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IB–ACIO

Grade II/Executive

Assistant Central Intelligence Officer Examination

Volume - 1

General Awareness & Science

SIERRA INNOVATIONS

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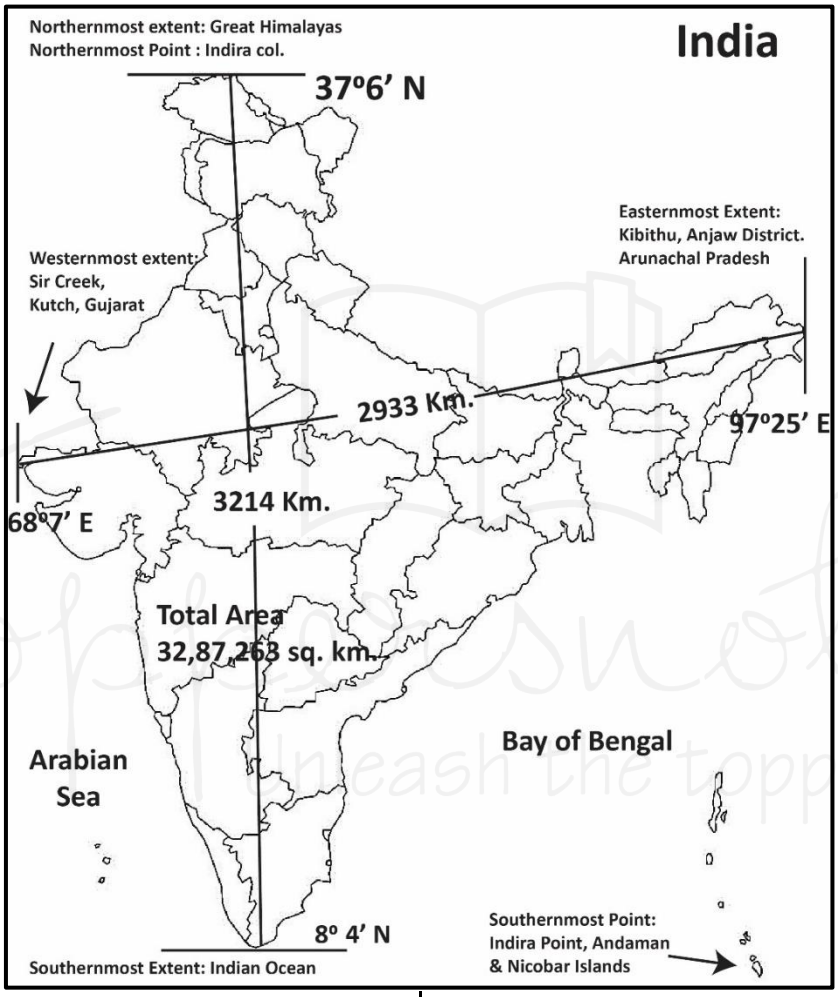
1 CHAPTER

India-Size & Location

- **7th largest country** in the world.
- Situated in the **northern hemisphere** (**8°4'N to 37°6'N and 68°7'E to 97°25'E**)
  - India lies to the north of the equator between **6° 44′ and 37°6'N latitude** and 68° 7′ and 97° 25′ east longitude (including the islands).
- **Area**: 32,87,263 sq. km (**2.42% of the world**)
- 2nd most populated country in the world (**17.5% of the world's population**)
- **Total land boundary** = 15,200 km.
- **Total Sea boundary** = 7516.6 Km
  - Without islands = 6100 Km



Border Countries:

North-west	● Afghanistan and Pakistan ● Indo-Pak border: Radcliffe line ● Pak - Afghanistan border: Durand Line
North	● China, Bhutan and Nepal ● Indo-China border: McMahon line
East	● Myanmar, Bangladesh ● Longest boundary with Bangladesh
South	● Sri Lanka ● Separated by Palk Strait & Gulf of Mannar

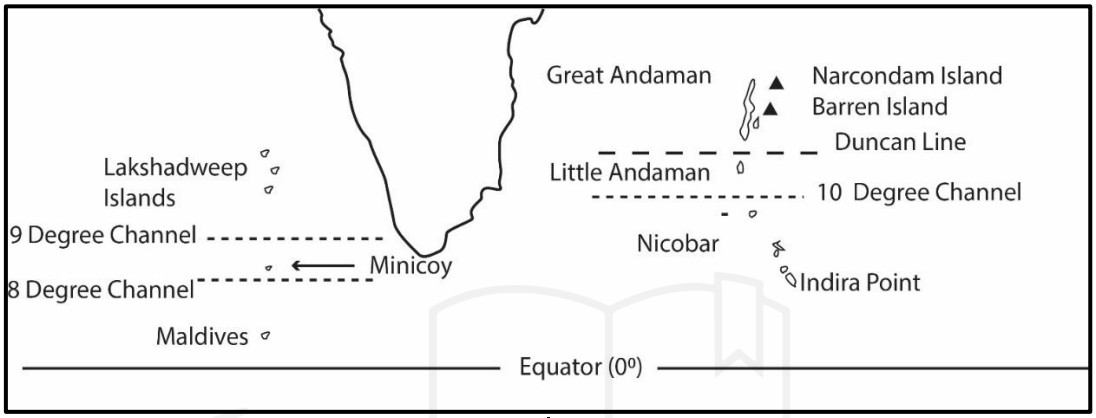
States sharing International borders:

Bangladesh	**5 States:** West Bengal, Mizoram, Meghalaya, Tripura, and Assam (**4096 km)**
China	**4 States and1 UT:** Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and Ladakh (**3488 km)**
Pakistan	**3 States and 2 UTs:** J&K, Punjab, Gujarat, Rajasthan and Ladakh (**3323 km)**

Nepal	**5 States:** Uttar Pradesh, Bihar, Uttarakhand, Sikkim, West Bengal **(1751km)**
Myanmar	**4 States**: Arunachal Pradesh, Manipur, Mizoram, and Nagaland (**1643 km)**
Bhutan	**4 States**: Arunachal Pradesh, Assam, Sikkim, and West Bengal (**699 km)**
Afghanistan	**1 UT:** Ladakh (**106 km)**

- **Indian Standard Meridian**
  - **82°30'E**, **Mirzapur(UP)** - India's Standard Meridian.
  - **Ahead of meantime** by **5 hours and 30 minutes.**
  - **States through which IST Passes:** Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Odisha and Andhra Pradesh.
- **Tropic of cancer** (23°30'N) - Gujarat, Rajasthan, MP, Chhattisgarh, Jharkhand, West Bengal, Mizoram, and Tripura.
- **Coastal states of India: 9** (West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra, and Gujarat)

Various Channels and their Location



- **Ten Degree Channel**
  - **Separates** the **Andaman Islands** from the **Nicobar Islands** in the Bay of Bengal
  - **150 km wide** from north to south and **10 km long** from east to west with a minimum depth of 7.3m.
- **Nine Degree Channel**
  - **Separates Minicoy** island from the **Lakshadweep archipelago**.
  - **200 km wide** with a **depth** of **2597 metres**.
  - **Strategic importance**: Passage of major merchant shipping between Europe, the Middle East and Western Asia with South-East Asia and the far East.
- **Eight Degree Channel**
  - **Maritime boundary** between the **Maldives** and **India**
  - **Separates** the islands of **Minicoy** and **Maldives**.
  - Traditionally known as **Maliku Kandu** and **Māmalē Kandu Divehi**.

