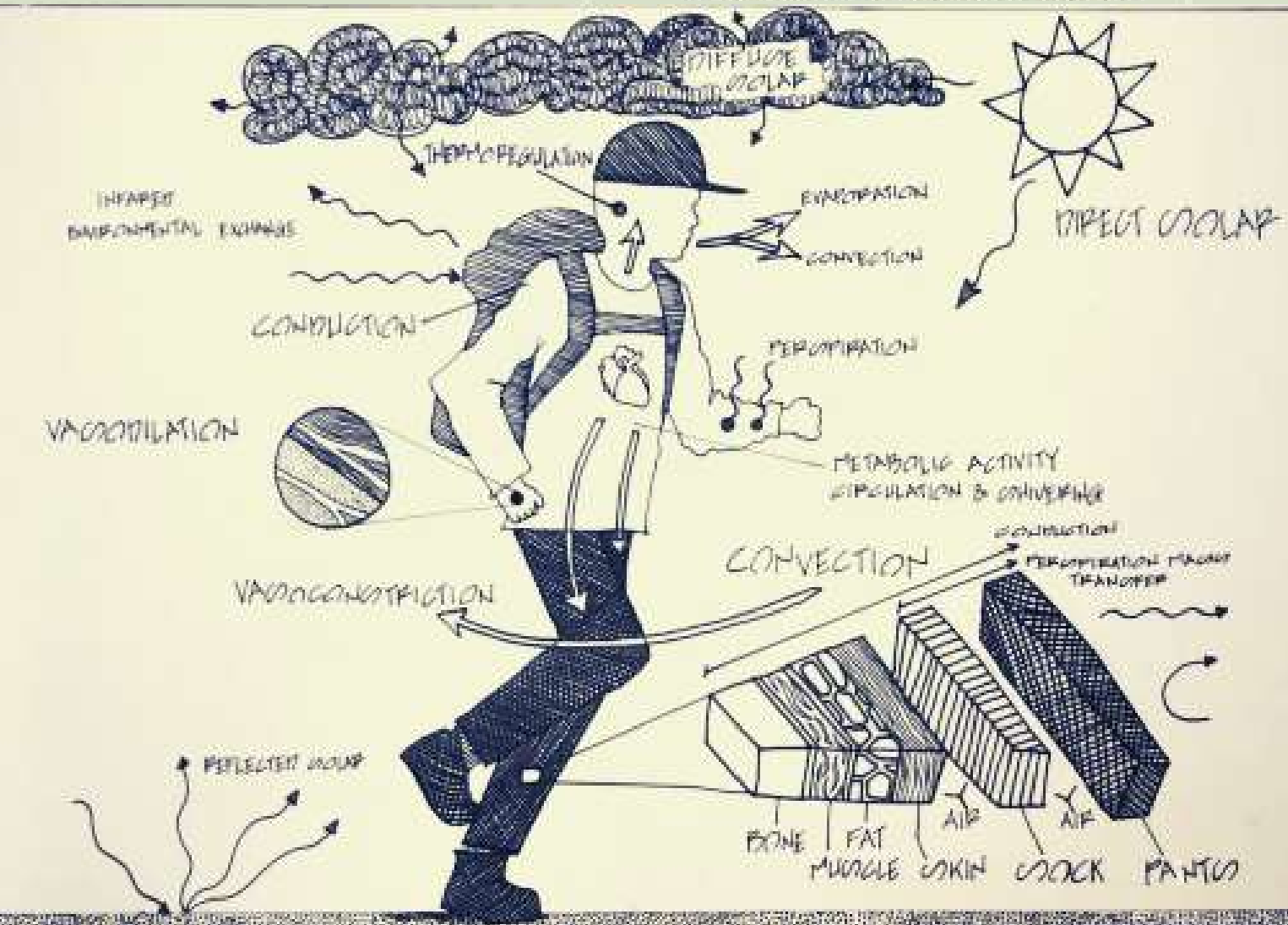
3.2

- Determine the psychological effects of thermal comfort by using portable thermal comfort meter
-

