NCA Test Series Final
General Science

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Q.3 (a)

Why Do Atoms Form Chemical Bonds?

① Achieving Stable Electron Configuration
→ atoms have a tendency to seek a stable electron arrangement, usually by filling outermost electron shell to maximum capacity (octet rule)

② Lowering Energy
→ bonding lowers energy of system
→ through share/transfer of e^-, resulting molecule has lower potential energy than individual atoms

③ Increasing Stability Through Bond Types
Atoms bond in different ways to achieve stability:
Covalent → share e^- to fill outer shells
Ionic → transfer e^- to form positive and negative ions that attract each other
Metallic → share a sea of e^- that move freely

④ Electronegativity + Charge Distribution
→ atoms will bond in a way that minimizes their potential energy and creates a stable distribution of e^-

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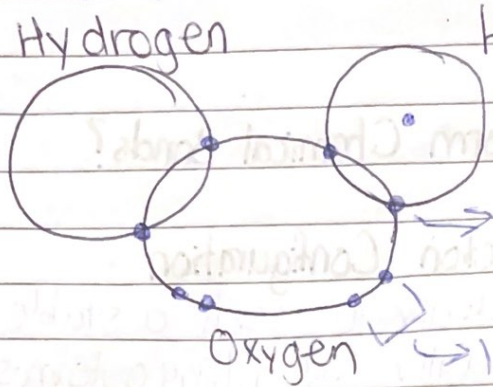
Covalent Bond in Water Molecule



Formation of Covalent Bond

→ each H atom shares its single e⁻ w/ O atom
→ in turn, O atom shares one of its e⁻ w/ each H atom
→ sharing creates 2 covalent bonds, one between the O and each H atom

Nature of Bond

→ polar covalent bond → O is more electronegative than H, attracts shared e⁻ more strongly
→ shared e⁻ closer to O atom, creating partial -ve charge on O atom and partial +ve charge on H atom

Bond Angle + Geometry

→ bent shape, due to repulsion between lone pairs of e⁻ on O atom
→ bond angle = 104.5°

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Q.3. (b)

What is Doping?

Definition

→ the process of intentionally introducing impurities into a pure material to modify its electrical / optical / mechanical properties

Application

→ commonly applied in semiconductors to enhance their conductivity or in ceramics to tailor their functional properties

In ceramics, doping can affect:

1) Electrical conductivity
2) Mechanical Strength
3) Thermal Stability

Types of Doping

① N-Type Doping

→ adding a small amount of impurity w/ more valence e⁻ introduces free e⁻.

→ These e⁻ can move and carry electric current, enhancing conductivity

② P-Type Doping

→ adding an impurity with fewer valence e⁻ creates "holes" in crystal structure

→ these holes can move as neighbouring e⁻ jump into them, conducting electricity

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Types of Ceramics

① Traditional Ceramics

→ made from naturally occurring materials such as clay / quartz / feldspar

E.g. earthenware → porous and opaque

② Advanced (Engineering) Ceramics

→ made from highly refined materials and designed for specific applications, such as electronics / aerospace / medical devices

E.g. oxide Ceramics

③ Glass Ceramics

→ formed by controlled crystallization of glass

→ high strength, low thermal expansion, excellent resistance to thermal shock

④ Bioceramics

→ used in medical applications due to their biocompatibility

⑤ Electoceramics

→ exhibit unique electrical properties

E.g. Ferroelectric ceramics

⑥ Refractory Ceramics

→ resistant to high temps, used in furnaces + kilns

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Q.3.(c)

Merits of Global Warming

- ① Longer Growing Seasons
→ in colder regions such as Siberia, warmer temps could extend the growing season for crops, yielding increased agricultural production

- ② New Agricultural Opportunities
→ areas that were previously too cold for farming, could become arable, enabling cultivation of new crops

- ③ Access to Arctic Resources
→ melting ice in Arctic has opened new shipping routes (e.g. Northwest Passage) and made previously inaccessible oil/gas/mineral resources now more accessible

- ④ Enhanced Plant Growth
→ higher levels of atmospheric CO_2 can boost photosynthesis, potentially increasing the growth of plants/forests

- ⑤ Potential Economic Benefits
→ warmer climates could increase tourism in certain regions that were previously too cold, boosting local economies

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Demerits of Global Warming

- ① Rising Sea Levels
→ melting polar ice caps and thermal expansion of seawater lead to rising sea levels, which threaten low-lying coastal regions (eg. Maldives)

- ② Threat to Biodiversity
→ many species are unable to adapt quickly to changing temperatures, leading to habitat loss, extinction, ecosystem imbalances

- ③ Health Risks
→ higher temps can exacerbate health problems, including heatstroke, respiratory issues, and the spread of diseases like malaria and dengue fever

- ④ Extreme Weather Events
→ increased global temps intensify weather events such as hurricanes, floods, droughts, and heatwaves, causing widespread damage and loss of life

- ⑤ Displacement of Populations
→ sea level rise and extreme weather events force millions of people to migrate → social/political tensions

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Q3.(d)

What is Polio?

