GENERAL SCIENCE & ABILITY July 10, 2024

QUESTION NO. 03

(a) Why do atoms form chemical Covalent Bonds?

Chemical bond refers to the strong electrical forces of attraction between the atoms or ions in the structure. Atoms form chemical bonds in order to make their outer electron shells more stable. The type of chemical bond maximizes the stability of the atoms that form it. An ionic bond, where one atom essentially donates an electron to another, forms when one atom becomes stable by losing its outer electrons and the other atoms become stable by gaining the electrons. Covalent bonds form when sharing electrons results in higher stability. Some atoms do not combine with other atoms and exist around us as single atoms such as Noble gases. All other atoms therefore, bond together to become electronically more stable.

↓ because their outer shells are full.

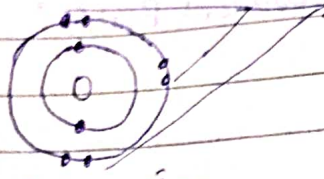
Covalent Bond in a Water molecule (H_2O):

When two non-metal atoms combine, they mutually share one, or more, pairs of electrons. This sharing is called covalent bond.

In water, both hydrogen and oxygen are non-metals. Hydrogen has an atomic number ($Z = 1$) and electronic configuration is written as $^1H \rightarrow 1s^1$. Hence it has one electron in its outermost shell. For attaining the nearest noble gas configuration each hydrogen atom shares its valence electron with other atoms and form a covalent bond.

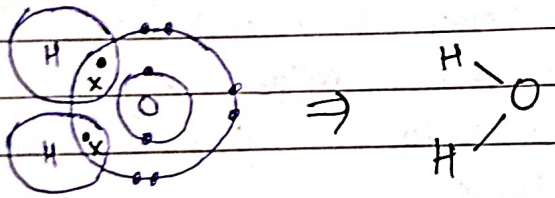
Hydrogen atom

Similaly oxygen has an atomic number ($Z=8$) and electronic configuration could be written as $1s^2, 2s^2, 2p^4 \leftarrow {}^8O$ - It has 6 electrons in outermost shell.

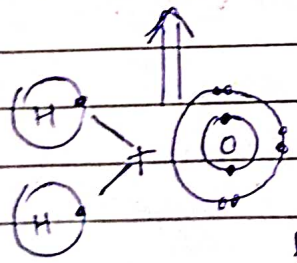


Oxygen atom

To form water molecule and to gain stability each of the two hydrogen atoms share their 1 valence electron to oxygen atom to complete its octet and hence become stable. Since hydrogen is only capable of sharing 1 electron therefore it will form single covalent bond with oxygen atom.



Structural formula of water molecule forming single covalent bonds.



formation of water molecule H_2O

(b)

DOPING:

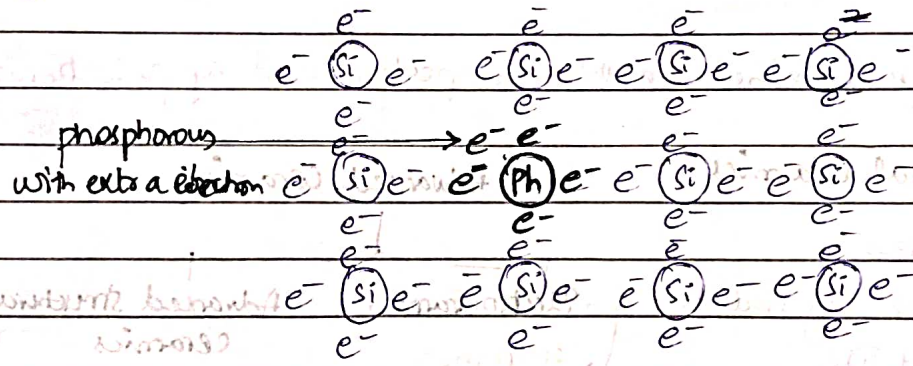
Doping is process of intentional introduction of impurities into an intrinsic semiconductor to modify its electrical properties. The impurities added are called **dopants**, and they can increase the number of free charge carries (electrons or holes) significantly in the semiconductor, thus enhancing its conductivity. Doping is a critical process in the fabrication of electronic devices such as diodes, transistors, and integrated circuits.

