Way to Success 👍

10

SCIENCE

A COMPLETE GUIDE

A Product from
WAY TO SUCCESS TEAM

AVAIL : PRACTICE BOOK, QUESTION BANK

Way to Success புத்தகங்களை மொத்தமாக பெற வேண்டுவோர் இப்புத்தகத்தின் கடைசிப் பக்கத்தில் கொடுக்கப்பட்டுள்ள அலைபேசி எண்களில் உங்கள் **மாவட்ட ஒருங்கிணைப்பாளரை** அழைக்கவும் அல்லது **9787609090, 9787201010** ஆகிய எண்களைத் தொடர்புகொள்ளுங்கள்.

CONTENTS

PRACTICALS

QUESTION PATTERN & TIME MANAGEMENT

Time : 15 Minutes + 3 Hours **Total Marks : 75**

முதல் 15 நிமிடத்தை மாணவர்கள் வினாத்தாள் வாசிக்கவும், விடைத்தாளில் பதிவெண், புகைப்படம், பக்கங்கள் ஆகியவற்றை சரிபார்க்கவும் பயன்படுத்திக் கொள்ளவும்.

Parts	Question Number	Marks	Time
Part – I (1 marks)	**Qn. No : 1 - 12** • Choose (Physics - 3 *Qns*, Chemistry - 3 *Qns*, Biology - 6 *Qns*)	**12 × 1** 12 Marks	10:15 - 10:30 15 Minutes
Part – II (2 marks) (7 out of 10)	**Qn. No : 13 - 22** • Question **22★** Compulsory question. • Physics - 3 *Qns*, Chemistry – 2 *Qns*, Biology – 5 *Qns*	**7 × 2** 14 Marks	10:30 - 11:10 40 Minutes
Part – III (4 marks) (7 out of 10)	**Qn. No : 23 - 32** • Question **32★** Compulsory question. • Physics - 3 *Qns*, Chemistry - 2 *Qns*, Biology - 5 *Qns*	**7 × 4** 28 Marks	11:10 - 12:10 60 Minutes
Part – IV (7 marks)	**Qn. No : 33 - 35** • Either – Or வகையில் 3 வினாக்கள் கேட்கப்படும். மூன்றிற்கும் விடையளிக்க வேண்டும். • 2 அல்லது 3 பகுதிகளாக பிரித்தும் வினா கேட்கப்படலாம். • Physics - 1 *Qns*, Chemistry - 1 *Qns*, Biology - 1 *Qns*	**3 × 7** 21 Marks	12:10 - 12:55 45 Minutes

கடைசி 20 நிமிடத்தை திருப்புதலுக்காக பயன்படுத்திக் கொள்ளவும்.

		75	10:15 - 1:15

Physics -28 marks, chemistry – 22 marks, biology – 43 marks என மொத்தமாக 93 மதிப்பெண்களுக்கு வினாத்தாள் வடிவமைக்கப்பட்டிருக்கும். அதில் 75 மதிப்பெண்களுக்கு விடையளிக்க வேண்டும்.

குறிப்பு: மேலே கொடுக்கப்பட்டுள்ள ஒவ்வொரு பகுதிக்குமான (*Physics/Chemistry/Biology*) வினாக்களின் எண்ணிக்கை தோராயமாக கொடுக்கப்பட்டுள்ளது. அவை மாறுபடலாம். கட்டாய வினாக்கள் (22, 32) 23 பாடங்களில் எதில் வேண்டுமானாலும் கேட்கலாம்.

SCIENCE பாடத்தில் அதிக மதிப்பெண் பெற என்ன செய்யவேண்டும்?

நீங்கள் படிக்க வேண்டியவை:

மற்ற பாடங்களுடன் ஒப்பிடும்போது அறிவியலில் Practical மதிப்பெண்கள் இருப்பதால் தேர்ச்சிப்பெறுவது எளிது. ஆனால் வினாத்தாள் வடிவமைப்பு ஏதும் இல்லாததால் நூற்றுக்கு நூறு பெறுவது சற்று கடினம்.

நீங்கள் படிக்க வேண்டியவை: (75 மதிப்பெண்களுக்கு)

40 மதிப்பெண்கள் பெற	50 – 60 மதிப்பெண்கள் பெற	Centum
அனைத்து பாடத்திற்குமான	கூடுதலாக, அனைத்து பாடத்திற்குமான	கூடுதலாக, அனைத்து பாடத்திற்குமான
❖ Choose	❖ Diagram Questions ❖ Fill up	❖ Do you Know? ❖ More to know
❖ Answer in a word / sentence	❖ True / False ❖ Match	❖ Table content
❖ Answer briefly / shortly	❖ Assertion / Reason ❖ Problems	❖ Activity
❖ Answer in detail	❖ Higher order thinking Questions	❖ Test yourself

முழு மதிப்பெண்கள் பெற சில முக்கிய குறிப்புகள்

☞ 1 மதிப்பெண் வினாவிற்கு விடையளிக்கும் போது கொடுக்கப்பட்ட விடைகளை நன்கு கவனித்து விடையளிக்கவும்.

Ex : If V_B, V_G, V_R be the velocity of blue, green and red light respectively in a glass prism, then which of the following statement gives the correct relation ?

புத்தக விடைகள் : a) $V_B = V_G = V_R$ b) $V_B > V_G > V_R$ c) $V_B < V_G < V_R$ d) $V_B < V_G > V_R$

மாற்று விடைகள் : a) $V_R = V_G = V_B$ b) $V_R > V_G < V_B$ c) $V_R < V_G < V_B$ d) $V_R > V_G > V_B$

இவ்வாறாக விடைகள் மாற்றியும் கொடுக்கப்படலாம், எனவே கவனித்து விடையளிக்கவும்.

☞ Optics பாடத்தில் cartesian sign conventions rules –ஐ புரிந்துக்கொண்டு பின்பு formation of image, Nature of the image இவற்றை படிக்கவும்.

☞ Chemistry பாடத்திற்கு சில அடிப்படை Elements-களுக்கு Atomic Number, Atomic Mass, Valency தெரிந்து வைத்து கொள்வது நல்லது.

☞ Equations, Formulae தேவையான இடங்களில் கண்டிப்பாக எழுதவேண்டும்.

☞ சமன்பாடுகளை எழுதும் போது, ● வினையில் இடம்பெற்றுள்ள வினையூக்கி (Heat (Δ))

● வினைபடு மற்றும் வினைவிளை பொருள்களின் நிலை: Liquid(l), Gas($\uparrow_g$), Solid(s)

● Precipitation ($\downarrow$))   ● Forward reaction ($\rightarrow$)   ● Backward reaction ($\leftarrow$)

இவற்றை தெளிவாக குறிப்பிடவும். ஒருமுறைக்கு பல முறை சரிபார்த்துக் கொள்ளவும்.

☞ Arrive Systematically its IUPAC name என்ற வினாவிற்கு steps இல்லாமல் நேரடியாக விடை எழுதினால் சதம் பெறும் வாய்ப்பினை இழக்கக்கூடும்.

☞ கேட்கப்பட்ட வினாவிற்கு பொருத்தமாகவும், மதிப்பெண்ணுக்கு ஏற்றவாறும் விடையளிக்கவும். கூடுதலாக தவறுடன் எழுதி மதிப்பெண்களை இழந்து விடாதீர்கள். உதாரணமாக, Write any 2 points or examples என்று கேட்கப்பட்டிருந்தால் கேட்கப்பட்ட எண்ணிக்கையை எழுதினால் போதுமானது. தவறின்றி எழுத முடியும் என்றால் மட்டும் கூடுதலாக எழுதவும்.

வினாத்தாள் வாசித்தலில், முதலில் 7, 4, 2 மதிப்பெண் வினாக்களைப் படித்து எந்த வினாக்களை எழுதலாம் என்பதை மனதில் தீர்மானித்துக்கொள்ளுங்கள். பிறகு ஒரு மதிப்பெண் வினாக்களை முழுமையாக வாசித்து விடையை கண்டறியவும். 1 மதிப்பெண் வினாக்களை வாசிக்க நேரம் போதவில்லையென்றாலும் எழுதும்போதே படித்து விடை எழுதலாம்.

வினாக்களை சரியாக தேர்வு செய்ய வேண்டும்.

☞ வினா தேர்வு செய்யும் போது குறைவாகவும், எளிதாகவும் எழுதி நல்ல மதிப்பெண் பெறக்கூடிய வினாவை தேர்வு செய்து எழுதவும். **Eg.** Distinguish, Problems, Advantages & Disadvantages, Proof of the Law, Equation.

☞ 2, 3 பிரிவுகளாக வினாக்கள் கேட்கும் போது, அனைத்தையும் சரியாக எழுதினால் தான் முழு மதிப்பெண் பெறமுடியும். அதிக மதிப்பெண் ஈட்டும் வினாக்கள் அல்லது நன்றாக தெரிந்த வினாக்களை தேர்வு செய்யவும்.

1 மதிப்பெண் வினாக்கள்: (கேட்கப்பட்ட 12 வினாக்களுக்கும் கட்டாயம் விடையளிக்க வேண்டும்)

☞ மொத்தம் உள்ள 23 பாடங்களில் இருந்து 12 வினாக்கள் கேட்கப்படுகிறது. 2 அல்லது அதற்கு மேற்பட்ட வினாக்கள் Inside Book Questions –ல் இருந்து கேட்கப்பட வாய்ப்பு உள்ளது.

☞ அறிவியலில் நூற்றுக்கு நூறு மதிப்பெண்ணை தீர்மானிப்பது 1 மதிப்பெண் வினாக்கள்.

☞ Book back question-ஐ படித்தாலே குறைந்தது 7-10 மதிப்பெண்கள் வரை பெறலாம். Fill up, True / False, Assertion / Reason, Match, Problems போன்ற பகுதிகளை choose வடிவில் தேர்வில் கேட்கப்படலாம். அதனை நன்கு படித்து கொள்ளவும்.

☞ பாடங்களை ஆழ்ந்து படித்து கூடுதல் 1 மதிப்பெண் வினாக்களை அடிக்கோடிட்டு படித்து வருவதன் மூலம் 12 வினாக்களுக்கும் சரியான விடை அளிக்க முடியும்.

2 மதிப்பெண் வினாக்கள்: (10 வினாவில் 7 வினாவிற்கு விடை எழுத வேண்டும். அதில் 22* கட்டாய வினா)

☞ பாடப்புத்தகத்தில் உள்ள இரண்டு மதிப்பெண் வினாக்களை நன்கு படித்துக்கொள்ளவும்.