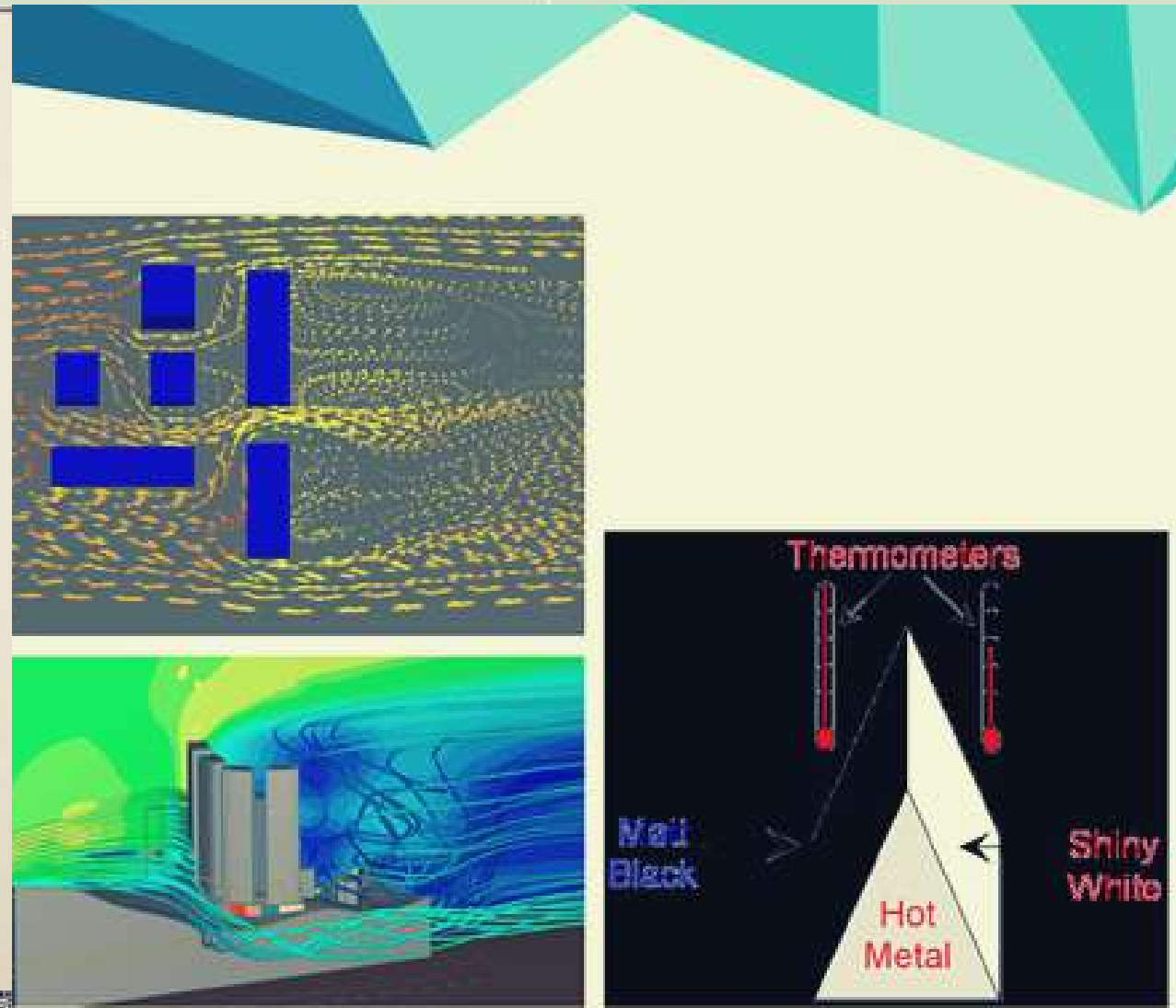
TERMS

3.2

THERMAL COMFORT INDEX	BUILDING THERMODYNAMIC	HEAT ABSORPTION (Thermal Mass in Buildings)	NATURAL VENTILATION
<p>A single scale which combines the effects of various thermal comfort factors e.g.</p> <ul style="list-style-type: none"> i. air temperature; ii. humidity; iii. air movement; iv. radiation 	<p>Relationship between temperature and energy; to keep people comfortable in a building while using energy in smarter ways</p> <p>Law of thermodynamics:</p> <ul style="list-style-type: none"> i. Energy moves from place to place ii. Energy changes from one form to another iii. Energy cannot be created or destroyed 	<p>Characteristics of buildings that consider external environmental conditions and maintain internal conditions using the minimum resources of materials and fuel; active and passive building services systems.</p>	<p>Natural ventilation is the process in which air is supplied and removed from an indoor space by natural means without using mechanical systems.</p> <p>It refers to the flow of external air to an indoor space as a result of pressure differences arising from natural forces (passive design).</p>



Thermal comfort index



Building thermodynamic, natural ventilation

Heat absorption

THERMAL COMFORT METER

3.2

i. There are a variety of meters for measuring relative humidity and temperature.

ii. Thermal comfort meter is one of the tools that used to measure thermal comfort and transfer it into thermal comfort index.



Table 1

Thermal comfort index expressed in units

U[%]	0	5	10	15	20	25	30
°C	Heat index expressed in units						
20	62,5	62,775	63,05	63,325	63,6	63,875	64,15
22	64,12	64,494	64,868	65,242	65,616	65,99	66,364
24	65,74	66,213	66,686	67,159	67,632	68,105	68,578
26	67,36	67,932	68,504	69,076	69,648	70,22	70,792
28	68,98	69,651	70,322	70,993	71,664	72,335	73,006
30	70,6	71,37	72,14	72,91	73,68	74,45	75,22
32	72,22	73,089	73,958	74,827	75,696	76,565	77,434
34	73,84	74,808	75,776	76,744	77,712	78,68	79,648
36	75,46	76,46	77,594	78,661	79,728	80,795	81,862
38	77,08	78,246	79,412	80,578	81,744	82,91	84,076
40	78,7	79,965	81,23	82,495	83,76	85,025	86,29
42	78,7	79,965	81,23	82,495	83,76	85,025	86,29
44	80,32	81,684	83,048	84,412	85,776	87,14	88,504