Duncan Passage

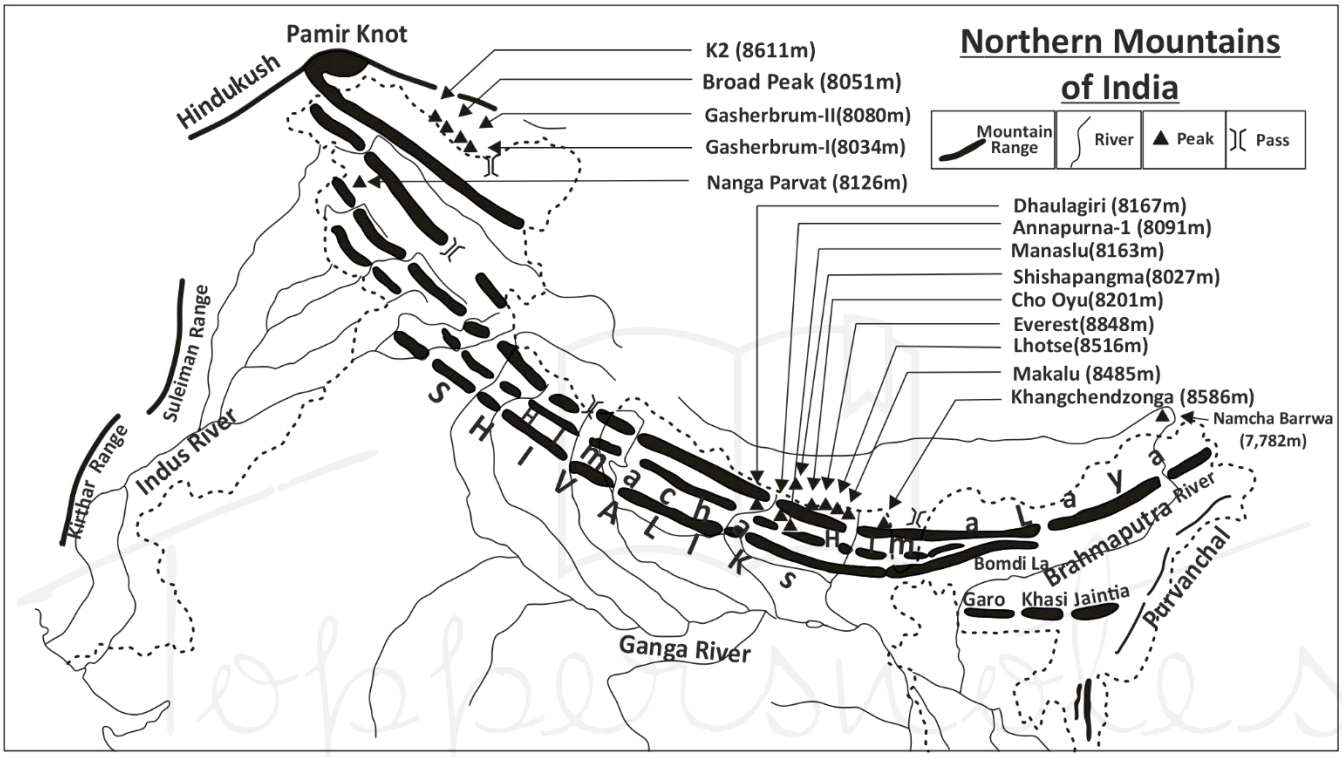
- A strait in the Indian Ocean.
- Located in between South Andaman and Little Andaman.
- Also lies within the EEZ of India, protected by the integrated tri-services Andaman and Nicobar Command of Indian Military.
- **Width**: ~ 48km.

2 CHAPTER Physiographic Divisions of India

Based on physical features, India is divided into six physiographic divisions:

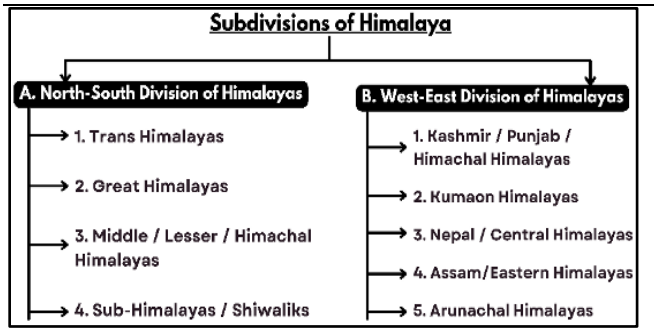
1. Himalayan Mountains
2. Great Plains of India
3. Peninsular Plateau
4. Indian Desert
5. Coastal Plains
6. Islands

1. Himalayan Mountains

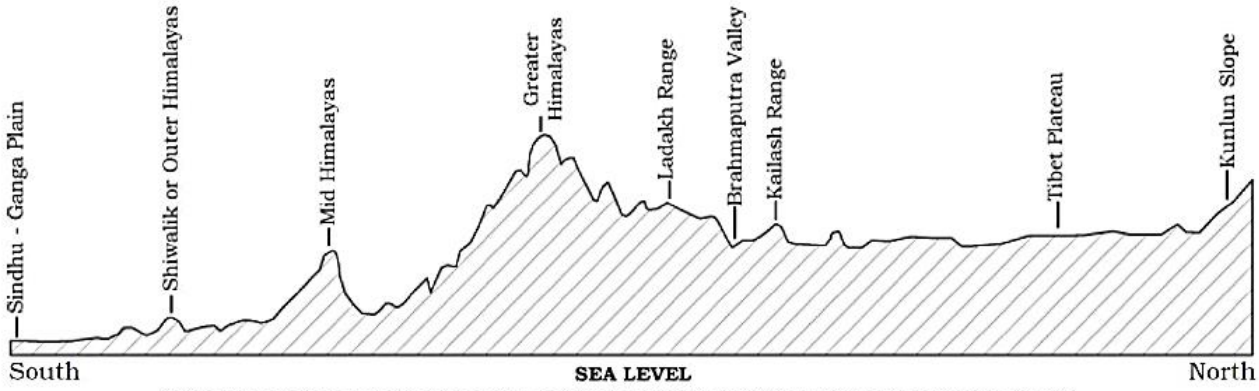


- **Highest and the youngest fold mountain** ranges of the world.
- **One of the highest earthquake-prone regions** of the world.
- **Length:** runs **west-northwest to east-southeast** in an arc **2,500 km long.**
  - **Western anchor**: **Nanga Parbat** (lies just south of the northernmost bend of the Indus River)
  - **Eastern anchor: Namcha Barwa** (lies immediately west of the great bend of the Yarlung Tsangpo River)
- **Width**: 400 km - 150 km (West- East).
- **Soaring heights, steep-sided** jagged peaks, valley and alpine glaciers often of stupendous size
- **Topography** deeply cut by **erosion**, seemingly **unfathomable river gorges**, **complex geologic structure**, and **series of elevational belts** (or zones)
- **Greater part of the Himalayas** lies below the snow line.
- The **mountain-building process** that created the range is still active.
- **Considerable stream erosion** and **gigantic landslides**.

Sub Divisions of the Himalayas



A. North-South Division of Himalayas



Himalayan Mountain Complex : Cross Sectional View from South to North

1. Trans-Himalayan Ranges:

- **Location:** North of the Great Himalayas
- Also known as **Tibetan Himalaya** because most of it lies in Tibet.
- **Lifted much before the Himalayas** between Jurassic and Cretaceous
- **Geologically not a part of the Himalayas**.
- **Start** from **Pamir Knot.**
- **Godwin Austen/ K2/ Qogir** (8,611 m) - **second highest** peak in the **world / highest peak in the Indian Union** found in Karakoram Range
- **Length- 1,000 km** in the **east-west** direction.
- **Average elevation - 5000 m** above mean sea level.
- **Average width** - 40 km- 225 km (extremities -central part).
- **Siachen glacier** - highest battlefield.
- **Glacier Baltaro** - largest Mountain glacier from the Karakoram range.
- **Karakoram Pass** - connects the **Aksai Chin,** an erosional plateau of an average height 5000m.
- **Main ranges**:

Karakoram Range	● **Northernmost range** of the Trans-Himalayan Ranges in India ● Also known as **Krishnagiri range** ● Extends eastwards **from Pamir for about 800 km.** ● **Average elevation** - 5,500 m and above.
Ladakh Range	● **North of the Zaskar** Range ● **Highest point** - Rakaposhi ● Lies **north of Leh.** ● **Merges with the Kailash range** in Tibet. ● **Important passes** - Khardung La, and Digar La.
Zaskar Range	● A mountain range in the **union territory of Ladakh.** ● **Separates Zanskar from Ladakh.** ● **Average height** - about 6,000 m. ● Acts as a **climatic barrier protecting Ladakh and Zanskar from monsoon** ● **Major passes**- Marbal Pass, Zojila Pass - extreme northwest. ● **Major rivers**- Hanle River, Khurna River, Zanskar River, Suru River (Indus), and Shingo River.
Kailas Range	● **Offshoot** of the **Ladakh Range**. ● **Highest peak -** Mount Kailash (6714 m). ● **River Indus** originates from the **northern slopes of the Kailas range**.