Types of Doping:

There are two types of doping:

1- N-type Doping:

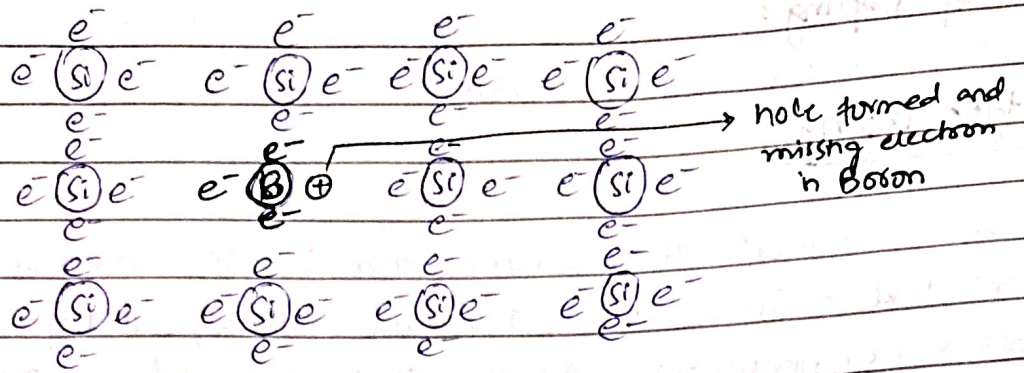
Elements with more valence electrons than the semiconductor are dopants like in silicon (having 4 valence electrons), n-type dopants include phosphorous, arsenic, or antimony which have 5 valence electrons. The extra valence electron from dopant material is needed for bonding with silicon atoms and thus becomes a free electron in semiconductor. This free electron increases the semiconductor's conductivity making it more negatively charged with electrons as majority charge carriers - n-type → negative type.



N-type semiconductor doped with phosphorous.

2- P-type Doping:

Elements with fewer valence electrons than semiconductor are dopants in p-type semiconductor like in silicon, common p-type dopants include boron (B), aluminum (Al) or gallium (Ga) which have 3 valence electrons. The dopant atom creates a "hole" by leaving one bond unsatisfied, it lacks enough electrons to form all 4 covalent bonds with Si atoms. These holes are positive charg carriers and makes the semiconductor positively charged - p-type - being majority carriers.



P-type semiconductor doped with Boron

CERAMICS:

Ceramics are non-metallic, inorganic materials that are typically in crystalline in nature and are compounds formed between metallic and non-metallic elements.

Ceramics can be classified on their composition and applications:

- Traditional ceramics
  - Whitewares
  - Structural clay Products
  - Brick and Tile
  - Abrasives
  - Refractories
  - Cement
- Advanced Ceramics
  - Electroceramics
    - Electronic substrate, packaged ceramics
    - Capacitor Dielectric
    - Magnetic Ceramics
    - Optical Ceramics
    - Conductive Ceramics
  - Advanced structural ceramics
    - Nuclear ceramics
    - Bioceramics
    - Tribological ceramics
    - Automotive ceramics.

1- Traditional ceramics:

- Ceramics made from natural raw materials and are often used for everyday products.
- used in construction materials, household items, bricks, tiles, dishes, pottery, art and decorative objects.

Examples: earthenware, porcelain, clay products.

2 - Electroceramics:

- Possess unique electrical properties such as piezoelectricity, ferroelectricity and superconductivity.
- used in capacitors, sensors, actuators, varistors etc.

Examples: Barium Titanate ($BaTiO_3$), lead Zirconate titanate (PZT) and zinc oxide (ZnO).