TABLE OF COMFORT METER



ITEM 3

PSYCHOLOGICAL EFFECTS

3.3

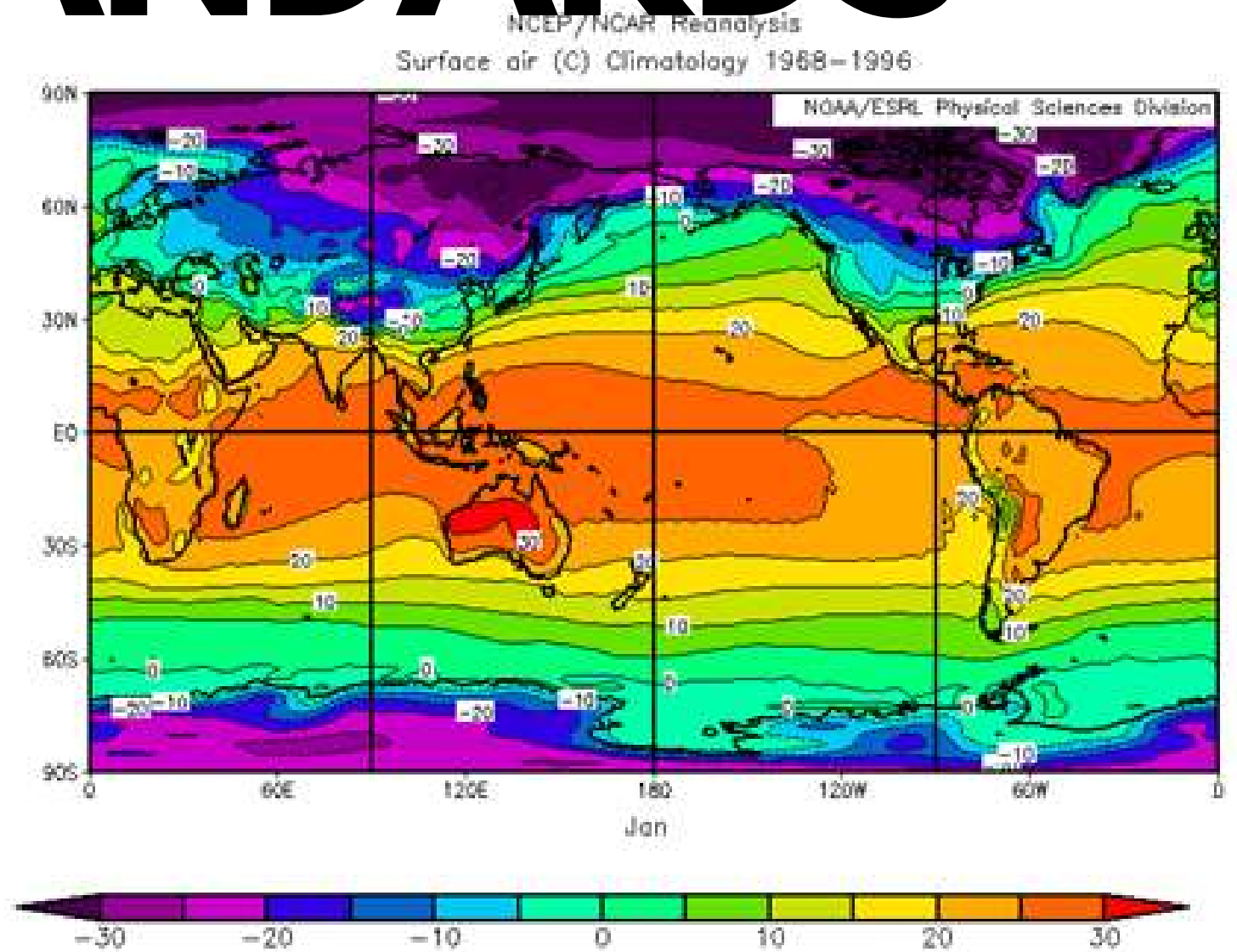
- Analyze thermal comfort factors that influence the sustainable building design in the context of user, environmental and climate and building design based on the Malaysia green rating tools standards.