Ladakh Plateau

- **Cold desert**
- Lies to the **northeast of the Karakoram Range**.
- **Dissected into** many plains and mountains - **Soda Plains, Aksai Chin, Lingzi Tang, Depsang Plains and Chang Chenmo**.
- **Northwestern part - Deosai mountains** are the **end of the Trans-Himalayan region**

2. Great Himalayas:

- Also known as **Himadri.**
- **Average height** - 6000 m
- **Average width** - 25 km
- **Extension -** Mt. Namcha Barwa to Nanga Parbat (2400 km)- World's one of the longest-running fold mountain ranges
- **Features:** High relief, deep gorges, vertical slopes, symmetrical convexity, and antecedent drainage.
- **Terminates abruptly** at the **syntaxial bends**.
  - **Nanga Parbat** - north-west
  - **Namcha Barwa** - north-east.
- **Composed** of **metamorphic** and **sedimentary** rocks.

- **Core** - **Batholith** representing the intrusion of Magma (Granitic Magma)
- **Have asymmetrical folds** due to high compression, and they **have fractured rocks** in the **eastern part.**
- **14 of the 28 tallest peaks** in the world (> 8000 m) are situated here.
- **Major passes -** Zojila Pass (connects Srinagar with Leh), Shipki La Pass, Burzil Pass, Nathu La Pass etc.
- **Major glaciers** - Rongbuk glacier (largest in the Himadri), Gangotri, Zemu etc.
- **Separated from lesser Himalayas** by longitudinal **valleys** filled with sediments known as **Doons**.
    - **Eg.** Patli Dun, Chaukamba Dun, Dehradun etc.

3. <u>Middle/ Lesser/ Himachal Himalaya:</u>

- **Most rugged** mountain system.
- Lies **between** the **Shiwaliks** in the south and the **Greater Himalayas** in the north.
- **Composed** of **highly compressed and altered rocks.**
- **Average altitude** - 3,700 - 4,500 metres.
- **Average width** - 50 to 80 Km.
- **Pir Panjal range - longest**
    - **Extends from Jhelum - upper Beas River** for over 300 km.
    - Rises to 5,000 metres and contains **mostly volcanic rocks**.
- **Passes:**
    - **Pir Panjal Pass** (3,480 m), the Bidil (4,270 m), Gulabgarh Pass (3,812 m) and **Banihal Pass** (2,835 m).
    - **Banihal Pass**- Jammu-Srinagar highway and Jammu-Baramulla railway.
- **Rivers**: Kishanganga, the Jhelum and Chenab.
- **Important Valleys**

Valley of Kashmir	• Between the **Pir Panjal** and the **Zaskar Range** (average elevation- 1,585 m) • **Composed** of alluvial, lacustrine [lake deposits], fluvial [river action] and glacial deposits. • **Jhelum River meanders** through these deposits and cuts **a deep gorge** in Pir Panjal.
Kangra Valley	• **Extends from** the foot of the **Dhauladhar Range to the south of Beas**.
Kullu Valley	• In the **upper course of the Ravi** • A **transverse valley.**

- **Most important range** - Dhaula Dhar and Mahabharat ranges.
- **Includes** famous valley of Kashmir, the Kangra and Kullu Valley in Himachal Pradesh.
    - Well **known for its hill stations.**
- **Cut across by the Jhelum and Chenab rivers.**
- **Dhauladhar ranges** – an extension of Pir Panjal into Himachal Pradesh - cut across by the river Ravi.
- **Mussoorie ranges** - divide the waters of Sutlej and Ganga
- Have **steep, bare southern slopes** [prevents soil formation] and gentler**, forest-covered northern slopes.**
- **Uttarakhand**- marked by **Mussoorie and Nag Tibba ranges**.

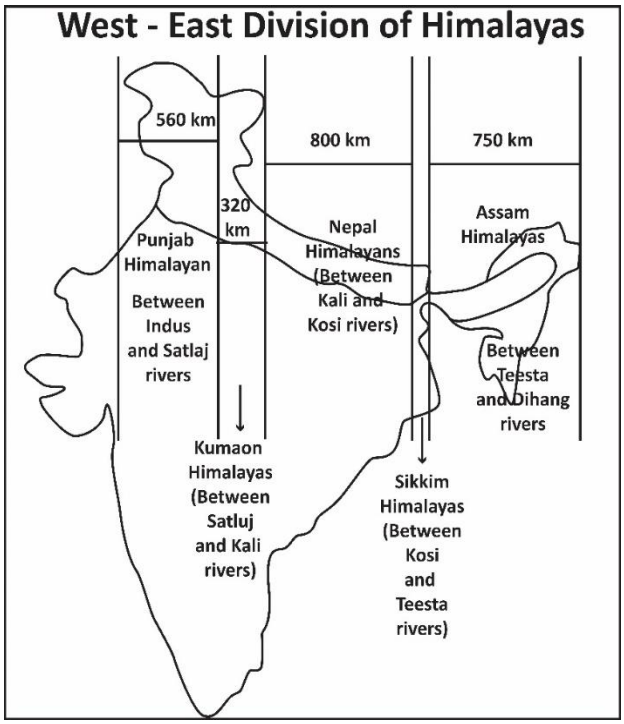
Important ranges of Lesser Himalayas	Region
Pir Panjal Range	Jammu and Kashmir (south of Kashmir Valley)
Dhauladhar Range	Himachal Pradesh
Mussoorie Range and Nag Tibba Range	Uttarakhand
Mahabharat Range	Nepal

4. <u>Sub-Himalayas/ Shiwaliks:</u>

- Also known as **Outer Himalayas.**
- **Between Great Plains and Lesser Himalayas**.
- **Altitude**- 600-1500 metres.
- **Length**- 2,400 km - **Potwar Plateau to Brahmaputra valley.**
- **Southern slopes** - steep
- **Northern slopes** - gentle.
- **Width** - 50 km - 15 km (Himachal Pradesh -Arunachal Pradesh).
- **Almost unbroken except** for 80-90 km – **Tista and Raidak River valley**.
- Covered with **thick forests from North-East India up to Nepal**.
- **Southern slopes** in **Punjab** and **Himachal Pradesh**- almost **NO forest cover.**
- **Highly dissected** by **seasonal streams** - **Chos**.
- **Valleys** - part of **synclines** and **hills** - part of **anticlines**
- **Different names:**

Region	Name of Shiwaliks
Jammu Region	Jammu Hills
Dafla, Miri, Abor and Mishmi Hills	Arunachal Pradesh
The Dhang Range, Dundwa Range	Uttarakhand
Churia Ghat Hills	Nepal

B. West-East Division of Himalayas



1. Kashmir /Punjab/ Himachal Himalayas

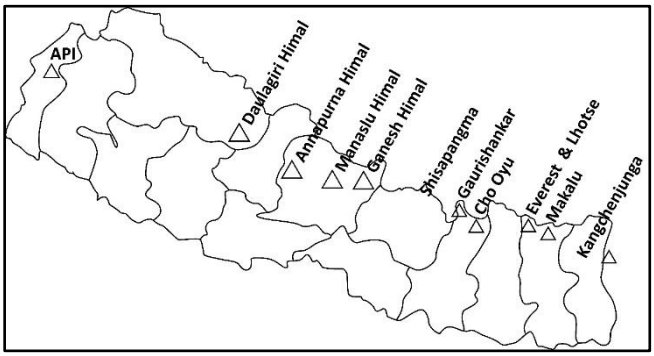
- Located **between Indus and Satluj gorge**
- **Length**- 560 kms
- **Width** - 320 kms
- **Zaskar range -** northern boundary and **Shiwaliks -** Southern boundary
- **Characterized by** ridge and valley topography (Kashmir Valley is the syncline basin) formed by the Lacustrine deposits (**Karewas**- helpful in **growing saffron**- from Pulwama to Pampore) of Jhelum.
- **Major ox-bow lakes** - Wular lake, Dal Lake, etc.
- Also known as "**Vail of Kashmir**"
- **Rainfall** upto 100cm in **summers** and **snow** during **winters**
- **Only gateway to Kashmir - Banihal pass** - Jawahar tunnel (Second Largest in India)
- **Major passes**- Burzil pass, Zozila pass.