3 - Bioceramics:

- Biocompatible materials used for medical applications such as implants and prosthetics.
- used in joint replacements, bone and dental implants, tissue engineering scaffolds.

Examples: Hydroxyapatite, Bioglass, Zirconia, Alumina.

(C) GLOBAL WARMING:

Global warming refers to the recent and ongoing rise in global average temperature near Earth's surface. Global warming is causing climate patterns to change.

MERITS OF GLOBAL WARMING:

While global warming is largely seen as a detrimental phenomenon, some argue that there are few potential benefits:

1 - Longer Growing Seasons:

Warmer temperatures could extend the growing seasons in some regions, potentially increasing agricultural productivity in areas that were previously too cold for certain crops.

2- Increased Agricultural Yields:
Higher levels of carbon dioxide can enhance photosynthesis, leading to increased plant growth and potentially higher yields.

3- New Shipping Routes:
Melting ice in Arctic could open new shipping routes, reducing travel time and fuel consumption for shipping between Europe, Asia and North America.

4- Reduced Winter Mortality:
Milder winters may result in fewer cold-related deaths and illnesses, particularly in temperate regions.

5- Expanded Habitats for some species:
Warmer temperatures could expand the habitats for certain plant and animal species, allowing them to thrive in new areas.

DEMERITS OF GLOBAL WARMING:

While the merits of global warming are few, the demerits are far more extensive and severe:

1- Rising Sea levels: Melting polar ice caps contribute to rising sea levels, which can cause coastal flooding, erosion and displacement of communities.

2- Extreme weather events: Increased frequency and intensity of extreme weather events such as hurricane, heatwaves, droughts and heavy rainfall can cause a significant damage to infrastructure, agriculture and ecosystem.

3- Loss of Biodiversity: Many species maybe unable to adapt to rapid climate changes leading to habitat loss, reduced biodiversity and extinctions.

4- **Agricultural Disruptions:** while some regions may benefit from longer growing seasons, other may suffer from increased droughts, heat stress and shifting growing zones, negatively impacting food security.

5- **Health Risks:** Higher temperatures can exacerbate health issues such as heat stress, respiratory problems and spread of malaria and dengue fever.

6- **Ocean Acidification:** Increased CO_2 levels lead to ocean acidification, which harms marine life.

7- **Economic Costs:** The economic costs of adapting to climate change, repairing the damage from extreme weather events and mitigating its effects are substantial and can strain national & global economies.

8- **Displacement and Migration:** Rising sea levels, extreme weather events and resource scarcity can force communities to relocate leading to a mass displacement and migration.

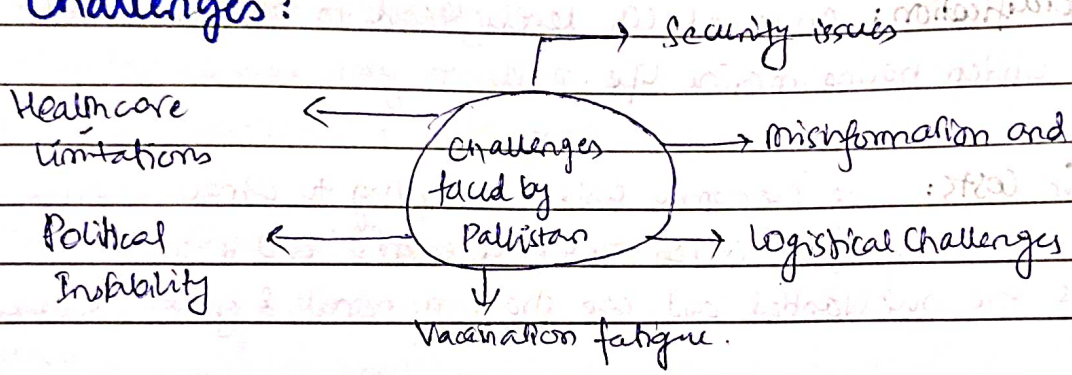
9. **Water Scarcity:** changes in precipitation patterns and increased evaporation rates lead to water shortages, affecting drinking water supplies, agriculture and hydropower generation.