☞ ஒவ்வொரு பாடத்திலுள்ள Define, What is, Distinguish, Laws, Give reason, Give example, Label the parts, Problems போன்ற வகை கேள்விகள் கேட்கப்படுவதால் இதனை கூடுதல் கவனம் செலுத்தி படித்துக்கொள்ளவும்.

☞ Match the following, Fill in the blanks, Find the errors and correct it போன்றவையும் கேட்கப்படலாம்.

☞ Distinguish கேள்விக்கு 2 Point எழுதினால் போதுமானது. ஆனால் 3-4 points எழுதினால் சிறந்தது.

☞ Definitions, சொந்தமாக எழுதாமல் புத்தகத்தில் உள்ளதைப்போல் எழுத வேண்டும்.

4 மதிப்பெண் வினாக்கள்: (10 வினாவில் 7 வினாவிற்கு விடை எழுத வேண்டும். அதில் 32* கட்டாய வினா)

☞ இந்த பகுதியிலுள்ள வினாக்கள் ஒரே கேள்வியாகவோ, 2 அல்லது 3 பிரிவுகளாகவோ கேட்கப்படலாம்.

☞ Proof of Law, Distinguish, …Describe / Explain, Uses & applications, Advantages & Disadvantages, Problems, Identify & write the equations, Draw and label the parts போன்ற வகை கேள்விகள் கேட்கப்படுவதால் இதனை கூடுதல் கவனம் செலுத்தி படித்துக்கொள்ளவும்.

7 மதிப்பெண் வினாக்கள்: (வினாத்தாள் வடிவமைப்பின் படி Either Or type model-ல் கேள்விகள் கேட்கப்படும்)

☞ இப்பகுதியில் பெரும்பாலும் 2, 4 மதிப்பெண் வினாக்களில் குறிப்பிட்டுள்ள வகை வினாக்கள் 2 அல்லது 3 பிரிவுகளாக கேட்கப்படுகின்றன. ஒரே கேள்வியாகவும் கேட்கலாம். அதிக மதிப்பெண்கள் பெறும் வகையில் வினாக்களைத் தேர்வு செய்யவும்.

☞ Answer in a word / Sentence, Higher order thinking Questions போன்ற வகை வினாக்களும் இப்பகுதியில் கேட்கப்படுகின்றன.

Diagrams: வரைபடங்களை தெளிவாக வரைந்து பாகங்களை பிழையின்றி குறிக்க வேண்டும்.

☞ Draw diagram and label the parts போன்ற வினாவில் படத்தை பென்சிலில் தெளிவாக வரைந்து பாகங்களை கோடிட்டு காட்டி பிழையின்றி எழுத வேண்டும்.

☞ Identify the parts A, B, C, D in figure வினாக்களுக்கு மீண்டும் படம் வரைய தேவையில்லை பாகங்களை மட்டும் A, B, C, D என குறிப்பிட்டு எழுத வேண்டும். வினாவில் எத்தனை பாகங்கள் கேட்டுள்ளனவோ அவற்றை மட்டுமே எழுதினால் போதுமானது.

☞ படம் தேவைப்படும் இடத்தில் படம் வரைய வேண்டும். Draw and explain கேள்விகளுக்கு மட்டுமின்றி construction or structure, working, Experiment போன்ற வினாக்களுக்கு படம் வரைய சொல்லவில்லை என்றாலும் படம் வரைந்து விளக்கம் எழுதினால், சிறப்பாக இருக்கும், மதிப்பெண்களையும் இழக்க நேரிடாது. **Eg.** Defects of Eye, Compound microscope, Di-hybrid cross, human brain, heart and neuron போன்றவை.

Compulsory Questions: Part-II - Q.No. **22**   &   Part-III - Q.No. **32**

கட்டாய வினாவிற்கு தவறாமல் விடையளிக்கவும். இதற்கு பதில் வேறு வினாவிற்கு விடையளிக்க கூடாது.

☞ Physics, Chemistry, biology என்று எந்த பிரிவில் இருந்தும் கேட்கலாம். பெரும்பாலும் Physics, Chemistry-இல் உள்ள Problems தான் Compulsory வினாவாக கேட்கப்பட அதிக வாய்ப்புள்ளது. இது தவிர Laws, Give reason, Diagram Question, Higher order thinking போன்றவையும் கேட்கலாம்.

☞ இவை Bookback Question, examples-ஆகவும் இருக்கலாம் பாடத்தினுள் இருந்தும் கேட்கப்படலாம்.

☞ Physics-இல் உள்ள Ray Diagram மற்றும் Chemistry-இல் உள்ள Identify A,B,C & write the equations போன்றவையும் கேட்கப்படுகின்றன.

சதம் பெறுவதற்கான வழிகள்

☞ 100/100 இலக்குள்ள மாணவர்கள் புத்தக பயிற்சி வினாக்கள் அனைத்தையும் choice இன்றி படிக்கவும்.

☞ 2, 4 மதிப்பெண் வினாக்களை பொறுத்தவரை Inside Textbook–ல் இருந்து புதிய வினா கேட்டாலும் அவற்றை எழுதாமல் choice-ல் தவிர்க்கலாம். ஆனால் choice-யின்றி விடையளிக்க வேண்டியது:

◆ **1 மதிப்பெண் வினாக்கள்** ◆ **7 மதிப்பெண் வினா** ◆ **கட்டாய வினாக்கள்** (Q.No. 22, 32)

எனவே, சதமடிக்க இவற்றில் கூடுதல் கவனம் செலுத்த வேண்டும்.

☞ புத்தகத்தின் உள்ளிருந்து கேட்கப்படும் வினாக்கள் எந்த பகுதிகளிருந்து கேட்க வாய்ப்பு உள்ளது என்பதை உதாரணத்துடன் தொகுத்து கொடுக்கப்பட்டுள்ளது. இவற்றில் கூடுதல் கவனம் செலுத்தவும்.

பகுதிகள்	உதாரணம்
Modification of book back question	✴ SI unit of specific resistance is ____. **[PTA-4] (U-4)** a) mho b) ohm/ metre c) ohm **d) ohm metre** ✴ புத்தக வினாவில் **compound microscope** கேட்கப்பட்டுள்ளது. **simple microscope [PTA – 2]** தேர்வில் கேட்கலாம். இது போன்று கேட்க வாய்ப்புள்ள வினாக்களை படித்துக்கொள்ளவும்.
Numerical Value based question	✴ Sound waves travel in air with a speed of about ____ at NTP. **[SEP -21] (U-5)** a) $340 \times 10^8 m/s$ **b) $340\ m/s$** c) $3 \times 10^8 m/s$ d) $3 \times 10^{-8} m/s$
Scientist and important days	✴ The concept of blood group is derived by ____. **[SEP-21] (U-14)** a) Wiener **b) Karl Landsteiner** c) William Harvey d) His
Table contents (comparison, properties, etc)	✴ The elements having atomic number ____ undergo spontaneous radioactivity. **[PTA-4] (U-6)** **a) more than 83** b) less than 83 c) less than 73 d) equal to 83 ✴ Write the symbols for the following component. **[SEP – 2021] (U-4)** (i) Ground connection (ii) Resistor (iii) Light emitting diode (iv) A diode ✴ Differentiate nuclear fission and nuclear fusion. **[MDL – 19, PTA – 6] (U-6)**
HOTS - Higher Order Thinking Skills	✴ Octopus, cockroach and frog all have eyes. Can we group these animals together to establish a common evolutionary origin. Justify your answer. **[PTA-4] (U-19)**
Activity	✴ Under same conditions of temperature and pressure if you collect 3 litre of O_2, 5 litre of Cl_2 and 6 litre of H_2. i) Which has the highest number of molecules? **[APR – 24]** ii) Which has the lowest number of molecules? **[Activity :7.3, TB - 98] (U- 7)**
Do you Know?	✴ The gram molecular mass of water is ____. a) $2\ g$ b) $16\ g$ **c) $18\ g$** d) $8\ g$ **[APR-23] (U-7)**
More to know	✴ The heart of amphibians possess ____ chambers. **a) 3** b) 4 c) 2 d) 5 **[APR-23] (U-14)**
Test Yourself	✴ Electronegativity value of hydrogen is 2.1 and that of sodium is 1. Find out the nature of bonding present in the compound, when hydrogen combines with fluorine and hydrogen combines with sodium. (Electronegativity value of fluorine is 4) **[PTA-2] [TB - 112] (U-8)**
Conceptual thoughts	✴ Why pure water have pH 7 at room temperature? **[TB-149] (U-10)**

☞ பாடங்களை படிக்கும் போது கூடுதல் 1 மதிப்பெண் வினாக்களை அடிக்கோடிட்டு தேர்வு செய்து படிக்கவும்.

☞ தேர்வில் புத்தக வினாவில் உள்ளது போல் அல்லாமல் மாற்று பெயர்களை பயன்படுத்தியும் கேட்கலாம். எ.கா.: புத்தகத்தில் Explain the types of Double displacement reaction என்ற வினா உள்ளது. தேர்வில் Explain the types of Metathesis Reaction என்று கேட்கலாம். எனவே, Other Names-யும் படிப்பது நல்லது.

☞ புத்தகத்தின் உள்ளிருந்து கேட்கப்படும் 2 மதிப்பெண் வினாக்களுக்கு விடையளிக்க புத்தகத்தில் உள்ள Activity, Higher order thinking questions, Test yourself போன்றவற்றை படித்துக்கொள்ளவும்.

☞ Definitions, Types, Examples, Application, Advantages, Disadvantages, Uses, Laws, Differentiate, Conditions, Relations, Naming Questions, Why type Questions, Give Reason போன்றவை புத்தகத்தின் உள்ளிருந்து கேட்கப்படும்.

☞ மேற்குறிப்பிட்ட அனைத்து வகை வினாக்களும் இக்கையேட்டில் ஒவ்வொரு பாடத்திலும் Other Textbook Question, Additional Questions என தெளிவான எளிய விடையுடன் வழங்கப்பட்டுள்ளது. பயன்படுத்துங்கள்

Problems

☞ Physics and chemistry பாடங்களில் உள்ள Example & Exercise கணக்குகளை நன்கு பயிற்சிக்கவும்.

☞ Problems-இல் Units எழுத தவறினால் மதிப்பெண் இழக்க நேரிடும்.