2. Kumaon Himalayas

- Located between **Satluj and Kali gorges**
- **Length**- 320 kms
- **Major mountain ranges -** Nag Tibba, Dhaula Dhar, Mussoorie, and the Greater Himalayas.
- **Major peaks -** Nandadevi, Kamet, Badrinath, Kedarnath, etc.
- **Major rivers –** Gangotri, Yamunotri, Pindari, etc.
- **Characteristics:**
  - **Snowfall** in winters
  - **Coniferous** forests above **3200m** and **Deodar** Forest between **1600-3200m**.
  - Has **tectonic valleys**- Kullu, Manali, and Kangra.
  - **Rainfall** of about 200cm in summers
  - **More prone to Seismicity** and landslides.

3. Nepal/ Central Himalaya

- **Length- 800 km**
- **Between Kali** in the west and **Tista** in the east.
- **Great Himalayas attain a maximum height** in this portion.
- **Major peaks**- Mt. Everest, Kanchenjunga, Makalu, Annapurna, Gosainthan and Dhaulagiri.
- **Lesser Himalaya** is known as **Mahabharat Lekh** here.
- **Major rivers**- Ghaghara, Gandak, Kosi, etc.
- **Major valleys**- Kathmandu and Pokhra lacustrine valleys (previously lakes).



4. Assam/ Eastern Himalayas

- **Length-** 750km
- Located between **Tista** in the **west** and **Brahmaputra** (Dihang gorges) in the **east**.
- Occupy **mainly Arunachal Pradesh** and **Bhutan**.
- Narrow longitudinal valleys
- **Rainfall > 200cms.**
- Show a **marked dominance of fluvial erosion** due to heavy rainfall.
- **Landslides** and **earthquakes** are very **common** as rocks are fractured
- **Inhabited by tribes**
- **Important peaks** - Namcha Barwa (7756 m), Kula Kangri (7554 m), ChomoLhari (7327 m).
- **Major hills** - Also known as hills, Dafla hills, Miri hills, Abor hills, Mishmi hills, Namcha Barwa, Patkai bum, Manipur hills, Blue Mountain, Tripura range, and Braille range.
- **Major passes-** Bomdi La, Yong Yap, Diphu, Pangsau, Tse La, Dihang, Debang, Tunga, and Bom La.

5. Arunachal Himalayas

- **Form the eastern frontier** of the **Eastern Himalayas.**
- **Namcha Barwa** - **extreme east** of Arunachal Pradesh.
- **Earlier known as Assam Himalayas.**
- **Himalayan range** enters Arunachal Pradesh **from Bhutan** in the West Kameng district.
- **Characteristics**
  - **High ridges** and **low valleys**
  - **Altitude** - 800 m to 7,000 m above sea level.
  - **Extend** from the east of the Bhutan Himalayas - Diphu pass in the east.
  - **Dissected by the Brahmaputra,** which flows through a deep gorge after crossing Namcha Barwa.
- **Major tribes**- Monpa, Abor, Mishmi, Nyishi and the Nagas- practice Jhumming.

Purvanchal Himalayas

- Geologically considered **part of the Himalayas**
- Has **structural differences**, thus, **separated from the main Himalayan ranges**.
- Lies **south of the Brahmaputra valley.**
- Belong to **Arakan Yoma orogenesis.**
- Have **loose, fragmented sedimentary rocks** like shale, mudstone, sandstone, quartzite
- **Most fractured parts** of the Himalayas.
- **Naga fault line**- earthquakes and landslides
- **Rainfall** - 150-200 cm
- **Densely forested**
- **Elevation** decreases from **north to south.**
- **Convex to the west.**
- **Low hills** where Jhum cultivation is prevalent.
- **Major Hills**:

Dafla Hills	● **Location**: north of Tezpur and north Lakhimpur ● Bounded on **west** by the **Aka Hills** and on the **east** by the **Abor Range.**
Abor Hills	● **Location:** region of Arunachal Pradesh in NE of India, near China border ● Bordered by **Mishmi Hills** and **Miri Hills.** ● **Drained by the Dibang River**, a tributary of the Brahmaputra.
Mishmi Hills	● **Location:** southward extension of the Great Himalayan ranges. ● **Northern and eastern parts touch China.**
Patkai Bum Hills	● **Location:** India's NE border between Arunachal Pradesh and Myanmar. ● **"Patkai" - "to cut chicken"** in Tai-Ahom language. ● **Originated by the same tectonic processes** that resulted in the **formation of the Himalayas** in the Mesozoic. ● Have **conical peaks, steep slopes** and **deep valleys** ● **Not** as **rough** as the **Himalayas**. ● Whole region is **surrounded by forests** composed of sandstones.
Naga Hills	● **Location:** extending into Myanmar forms a divide between India and Myanmar. ● **Highest peak** - Saramati. ● Receive a **heavy monsoon rainfall** and densely forested.
Manipur Hills	● **Location:** north of Nagaland, Mizoram in the south, upper Myanmar in east and Assam in the west bound Manipur Hills. ● **Border** between **Manipur and Myanmar.** ● **Loktak Lake** - only floating national park of the world. ● **Keibul-Lamjao national park** situated here.
Mizo Hills	● **Location-** south-eastern Mizoram state. ● **Formerly** known as **Lushai Hills.** ● **Highest part**- Blue Mountain. ● Part of the **North Arakan Yoma system.** ● Also known as **'Molasses basin'** - made up of **soft unconsolidated deposits.** ● **Shifting agriculture** and some **terrace cultivation** practised.
Tripura Hills	● series of **parallel north-south folds**, **decreasing** in **elevation** to **south**. ● Merge into **greater Ganges-Brahmaputra lowlands** (aka Eastern Plains).
Mikir Hills	● **Location-** south of the Kaziranga National Park, Assam. ● Part of the **Karbi Anglong Plateau.** ● **Mikir Hills** - oldest landform in Assam. ● **Radial drainage pattern** ● **Major rivers**- Dhansiri and Jamuna. ● **Highest peak –** Dambuchko.
Garo Hills	● **Location:** Meghalaya state. ● **Highest peak**: Nokrek Peak.
Khasi Hills	● Part of **Garo-Khasi Range** in Meghalaya. ● **Cherrapunji** - East Khasi Hills. ● **Highest peak**: Lum Shyllong.
Jaintia Hills	● **Location:** further to the east of the Khasi Hills.
Barail Hill	● **Location:** North Cachar Hill District. ● **Southwestern extension** of the **Patkai Range.** ● Runs in a **south-westerly direction from southern Nagaland** and parts of **northern Manipur** up to the Jaintia Hills of Meghalaya.

Himalayan Passes

1. Passes of Jammu and Kashmir and Ladakh

Banihal Pass (Jawahar Tunnel)	● A famous pass in Jammu and Kashmir. ● Situated in **Pir- Panjal Range**. ● Connects **Banihal with Qazigund**.
Zoji La	● Connects **Srinagar with Kargil and Leh.** ● **Border Road Organization**- clears and **maintains** the road, especially during winter.
Burzil Pass	● **Srinagar- Kishan Ganga Valley** ● Joins the Valley of **Kashmir with** the **Deosai Plains of Ladakh**.
Pir-Panjal Pass	● A traditional pass **from Jammu to Srinagar**. ● **Closed after the partition**. ● **Shortest roadway access to Kashmir** valley from Jammu.
Qara Tagh Pass	● Located in the **Karakoram Mountains**. ● A **subsidiary of the ancient silk route.**
Khardung La	● **Highest motorable pass** in the country (5602 m). ● **Connects Leh and Siachen** glaciers. ● **Closed** during the **winter**.
Thang La	● Located in **Ladakh**. ● **Second highest motorable** mountain **pass** in **India**.
Aghil Pass	● **North of Mount Godwin-Austen** in Karakoram. ● Connects **Ladakh with Xinjiang province** of China.
Chang-La	● Connects **Ladakh with Tibet.**
Lanak La	● **Aksai Chin** in Ladakh region. ● Connects **Ladakh and Lhasa**. ● **Chinese** authorities have built a **road to join Xinjiang with Tibet**.
Khunjerab Pass	● **Kashmir** and **China** ● On the **Indo-China border**
Mintaka Pass	● **Kashmir and China** ● **Tri Junction** of **India-China** and **Afghanistan border**