(d) **Polio:**

Poliomyelitis (polio) is a highly infectious viral disease which mainly affects young children. It mainly affects children under 5 years of age. As long as a single child remains infected, children are at risk of contracting polio.

The poliovirus spreads in human faeces: People become infected with the virus through contaminated food and water, especially in areas where sanitation and hygiene are poor. Polio virus typically enters from mouth and proceeds through the digestive tract to the intestines. After multiplying in the body, the virus is shed in faeces, from which it can spread and cause further infections, especially when infected people dont wash their hands and touch food or other people.

Challenges:



(1) Security Issues:

- **Conflict zones:** Many polio-endemic regions in Pakistan such as KPK and Balochistan are conflict zones where vaccination teams face threats from militant groups.
- **Attacks on health workers:** Polio vaccination teams have been targeted with health workers being attacked or killed, leading to fear and reduced access to certain areas.

(2) Misinformation and Mistrust:

- **Myths and Rumors:** There are widespread rumors and myths about polio vaccine including false beliefs that it would cause infertility or contains harmful substances.
- **Suspicion of foreign influence:** Some communities are suspicious of vaccination campaigns, viewing them as foreign interventions or espionage efforts, partly fueled by historical events such as CIA's use of fake vaccination campaign in the hunt of Osama Bin Laden.

3- Logistical challenges:

- Remote and hard-to-reach areas: Many polio-endemic areas areas are remote with difficult terrain and limited infrastructure making it hard for vaccination teams to reach every child.
- Population movements: High mobility and population movements, including internal displacement due to conflict, making it challenging to track and vaccinate all children.

4- Healthcare System Limitations:

- Weak Health Infrastructure: The overall health infrastructure in Pakistan's regions is weak or with inadequate facilities and a shortage of trained healthcare workers.
- Lack of Coordination: There can be poor coordination between different health agencies and organizations involved in vaccination campaigns.

5- Vaccination fatigue:

Frequent polio vaccination campaigns can lead to vaccination fatigue, where parents and communities become less responsive to repeated efforts.

QUESTION NO. 04

(a) LIVER JUICE: BILE

"Bile", also known as liver juice - is a crucial digestive fluid produced by the liver and stored in the gallbladder. It plays a vital role in digestion and absorption of fats and fat-soluble vitamins in small intestine.

The liver cells (hepatocytes) continuously produce bile. Bile is secreted into small ducts that merge to form the common hepatic duct. Between meals, bile is stored and concentrated in the gallbladder. During storage, water and electrolytes are absorbed by gallbladder, making the bile more concentrated.

Composition of Bile:

Bile is a complex fluid consisting of:

- Bile salts: critical for emulsification and absorption of fats.
- Bile pigments: Bilirubin and biliverdin.
- Cholesterol: A lipid - forms gallstones if precipitates out of solution.
- Phospholipids: lecithin - help in emulsifying fats.
- Electrolytes: Sodium, potassium, calcium, neutralize stomach acids
- Water: primary solvent of bile, making upto about 85-95% of its composition.

FUNCTION OF BILE:

1- Emulsification of fats:

Bile breaks down large fat globules into smaller micelles, increasing the surface area for pancreatic lipases to act on, facilitating fat digestion.

2- Absorption of fat-soluble Vitamins:

Vitamins A, D, E and K which are fat-soluble, are absorbed more efficiently in the presence of bile.

3. Excretion of waste products:

Bile acts as a route for excretion of bilirubin (a byproduct of red blood cell breakdown) and excess cholesterol from the body.

4. Neutralization of Stomach Acid: Bicarbonate ions in bile help neutralize the acidic chyme that enters the small intestine from stomach, creating an optimal pH for enzyme activity in intestines.

