



Estimation Modelling Of Melting Points For Metallic Elements: A Comparative Analysis And Algorithmic Approach

Amrita Sajja, T.Sravanthi, B.Mounika

Department of electronics and communication engineering, Anurag University, Ghatkesar, Telangana, India

Abstract:

The melting point of a substance is the temperature at which it changes state from solid to liquid. It depends on pressure and is usually specified at a standard pressure such as 1 atmosphere or 100 kPa. By using a C program we have achieved melting point of a substance with enthalpy change, entropy change and pressure. This program utilizes the provided enthalpy change, entropy change and pressure to determine the temperature at which solid converts to liquid.

Introduction:

The melting point is the temperature at which a substance changes from a solid to a liquid state under standard atmospheric pressure. It's a critical property used to assess purity, composition, and applications across various fields.

The melting points of metals play a pivotal role in metallurgy, influencing material processing methods like machining and shaping. Higher melting points offer advantages in CNC machining by preventing melting or deformation. The strength of atomic attraction determines a metal's melting point. Understanding melting points is crucial in manufacturing processes such as smelting and welding, indicating crystalline compound purity and guiding steel production. Various methods, including Mel-Temp and Fisher-Johns apparatus, determine melting points, influenced by factors like pressure and impurity levels. Melting points are fundamental in material characterization, guiding research, development, and quality control, impacting material selection and fabrication methods. The process of melting and solidification is essential in comprehending material properties under diverse conditions.

METHODOLOGY:

To determine the melting point of a metal accurately, it's essential to start with a pure sample. Utilize a melting point apparatus like a Mel-Temp device or a Bunsen burner with a capillary tube for the test. Calibration ensures accuracy before proceeding. Prepare the metal sample into a thin wire or small pellet for uniform heating. Slowly heat the sample, observing it closely for any changes. Note the temperature at which phase changes occur, indicating the softening and complete melting of the metal. Record the melting point accurately and compare it with literature values for verification. Thoroughly clean the apparatus afterward and document all experimental

details for future reference. This methodology ensures precise determination of metal melting points, vital for various industrial and scientific purposes.

1.FORMULAE:

$$T_m = \Delta H / (\Delta S + R \ln(P/P_0))$$

Where,

T_m =Melting point temperature

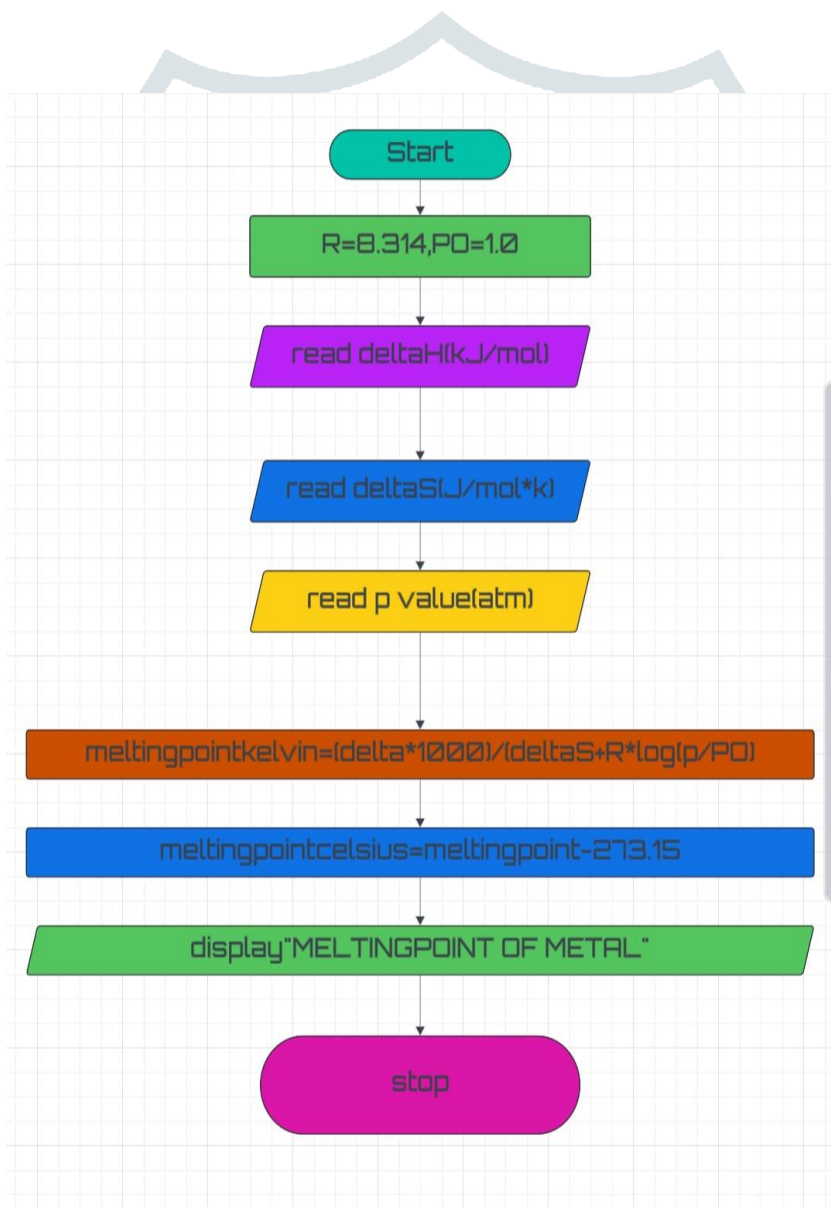
ΔS =entropy change

R=gas constant

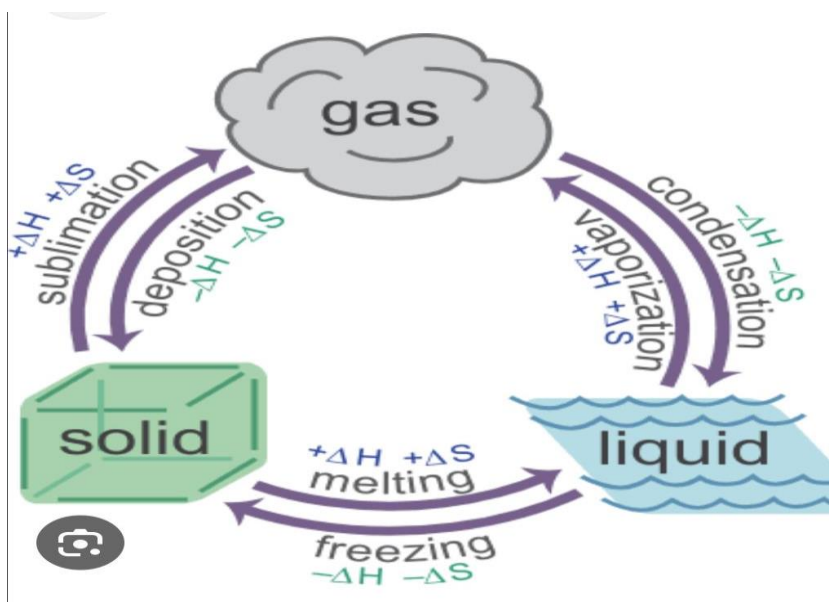
P=pressure

P_0 =reference pressure

2.FLOWCHART:



Explains the procedure of the program by defining the gas constant value(8.314)and atmospheric pressure as1.0.Then,read the entropy change,enthalpy change,and pressure values.Substitute this value into the formula for calculating the melting point in kelvin.Next,convert the melting point from kelvin to celsius.Finally,print the calculated melting point.



It explains when a solid melts, it turns to liquid with heat. When a liquid evaporates, it becomes gas and when a gas cools down, it can turn to solid under temperature conditions.

Phase transitions involve the conversion of matter between solid, liquid, and gas states. Melting turns solids into liquids by adding heat, vaporisation changes liquids into gases by adding heat, and deposition transforms gases into solids by removing heat. These transitions are fundamental in understanding material behaviour and natural processes.