2. Passes of Himachal Pradesh

Shipki La Pass	● Passes **through Sutlej Gorge.** ● **Connects Himachal Pradesh with Tibet.** ● **India's 3rd border post** for **trade with China** (Lipu Lekh and Nathula Pass)
Bara-Lacha Pass	● **Himachal Pradesh- Leh-Ladakh** ● Situated **on the National Highway** in Jammu and Kashmir. ● Connects **Manali and Leh**.
Debsa Pass	● Joins **Spiti and Parvati Valley.** ● **Between the Kullu and Spiti** of Himachal Pradesh. ● **Bypass** route of **Pin-Parvati Pass.**
Rohtang Pass	● **High road transportation**- high jams ● Connects **Kullu, Spiti, and Lahaul.**

3. Passes of Uttarakhand

Lipu Lekh	● Connects **Uttarakhand with Tibet.** ● **Important border post** for trade with China. ● The **pilgrims for Kailash-Manasarovar travel** through this pass.
Mana Pass	● Located in the **Greater Himalayas**. ● Connects **Tibet with Uttarakhand.** ● **Remains under snow for six months** during winter.
Mangsha Dhura Pass	● Connects **Uttarakhand-Tibet**. ● **Known for landslides**. ● **Pilgrims for Manasarovar** cross this route.
Muling La	● **Seasonal pass** ● Connects **Uttarakhand with Tibet** ● Snow covered during the winter season
Niti Pass	● **Joins Uttarakhand with Tibet.** ● Remains **snow-covered during the winter** season.
Traill's Pass	● Situated at the **end of the Pindari glacier**. ● Connects the **Pindari valley to Milam valley**. ● **Steep** and rugged.

4. Passes of Sikkim

Nathu La Pass	● Located on the **India- China border.** ● Forms a part of an **offshoot of the ancient silk route.** ● One of the **trading borders posts between India and China.**
Jelep La Pass	● Passes **through the Chumbi valley.** ● Connects **Sikkim with Lhasa**, the capital of Tibet.

5. Passes of Arunachal Pradesh

Bomdi-La	● Connects **Arunachal Pradesh-Lhasa**, the capital city of Tibet. ● Located in the **east of Bhutan.**
Dihang pass	● **Located** in the **Northeastern states of Arunachal Pradesh.** ● **Connects Arunachal Pradesh with Myanmar** (Mandalay)
Diphu pass	● An alternate route to **Myanmar.** ● **Remains open throughout the year** for transportation and trade.
Lekhapani	● **Remains open throughout** a year for transport and trade. ● Connects **Arunachal Pradesh with Myanmar**.
Pangsan Pass	Connects **Arunachal Pradesh and Myanmar**.

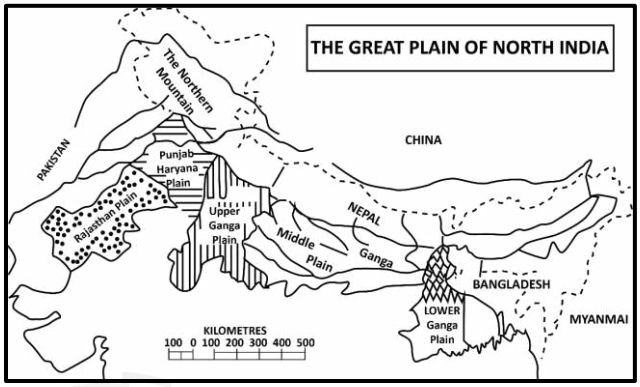
Yonggyap Pass	Connects **Arunachal Pradesh with Tibet**
Kumjawng Pass	Connects **Arunachal Pradesh with Myanmar**
Hpungan Pass	Connects **Arunachal Pradesh with Myanmar**
Chankan Pass	Connects **Arunachal Pradesh with Myanmar**

Tuju Pass:

- **Manipur.**
- Connects **Imphal to Myanmar**.

2. Great Plains of India

- Lie to the **south of Shiwalik** separated by the Himalayan Front Fault (HFF).
- A **transitional zone between the Himalayas** and **Peninsular India**.
- **Aggradation plain** formed by **alluvial deposits of the Indus, Ganga, Brahmaputra** and their tributaries.
- Stretches for about **2400 km from west to east.**
- **Width**- 90-100 in Assam, 160 km near Rajmahal (Jharkhand), 200 km in Bihar, 280 km near Allahabad and 500 km in Punjab. (Increases from east to west.)
- **Consists largely of alluvial deposits** brought down by rivers of the Himalayan and the Peninsular region.
  - **Maximum depth > 8000 metres** - Ambala, Yamunanager and Jagadhri (Haryana).
- Merges into the **Thar Desert** in the **southwest**.
- A **low watershed of the Delhi ridge** (278 m) + **Yamuna** River **separates** the **Satluj plains** (a part of the Indus plain) from the **Ganga plains**.



Divisions of the Great Plains

A. <u>North-South Division of Great Plains of India</u>

1. Bhabar	● Along the **foot of Siwaliks** with remarkable continuity **from Indus to Tista.** ● **8-16 km wide belt** consisting of **gravel and unassorted sediments** ● **Deposited** by **Himalayan rivers** in the foreland zone **due to sudden slope break**. ● **Himalayan rivers deposit** their loads along the **foothills** in the form of **alluvial fans.** ○ **Coarser sediments** merged to build up piedmont plain/ Bhabar. ● Most **unique feature** - **porosity**. ○ Porous due to the **deposition of a huge number of pebbles** and **rock debris** across the alluvial fans. ○ **Not suitable for agriculture** ● **Comparatively narrow** in the **east**
2. Tarai	● **10-20 km wide marshy region** in the **south of Bhabar** and runs parallel to it. ● **Wider in eastern parts** of the Great Plains - Brahmaputra valley due to heavy rainfall. ● **Re-emergence of underground streams** of the Bhabar belt ● Most of Terai land (especially in Punjab, Uttar Pradesh and Uttarakhand) has been **reclaimed and turned into agricultural land** over some time. ● Receives **high rainfall** and has **excessive humidity**. ● Has **underground streams** $\rightarrow$ ground **marshy**. ● **Suitable for** wheat, maize, rice, rice, sugarcane, etc.
3. Khadar	● **Younger alluvium** of flood plains of numerous rivers ● Also known as **Bet/betlands** (in Punjab). ● **Contains new alluvial deposits** along the course of the river. ● **Alluvium** – light-coloured and poor calcareous matter consisting of sand, silt, mud and clay deposits. ● Suitable for **extensive cultivation**. ● **Rivers in the Punjab-Haryana** plains have **broad floodplains** of Khadar **flanked by bluffs** known as Dhayas.
4. Bangar or Bhangar Plains	● **Uplands** (alluvial terrace) formed by **deposition of older alluvium.** ● **Lies above the flood limit** of the plains. ● **Main constituent: clay.** ● **Rich in humus - high yield.**

	● **Contains** Calcium Carbonate nodules known as **'Kankars'** - impure and found in doabs ● **Regional variations**: ○ **Barind plains**- the deltaic region of Bengal ○ **Bhur formations** - middle Ganga and Yamuna doab. ○ **'Reh', 'Kollar' or 'Bhur'** - Drier areas- exhibit small tracts of saline and alkaline efflorescence.

B. Regional Classification of Great Plains

1. Sindh Plain

- Lies **in Pakistan**
- Mainly **formed of** the **Bhangar Plains.**
- **Dhors: Long narrow depressions** - **remnants of** the course of **former rivers.**
- **Dhand: Alkaline lakes on some Dhors.**

2. Rajasthan Plains

- **Occupied by Thar Desert.**
- An **undulating plain** (average elevation - 325 m above mean sea level).
- **Desert region known as Marusthali** forms a greater **part of the Marwar plain.**
- Has a few outcrops of **gneisses, schists** and **granites**
  - Proof that it is **geologically a part of the Peninsular Plateau.**
- **Eastern part is rocky,** while the **western part** has **shifting sand dunes**.
- **Eastern part of Thar Desert** till **Aravalli Range** - **Rajasthan Bangar**- semi-arid plain.
- **Drained by** several **short seasonal streams** from the Aravali and **supports agriculture** in some patches of fertile tracts.
- **Luni –** a significant **seasonal stream** which **flows into Rann of Kutch.**
- **Tract north of Luni** - **thali** or sandy plain.

