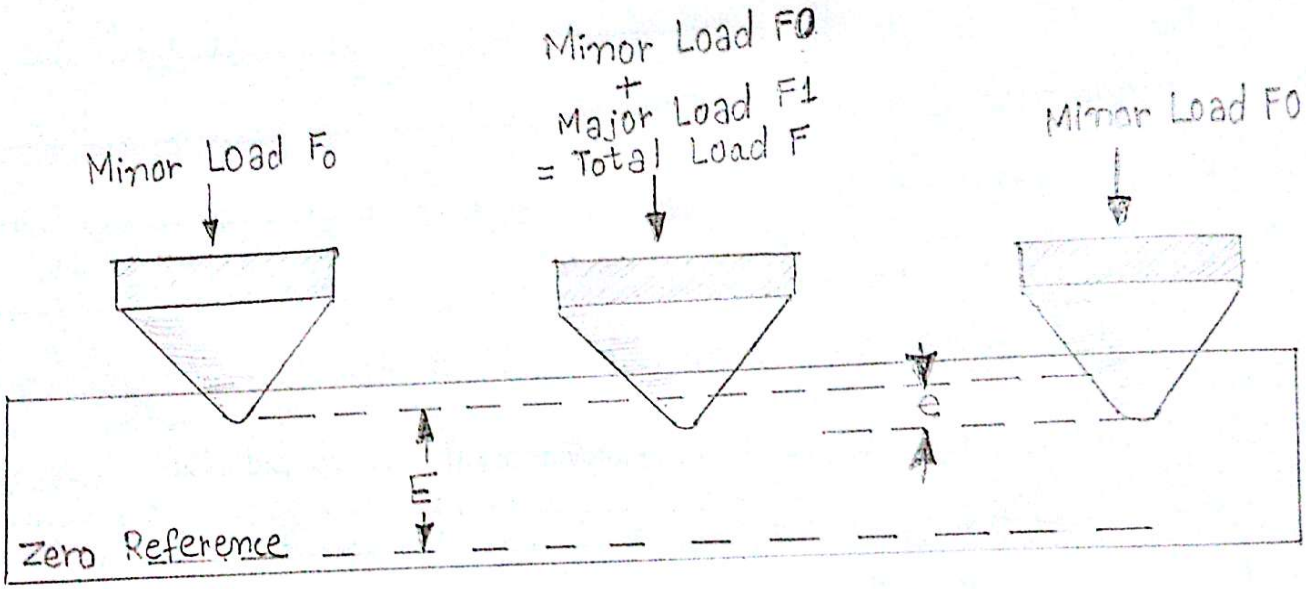


ROCKWELL PRINCIPLE

IMPACT AND HARDNESS TESTING

A. HARDNESS TEST

- **Objective:** To determine the hardness number of different specimens using Rockwell Hardness testing machine.

- **Apparatus Required:**
  - Rockwell Hardness testing machine.
  - Steel ball or diamond indenter
  - Test specimens

- **Theory:** Hardness of a material is defined as the resistance of material to plastic deformation of its surface. There are three main types of tests used to determine hardness of a material.

(i) Scratch test

(ii) Dynamic Hardness test

(iii) Static Indentation test

Static indentation tests are used for many engineering purposes. This test is based on the measure of indentation by a penetrator under a given load. Rockwell test is one of the static indentation tests. Rockwell hardness test method consists of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load of 10 kgf.

While minor load is still applied, an additional major load is applied with resulting increase in penetration.

● Observations:

a) 0.6% C steel : Heat Treatment at 900°C for 1 hour

	FURTHER COOLING PROCESS	HARDNESS NUMBER (RHB)
1.	Water Quenched	36.4
2.	Oil Quenched and Tempered at 300°C for 1 hour	25.6

b) 1% C steel : Heat Treatment at 900°C for 1 hour

	FURTHER COOLING PROCESS	HARDNESS NUMBER (RHB)
1.	Water Quenched	58.7
2.	Oil Quenched	22.1
3.	Oil Quenched and Tempered at 300°C for 1 hour	68.3

when equilibrium has been reached, additional major load is removed but preliminary minor load is still maintained. The permanent increase in depth of penetration resulting from the application and removal of additional major load is used to calculate the Rockwell hardness number.

$$HR = E - e$$

where, e → Permanent increase in depth of penetration due to major load F1

E → constant : 100 units for diamond indenter.