TOOLS STANDARDS

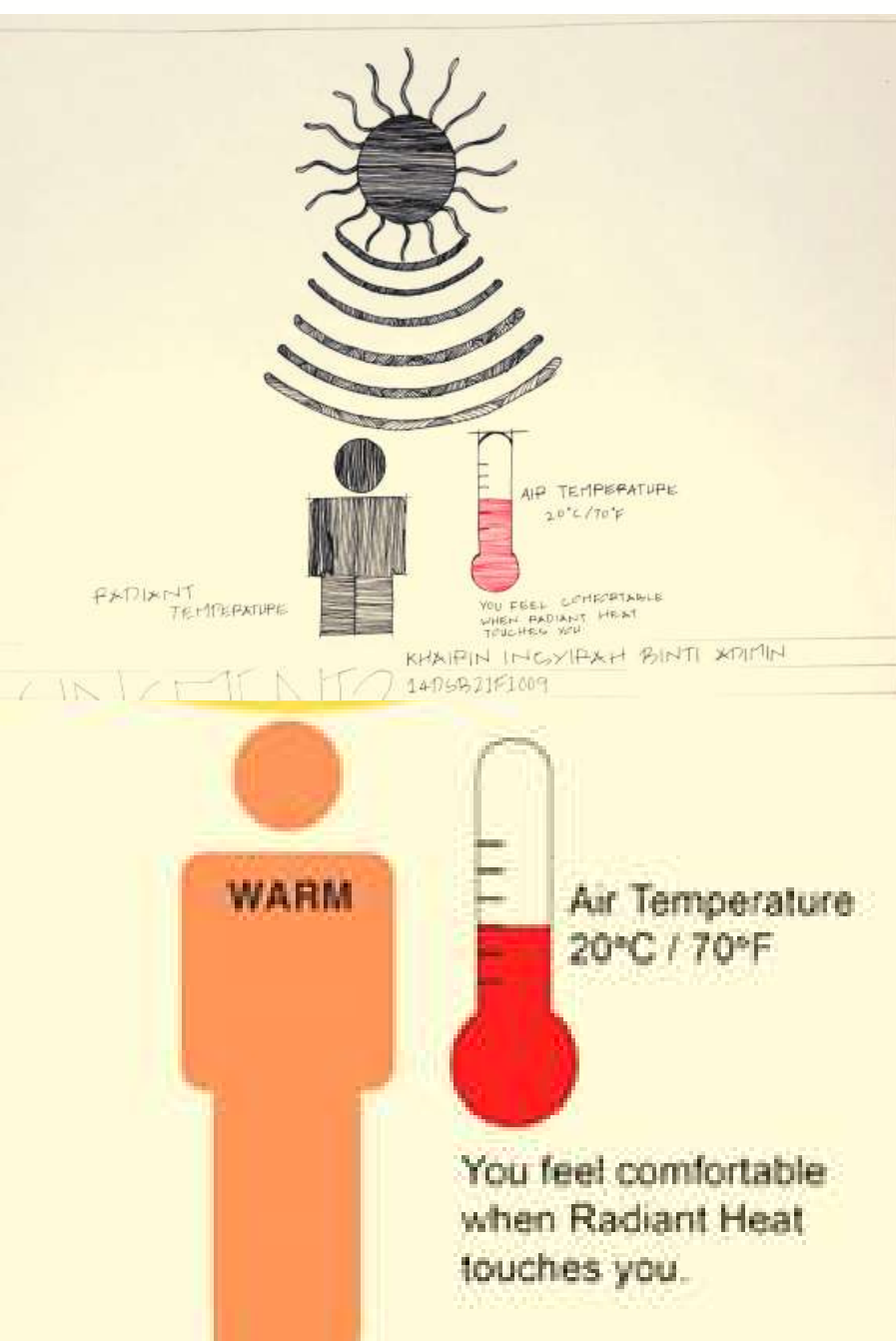
MALAYSIA GREEN RATING

3.3

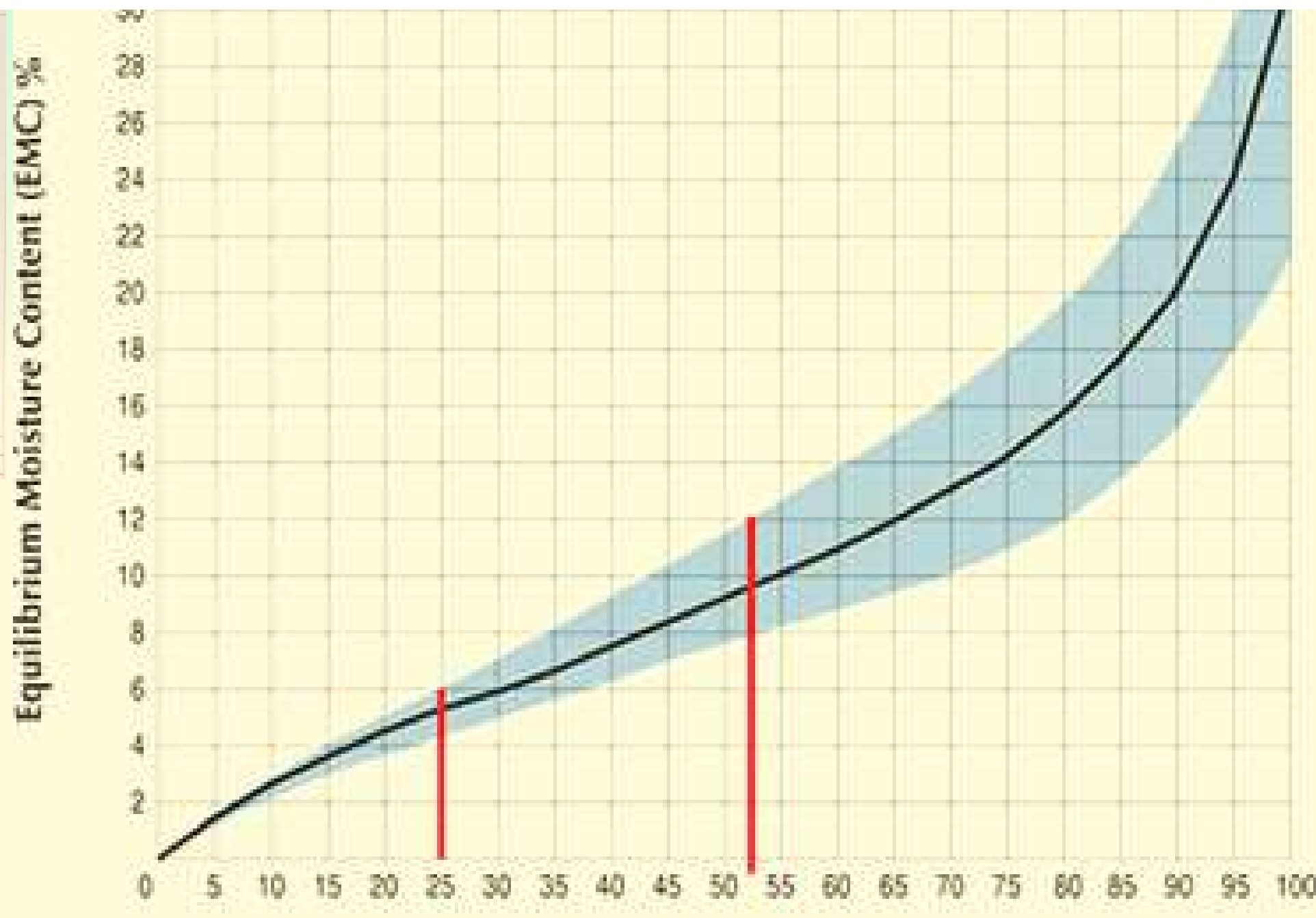
Analyze thermal comfort factors that influence the sustainable building design in the context of user, environmental and climate and building design based on the Malaysia green rating tools standards