3. Punjab Plain

- Form the **western part of northern plain.**
- Majorly **in Pakistan.**
- **Divided into many Doabs**. Formed by **5 important rivers** of the Indus system.
- **Literally means** "(**The Land of Five Waters**" referring to: **Jhelum, Chenab, Ravi, Sutlej,** and **Beas.**

Sindh Sagar Doab	between the **Indus** and **Jhelum** rivers.
Jech Doabs/ Chaj Doab	between the **Jhelum** and **Chenab** rivers.
Rechna Doab	between the **Chenab** and **Ravi** rivers.
Bari Doabs	between the **Ravi** and **Beas** rivers.
Bist Doab	between the **Beas** and **Sutlej** rivers.

- **Total area** - 1.75 lakh sq km.
- **Average elevation** - 250 m above mean sea level.
- **Eastern boundary** - Delhi-Aravali ridge.
- **Northern part** [Shivalik hills] is **intensively eroded** by numerous **streams** called **Chaos**.
  - Resulted in **enormous gullying**.
- **South of Satluj river** - **Malwa plain** of Punjab.
- **Area** between the **Ghaggar and Yamuna rivers - 'Haryana Tract'**.
  - **Water divide** b/w **Yamuna and Satluj** rivers.

Other Doabs of India:

- **Malwa Doab:** Covers Madhya Pradesh and parts of north-eastern Rajasthan.
- **Raichur Doab:** A triangular region of Andhra Pradesh and Karnataka lying between Krishna and its tributary Tungabhadra River.

4. Ganga Plain

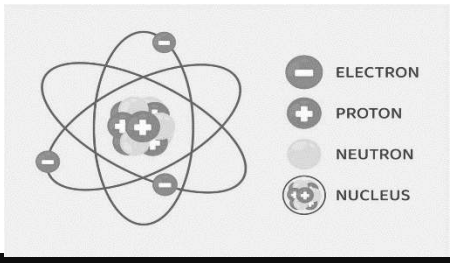
- **Extend from Yamuna River** in west **to western borders of Bangladesh** (~ 1,400 km).
- **Average width** - 300 km.
- **Maximum height** - Saharanpur (276m) - decreases towards Sagar Islands (3 m).
- **Largest unit of Great Plain** of India - from **Delhi to Kolkata** (about 3.75 lakh sq km).
- **Major Himalayan river**- Ganga.
- **Peninsular rivers** - Chambal, Betwa, Ken, Son, etc. (join Ganga river system - contribute to formation of this plain).
- **Slope -** east and south east.
- **Rivers flow sluggishly in lower sections of Ganges** resulting in levees**, bluffs, oxbow lakes, marshes, ravines,** etc.
- **Rivers keep shifting their courses** making this area **prone to frequent floods**.
  - **Kosi** river- 'Sorrow of Bihar'.

47 CHAPTER Chemistry

Atomic Structure

Fundamental Constituents of an Atom

- An atom contains **three basic particles** namely protons, neutrons and electrons.
- The **nucleus** of the atom contains **protons** and **neutrons**.
  - **Protons** are **positively charged**.
  - **Neutrons** are **neutral**.
- The **electrons** are located at the **outermost regions** called the **electron shell**.

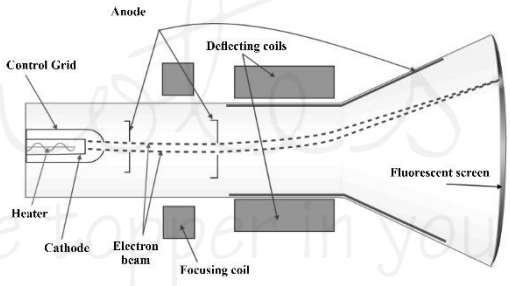


Electron

- **J. J. Thomson**, in **1897**, discovered **negatively charged particles** emitted by the **cathode** towards the anode in a cathode ray experiment.
- These **negatively** charged particles are **Electrons**.

Cathode ray experiment

- **J. J. Thomson** discovered the **existence** of **electrons**.
- He did this using a cathode ray tube, which is a **vacuum-sealed tube** with a **cathode** and **anode** on one end that created a **beam** of electrons travelling towards the other end of the tube.
- The air inside the **chamber** is subjected to **high voltage** and **electricity** flows through the air from the **negative electrode** to the **positive electrode**.
- The **characteristics** of cathode rays (electrons) **do not depend** upon the **material** of **electrodes** and the **nature** of the **gas** present in the cathode ray tube.
- The experiment showed that the **atom** was **not** a **simple**, **indivisible** particle and contained **at least one subatomic particle** – the electron.



Protons

- **Ernest Goldstein**, in 1886, discovered that with a different condition in the same chamber, **anode** emitted **positively charged particles** known as **Canal rays** or later named as **Protons**.

Neutrons

- **J. Chadwick** discovered a subatomic particle with **no charge** and a **mass** equivalent to **protons** in the nucleus of all atoms.
- These **neutrally charged** particles are Neutrons.

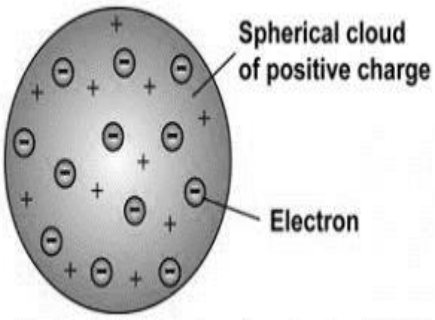
Properties of electrons, protons, and neutrons

Property	Electrons	Protons	Neutrons
Charge	Negatively Charged	Positively Charged	No Charge
Affinity	Attracts to positively charged	Attracts to negatively charged	Get attracted neither to positive nor negative
Weight	Mass is negligible	1 a.m.u	1 a.m.u
Location	Outside the nucleus	Within the nucleus	Inside the nucleus

Different Models on Structure of an Atom

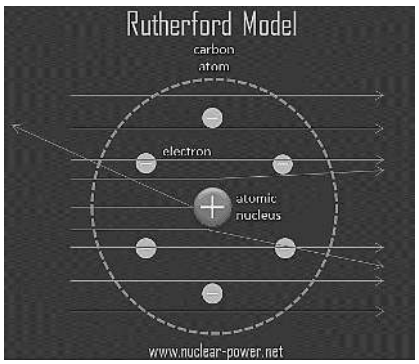
Thomson's Model of an Atom

- **J. J. Thomson** proposed that the structure of an atom is similar to that of a **Christmas pudding** where electrons are embedded like currants in the sphere.
- He **proposed** that:
  - The **structure** of an **atom** is a **positively charged sphere** that embeds electrons in it
  - An atom is **electrically neutral** as the **protons** and **electrons** are **equal** in magnitude
- **Drawbacks** of Thomson's Model:
  - Thomson's structure of an atom **failed** to **explain** the **arrangement** of **protons** and **electrons** in its structure.