☞ இறுதியில் வினாவிற்கேற்ப எடுத்து எழுத வேண்டும்.

☞ புதிய கணக்குகள் தேர்வில் கேட்டால் வினாவில் கொடுக்கப்பட்டுள்ளவற்றை எழுதினாலே (Given), Formula-வை கண்டுபிடித்து விடலாம். பிறகு மதிப்புகளை பிரதியிட்டு விடையை கண்டறியலாம்.

☞ கணக்கீடுகளில் சூத்திரத்தின் பொது வடிவத்தை முதலில் எழுதி, கேட்கப்பட்ட கேள்விக்கு தகுந்தாற்போல் மாற்றி எழுதி, பிறகு மதிப்புகளை பிரதியிடுவதே சிறந்தது.

Ex : நிறையும், உந்தமும் கொடுத்து திசைவேகம் கேட்கப்பட்டால்,

முதலில், உந்தம் (p) = நிறை(m)×திசைவேகம்(v) என எழுதி,

பிறகு, திசைவேகம்(v) = $\frac{உந்தம்\ (p)}{நிறை\ (m)}$ என மாற்றி மதிப்பீடுகளை பிரதியிட்டு விடையை கண்டறியவும்.

(If mass and momentum are given, first write general formula for momentum and write the derieved formula for velocity. Then substitute the values and find the answer.)

☞ Problems-ஐ மனப்பாடம் செய்யாமல் புரிந்து, Group செய்து படித்திருந்தால், புதிய வினாக்கள் கேட்டாலும் எளிதில் விடையளிக்கலாம். உதாரணமாக, unit–7 இல் மொத்தமாக 18 கணக்குகள் உள்ளன. எண்ணிக்கையை கண்டு மிரளாமல் சற்று Group செய்தால் மூன்றே Formula-களில் அவை அனைத்திற்கும் விடையளிக்கலாம்.

அவை ➔ Number of moles formula   ➔ No. of atoms / molecules formula

➔ Percentage composition formula இவ்வளவுதான் அப்பாடத்தின் கணக்குகள்.

குறிப்பு:   ◆ கீழே அனைத்து பாடத்திற்குமான formula-கள் group செய்து கொடுக்கப்பட்டுள்ளது.

◆ இதை படித்தாலே ஒவ்வொரு பாடத்திலுள்ள கணக்குகளை எளிய முறையில் தீர்க்கலாம்.

◆ ஒவ்வொரு சமன்பாடுகளைக் கொண்டு solve செய்யப்படும் புத்தக கணக்குகளின் எண்ணிக்கைகள் (*4) குறியீட்டுடன் காண்பிக்கப்பட்டுள்ளன.

◆ Bold செய்த formula–கள் முக்கியமானது அவற்றை நன்கு பயிற்சிக்கவும். கூடுதலாக மற்ற formula–களை படித்துக்கொண்டால் புதிய வினாக்களுக்கு எளிதாக விடையளிக்கலாம்.

UNIT – 1

Force	$F = m \times a$ **(*4)**	**Apparent weight**	$R = m(g + a)$ **(*1)**
Linear Momentum	$p = m \times v$ **(*2)**	Torque	$\tau = F \times d$ **(*1)**
Change in momentum	$\Delta p = m(v - u)$ (*1)	Momentum of couple	$M = F \times S$ **(*1)**
Acceleration due to gravity	$g = \frac{GM}{R^2}$ **(*2)**	Kinetic Energy	$E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ **(*1)**
Weight	$W = m \times g$ **(*1)**	Impulse	$J = F \times t = \Delta p$
Gravitational Force $F = \frac{Gm_1m_2}{r^2}$			
Important Values:	❖ Acceleration due to gravity: on Earth - $9.8\ ms^{-2}$; on Moon - $1.625\ ms^{-2}$ ❖ For Earth: Radius (R) = 6400km ; Mass (M) = $5.972\times\times10^{24}$ kg ❖ Gravitational constant (G) = 6.674×10^{-11} Nm² kg⁻²		

UNIT – 2

Power $P = \frac{1}{f}$ (*2)	**Lens Formula** $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (*3)	**Magnification** $\frac{v}{u} = \frac{h'}{h}$ (*1)
Snell's law $\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$ (*1)	Velocity of light $c = v\,\lambda$	Rayleigh's law $S \alpha \frac{1}{\lambda^4}$
Focal length of corrective lens:(*1)	for Myopia: $f = \frac{xy}{x-y}$ (concave lens)	for Hypermetropia: $f = \frac{dD}{d-D}$ (convex lens)

UNIT– 3

Linear expansion	$\frac{\Delta L}{L_0} = \alpha_L \Delta T$ (*1)	**Apparent expansion** $= L_3 - L_1$ & **Real expansion** $= L_3 - L_2$ **(*1)**	
Cubical expansion		$\frac{\Delta V}{V_0} = \alpha_V \Delta T$ (*1)	**Superficial expansion**	$\frac{\Delta A}{A_0} = \alpha_A \Delta T$ **(*1)**
Boyle's law $P \alpha \frac{1}{V}$ (*1)	Charles's law $V \alpha T$	Avogadro's law $V \alpha n$	Ideal gas equation PV = RT
Important Values :	$k_B = 1.38 \times 10^{-23}$ JK⁻¹ ; R = 8.31 J mol⁻¹K⁻¹		

UNIT– 4

Ohm's law $V = IR$ / $I = \dfrac{V}{R}$ / $R = \dfrac{V}{I}$ **(*5)**	**Current** $\quad I = \dfrac{Q}{T}$ **(*3)**	**Resistivity** $\quad \rho = \dfrac{RA}{L}$ **(*4)**
Joule's law of heating $H = I^2 R t$ **(*1)**	Electric Power $\quad P = \dfrac{Work}{Time} = VI = \dfrac{V^2}{R}$ **(*4)**	
Resistors in Series $R_S = R_1 + R_2 + R_3 + ...$ (for equal resistance $R_S = n R$) **(*2)**	**Potential difference** (V) $\dfrac{Work\ done\ (W)}{Charge\ (Q)}$ **(*1)**	
Resistors in Parallel $\dfrac{1}{R_P} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + ...$ (for equal resistance $R_P = \dfrac{R}{n}$) **(*3)**	Conductivity $\quad \sigma = \dfrac{1}{\rho}$ **(*1)**	

UNIT– 5

Wave velocity $\quad V = \dfrac{\lambda}{T} = n\lambda$ **(*3)**	**Speed of Echo** $\quad \dfrac{2d}{t}$ **(*4)**	**Frequency** $\quad \nu = \dfrac{c}{\lambda}$ **(*1)**
Doppler Frequency $n' = \left(\dfrac{V + V_L}{V - V_S}\right) n$ **(*5)**	Effect of Temperature $V \propto \sqrt{T}$; $V_T = (V_0 + 0.61\,T)\,ms^{-1}$ **(*1)**	

UNIT– 6

α decay : $_ZY^A \rightarrow \,_{Z\text{-}2}Y^{A\text{-}4} + \,_2He^4$	**β decay**: $_ZY^A \rightarrow \,_{Z+1}Y^A + \,_{-1}e^0$
No. of neutrons $= A - Z$ (A - Mass number, Z - atomic number) **(*4)**	
Curie - Becquerel conversion 1 Curie $= 3.7 \times 10^{10}$ Bq **(*2)**	
Amount of energy released (Einsten's equation) $E = mc^2$ **(*1)**	

UNIT– 7

Number of moles $= \dfrac{Mass}{Atomic/molecular\ mass}$ (OR) $\dfrac{No.\ of\ atoms/molecules}{Avogadro's\ number(N_A)}$ **(*5)**	**Atomicity** $= \dfrac{Molecular\ mass}{Atomic\ mass}$	
No. of atoms/molecules $=$ No. of moles $\times N_A$ **(*5)**	Molecular mass $= 2 \times$ Vapour density	
Percentage composition $= \dfrac{mass\ of\ the\ element}{molecular\ mass\ of\ the\ compound} \times 100$ **(*5)**	Avogadro's number $(N_A) = 6.023 \times 10^{23}$ Molar volume $= 22.4$ L/22400 ml	

UNIT – 9

Solubility $= \dfrac{Mass\ of\ the\ solute}{Mass\ of\ the\ solvent} \times 100$ **(*5)**	
Mass percentage $= \dfrac{Mass\ of\ solute}{Mass\ of\ solute + Mass\ of\ solvent} \times 100$ **(*5)**	Volume percentage $= \dfrac{Volume\ of\ solute}{Volume\ of\ solute + Volume\ of\ solvent} \times 100$ **(*3)**

UNIT– 10

$pH = -\log_{10}[H^+]$ **(*6)** ;	$pOH = -\log_{10}[OH^-]$ **(*3)**	$pH + pOH = 14$ **(*5)**
Ionic product $K_W = [H^+][OH^-]$ **(*1)**		

Other Values

1 Dyne	1 g cm⁻²	1 gf	980 dyne
1 Newton	10^5 dyne	One Horse Power	746 watt
1 kgf	9.8 Newton	1 Kilo Watt hour (kWh)	3.6×10^6 Joule

		Electrical resistivity of some materials	
Speed of light in vaccum (C)	3×10^8 ms⁻¹		
Hearing range	20 Hz - 20,000 Hz	1. Copper	$1.62 \times 10^{-8}\ \Omega m$
Velocity of sound in air	340 (or) 344 ms⁻¹	2. Nickel	$6.84 \times 10^{-8}\ \Omega m$
Persistence of hearing	0.1 sec	3. Chromium	$12.9 \times 10^{-8}\ \Omega m$
Minimum distance to hear echo	17.2 m	4. Glass	$10^{10}\ to\ 10^{14}\ \Omega m$
Least distance of distinct vision	25 cm	5. Rubber	$10^{13}\ to\ 10^{16}\ \Omega m$
Age of the earth	4.54×10^9 years	6. Nichrome	$1.5 \times 10^{-6}\ \Omega m$