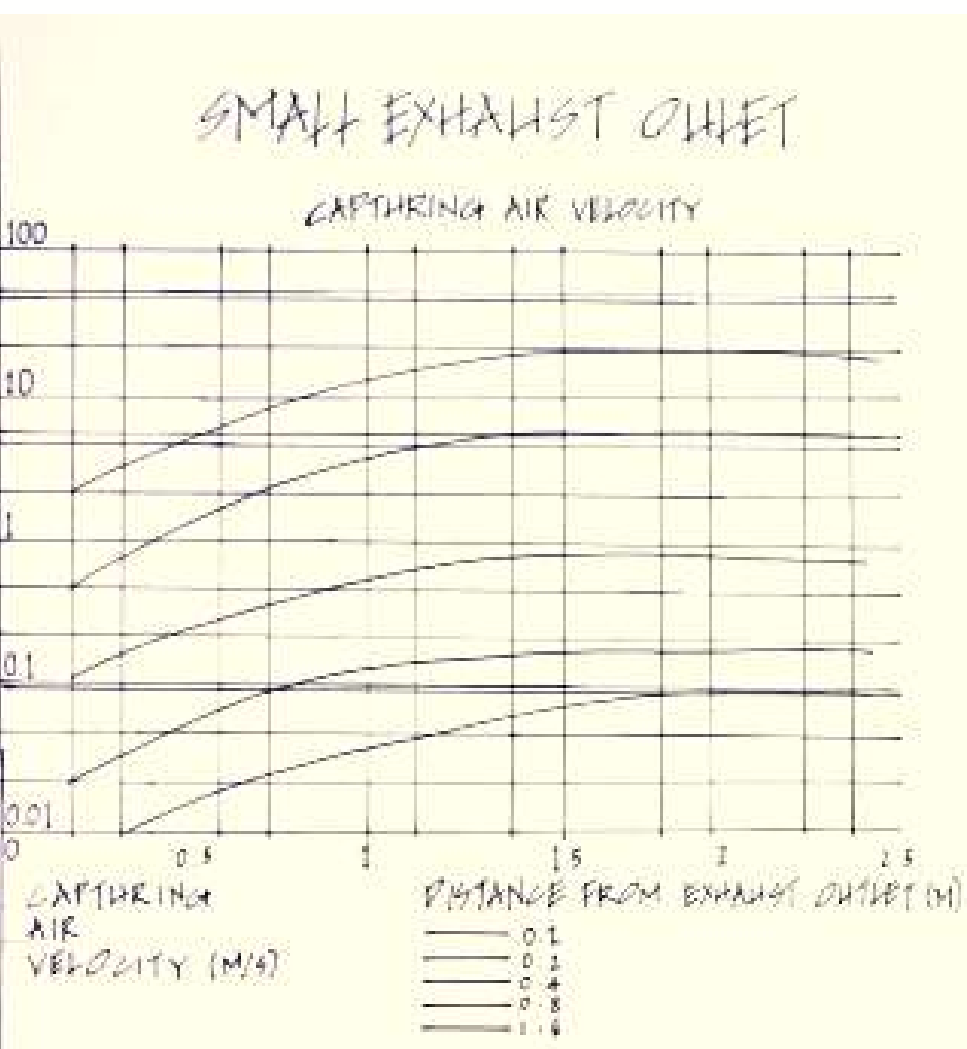
AIR TEMPERATURE



RADIANT TEMPERATURE



RELATIVE HUMIDITY



AIR VELOCITY