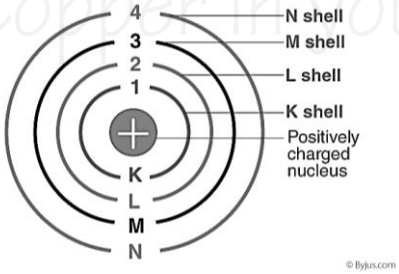
Rutherford's Model of an Atom

- **Rutherford** conducted an experiment **bombarding** the **alpha (α)-particles** on a **gold foil**.
- He observed the **trajectory** of the **alpha (α)-particles** after passing through an atom and **drafted** some **postulates** of the experiment, which are:
  - **Most** of the **space** in an **atom** is **empty** as the **particles passed** through the **gold foil** without any **hindrance**
  - The **positively charged centre** is called the **Nucleus**, and all the **mass** of an atom **resides** in the **centre**.
    - **The** particles **deflected 180°** after **bombarding** the **nucleus**
  - The **electrons orbit** the centre in a **defined path**
  - The **size** of the **nucleus** is **small** compared to the total size of the atom
- **Drawbacks** of the Model:
  - Although **Rutherford** presented an **entirely new model** regarding the structure of the atom, there were a lot of drawbacks which he failed to explain, are-
    - The **electrons revolve** in an **unstable path**, and they undergo **acceleration radiating energy**.
    - When the **electrons revolve**, they **lose energy**.
    - Soon electrons would **collapse** into the **nucleus**.
    - This tendency would make an **atom highly unstable** while the **atom** is **highly stable**
    - Rutherford's structure of an atom **failed** to **explain** the **atomic number** concept as it explained only the presence of protons in the nucleus



Bohr's Model of an Atom

- Bohr devised a model in order to **overcome** the **objections** that **Rutherford's model** raised.
- So, he stated the following **postulates**:
  - An atom **permits** only a **discrete** amount of **orbitals** for the **electrons** to **orbit** and make the outer structure of an atom
  - While revolving, the **negatively charged particles** do **not lose energy** in these **orbitals** or **energy levels**
  - When the **electron jumps** from **one energy shell** to **another**, a change in magnitude takes place
- Bohr's model gives an **elaborative explanation** on the structure of an atom and **overcomes** the **objections** faced by all the other models on the structure of an atom**.**



Distribution of Electrons in Distinct Shells

- Bohr-Bury Scheme **suggested** the **arrangement** of **particles** in **different orbits**.
- The following are the rules to write the number of particles in different orbitals:
  - The formula **2n^2** gives the accommodation of the **maximum number of electrons** in each shell, n=1, 2, 3, 4 for K=2, L=8, M=18, N=32.
  - The **outermost orbit** can hold a **maximum** of **8 electrons.**
  - The electrons fill the inner levels first as they **follow** the **stepwise filling of orbitals**
- **Number of electrons in K-shell:** n = 1
  - 2n^2 = 2 × 1^2 = 2
  - Maximum number of electrons in K-shell, first shell = 2

- **Number of electrons in L-shell, n** = 2,
  - 2n^2 = 2 × 2^2 = 8
  - Maximum number of electrons in L-shell, Second shell = 8
- Using the **formula 2n^2** number of **electrons** in any shell can be **calculated**.

Valency

- **Valence Electrons** - The negatively charged particles present in the outermost shell.
  - These valence electrons are **responsible** for the **valency** of an atom.
- **Valency** - tendency of an atom to react with the other atoms of the same or various elements.
  - The atoms that fill the **outermost paths** show **chemical activity** towards other valence electrons.
  - This reactivity is **responsible** for the **formation** of **molecules** between two or more atoms.
- The valency **becomes zero** for an **atom** when the **outer bounds** have **eight electrons** or **no electrons** to lose.
- The particle with **eight electrons** in the **outermost shell** is an octet, and these molecules are **mostly inert** in nature.
- **Eg**:
  - **Magnesium** (Mg) has a configuration (2, 8, and 2), so the valency is two.
  - **Oxygen** (O) (2, 8, and 6) has the valency two as the number electrons it can gain is two to achieve a packed outer energy level.
  - **Helium** (He) has 2 electrons in its outer shell, Neon (Ne) (2, 8, and 8) has eight electrons in its outer shell.
    - Hence, they do not show any chemical activity.

Atomic Number (Z)

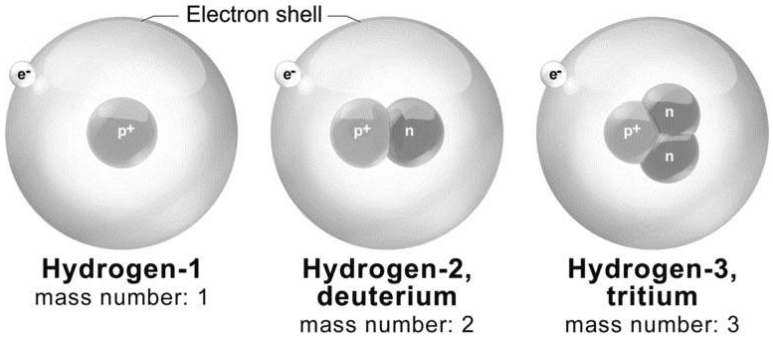
- Atomic number = **number of protons** present in one atom of an element.
- As the atom is **electrically neutral**, the number of **protons** and **electrons** are the same.
- The notation **Z** denotes an **Atomic number**.
- The atomic number of Hydrogen is one as it has **only one proton.**
  - **Number of Protons** present in an atom = Atomic number (Z)
  - **Number of Electrons** present in an atom= Atomic number (Z)
  - **Number of Neutrons** = Mass number (A)- Atomic number (Z)

Mass Number (A)

- Measure of the **total** number of **protons** and **neutrons** in the nucleus of an atom.
- The notation **A** indicates the Mass number.
- N = total number of **neutrons**.
- Mass Number = **Atomic Number + Number of Neutrons** in the Nucleus
  - A = Z + n°
- aka **Nucleon** number.

Isotopes

- The atoms of the **same elements** with the **same atomic number** and **different mass numbers**.
- **Hydrogen** has **three isotopes**: *Protium, Deuterium, Tritium*.



Isobars

- The atoms of **different molecules** with the **same mass number**.
- **Eg**, in **Calcium**, atomic number 20, and **argon**, atomic number 18, the mass number of both these elements is 40.
  - This shows that the total number of **nucleons** is the **same** in the atoms.

Metals, Non- metals and Metalloids

Metalloids

- Elements which have the properties of both metals and non-metals are known as metalloids.
  - For example, Boron, Arsenic, etc.

METALS

Physical Properties
- Solid.
- Lustrous.
- Malleable and ductile.
- Hard and have high density.
- Good conductors of heat and electricity.
- High melting and boiling points.

Chemical Properties
- React with dilute acids to liberate hydrogen gas
- React with oxygen to form basic oxides.
- Do not combine with hydrogen.
- React with water to form metal oxides or metal hydroxides.
- Electropositive i.e. form positive ions by losing electrons.
- Reducing agents.

METALS AND NON-METALS

NON-METALS

Physical Properties
- Solids, liquids and gases.
- Non-lustrous.
- Non-malleable and non-ductile.
- Varying hardness and have low density.
- Poor conductors of heat and electricity.
- Low melting and boiling points.

Chemical Properties
- Do not displace hydrogen on reaction with dilute acids.
- React with oxygen to form acidic or neutral oxides
- Combine with hydrogen to form stable hydrides.
- Do not react with water.
- Electronegative i.e. form negative ions by gaining electrons.
- Oxidising agents.

Corrosion

The eating up of metals by the action of air and moisture or a chemical on their surface.

Alloys

It is a homogeneous mixture of two or more metals (or a metal and a non-metal). For e.g. Brass is an alloy of 2 metals-copper and zinc.

Rusting

The corrosion of iron is known as rusting. Rust is hydrated iron (III) oxide, $Fe_2O_3 . xH_2O$.
Presence of air and water are the two conditions necessary for rust. It can be prevented by painting, applying grease, by galvanization and by alloying.

Ionic Compounds
1. Usually crystalline solids.
2. Have high melting point and boiling point.
3. Conduct electricity when dissolved in water or melted.
4. Usually soluble in water and insoluble in organic solvent.

Covalent Compounds
1. Usually liquids / gases, few are solids.
2. Have low melting and boiling point.
3. Do not conduct electricity.
4. Usually insoluble in water and soluble in organic solvents.

Table 5.6 Modern Periodic Table

Metals | Metalloids | Non-metals

The zigzag line separates the metals from the non-metals.

PERIODS	GROUP NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.0																	2 He Helium 4.0
2	3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
3	11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulphur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
4	19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.8	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
5	37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (99)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.3	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
6	55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La* Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 181.0	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac** Actinium (227)	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	–	114 Uuq	–	Uuh	–	–

* Lanthanoides	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.5
** Actinoides	90 Th Thorium 232.0	91 Pa Protactinium (231)	92 U Uranium 238.1	93 Np Neptunium (237)	94 Pu Plutonium (242)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (245)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (253)	101 Md Mendelevium (256)	102 No Nobelium (254)	103 Lr Lawrencium (257)

Properties of Metalloids

- They have a metallic luster but behave like non-metals.
- They are brittle, shiny substances
- They are solid at ambient temperatures and have relatively high melting points.