Definition
→highly infectious disease caused by the poliovirus, which primarily affects children under the age of 5

Causes
Virus = poliovirus, member of Enterovirus genus
Transmission = fecal-oral route: ingesting food or water contaminated w/ feces from an infected person OR direct contact w/ respiratory droplets/saliva

Symptoms
→most cases (~70-90%) are asymptomatic
Mild Polio Symptoms = fever, fatigue, sore throat, headache, nausea, vomiting
Paralytic Polio Symptoms = stiffness in neck and back, pain in limbs

Prevention
① Oral-Polio Vaccine
→contains weakened live virus
② Inactivated Polio Vaccine
→injected
→ contains inactivated (killed) virus

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Challenges in Eradicating Polio in Pakistan

① Security Concerns
→ in conflict-prone areas such as Balochistan, safety of health workers is an issue
→ polio vaccination teams are often attacked, and face threats from militant groups

② Misinformation + Mistrust
→ widespread misinformation about polio vaccines, particularly in rural areas
→ some ppl believe vaccine is part of a foreign conspiracy

③ Weak Healthcare Infrastructure
→ in some parts of the country, infrastructure is inadequate, limiting the ability to reach every child with the polio virus

④ Political Will + Governance Issues
→ inconsistencies in political leadership and coordination at the provincial and federal levels, affecting the effectiveness of the national polio eradication program

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Section II

Q.6.(a)

Use Archimedes Principle = buoyant force acting on a submerged object is equal to the weight of the fluid displaced by the object

① Volume of Water Displaced

When boat sinks by 1 cm (0.01 m), additional volume of water displaced is:

Volume Displaced = length × breadth × depth

$= 3\,m \times 2\,m \times 0.01\,m$

$= 0.06\,m^3$

② Mass of Water Displaced

Mass of water displaced = Volume displaced × density of water

$= 0.06\,m^3 \times 1000\,kg/m^3$

$= 60\,kg$

∴ Mass of man is 60 kg

Q.6.(b)

Cost price of one ball = x

Total cost price of 17 balls = 17x

Loss = cost price of 5 balls = 5x

Selling Price = Cost Price - Loss

$720 = 17x - 5x$

$720 = 12x$

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$x = 720/12 = 60$

∴ Cost price of one ball is Rs. 60

Q.6(c)

Age (present) of Man = a

Present Age of son = b

$a = b + 24$ (24 years older than his son)

$a + 2 = 2b$ (in 2 years, age is twice the age of his son)

$a = 2b - 2$

Substitute into first equation:

$a = b + 24$

$2b - 2 = b + 24$

$b = 26$

∴ present age of son = 26 years

present age of dad = 26 + 24 = 50 years

Q.6(c)

Son's current age = x

Father's current age = x + 24 (24 years older than son)

In 2 years:

Son → x + 2

Father → x + 24 + 2 = x + 26

Father's age will be twice son's age

$x + 26 = 2(x + 2)$

$x + 26 = 2x + 4$

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$26 = x + 4$

$x = 22$

∴ Present age of son is 22 years old

Q.6.(d)

Rashid's Typing Rate:

$= \frac{32}{6} = \frac{16}{3}$ pages per hour

Kamran's Typing Rate:

$= 40/5 = 8$ pages per hour

Combined Rate (Kamran + Rashid):

$= 16/3 + 8 = 16/3 + 24/3 = 40/3$ pages per hour

Time to type 110 pages:

$\text{Time} = \frac{\text{Total Pages}}{\text{Combined Rate}} = \frac{110}{40/3} = \frac{110}{1} \times \frac{3}{40}$

$= \frac{330}{40} = 8.25$ hours

$\rightarrow$ 8 hours 15 minutes

∴ It will take Rashid and Kamran 8 hours and 15 minutes to type 110 pages together