SCIENTISTS – INVENTIONS & DISCOVERIES

Father of		Laws	
Leonardo da Vinci	Paleontology	*Newton*	Laws of motion
Kaspar Maria Von Sternberg	Paleobotany	*Snell*	Law of refraction
Birbal Sahani	Indian Paleobotany	*Soddy & Fajan*	Displacement law
Thomas Addison	Endocrinology	*Henry Moseley*	Modern periodic law
Nehemiah Grew	Plant Anatomy	*Boyle, Charles, Avogadro*	Fundamental Laws of gases
William Harvey **[SEP-20]**	Modern physiology	*Rayleigh, Mie, Tyndall, Raman*	Law of Scattering
Gregor Johann Mendel	Genetics	*Albert Einstein*	Mass energy equivalence
Dr. Norman E. Borlaug	Green Revolution	*W.F. Libby* **[PTA-5]**	Radio carbon dating
Dr.M.S.Swaminathan **[APR-24]**	Indian Green Revolution	*Sachs*	Tissue system classification

Others

Goldstein - discovered Protons & Rutherford named Protons	*JJ Thomson* - Electron
T.H. Morgan - Determining the role of chromosomes in heredity	*John Dalton* - Atom
Galileo - Made a telescope to observe distant stars	*James Chadwick* - Neutrons
Johann Lippershey - Invented the First Telescope	*Henry Bequerel* - Natural radioactivity
Otto Hahn &F.Strassman - Nuclear fission	*Irene Curie* - Artificial radioactivity
Marie curie, Pierre curie - Radium, Radioactivity in pitchblende	*Martin Klaproth* - Uranium
W.M.Bayliss & E.H.Starling - introduced the term Hormone	*Landsteiner & Wiener* - Rh factor
Charles Harrington, George Barger - Molecular structure of thyroxine	*Robin Hill* - Light reaction
Edward C. Kendal - Crystallised thyroxine hormone	*Hugo De Vries* - Mutation
Langdon Down - First identified the Down's syndrome	*Kolliker* - mitochondria
Melvin Calvin - Chemical pathway for photosynthesis	*Waldeyer* **[MAY-22]** - Chromosome
Dr. Suniti Solomon - Pioneered HIV research & treatment in India	*Alec Jeffrey* - DNA fingerprinting
Frits Warmolt Went - Demonstrated the existence of auxin.	*Kogl, Haagen Smith* - Named Auxin

Kurosawa - Bakanae/foolish seedling disease in rice crop	**Important Years**
Oparin & Haldane - Chemical evolution of life	National Forest Policy - 1952 & 1988
Ernst Haeckel - Biogenetic law / Recapitulation theory	Forest conservation Act - 1980
Jean Baptiste Lamarck - Theories of Evolution (Use & Disuse Theory)	Chipko movement victory - 1980
Charles Darwin **[PTA-6]** - Theory of Natural Selection(Origin of species)	Wildlife protection Act - 1972

Louis Pasteur **[SEP-21]** - Speculated biogenesis - Life originates from pre-existing life
Erwin Chargaff - Proportion of Adenine = Thymine & Guanine = Cytosine
J.W. Harshberger - Coined the term Ethnobotany **[APR-23, MAY-22]**
Dr.Homi Jahangir Bhaba - First chairman of Indian Atomic Energy Commision.
Fredrick Banting, Charles Best & MacLeod - Human insulin
James Watson & Francis Crick - Three-dimensional model of DNA.

IMPORTANT DAYS

Menstrual Hygiene day	May 28th	AIDS Day	December 1st
National Cancer awareness day	November 7th	World Cancer Day	February 4th
World Anti / No Tobacco Day **[JUN-23]**	May 31st	Anti Tobacco Act	May 1st 2004
International day against drug abuse & Illicit trafficking	June 26th	Child helpline number	1098

PHYSICS

S.No	TITLES
1.	Laws of Motion
2.	Optics
3.	Thermal Physics
4.	Electricity
5.	Acoustics
6.	Nuclear Physics

UNIT - 1
LAWS OF MOTION

POINTS TO REMEMBER

Mechanics	A branch of physics that deals with the effect of force on bodies. ❋ **Statics:** The study of bodies, which are at rest under the action of forces. ❋ **Dynamics:** The study of moving bodies under the action of forces. ❖ *Kinematics*: Dynamics that do not consider the cause of motion. ❖ *Kinetics:* Dynamics that consider the cause of motion.
Force & Motion	❋*Natural motion (Force independent):* It is the motion when a moving body naturally comes to rest without any external influence of force. ❋*Violent motion (Force dependent):* It is the motion in which a force is needed to make the bodies to move and behave contrary to their natural state.
Inertia	The inherent property of a body to resist any change in its state (rest or motion), unless it is influenced by an external unbalanced force. ❋ *Inertia of rest:* Resistance to change the state of rest. *Eg : Leaves are detached when tree is shaken.* ❋ *Inertia of motion*: Resistance to change the state of motion. *Eg : Athlete run a distance before high jump or long jump.* ❋ *Inertia of direction:* Resistance to change the direction of motion. *Eg : We lean sideways when bus turns while driving.*
Linear Momentum	It is the product of mass and velocity of a moving body that acts in the direction of the velocity of the object. It is a vector quantity. SI unit is $kgms^{-1}$.
Force	An external effort in the form of push or pull. It is a vector quantity. *Types:* Like parallel forces, Unlike parallel forces.
Torque (or) Moment of force	The rotating or turning effect of a force about a fixed point or axis is called torque (τ). It is a vector quantity. Its SI unit is N m. *Application:* Gears, Seasaw, Steering Wheel.
Couple	Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple. It doesn't produce any translatory motion. *Eg :* Turning a Tap
Impulse	A large force acting for a very short interval of time is called as 'Impulsive force'. It is represented as J. Its SI unit is $kg\ ms^{-1}$ (or) Ns.
Resultant Force	❋ Parallel force in same direction $\quad$ $F_{net} = F_1 + F_2$ ❋ Parallel unequal force in opposite direction $\quad$ $F_{net} = F_1 - F_2\ (F_1>F_2)$ $\quad$ $F_{net} = F_2 - F_1\ (F_2>F_1)$ ❋ Parallel equal force in opposite direction $\quad$ $F_{net} = F_1 - F_2$

Newton's 1st Law (or) Law of Inertia	*The law states that every body continues to be in its state of rest or in the state of uniform motion along a straight line unless it is acted upon by some external force.*
Newton's 2nd Law (or) Law of Force	*The force acting on a body is directly proportional to the rate of change of linear momentum of the body. The change in momentum takes place in the direction of the force.* $F \propto \frac{\Delta p}{t}$ **(or)** $F = ma$
Newton's 3rd Law	*For every action, there is an equal and opposite reaction. They always act on two different bodies.* $F_B = -F_A$. ***Application:*** Propulsion of rocket.
Law of Conservation of Linear Momentum	*There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.*
Newton's universal law of gravitation	*The law states that the gravitational force between any two bodies in the universe is directly proportional to the product of their masses and inversely proportional to the square of the distance between the centers of these masses. The direction of the force acts along the line joining the masses.*
Acceleration due to gravity	• It is the acceleration attained by a body due to Earth's gravitational force. • Its SI unit is ms^{-2}. $g = \frac{GM}{R^2}$
Mass	• It is defined as the quantity of matter contained in the body. • Its SI unit is kilogram (kg).
Weight	• It is defined as the gravitational force exerted on a body due to gravity. • Its SI unit is Newton(N).

FORMULAE

Important Formulae

★ Force : $F = m \times a$

★ Linear Momentum : $p = m \times v$

★ Torque : $\tau = F \times d$

★ Change in momentum :
$$\Delta p = P_f - P_i = mv - mu$$

★ Momentum of a couple : $M = F \times S$

★ Impulse : $J = F \times t = \Delta p$

★ Gravitational Force : $F = \frac{Gm_1 m_2}{r^2}$

★ Acceleration due to gravity : $g = \frac{GM}{R^2}$

★ Weight : $W = m \times g$

★ Kinetic Energy : $E_k = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

Important Values to remember

★ ***Acceleration due to gravity***
on the surface of the Earth = 9.8 ms^{-2}
on the surface of the Moon = 1.625 ms^{-2}

★ Radius of Earth (R) = 6378km $\cong$ 6400km

★ Mass of Earth (M) = 5.972×10^{24}kg

★ Gravitational constant (G)= 6.674×10^{-11} Nm^2 kg^{-2}

★ 1N = 1 kg m s^{-1} = 10^5 dyne

★ 1 kg f = 9.8 N = 98×10^4 dyne

★ 1 g f = 9.8×10^{-3}N= 980 dyne

Important Principle

★ At equilibrium, the algebraic sum of the moments of all the individual forces about any point is equal to zero.

EVALUATION

Online Test

I. Choose the correct answer

1. Inertia of a body depends on   **[APR-24]**
   a) weight of the object
   b) acceleration due to gravity of the planet
   c) mass of the object
   d) Both a & b

2. Impulse is equals to (or) Impulse is the   **[PTA-1]**
   a) rate of change of momentum
   b) rate of force and time
   c) change of momentum
   d) rate of change of mass

3. Newton's III law is applicable
   a) for a body is at rest
   b) for a body in motion
   c) both a & b
   d) only for bodies with equal masses

4. Plotting a graph for momentum on the Y-axis and time on X-axis. Slope of momentum-time graph gives
   a) Impulsive force   b) Acceleration   **c) Force**   d) Rate of force

5. In which of the following sport the turning of effect of force used
   a) swimming   b) tennis   **c) cycling**   d) hockey

6. The unit of 'g' is m s⁻². It can be also expressed as
   a) cm s⁻¹   **b) N kg⁻¹**   c) N m² kg⁻¹   d) cm² s⁻²

   Hint : $F = mg \Rightarrow g = \dfrac{F}{m} = \dfrac{N}{Kg} = Nkg^{-1}$

7. One kilogram force equals to
   a) 9.8 dyne   b) 9.8×10^4 N   **c) 98×10^4 dyne**   d) 980 dyne

8. The mass of a body is measured on planet Earth as M kg. When it is taken to a planet of radius half that of the Earth then its value will be _____ kg.
   a) 4 M   b) 2M   c) $\dfrac{M}{4}$ **d) M**

   Hint : *Mass of a body remains same in any planet.*

9. If the Earth shrinks to 50% of its real radius its mass remaining the same, the weight of a body on the Earth will
   a) decrease by 50%
   b) increase by 50%
   c) decrease by 25%
   d) increase by 300%

   Hint : $R' = \dfrac{50}{100} \ R = \dfrac{1}{2}R; \quad g = \dfrac{GM}{R^2} \Rightarrow g' = \dfrac{GM}{(\frac{1}{2}R)^2} = \dfrac{g}{\frac{1}{4}} = 4g$

   $W' = m \times g' = m \times 4g = 4W = W + 3W$

   This can be said as weight increases by 3 times (or) increase by 300%

10. To project the rockets which of the following principle(s) is/are required?
    a) Newton's third law of motion   **[JUN-23, AUG-22, SEP-21, MDL-19]**
    b) Newton's law of gravitation
    c) law of conservation of linear momentum
    d) both a and c

Additional Govt Exam Questions

11. F be the force between the two bodies placed at a certain distance. If the distance between them is doubled then the gravitational force F will be _____. **[PTA-5]**

a) 2F   b) $\frac{F}{2}$ **c)** $\frac{F}{4}$ d) 4F

Hint : $F = \frac{GM_1M_2}{R^2}$; $F' = \frac{GM_1M_2}{(2R)^2} = \frac{1}{4} \times \frac{GM_1M_2}{R^2} = \frac{F}{4}$

12. The force required to produce an acceleration of 1 cm s^{-2} on a body of mass 1 g is **[PTA-6]**

a) 1 N   b) 10 N   c) 10^2 dyne   **d) 1 dyne**

Hint : 1 dyne (F=ma=1 gcms^{-2} = 1dyne)

II. Fill in the blanks

1. To produce a displacement **unbalanced force** is required.

2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by **inertia of motion.**

3. By convention, the clockwise moments are taken as **negative** and the anticlockwise moments are taken as **positive.**

4. **Gears** is used to change the speed of car.