TOOLS STANDARDS

MALAYSIA GREEN RATING

3.3

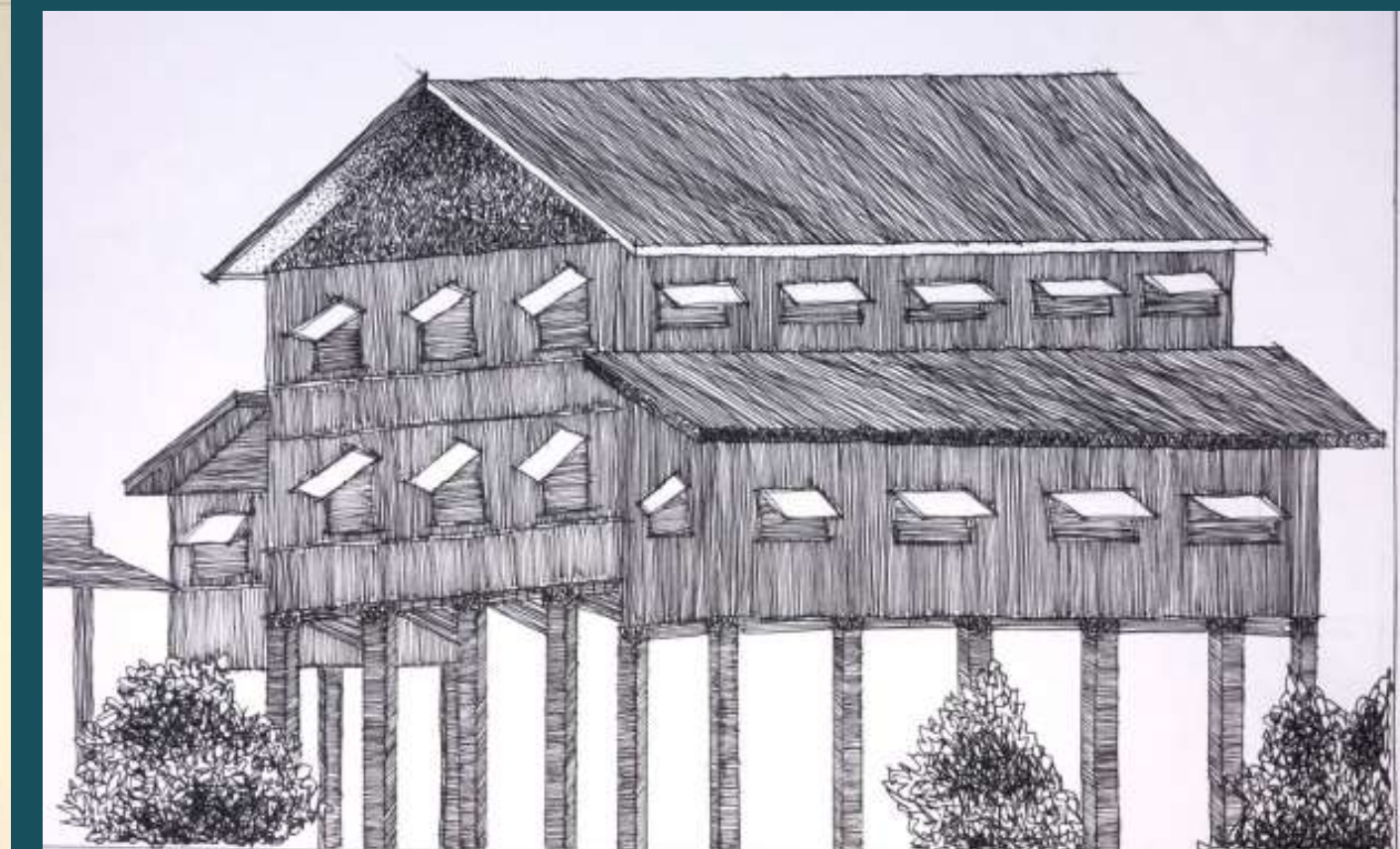
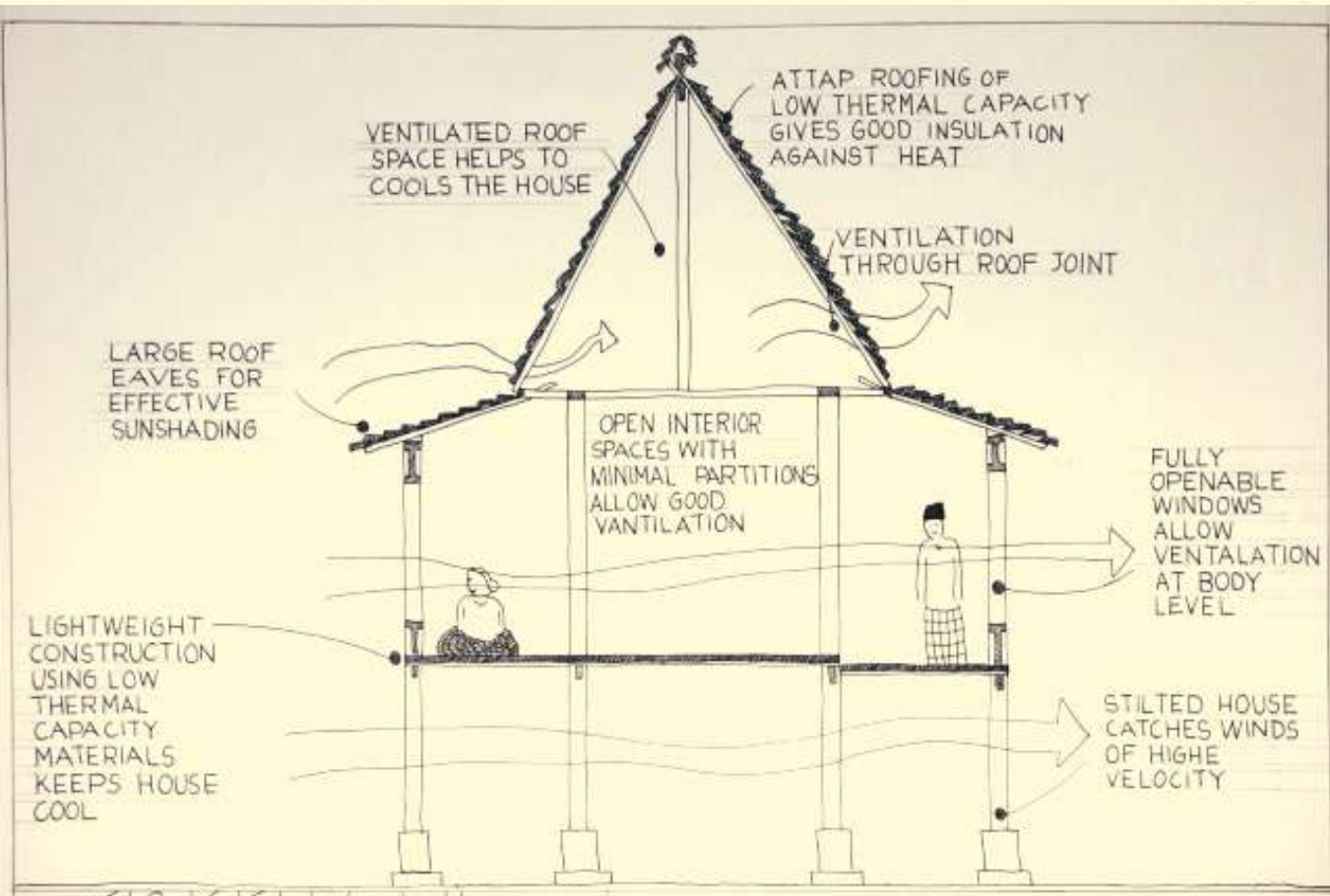