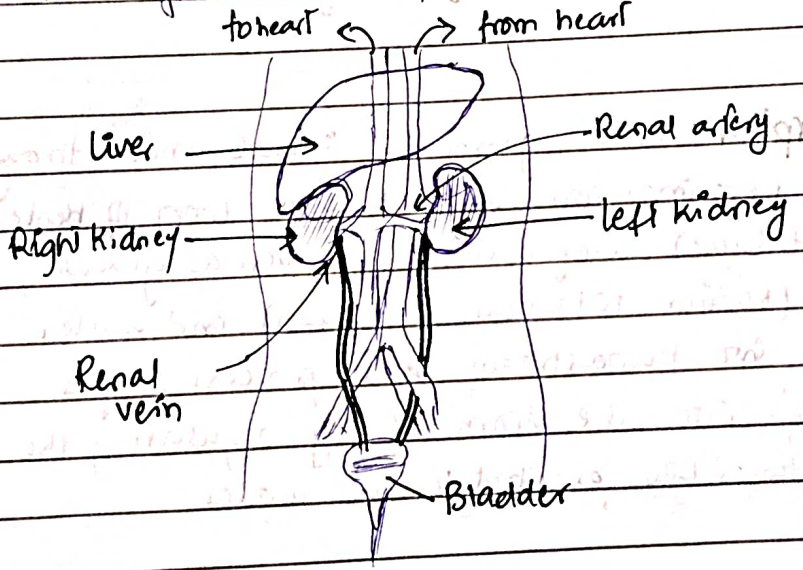
Regulation of Bile:

The secretion and release of bile are regulated by hormonal and neural mechanisms and its dysfunction can lead to various medical conditions such as gallstones and jaundice.

(b)

ROLE OF KIDNEY IN EXCRETION SYSTEM:

The kidneys play a vital role in the excretory system of the body, responsible for filtering waste products and excess substances from blood to form urine.

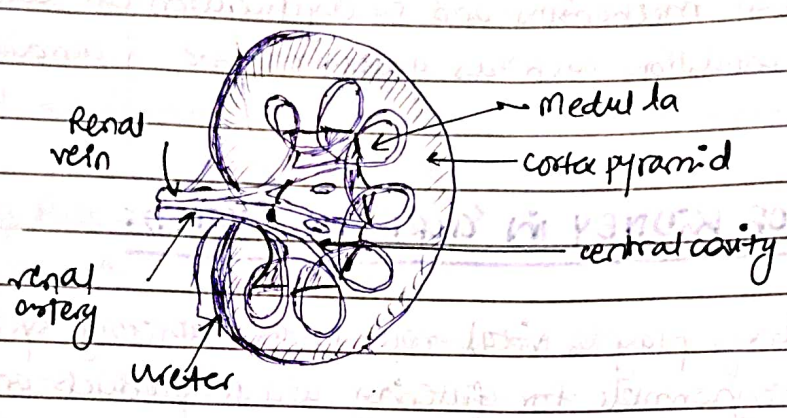


Human excretory system

1) FILTRATION:

- **Blood Filtration:** The kidneys receive about 20% of cardiac output, allowing them to filter large volumes of blood continuously. Each kidney contains millions of nephrons, which are function units responsible for filtration.
- **Glomerular Filtration:** Blood enters the kidney through renal artery and flows into tiny clusters of capillaries called "glomeruli". Here, blood pressure forces the water, ions, glucose, amino acids and

other small molecules out of the blood and into the Bowman's capsule, forming a fluid called glomerular filtrate.



Structure of kidney

(2) REABSORPTION:

- **Tubular Reabsorption:** As the glomerular filtrate moves through the renal tubules (proximal convoluted tubule, loops of Henle, distal convoluted tubule), useful substances such as glucose, amino acids, ion (sodium, Potassium, calcium) and water are reabsorbed back into bloodstream. This process helps maintain the body's internal environment by regulating the concentration of substances like electrolytes and water.