Melting Temperatures of Metalloids

Element	Melting Temperature (°C)
Boron	2079
Silicon	1410

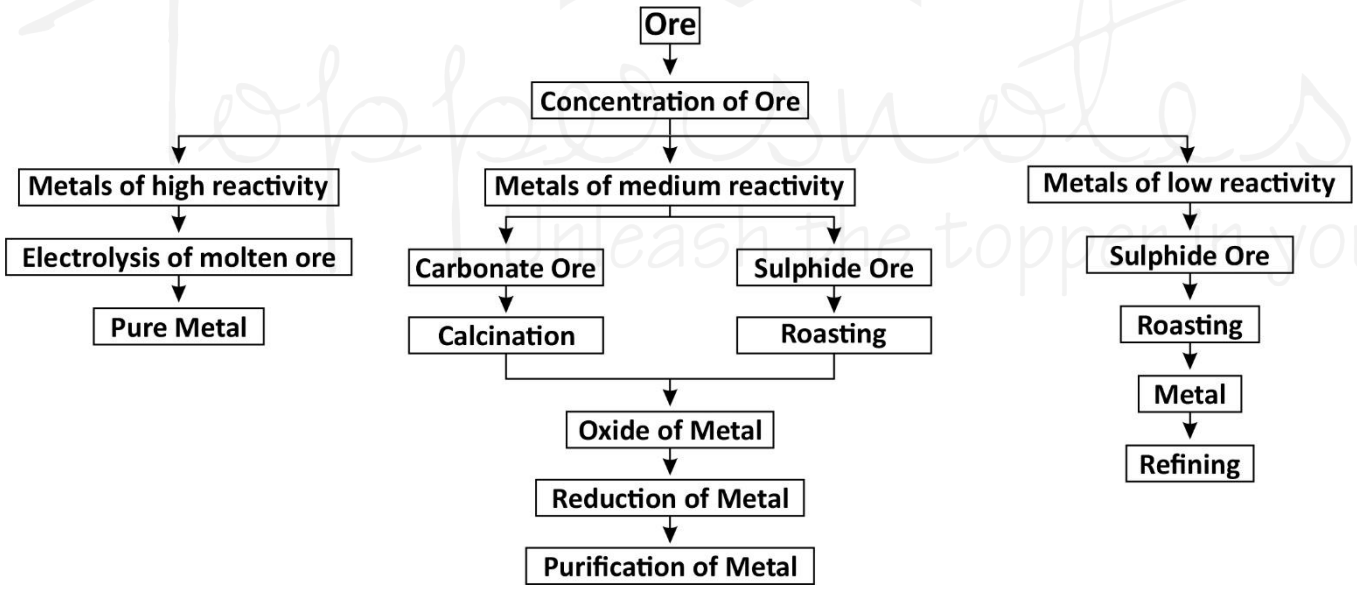
Germanium	938.3
Arsenic	817
Tellurium	449.5
Antimony	631

- They are good electric conductors but poorer than metals.
- They have intermediate energies of ionisation and values of electronegativity
- Like non-metals, they form anions, have multiple oxidation states, and form covalent bonds
- They form metallic alloys.

Metalloids and their applications

Element	Description	Application
Boron	An allotropic semimetal that is extremely hard and heat resistant. Has an atomic number of 5.	Used with silicon to make thermal shock-resistant glass.
Silicon	A grey and shiny semiconductive metal. It has high melting (1,410 °C) and boiling points (3,265 °C). Has an atomic number of 14.	Commonly used for semiconductors.
Germanium	Is hard and brittle in its elemental form. Has an atomic number of 32.	Less commonly used for semiconductors.
Arsenic	A steel-grey semimetal known for being poisonous. It has an atomic number of 33.	Often used as an insecticide.
Tellurium	Brittle in its elemental form. It is a chalcogen, along with selenium and sulfur. It has an atomic number of 52.	Used as a steel additive to improve machinability.
Antimony	A hard and brittle semimetal with an atomic number of 51.	Used to colour paints; often alloyed with lead.

Metallurgical Principles and methods



- **Metallurgy** - a process that is used for the extraction of metals in their pure form.
- **Minerals** - The compounds of metals mixed with soil, limestone, sand, and rocks.
- Metals are **commercially extracted** from **minerals** at **low cost** and minimum effort.
  - These minerals are known as **ores**.
- A **substance** which is added to the **charge** in the **furnace** to remove the **gangue** (impurities) is known as **flux**.
- Metallurgy **deals** with the **process** of **purification** of **metals** and the **formation** of **alloys**.

Steps in Metallurgical Process

- The following are the various **steps** in the metal extraction or metallurgical process:
  - **Crushing** and **grinding** the ore.
  - The **concentration of ore**, is also known as ore enrichment.
  - **Metal extraction** from concentrated ore.
  - Impure metals are **refined** or **purified**.

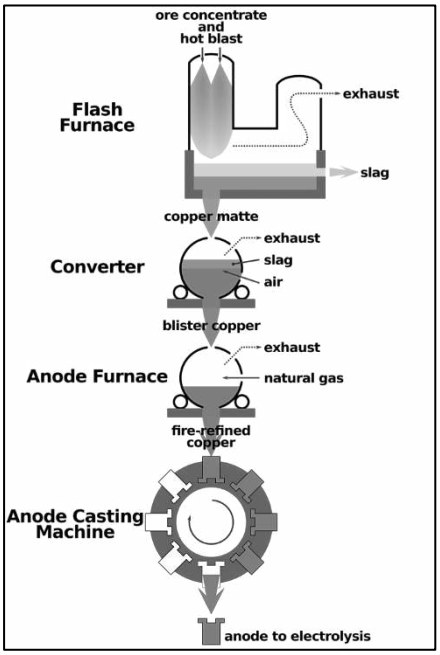


Fig. Copper Flash Smelting Process

Principles of Metallurgy

- The metallurgical process can be **classified** as the following:
  - Crushing and grinding
    - The **first process** in **metallurgy**.
    - Crushing of ores into a **fine powder** in a **crusher** or **ball mill**.
- This process is known as **pulverization**.
  - Concentration of ores
    - aka **ore dressing.**
    - It is the process of **removing impurities** from ore.
    - In metallurgy, we concentrate the ores mainly by the following **methods**.
  - Hydrolytic method
    - The **ore** is **poured** over a sloping, **vibrating** corrugated **table** with grooves.
    - A **jet** of **water** is allowed to **flow** over the **surface**.
    - The denser ore particles **settle** in the **grooves**, and the **impurities** are **washed away** by water.
  - Magnetic separation
    - The **crushed ore** is placed on a **conveyor belt**.
    - This belt **rotates** around **two wheels** in which one of the **wheels** is **magnetic**, and therefore the **magnetic particles** get **attracted** to the **magnetic wheel** and fall apart from the **non-magnetic particles**.
  - Froth floatation
    - The **crushed ore** is taken in a **large tank** which contains **oil** and **water**.
    - A **current** of **compressed** air is **passed** through it.
    - The ore gets **wet** by **oil** and is **separated** from the **impurities** in the form of **froth**.
    - **Ore** is **lighter**, and so it **comes** on the **surface** and impurities are left behind.
  - Roasting and calcination
    - **Roasting** - The process of heating a concentrated ore in the **presence** of **oxygen**.
- This process is applied in the case of **sulfide ores**.
  - **Calcination** - For ores containing **carbonate** or **hydrated oxides**, heating is done in the **absence** of **air** to melt the ores.

Important ores and alloys

Ores

- A mineral from which a metal can be extracted economically is called an ore.
- In it, a metal is present in appreciable quantities and from which the metal can be extracted economically.
- The main active substances present in nature, expecially in the atmosphere are oxygen and carbon dioxide.
- In the earth's crust, sulphur and silicon are found in large quantities.
- Sea-water contains large quantities of chloride ions (obtained from dissolved sodium chloride).
- Most active metals are highly electropositive and therefore exist as ions.
- It is for this reason that most of the important ores of these metals occur as
  - Oxides
  - Sulphides
  - carbonates
  - halides
  - silicates
- Some sulphide ores undergo oxidation by air to form sulphates.
  - This explains the occurrence of sulphate ores.
- Ores are invariably found in nature in contact with rocky materials.
  - These rocky or earthy impurities accompanying the ores are termed as gangue or matrix.