Outcomes Illumination:

```
Enter enthalpy change (kJ/mol) : 824
Enter the entropy change (J/(mol*K)) : 298
Enter the pressure (atm) : 1
The melting point is: 2491.95 degrees Celsius
```

The provided data suggests that for a substance undergoing a phase transition from solid to liquid, with an enthalpy change of 824 kJ/mol and an entropy change of 298 J/(mol*K), under a pressure of 1 atmosphere, the calculated melting point is 2491.95 degrees Celsius. This melting point signifies the temperature at which the solid and liquid phases of the substance exist in equilibrium, with the given enthalpy and entropy changes playing crucial roles in determining this transition temperature. The enthalpy change represents the heat absorbed or released during the phase transition, while the entropy change accounts for the change in disorder or randomness of the molecules. At a pressure of 1 atmosphere, these thermodynamic parameters combine to yield the specific melting point, serving as a key parameter in understanding the material's behaviour and facilitating various industrial processes like casting, moulding, and shaping.

```
Enter enthalpy change (kJ/mol) : 3584
Enter the entropy change (J/(mol*K)) : 287
Enter the pressure (atm) : 1
The melting point is: 12214.65 degrees Celsius
```

The given enthalpy change of 3584 kJ/mol and entropy change of 287 J/(mol*K) indicate a substantial energy requirement and increase in disorder during the solid to liquid phase transition. Under standard atmospheric pressure, these thermodynamic parameters culminate in an extraordinary melting point of 12214.65 degrees Celsius, reflecting the significant energy needed to disrupt the solid structure and induce liquefaction. This exceptionally high melting point underscores the formidable intermolecular forces holding the substance together in its solid state, highlighting its unique thermodynamic characteristics and potential industrial applications in extreme temperature environments.

At constant pressure when entropy value increases melting point decreases enthalpy value increases melting point increases

Examples

Melting points for some metals and alloys:

TABLE-1

Metals and Alloys	Melting Points
Admiralty Brass.	900 - 940
Aluminum	660
Aluminum Alloy	463 - 671
Aluminum Bronze	1027 - 1038
Antimony	630
Babbitt	249
Beryllium	1285
Platinum	1770
Lead	327.5
Nickel	1453
Mercury	38.86
Molybdenum	2620
Osmium	3025
Zirconium	1854
Zinc	419.5
Yellow Brass	905 - 932
Vanadium	1900
Steel, Stainless.	1510
Silver, Coin.	879

The melting points listed above showcase the diverse range of temperatures at which various metals and alloys transition from a solid to a liquid state. Metals like aluminium and zinc exhibit relatively low melting points, with aluminium at 660°C and zinc at 419.5°C. Conversely, high melting points are observed in metals such as platinum, with a melting point of 1770°C, and osmium, which boasts the highest melting point of any naturally occurring element at 3025°C. Alloy compositions, such as aluminium alloy and stainless steel, demonstrate a wide range of melting points due to the combination of different metals, offering tailored properties for specific applications. Notably, brass compositions like admiralty brass and yellow brass fall within a moderate melting point range, between 900°C to 940°C and 905°C to 932°C

respectively. The melting points of metals and alloys are crucial in determining their utility in various industries, from manufacturing to aerospace, influencing processes such as casting, welding, and machining. Understanding these melting points allows for the precise selection and manipulation of materials to meet the demands of diverse applications, ensuring optimal performance and efficiency in countless endeavours.

Conclusion:

In conclusion, the melting point of a substance serves as a pivotal indicator of its transition from a solid to a liquid state, establishing equilibrium between both phases. This critical temperature, defined by rigorous scientific investigation, encapsulates the delicate interplay of enthalpy and entropy changes within the material. Moreover, the determination of a substance's melting point necessitates meticulous consideration of external factors, particularly pressure, typically standardised at conditions such as 1 atmosphere or 100 kilopascals. Through meticulous analysis and experimentation, scientists unravel the intricate thermodynamic characteristics underlying this fundamental property, shedding light on the behaviour of matter under varying conditions. Thus, the melting point stands as a cornerstone in the understanding of material science, offering insights into the physical transformations that shape our world.

REFERENCES:

- 1.Ramsay, J. A. (1949). "A new method of freezing-point determination for small quantities" . J. Exp. Biol. 26 (1): 57- 64. PMID 15406812
- 2.<https://www.wilkes.edu/centers-and-institutes/labs-and-equipment>
- 3.docs docs<https://www.wilkes.edu/centers-and-institutes>
- 4.<https://brainty.com/question>
- 5.[https://www.wilkes.edu/centers-and-institutes/labs-and-equipment: docs](https://www.wilkes.edu/centers-and-institutes/labs-and-equipment/docs)