(3) SECRETION:

- **Tubular secretion:** Certain substances, such as H^+ ions, K^+ ions, creatinine and drugs are actively transported from bloodstream into renal tubules. This secretion process allows kidneys to eliminate additional waste products and maintain acid-base balance in the body.

(4) URINE FORMATION:

The remaining filtrate, now called urine, flows through the collecting ducts where further adjustments in water reabsorption

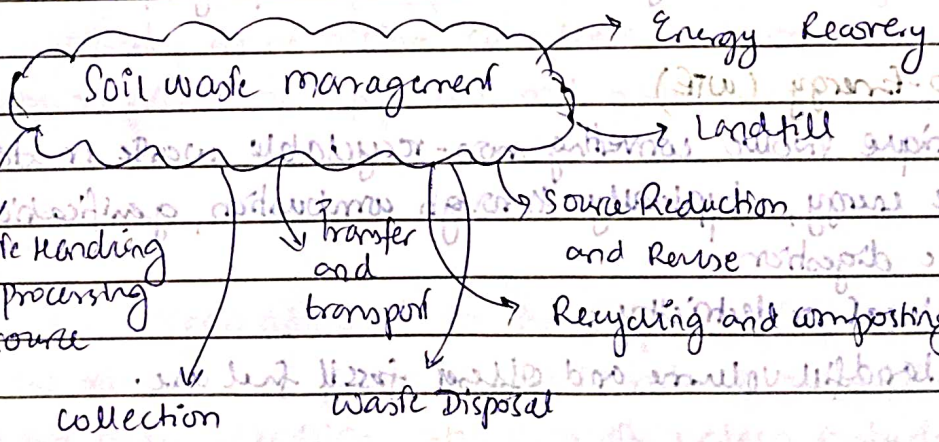
occur. Hormones such as antidiuretic hormone (ADH) and aldosterone regulate water reabsorption to concentrate or dilute urine according to the body's hydration status.

(5) **EXCRETION**: Finally urine exits the kidneys through the ureters and is stored in the bladder until it is expelled through the urethra during urination.

(C) SOIL WASTE MANAGEMENT:

Soil waste management (SWM) refers to the systematic management of the generation, collection, transfer, treatment, recycling, recovery and disposal of solid waste.

SWM involves various methods aimed at reducing, treating and disposing of solid waste generated by human activities. These methods include:



(2) Source Reduction and Reutilization:

This approach focuses on reducing the amount of waste generated at the source by encouraging practices such as reducing packaging, promoting reusable products and minimizing food waste.

- Reduce overall amount of waste needs to be managed
- Conserves resources
- Decreases environmental impact.

(2) Recycling and Reuse:

This approach involves collecting and processing materials that would otherwise be thrown away, turning them into new products. Reuse involves using products or materials again without significant alteration.

- Reduces the need for raw materials.
- Conserves energy
- Decreases landfill space usage
- Lowers greenhouse gass emissions.

(3) Composting:

It involves the decomposition of organic waste such as food scraps and yard trimmings, by microorganisms into a nutrient-rich soil amendment called compost.

- Diverts organic waste from landfills.
- Reduces methane emissions from landfills
- promotes sustainable agriculture and landscaping practices.

(4) Waste-to-Energy (WTE)

WTE technique involve converting non-recyclable waste materials into usable energy, typically through combustion, gasification or anaerobic digestion.

- Produces heat or electricity.
- Reduces landfill volume and offeset fossil fuel use.

(5) Incineration:

Incineration involves burning solid waste at high temperatures in controlled settings, often with energy recovery through steam generation or electricity production.

- Reduces waste volume
- Generates electricity
- Environment friendly.