Procedure:

1) Fixed the steel ball indenter in the testing machine.
2) Placed the specimen on the platform below the indenter.
3) Fixed the value shown in the machine to 360.0 corresponding to 10 kgf of minor load.
4) Applied the additional major load of 60 kgf using the knob on the machine.
5) Started the machine and observed the hardness number.

Discussions:

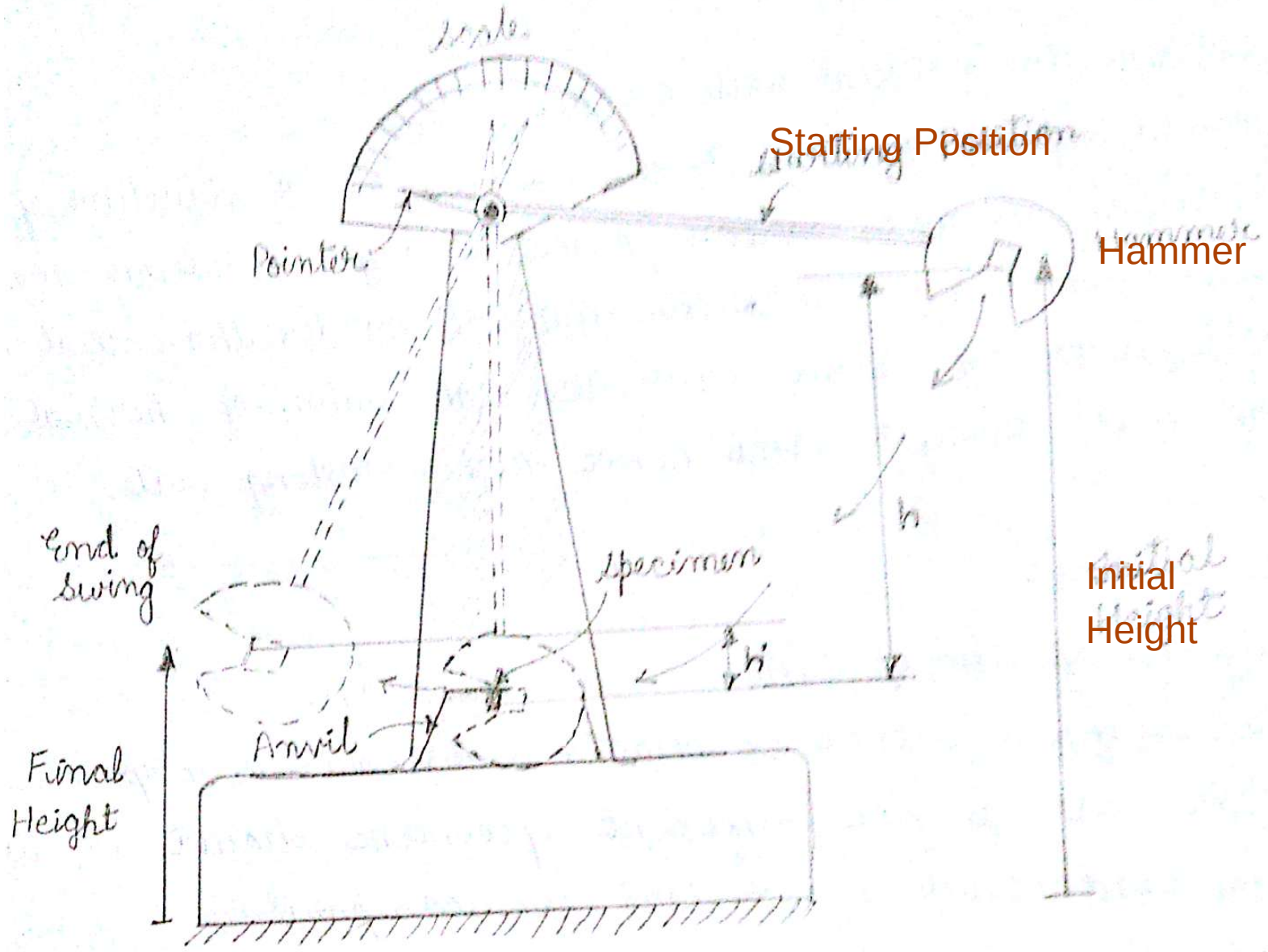
- We can infer from the readings that for the identical processes, increasing the carbon percentage increases the hardness of the material.
- For the same composition of material, the faster the cooling rate of the processes involved in making of the material, the