5. A man of mass 100 kg has a weight of **980 N** at the surface of the Earth.

Hint : w = mg = 100 × 9.8 = 980 N

III. True or False. If false correct

1. The linear momentum of a system of particles is always conserved. **[False]**

   Correct statement: *The linear momentum of a system of particles is conserved, when **no external force is applied**.*

2. Apparent weight of a person is always equal to his actual weight. **[False]**

   Correct statement: *Apparent weight of a person is equal to his actual weight **only when he is at rest**.*

3. Weight of a body is greater at the equator and less at the polar region. **[False]**

   Correct statement: *Weight of a body is **less** at the equator and **greater** at the polar region.*

4. Turning a nut with a spanner having a short handle is so easy than one with a long handle. **[False]**

   Correct Statement: *Turning a nut with a spanner having a **long** handle is so easy than one with a **short** handle.*

5. There is no gravity in the orbiting space station around the Earth. So the astronauts feel weightlessness. **[False]**

   Correct Statement: ***Astronauts and orbiting space station are under free fall with same acceleration and huge orbital velocity**. So the astronauts feel weightlessness.*

IV. Match the following

Column I	Column II	Answer
1. Newton's I law	a) Propulsion of a rocket	**1-b)** Stable equilibrium of a body
2. Newton's II law	b) Stable equilibrium of a body	**2-c)** Law of force
3. Newton's III law	c) Law of force	**3-d)** Flying nature of bird
4. Law of conservation of Linear momentum	d) Flying nature of bird	**4-a)** Propulsion of a rocket

V. Assertion & Reasoning

Mark the correct choice as

(a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

(b) If both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.

(c) Assertion is true, but the reason is false.

(d) Assertion is false, but the reason is true.

1. **Assertion:** The sum of the clockwise moments is equal to the sum of the anticlockwise moments.
   Reason : The principle of conservation of momentum is valid if the external force on the system is zero.

   Ans. (b) *Both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.*

2. **Assertion:** The value of 'g' decreases as height and depth increases from the surface of the Earth.
   Reason : 'g' depends on the mass of the object and the Earth.

   Ans. (c) *Assertion is true, but the reason is false.*

Additional Govt Exam Question

3. **Assertion :** When a person swims he pushes the water using the hands backwards and the water pushes the person in the forward direction **[PTA-3]**
   Reason : For every action there is an equal and opposite reaction.

   Ans. (a) *Both the assertion and the reason are true and the reason is the correct explanation of the assertion.*

VI. Answer briefly

1. **Define inertia. Give its classification.** **[APR-23, AUG-22]**

   The inherent property of a body **to resist any change** in its state of rest or uniform motion, unless it is influenced upon by an external unbalanced force is called inertia.

   Classification of Inertia :
   - Inertia of rest
   - Inertia of motion
   - Inertia of direction

2. **Classify the types of force based on their application.** **[AUG-22]**

   *Types of Forces:* (i) Like parallel force (ii) Unlike parallel force

3. **If a 5 N and a 15 N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force.**

    Given : $F_1 = 5N$ $F_2 = 15\ N$

    Two forces act opposite to one another. Resultant force is,

        $F_{net} = F_2 - F_1 = 15 - 5 = \mathbf{10\ N.}$

        ∴ The magnitude of resultant force is 10 N and its direction is along 15 N force.
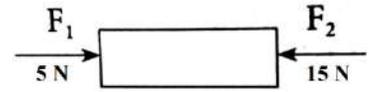
4. **Differentiate mass and weight.**   **[MAY-22]**

Mass	Weight
1. It is the **quantity of matter** in a body.	1. It is the **gravitational force** exerted on a body.
2. Its SI unit is **Kilogram** (Kg).	2. Its SI unit is **Newton** (N).
3. It is a **scalar** quantity.	3. It is a **vector** quantity.
4. It is a **fundamental** quantity.	4. It is a **derived** quantity.
5. Mass remains the **same** everywhere.	5. Weight **varies** from place to place.

5. **Define moment of a couple.**

    ❖ The rotating effect of a couple is known as moment of a couple.

    ❖ Moment of couple is the **product of** any one of **the forces (F)** and the **perpendicular distance (S)** between the line of action of two forces. **M = F × S**

    ❖ Its SI unit is **Newton meter (Nm).**

6. **State the principle of moments.**

    When like or unlike parallel forces act on a rigid body at equilibrium, the algebraic sum of moments in clockwise direction is equal to the algebraic sum of moments in anticlockwise direction.

    Moment of clockwise direction = Moment of anticlockwise direction

        F$_1$ d$_1$ = F$_2$ d$_2$

7. **State Newton's second law.**   **[MDL-19, MAY-22]**

    Newton's second law (OR) **Law of force :** The **force** acting on a body **is directly proportional to the rate of change of linear momentum** of the body and the change in momentum takes place in the direction of the force.

$$\boxed{\mathbf{F} = ma}$$

8. **Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?**

    ❖ The turning effect of a body is more when the perpendicular distance between the line of action of the applied force and the axis of rotation is more.

    ❖ Thus, the spanner with a **long handle requires less force** to tighten screws in heavy vehicles.

9. **While catching a cricket ball the fielder lowers his hands backwards. Why?**

    The fielder lowers his hands backwards while catching a cricket ball, because

    ❖ **It increase the time of contact** and **reduces the impulse** of the ball.

    ❖ Thus, it reduces the pain on his hand.

10. **How does an astronaut float in a space shuttle?**

    ❖ Astronauts are **not floating**. The space station and astronauts **have equal acceleration**.

    ❖ They are under **free fall condition with huge orbital velocity.** i.e., Apparent weight (R) = 0.

    ❖ Hence, both the astronauts and the space station are in the **state of weightlessness**.

Additional Govt Exam Questions

11. Write a short note on Gears. [SEP-20]
- ❖ A gear is a **circular wheel** with teeth around its rim.
- ❖ It **helps to change the** speed of **rotation of wheel** by changing torque.
- ❖ It also helps to **transmit power**.

12. Shock absorbers are used in luxury buses. Why? [PTA-2]
- ❖ Shock absorbers are used in luxury buses for the comfort purpose.
- ❖ It **protect us from the shocks or unwanted oscillations** of the bus due to damaged roads.

13. Name the law of motion used in flying of birds. Give another example. [PTA-2]

Newton's third law of motion is used in flying of birds.

Action : When birds fly, they push the air downwards with their wings.

Reaction : The air pushes the birds upwards.

Some examples:

i) Action : When a person swims, he pushes the water using the hands backwards.

Reaction : The water pushes the swimmer in the forward direction.

ii) Action : When we fire a bullet, the gun recoils backward and bullet moves forward.

Reaction : The gun equalizes this forward action by moving backward.

14. Why the apples weigh more at poles than at equator? [PTA-3]
- ❖ Weight depends on the acceleration due to gravity of the Earth (g).
- ❖ The **acceleration due to gravity is more at poles** than at equator.
- ❖ So, the apples weigh more at poles than at equator.

15. Use the analogy to fill the blank [PTA-4]

(a) Opening a door : Moment of force, Opening a water tap : <u>**Moment of a couple**</u>

(b) Pushing a bus by a group of people : Like parallel forces, Tug of war : <u>**Unlike parallel forces**</u>

VIII. Answer in detail

1. What are the types of inertia? Give an example for each type.

Types of Inertia :   a) Inertia of rest   b) Inertia of motion   c) Inertia of direction

a) Inertia of rest : [APR-24, AUG-22, PTA-3]

The **resistance** of a body **to change its state of rest** is called Inertia of rest.

Eg : When we shake the branches of a tree, some leaves and fruits fall down.

b) Inertia of motion :

The **resistance** of a body **to change its state of motion** is called inertia of motion.

Eg : An athlete runs some distance before jumping for a longer/higher jump.

c) Inertia of direction :

The **resistance** of a body **to change its direction of motion** is called Inertia of direction.

Eg : When we make a sharp turn while driving a car, we tend to lean sideways.

2. State Newton's laws of motion?   **[AUG-22, SEP-21]**

a) *Newton's First law (Law of inertia):*

Every body **continues to be in its state** of rest or the state of uniform motion along a straight line **unless** some external **force acts upon it.**

b) *Newton's second law (Law of force):*

The **force** acting on a body **is directly proportional to** the rate of **change of linear momentum** of the body. The change in momentum takes place in the direction of the force.

$$F = ma$$

c) *Newton's third law :*

For every action, there is an equal and opposite reaction. They act on two different bodies.

$$F_B = -F_A$$

3. Deduce the equation of a force using Newton's second law of motion. **[APR-23]** **(or) A body of mass m is initially moving with a velocity u. When a force 'F' acts on the body it picks up velocity 'v' in 't second' so that the acceleration 'a' is produced. Using this data derive the relation between the force, mass and acceleration.**   **[PTA-5]**

Newton's second law of motion :

The **force** acting on a body is **directly proportional to the rate of change of linear momentum** of the body and the change in momentum takes place in the direction of the force.