(d)

ANAEMIA:

Anaemia is a medical condition characterized by a deficiency in the number or quality of red blood cells (RBCs) or haemoglobin in the blood. This can result in symptoms such as fatigue, weakness, pale skin, shortness of breath, and sometimes palpitations. Anaemia can be caused by various factors including iron deficiency, vitamin B12 or folate deficiency, chronic diseases, genetic disorders or certain medications.

APPENDICITUS:

It refers to the inflammation of appendix, a small pouch attached to the large intestine. The inflammation is typically due to the blockage of appendix by faeces, a foreign body or infection. Symptoms often include abdominal pain, particularly in lower right quadrant, loss of appetite, nausea, vomiting and fever. If untreated, appendicitus can lead to serious complications such as rupture of appendix and peritonitis.

SPLEEN:

Spleen is an organ attached in the upper left part of abdomen, under the rib cage. It plays multiple roles in the body's immune system and blood filtration. Function of spleen include filtering and removing old or damaged RBC, storing platelets and white blood cells, and producing antibodies to fight infections. It also helps regulate the amount of blood in the body and can be removed surgically if diseased.

MYOPIA:

Myopia - commonly known as nearsightedness, is a refractive error of the eye where close objects appear clear

but distant objects appear blurry. It occurs when eyeball is too long or the cornea is too curved, causing light rays to focus in front of the retina instead of directly on it. Myopia can often be corrected with eyeglasses, contact lenses or refractive surgery.

ISOTONES:

Isotones refer to atoms or nuclei that have the same number of nucleons (protons and neutrons) but different number of protons. In other words, isotones are nuclides that have the same nucleon number but different atomic numbers. This term is primarily used in nuclear physics and chemistry to describe variations in nuclear composition while maintaining a constant total mass number.

SECTION – II

QUESTION – 06

(a)

Given:

$$A : B : C : D \rightarrow 4 : 7 : 3 : 1 \quad \text{---(i)}$$

Let the number of blocks be 'n'

Then number of A blocks = 4n
number of B blocks = 7n
number of C blocks = 3n
number of D blocks = 1n

} from eq (i)

Also given condition is:

number of A blocks is 50 more than no. of C blocks.

$\Rightarrow 4n = 50 + 3n$

$\Rightarrow 4n - 3n = 50$

$n = 50$

now,

number of B blocks $= 7n$

$\because n = 50$

$\Rightarrow \because$ no. of B blocks $= 7 \times 50$

$= 350$ blocks

(b) Given:

Original cost $= 80\$$

Discount $= 15\%$

Sales tax $= 10\%$

To find:

Final price $= ?$

Solution:

Discount on original cost $= 15\%$ of $80\$$

$= \frac{15}{100} \times 80\$$

$= 12\$$

Now cost after discount $= 80\$ - 12\$$

$= 68\$$

Sales tax applied on discounted price $= 10\%$ of $68\$$

$= \frac{10}{100} \times 68\$$

$= 6.8\$$

Price after sales tax to be added $= 68\$ + 6.8\$$

$= 74.8\$$

So the final price will be $74.8\$$

(c) Given:

distance = d = 42km

Speed = v = 36km/hr

To find:

Time = ?

Calculation:

$$\text{time} = \frac{\text{Distance}}{\text{speed}} \quad \because v = \frac{d}{t}$$

$$\text{time} = \frac{42\text{km}}{36\text{km}}\text{.hr}$$

$$\text{time} = \frac{42\text{km}}{36\text{km}} \times 60 \text{ mins}$$

time = 70 mins ≃ 1 hr 10 mins

(d) (i) teninsuperted
superintendent

(ii) hweti
white

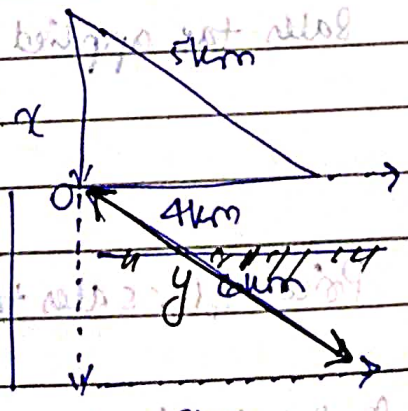
QUESTION-08

(a) Given:

Base = b = 4km

Hyp = h = 5km

let perp = x



Using pythagorean theorem:

$(\text{Perp})^2 = (\text{Hyp})^2 - (\text{Base})^2$

$x^2 = (5\text{km})^2 - (4\text{km})^2 = 25 - 16 = 9$

$\Rightarrow \sqrt{x^2} = \sqrt{9}$

$x = 3\,km$

Total distance $= 3km + 4km + 5km = 12km$

considering the 2nd part:

let Distance from the origin to final point $= y$

Now base $= 6km$

Perp $= 8km$

Hyp $= y = ?$

Using pythagorean theorem again:

$y^2 = (8km)^2 + (6km)^2$

$y^2 = 100$

$\Rightarrow \sqrt{y^2} = \sqrt{100}$

$y = 10km$

Distance from origin is 10km.

(b)

Given:

Total pocket money $=$ Rs. 8000

Let Aiba's pocket money $= A$

Ali's pocket money $= L$

Hassan's pocket money $= H$

Nasir's pocket money $= N$

Shahbaz's pocket money $= S$

According to conditions given:

$H = 1/3\ L$ — (i)

$L = 5A$ — (ii)

$A = 3N$ — (iii)

$S = N + L$ — (iv)

Also, $H + A + L + N + S = 8000$ — (A)

$\frac{1}{3}L + L + 3N + N + L + N = 8000$ (putting values and solving in terms of N and L)

$\frac{1}{3}L + 2L + 5N = 8000$

$\frac{7}{3}L + 5N = 8000$

Solution:

from eq (iii)

$A = 3N$

put in eq (ii)

$L = 5A = 5(3N) = 15N$

put in eq (i)

$H = \frac{1}{3}L = \frac{1}{3}(15N) = 5N$

put $L = 15N$ in eq (iv)

$S = N + L = N + 15N = 16N$

put values in (A)

$H + A + L + N + S = 8000$

$5N + 3N + 15N + N + 16N = 8000$

$40N = 8000$

$N = \frac{8000}{40}$

$N = 200$ (put back in equations)

$\because A = 3N = 3(200) = 600$

$\Rightarrow$ Akbar's pocket money = Rs/- 600

$\because N = 200$

$\Rightarrow$ Nasir's pocket money = Rs/- 200

$\because L = 5A = 15N = 15(200) = 3000$

$\Rightarrow$ Ali's pocket money is Rs/- 3000

$\because H = 5N = 5(200) = 1000$

$\Rightarrow$ Hasan's pocket money = Rs/- 1000

$\because S = 16N = 16(200) = 3200$

$\Rightarrow$ Shahbaz's pocket money = Rs/- 3200.

(C) Given: Radius = 7m

To find = Surface Area = A = ?

Volume = ?

Solution:

$A = 4\pi r^2$

$A = 4 \times 3.14 \times (7m)^2$

$A = 615.75 m^2 \Rightarrow$ Surface area of sphere

$V = 4/3 \cdot \pi r^3$

$= \frac{4}{3} \times 3.14 \times (7m)^3$

$V = 1436.75 m^3 \Rightarrow$ Volume of sphere

(d)

Total amount = 4320 Rs/-

Total parts to be distributed among three = 2 + 3 + 7

= 12 parts

1 part will be of Rs/- = $\frac{4320}{12}$

= 360 Rs/-

Then according to given conditions:

Zain's = 2 parts = 2 x 360 = 720 Rs/-

Aslam's = 3 parts = 3 x 360 = 1080 Rs/-

Ashraf's = 7 parts = 7 x 360 = 2520 Rs/-