harder the material will become.

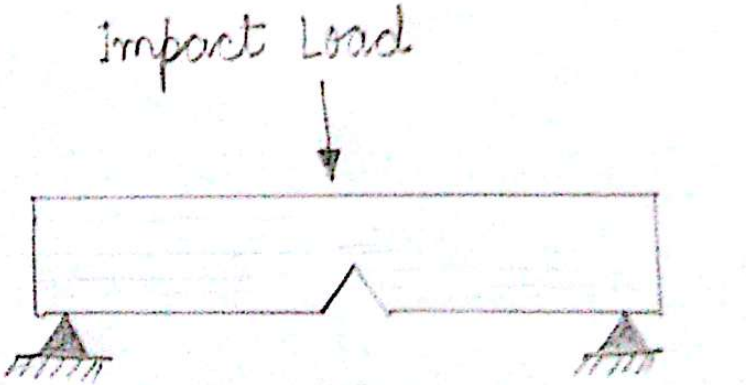
- Increasing carbon content changes the micro-structure of the material as more carbon forms stronger bonds in the material.
- Water quenching makes the material harder than that done by oil quenching, since water has high value of thermal conductivity of heat transfer and hence higher cooling rate.

Precautions:

- Surfaces of the specimens should be clean.
- Flat surfaces should be chosen and should be perpendicular.
- All the readings for different specimens should be taken at some additional major load for comparison.
- Loading speed should be standardised.



IMPACT TESTING MACHINE



Charpy V-Notch (top view)

SPECIMEN

IMPACT AND HARDNESS TESTING

B. IMPACT TESTING

Objective : To perform charpy impact test and determine the fracture toughness of given materials.

Apparatus Required:
- Impact testing machine,
- Charpy test specimen of mild steel, aluminium and cast-iron,
- Vernier calliper

Theory : Impact or shock loads are suddenly applied loads on mechanical components. The stress induced in these components is many times more than the stress produced by gradual loading. Therefore, impact tests are performed to assess shock absorbing capacity of materials subjected to suddenly applied loads.

Two types of notch impact tests are commonly used:

1) Charpy test
2) Izod test

In charpy test, the specimen is placed as simply supported beam

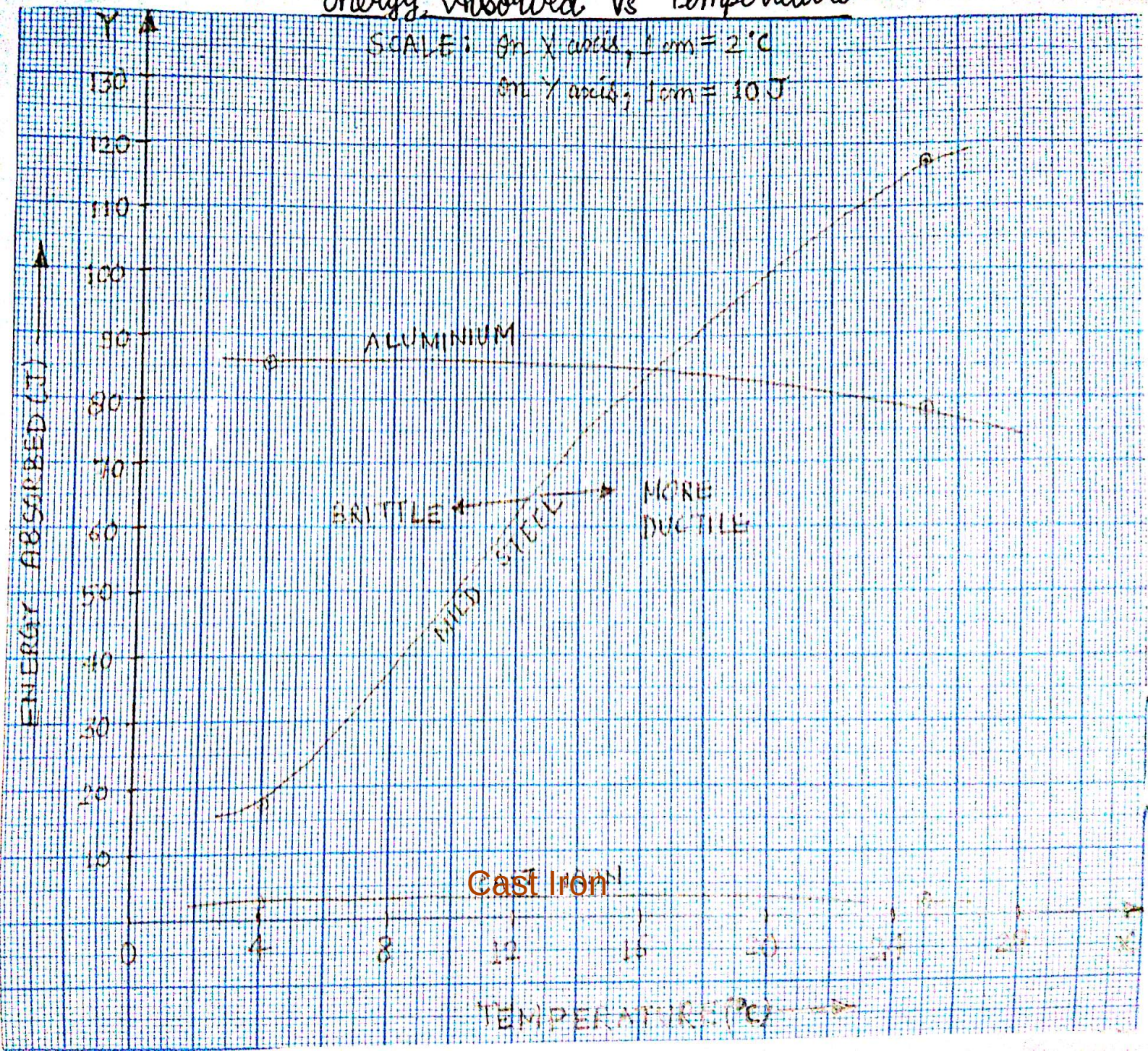
Procedure:

1) The specimen is taken and placed at the designated location in the impact testing machine using scissors tong.

Energy Absorbed Vs Temperature

SCALE: On X axis, 1 cm = 2°C

On Y axis, 1 cm = 10 J



2) The door of the machine is closed and the impact test is initiated.
3) After the test has been completed, the smashed chunks of specimen are cleared of the machine.
4) The machine sends the impact data to the computer which is recorded.
5) The same procedure is followed for other specimens.

● Observations

TABLE:1 - ENERGY ABSORBED

Sr. No.	Material	Room Temperature (25°C)	Low Temperature (4°C)
1.	Mild Steel	110.73 J	17.55 J
2.	Cast Iron	2.13 J	2.37 J
3.	Aluminium	78.46 J	86.08 J

● Results: ➤ As the temperature decreases, there is a tendency of certain materials to become brittle, as shown by the lesser amount of impact energy required to break them at low temperatures (as in the case of mild steel)

➤ Some materials are not that much susceptible to brittleness on temperature changes, like Aluminium and cast iron as observed here.

➤ BCC metals are more prone to showing DBTT

Discussions :

- One should be careful while placing the specimen inside the machine.
- For some specimens, the values of impact energy were not as accurate as they should be, this can be attributed to the misalignment of the notch while placing the specimen.
- More impact energy was required to break the ductile materials, thus proving the superior toughness of ductile materials over brittle materials.
- Impact tests are useful to test the materials which have to operate in the extremes of temperatures.