Derivation for the equation of force:

Let, m → mass of a moving body   F → unbalanced external force

u → initial velocity   v → final velocity after a time interval of 't'

Initial momentum of the body $P_i = mu$,   Final momentum of the body $P_f = mv$

Change in momentum, $\Delta P = P_f - P_i$

$$\Delta P = mv - mu$$

$$F \propto \frac{Change\ in\ momentum}{time}$$

$$F \propto \frac{mv-mu}{t}\ ,\ F = k\ \frac{mv-mu}{t}$$

K is proportionality constant, k = 1 in all systems of units.

$$F = \frac{mv-mu}{t} = m\left[\frac{v-u}{t}\right];$$

$$\textbf{F = ma}\qquad (\because \text{Acceleration, } a = \frac{v-u}{t})$$

$$\textbf{Force = mass} \times \textbf{acceleration}$$

SI unit of force is **Newton.**

4. State and prove the law of conservation of linear momentum.   **[MDL-19]**

Law of Conservation of momentum:

     There is **no change in the linear momentum** of a system of bodies as long as no net external force acts on them.

Proof:

Before collision   **on collision**   **After collision**
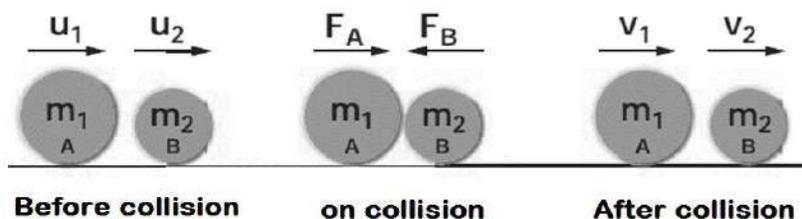
❖ Let two bodies A and B having masses m_1 and m_2 move in a straight line with the velocities of u_1 and u_2 $(u_1 > u_2)$.

❖ During an interval of time 't second', they tend to have a collision.

❖ After collision, A and B move in same straight line with a velocity v_1 and v_2 respectively.

Force on body B due to A,   Force on body A due to B

$$F_A = \frac{m_2(v_2 - u_2)}{t} \text{ -------- (1)} \qquad F_B = \frac{m_1(v_1 - u_1)}{t} \text{ -------- (2)}$$

By Newton's third law, Action Force (F_B) = Reaction force ($-F_A$)

$$\frac{m_1(v_1 - u_1)}{\cancel{t}} = -\frac{m_2(v_2 - u_2)}{\cancel{t}}$$

$$m_1(v_1 - u_1) = -m_2(v_2 - u_2)$$

$$m_1 v_1 - m_1 u_1 = -m_2 v_2 + m_2 u_2$$

$$\boxed{m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2}$$

     Thus, in the absence of an external force, the **algebraic sum of the momentum after collision is numerically equal to sum of the momentum before collision**.

5. Describe rocket propulsion.   **[AUG-22, SEP-20, PTA-4]**

Principles Used: Law of conservation of linear momentum and Newton's III law of motion.

❖ When the **rocket is fired,** the **fuel** in the propellant tank **is burnt**.

❖ A hot gas is ejected with a high speed from the nozzle of the rocket, **producing a huge momentum**.

❖ To balance this momentum, an **equal and opposite reaction force** is produced in the combustion chamber, which makes the **rocket project forward**.

❖ In motion, the **mass** of the rocket **gradually decreases**, until the fuel is completely burnt out.

❖ Mass of the rocket decreases with altitude and **increases the velocity gradually.**

❖ At one stage it **reaches a velocity**, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called **escape velocity**.

❖ There is no net external force acting on it. So **linear momentum** of the system **is conserved**.

6. State the universal law of gravitation and derive its mathematical expression.

Newton's Universal Law of gravitation :   **[JUN-23]**

❖ The Gravitational force is **directly proportional to the product of their masses** and **inversely proportional to the square of the distance** between the centers of these masses.

❖ The direction of the force acts along the line joining the masses.

❖ This force is always attractive and it does not depend on the medium where they are placed.

*Mathematical Expression of Universal Law of gravitation :*

Let, m_1 and m_2 be the masses of two bodies A and B placed 'r' metre apart in space.

$$F \propto m_1 m_2 \text{ --------- (1)}$$

$$F \propto \frac{1}{r^2} \text{ --------- (2)}$$

On combining (1) and (2), $F \propto \frac{m_1 m_2}{r^2}$ ⇒ $\mathbf{F = G \frac{m_1 m_2}{r^2}}$

Where Universal gravitational constant, $G = 6.674 \times 10^{-11} Nm^2 kg^{-2}$.
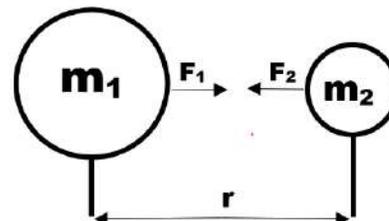
7. Give the applications of universal law of gravitation.

i) It is used to measure **the dimensions of heavenly bodies.** Mass and radius of the Earth, acceleration due to gravity etc., can be calculated with a higher accuracy.

ii) Helps in **discovering new stars and planets**.

iii) Irregularities in the motion of stars called Wobble lead to the disturbance in a nearby planet. In this condition **the mass of the star can be calculated** using the law of gravitation.

iv) It explains **geotropism**. Eg: germination of roots.

v) Helps to predict **the path of astronomical bodies**.

VII. Solve the given problems

1. Two bodies have a mass ratio of 3:4. The force applied on the bigger mass produces an acceleration of 12 ms⁻². What could be the acceleration of the other body, if the same force acts on it?

Given : $m_1 : m_2 = 3:4$; $F_1 = F_2$

Let m_2 be the bigger mass, acceleration due to bigger body, $a_2 = 12$ ms^{-2}

Solution : $F_1 = F_2$

$$m_1 a_1 = m_2 a_2 \qquad\qquad (\because F = ma)$$

$$a_1 = \frac{m_2}{m_1} a_2 = \frac{4}{3} \times 12 = 16 \text{ ms}^{-2}$$

∴ *Acceleration of the other body, a_1 is 16 ms^{-2}*

2. A ball of mass 1 kg moving with a speed of 10 ms⁻¹ rebounds after a perfect elastic collision with the floor. Calculate the change in linear momentum of the ball.

Given : Mass of ball (m) = 1 kg,   Initial velocity (u) = 10 m s^{-1}

It is perfect elastic collision, ball rebounds with the same speed but in opposite direction

Final velocity (v) = -10 m s^{-1}

Solution : $\Delta p = mv - mu = 1 \times (-10) - 1 \times (10) = -10 - 10 = -20$ kg m s^{-1}

(Negative sign indicates the direction of momentum)

∴ *Change in linear momentum of the ball is 20 $kgms^{-1}$*

3. **A mechanic unscrew a nut by applying a force of 140 N with a spanner of length 40 cm. What should be the length of the spanner if a force of 40 N is applied to unscrew the same nut?**

Given : Force $F_1 = 140\ N$, Length $d_1 = 40\ cm$; Force $F_2 = 40\ N$, Length $d_2 = ?$

Solution: Moment of couple is same for both the spanner, and so $F_1 d_1 = F_2 d_2$

$$d_2 = \frac{F_1 d_1}{F_2} = \frac{40 \times 140}{40} = 140\ cm$$

∴ **The length of the spanner should be 140 cm.**

4. **The ratio of masses of two planets is 2:3 and the ratio of their radii is 4:7. Find the ratio of their accelerations due to gravity.**

Given : Ratio of masses, $m_1 : m_2 = 2 : 3$ Ratio of radii, $R_1 : R_2 = 4 : 7$

Ratio of acceleration due to the gravity, $g_1 : g_2 = ?$

Solution: $g_1 = \frac{GM_1}{R_1^2}$ ---- (1) $g_2 = \frac{GM_2}{R_2^2}$ ------ (2)

Eqn (1) ÷ (2) ⇒ $\frac{g_1}{g_2} = \frac{\frac{GM_1}{R_1^2}}{\frac{GM_2}{R_2^2}} \Rightarrow \frac{g_1}{g_2} = \frac{\cancel{G}M_1}{R_1^2} \times \frac{R_2^2}{\cancel{G}M_2} = \frac{M_1}{M_2} \times \frac{R_2^2}{R_1^2}$

$$\frac{g_1}{g_2} = \frac{2}{3} \times \frac{7^2}{4^2} \Rightarrow \frac{2}{3} \times \frac{49}{16} = \frac{49}{24}$$

∴ **The ratio of acceleration due to gravity, $g_1 : g_2 = 49 : 24$**

Example Problems

5. **Calculate the velocity of moving body of mass 5 kg whose linear momentum is 2.5 kg m s⁻¹.** [TB-12]

Given : Mass = 5 kg ;
Linear momentum = 2.5 kg m s⁻¹

Solution :
Linear momentum = mass × velocity
Velocity = linear momentum / mass
$$V = \frac{2.5}{5} = \textbf{0.5 m s}^{-1}$$

6. **A door is pushed, at a point whose distance from the hinges is 90 cm, with a force of 40N. Calculate the moment of the force about the hinges.** [TB-12]

Given : F=40 N ; d=90 cm = 0.9 m

Solution :
The moment of a force M = F × d
M = 40 × 0.9 = **36 Nm**

7. **At what height from the centre of the Earth, the acceleration due to gravity will be 1/4ᵗʰ of its value as at the Earth.** [TB-12] [PTA-6]

Given : Height from the centre of the earth, $R' = R + h$

Acceleration due to gravity at that height, $g' = \frac{g}{4}$

Solution: $g = \frac{GM}{R^2}$, $g' = \frac{GM}{R'^2}$ ⇒ $\frac{g}{g'} = \left(\frac{R'}{R}\right)^2$

$$\frac{g}{g/4} = \left(\frac{R+h}{R}\right)^2 = \left(1 + \frac{h}{R}\right)^2$$

$$4 = \left(1 + \frac{h}{R}\right)^2 \text{ (take square root on both sides)}$$

$$2 = 1 + \frac{h}{R} \Rightarrow h = R$$

$$R' = R + R = \textbf{2R}$$

∴ From the centre of the Earth, object has to be placed at a height of **twice the radius of the earth**.