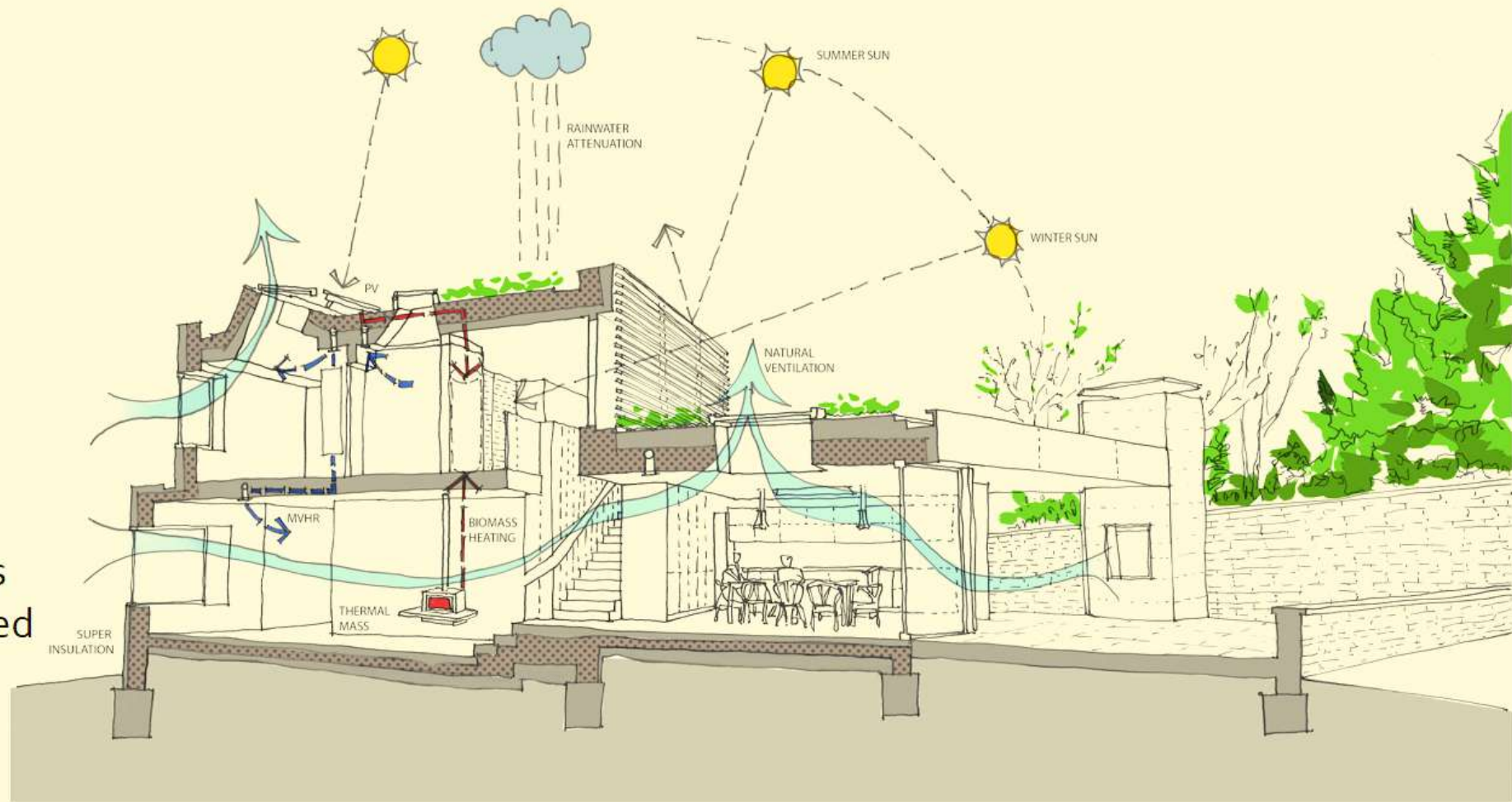
Data logger one off tools used to analyze thermal comfort.