Additional Govt Exam Questions

8. A lift is moving downwards with an acceleration of $1.8 \, m\,s^{-2}$. What is apparent weight realised by a man of mass 50 kg?   [PTA-1]

Given : Acceleration (a) = 1.8 m s^{-2}

  m = 50 kg

Solution :

If Lift is moving downward with an acceleration 'a' then,

The Apparent weight is, R = m(g − a)

  = 50 (9.8 − 1.8)

  R = 50 × 8 = **400 N**

9. A force of 5 N applied on a body produces and acceleration 5 cm s^{-2}. Calculate the mass of the body. [PTA-5]

Given : F = 5 N, a = 5 cms^{-2} = 0.05 ms^{-2}

Solution :   F = ma

  $m = \dfrac{F}{a} = \dfrac{5}{0.05} =$ **100 Kg**

10. A weight of a man is 686 N on the surface of the earth. Calculate the weight of the same person on moon. ('g' value of a moon is $1.625 \, m\,s^{-2}$)

Given : $W_e = mg_e = 686$ N   [PTA-2]

  g_m= 1.625 m s^{-2}

Solution : $m = \dfrac{W_e}{g_e} = \dfrac{686}{9.8} = 70$ kg

  $W_m = mg_m = 70 \times 1.625$

  $W_m = 113.75$ N

  ∴ Weight on moon is **113.75 N**

11. Calculate the velocity of moving body of mass 5 kilogram whose linear momentum is 2 kg m s^{-1}.

Given : Mass, m = 5 kg ; [MDL-19]

Linear momentum, p = 2 kg m s^{-1}

Solution : Linear momentum, p = mv

  $v = \dfrac{p}{m} = \dfrac{2}{5} =$ **0.4 m s^{-1}**

IX. Hot Questions

1. Two blocks of masses 8 kg and 2 kg respectively lie on a smooth horizontal surface in contact with one other. They are pushed by a horizontally applied force of 15 N. Calculate the force exerted on the 2 kg mass.

Given :
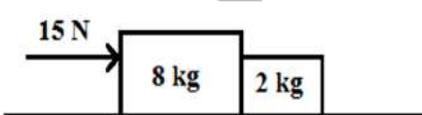
m_1 = 8 kg, m_2 = 2 kg, Force F = 15 N

Solution :

By Newton's 2nd law, F = ma

  F = $(m_1 + m_2)$ a

  $a = \dfrac{F}{m_1+m_2} = \dfrac{15}{8+2} = \dfrac{15}{10} = 1.5$ ms^{-2}

Force exerted on the 2 kg mass, m = 2 kg, a = 1.5 ms^{-2}

  F = ma = 2× 1.5 = **3N**

∴ The force exerted on the 2kg mass is **F = 3N**

2. A heavy truck and bike are moving with the same kinetic energy. If the mass of the truck is four times that of the bike, then calculate the ratio of their momenta. (Ratio of momenta = 2 : 1)

Given : Let, Mass of the bike = m_B ;

Mass of the truck = m_T; $\dfrac{m_T}{m_B} = 4$

Solution :   Kinetic Energy $= \dfrac{1}{2} mv^2$

K.E of truck = K.E of bike

  $\dfrac{1}{2} m_T v_T^2 = \dfrac{1}{2} m_B v_B^2$

  $\left(\dfrac{v_B}{v_T}\right)^2 = \dfrac{m_T}{m_B} = 4 \Rightarrow \dfrac{v_B}{v_T} = 2$ $\dfrac{v_T}{v_B} = \dfrac{1}{2}$

Ratio of their momentum is, $\dfrac{p_T}{p_B} = \dfrac{m_T \, v_T}{m_B \, v_B}$

  $= 4 \times \dfrac{1}{2} = 2$

∴ **Ratio of the momentum of truck to that of the bike is 2 : 1.**

  i.e. Momentum of the truck is twice the momentum of the bike.

3. "Wearing helmet and fastening the seat belt is highly recommended for safe journey". Justify your answer using Newton's laws of motion.

Wearing helmet is highly recommended for safe journey:

❖ According to Newton's second law, when you fall from a bike on the ground, you will fall with a force equal to your mass and acceleration of the bike.

❖ According to Newton's third law, an equal and opposite force from the ground is exerted on you.

❖ Wearing helmet will **reduce the effect of force** on you **and saves** us from **fatal head injuries**.

Fastening the seat belt is highly recommended for safe journey:

❖ According to Newton's first law, when vehicle stops suddenly we move forward and stay in motion until an unbalanced force acts upon us.

❖ If we wear seat belt, it gives an unbalanced force that **would stop us from being moved forward**.

❖ If we don't wear a seat belt, we would get hurt during this motion.

QR Code Questions

1. A heavy truck and bike are moving with same kinetic energy. If the mass of truck is four times that of the bike, then calculate ratio of their momenta.

    a) 1:4   b) 1:2   **c) 2 : 1**   d) 1:1

For solution, refer HOT question no 2 in this unit. Page no. :18

2. A planet has a mass of 20% more than that of earth, and radius is 20% less than that of earth. Then find the acceleration due to gravity.

    a) 17.375 m s⁻²   **b) 18.375 ms⁻²**   c) 16.375 m s⁻²   d) 11.375 ms⁻²

Hint :   Mass of the Planet $= M_E + 0.2\, M_E = 1.2 M_E$;   Radius of the Planet $= R_E - 0.2\, R_E = 0.8 R_E$

Acceleration due to gravity of the Planet $g' = \dfrac{G\,(1.2) M_E}{(0.8 R_E)^2} = \dfrac{1.2}{(0.8)^2} \times \dfrac{G M_E}{R_E{}^2}$

$$g' = \dfrac{1.2}{0.64} \times g_E = \dfrac{1.2}{0.64} \times 9.8 = \mathbf{18.375\ ms^{-2}}$$

3. Two planets are spiraling around sun in circular orbits of ratio m:n and the density ratio p:q, the acceleration due to gravity g is the ratio of _____ .

    a) mq : np   b) np : mq   c) nq : mp   **d) mp : nq**

Hint :

Ratio of the Radius, $R_1 : R_2 = m : n$

Ratio of the density, $d_1 : d_2 = p : q$

For sphere, volume $= \dfrac{4}{3} \pi R^3$

Mass = density × volume

$\dfrac{M_1}{M_2} = \dfrac{d_1 \times \frac{4}{3}\pi R_1{}^3}{d_2 \times \frac{4}{3}\pi R_2{}^3} = \dfrac{d_1\, R_1{}^3}{d_2\, R_2{}^3}$

$\dfrac{g_1}{g_2} = \dfrac{G M_1}{R_1{}^2} \times \dfrac{R_2{}^2}{G M_2} = \dfrac{M_1}{M_2} \times \dfrac{R_2{}^2}{R_1{}^2}$

$= \dfrac{d_1\, R_1{}^3}{d_2\, R_2{}^3} \times \dfrac{R_2{}^2}{R_1{}^2} = \dfrac{d_1 R_1}{d_2 R_2} = \dfrac{mp}{nq}$

4. Average force necessary to stop a hammer with 25 Ns momentum in 0.04s is _____ N.

    a) 625 N   b) 225 N   c) 50 N   d) 25N

Hint: Initial momentum $P_1 = 0$ Ns,   Time t = 0.04s

        Final momentum $P_2 = 25$ Ns   Force $= \dfrac{\text{Change in momentum}}{\text{Time}} = \dfrac{25 - 0}{0.04} = \mathbf{625\ N}$

5. When a person standing on spring balance. Reading on the balance is 65 kgf. If the man jumps off from the balance, then the momentary reading in the balance will be

    a) first increases and decreases   b) first decreases and increases

    c) decreases   d) no change

Hint :   *For jumping he presses the spring platform. So, the reading of spring balance increases and then it decreases and becomes zero.*

6. Two asteroids of equal masses revolve diametrically opposite to each other in a circle of radius 1000 km with equal velocity. If the mass of one of them is 10^8 kg, then find their velocity.
   ($G = 6.6 \times 10^{-11}$ N m^{-2} kg^{-2}) $(0.66)^{1/2} = 0.8124$

   a) 0.812×10^{-4} ms^{-1}   b) 0.816×10^{-3} ms^{-1}

   c) 0.716×10^{-3} ms^{-1} d) 0.716×10^{-2} ms^{-1}

Hint :	
$G = 6.6 \times 10^{-11}$ N m^{-2} kg^{-2} $r = 1000$ km $m_1 = m_2 = m = 10^8$ kg; $V = ?$ $F_N = \dfrac{Gm_1m_2}{r^2}$; $F_{CPF} = \dfrac{m_1v^2}{r}$ Comparing $\dfrac{Gm_1m_2}{r^2} = \dfrac{m_1v^2}{r}$ $\Rightarrow$ $\dfrac{Gm^2}{r^2} = \dfrac{mv^2}{r}$ $\Rightarrow$ $v = \sqrt{\dfrac{GM}{r}}$	$v = \sqrt{\dfrac{GM}{r}}$ $= \sqrt{\dfrac{6.6 \times 10^{-11} \times 10^8}{1000 \times 10^3}}$ $= \sqrt{6.6 \times 10^{-9}}$ $= \sqrt{0.66 \times 10^{-8}}$ $= \mathbf{0.812 \times 10^{-4}}$ ms^{-1}

7. A bomb of mass 10 kg is initially at rest explodes into two parts. Mass of 4 kg is moving with kinetic energy of 200 J. Velocity of other mass is _____ m/s
   a) 2.54   b) 6.6   c) -5.67 **d) -6.6**

Hint : Mass of the bomb $= 10$kg, $m_1 = 4$kg, $m_2 = 6$kg Kinetic Energy of mass 4 kg $(m_1) = 200$ J $\therefore \frac{1}{2}m_1V_1^2 = 200$ $\Rightarrow$ $\frac{1}{2} \times 4 \times V_1^2 = 200$ $2V_1^2 = 200$ $\Rightarrow$ $V_1^2 = \frac{200}{2} = 100$ $V_1 = \sqrt{100} = \mathbf{10 ms^{-1}}$	*Law of conservation of momentum,* $m_1V_1 + m_2V_2 = 0$ $4 \times 10 + 6 \times V_2 = 0$ $40 + 6V_2 = 0$ $6V_2 = -40$ $V_2 = \frac{-40}{6} = \mathbf{-6.6 ms^{-1}}$

8. A person jumps onto a swimming pool from a height of 1m and comes to rest by 0.2s If the same person increases his height by 8 m from its old position and jumps, comes to rest by 2s. Compare the ratio of forces exerted by him in both the cases.