SUMMARY

NATURAL VENTILATION SYSTEM RELATED TO SUSTAINABLE BUILDING DESIGN

- i. Many buildings use HVAC unit to control their thermal environment. Other buildings are naturally ventilated and do not rely on such mechanical systems to provide thermal comfort.
- ii. Depending on the climate, this can drastically reduce energy consumption.
- iii. It is sometimes seen as a risk, though, since indoor temperatures can be too extreme if the building is poorly designed. A Properly designed AND naturally ventilated buildings keep indoor conditions within the range of thermally comfortable.



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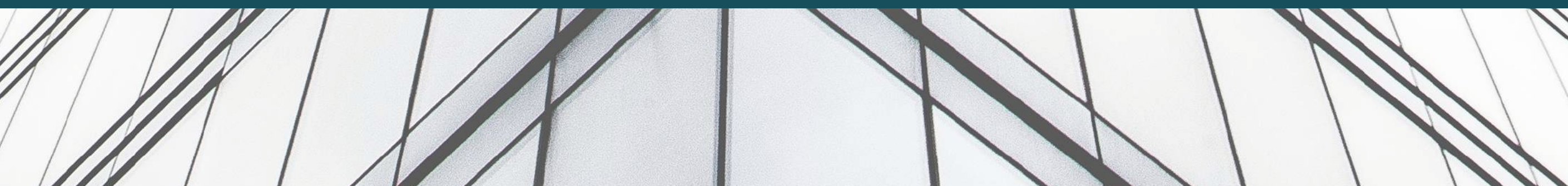
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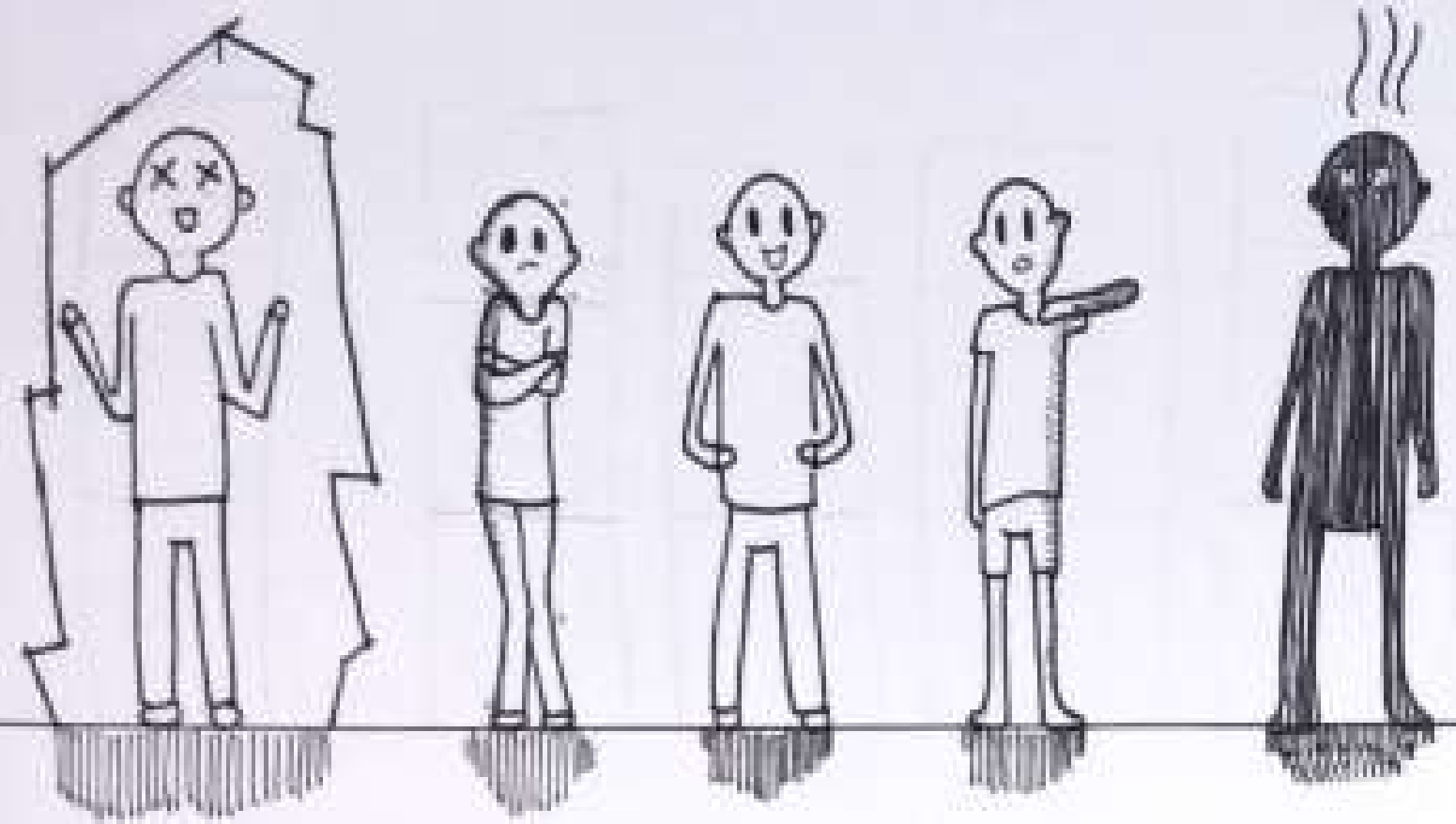
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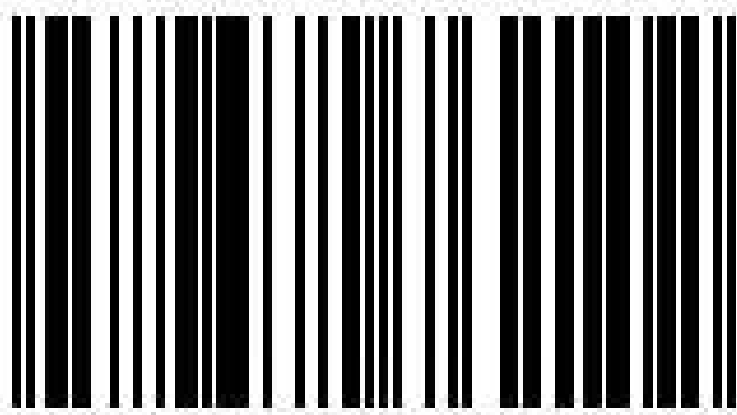




HOT ^{IT'S}
OR IT'S
COLD



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