   a) 10 : 3   b) 3:10   c) 1:1   d) none of the above

Hint :	
From 3rd equation of motion, $V^2 = u^2 + 2gh$ $V^2 = 2gh$ ($\because u = 0$) $V = \sqrt{2gh}$ ***Case 1: $h_1 = 1m$*** $V_1 = \sqrt{2gh_1} = \sqrt{2g}$ $F_1 = \dfrac{m(v_1 - u_1)}{t_1} = \dfrac{m(\sqrt{2g} - 0)}{0.2} = \dfrac{m\sqrt{2g}}{0.2}$	***Case 2: $h_2 = 1 + 8 = 9m$*** $V_2 = \sqrt{2gh_2} = \sqrt{2g \times 9} = 3\sqrt{2g}$ $F_2 = \dfrac{m(v_2 - u_2)}{t_2} = \dfrac{m(3\sqrt{2g} - 0)}{2} = \dfrac{3m\sqrt{2g}}{2}$ $\dfrac{F_1}{F_2} = \dfrac{m\sqrt{2g}}{0.2} \times \dfrac{2}{3m\sqrt{2g}} = \dfrac{1}{0.3} = \dfrac{10}{3}$ **The ratio of force is $= 10:3$**

9. Some force acts on two bodies of different masses 2kg and 4 kg initially at rest. The ratio of time required to acquire same final velocity is   a) 2:1   **b) 1 : 2**   c) 1:1   d) 4:16

Hint :	
$F_1 = F_2 \Rightarrow m_1a_1 = m_2a_2 \Rightarrow \dfrac{a_2}{a_1} = \dfrac{m_1}{m_2}$ $a = \dfrac{v-u}{t} = \dfrac{v}{t}$ ($\because u = 0$) $\Rightarrow \dfrac{a_2}{a_1} = \dfrac{v_2}{v_1} \times \dfrac{t_1}{t_2}$	$\because v_1 = v_2$, $\dfrac{a_2}{a_1} = \dfrac{t_1}{t_2} = \dfrac{m_1}{m_2} = \dfrac{2}{4} = \dfrac{1}{2}$ $\therefore \mathbf{t_1 : t_2 = 1 : 2}$

10. The lift is going up with the passengers. Total mass is 1 ton. The variation in velocity of lift in 2 sec is 3.6 ms^{-1}. Then the tension in the rope pulling the lift is _____ N.
    a) 1000 N   b) 80000 N   c) 800 N   **d) 8000 N**

Hint :	
Final velocity $v = 0$ Initial velocity $u = 3.6$ ms^{-1} $a = \dfrac{\text{change in velocity}}{\text{Time taken}} = \dfrac{v-u}{t} = \dfrac{0-3.6}{2} = -1.8$ ms^{-2}	*Tension in the rope,* $T = m(g + a)$ $T = 1000 (g + a) = 1000 (9.8 - 1.8)$ $T = 1000 \times 8 = \mathbf{8000 N}$

Additional Questions

Choose the correct answer

1. Force has _____ .
   a) Magnitude only   b) Direction only   **c) Both direction and magnitude**   d) None of the above

2. SI unit of force and impulse is _____ .
   a) Dyne, Ns   **b) Newton, Ns**   c) Nm, Newton   d) Nm, Ns

3. A fielder giving a swing while catching a ball is an example of _____ .
   a) Inertia   b) Newton's III law of motion
   c) Newton's II law of motion   d) Newton's I law of motion

4. A rider on a horseback falls back when the horse starts running all of a sudden because
   a) rider moves back   b) rider is afraid   **c) inertia of rest**   d) none of the above

5. An athlete runs some distance before taking a long jump because
   a) he gains energy to take him through long distance   b) it helps him to apply large weight
   c) by running action and reaction forces increase   **d) he gains inertia of motion during his run**

6. A system can be brought to equilibrium by applying a force, which is
   a) equal in magnitude but opposite in direction as that of resultant force
   b) equal in magnitude and in same direction as that of resultant force
   c) greater than the magnitude of resultant force but in opposite direction
   d) greater than the magnitude of resultant force and in same direction

7. Impulse can be achieved by,
   a) a large force acting for a short period of time   b) a large force acting for a longer period of time
   c) a short force acting for a longer period of time   **d) both a and c**

8. *Statement 1 :* Couple does not produce any translatory motion.
   Statement 2 : Resultant force of a couple is zero.
   Statement 3 : The line of action of the two forces of a couple does not coincide.
   a) All statements are true   b) All statements are false
   c) Statement 1 alone is true   d) Statement 2 and 3 only true

9. When you move to a higher altitude from the Earth's surface, the value of g _____ and when you move deep below the Earth's surface the value of g _____ .
   a) reduces, reduces   b) reduces, increases   c) increases, reduces   d) increases, increases

10. The acceleration due to gravity on the surface of the earth will be _____ at the polar region and _____ at the equatorial region.
    a) minimum, minimum   b) minimum, maximum   **c) maximum, minimum**   d) maximum, maximum

11. The value of g at the center of the Earth is _____ .
    a) $\frac{g}{2}$ **b) zero**   c) g   d) 2g

12. The value of acceleration due to gravity on the surface of the moon is _____ .
    a) 1.675 ms⁻²   b) 1.685 ms⁻¹   c) 1.625 ms⁻¹   **d) 1.625 ms⁻²**

13. The acceleration due to gravity of moon is about ___ times the acceleration due to gravity of Earth.
    a) 0.1655   b) 0.1734   **c) 0.1654**   d) 0.1554

14. If a person whose mass is 60 kg stands on the surface of Earth, his weight in moon is _____ .
   a) 975 N   **b) 97.5 N**   c) 588 N   d) 58.8 N
   > **Hint :** $W = mg = 60 \times 1.625 = 97.5$ N

15. The value of Universal gravitational constant is _____ .
   a) $6.74 \times 10^{-10} Nm^2 kg^{-2}$ b) $6.74 \times 10^{-11} Nm^2 kg^{-2}$
   c) $6.674 \times 10^{-11} Nm^2 kg^{-2}$ d) $6.674 \times 10^{-10} Nm^2 kg^{-2}$

16. Astronauts feel weightlessness in space because
   a) there is no gravitational force in space   b) they are floating in space
   c) they are under free fall condition   d) they wear a weightless coat

17. When a lift is moving upward, apparent weight is _____ than the actual weight.
   When a lift is moving downward, apparent weight is _____ than the actual weight.
   a) greater, greater   **b) greater, lesser**   c) lesser, greater   d) lesser, lesser

18. Match the correct apparent weight of a person in a moving lift

Column I	Column II	Answer
1. Lift is moving upward	i) R = 0	1. ii) R = m(g + a)
2. Lift is moving downward	ii) R = m(g + a)	2. iii) R = m(g − a)
3. Lift is at rest	iii) R = m(g − a)	3. iv) R = mg
4. Lift is falling down freely	iv) R = mg	4. i) R = 0

   a) 1-ii, 2-iii, 3-iv, 4-i   b) 1- iii, 2-ii, 3-i, 4- iv   c) 1-iii, 2-ii, 3-iv, 4-i   d) 1-ii,2-iii,3-i, 4-iv

19. A body will be in equilibrium, if the resultant force of all the forces acting on the body is _____ .
   a) zero   b) one   c) infinity   d) constant

20. If parallel forces F_1, F_2 are acting in the same direction, then the resultant force is _____ .
   a) F_1 - $2F_2$ b) F_1 - F_2 **c) $F_1 + F_2$**   d) $F_1 + 2F_2$

21. If parallel equal forces are acting in opposite directions in the same line of action, then the resultant force will be _____ .
   a) zero   b) one   c) infinity   d) constant

22. If parallel unequal force are acting in opposite directions, then the resultant force will be _____ .
   a) F_1 - $2F_2$ **b) $F_2 - F_1$**   c) $F_1 + F_2$ d) $F_1 + 2F_2$

◀ Answer briefly ▶

1. **Define couple.**
   - ❖ **Two equal and unlike parallel forces** applied simultaneously at two distinct points constitute a couple.
   - ❖ The **line of action** of the two forces **does not coincide**.
   - ❖ It does not produce any translatory motion but, results in rotating a body.

2. **Define Impulse.**
   - ❖ When a large force F acts on a body for a period of time t, then **the product of force and time** is known as Impulse. $J = F \times t$. SI unit of Impulse **kgms⁻¹** (or) **Ns.** $\tau = F \times d$

3. **Define Linear momentum with its unit.**
   - ❖ The **product of mass and velocity** of a moving body gives the magnitude of linear momentum.

   > **Linear momentum (p) = mass (m) × velocity (v)**

   - ❖ Linear momentum is a vector quantity. It acts in the direction of the velocity of the object.
   - ❖ Unit of momentum in SI system is **kgms⁻¹**.

4. Define torque. (or) Define moment of the force. Name some applications of torque.

❖ The rotating or turning effect of a force is called moment of the force or torque (τ).

❖ Torque is measured as the **product of the force (F)** and the **perpendicular distance (d)** between the fixed point or the fixed axis and the line of action of the force. Its SI unit is **Nm**.

❖ **Applications of torque:** Gears, Seasaw, Steering Wheel.

5. Define SI unit of force. (OR) Define 1 Newton.

❖ The SI unit of force is Newton(N). $1N = 1Kgm^{-2}$.

❖ 1 Newton (or) Unit force is defined as the amount of force required for a body of **mass 1 Kg** to produce an **acceleration of 1 ms⁻²**.

6. Define C.G.S unit of force. (OR) Define 1 dyne?

❖ The C.G.S unit of force is dyne. **1 dyne** = 1 gcms⁻². $1N = 10^5$ dyne.

❖ 1 dyne is the amount of force required for a body of **mass 1 gram** to produce an **acceleration of 1 cms⁻²**.

7. Define gravitational unit of force.

❖ Gravitational unit of force is the **gravitational force** experienced by a body **of unit mass** (1 Kg).

❖ In SI system it is kilogram force (kgf). In CGS system it is gram force (gf).

        1 kgf = 1 kg × 9.8 ms-2 = 9.8 N;   1 gf = 1 g × 980 cms-2 = 980 dyne

8. What is meant by apparent weight? Mention some examples where you feel apparent weight.

Apparent weight is the **weight** of the body **acquired** due to the action of gravity and other external forces acting on the body. **Eg:** Vertical giant wheel, swing, Roller coaster, Lift.

9. When a carpet is beaten with a stick dust comes out of it. Explain.

When a carpet is beaten with a stick, dust comes out because **carpet moves forward and backward**, but the loosely bound **dust** particles which **remain at rest** comes out due to the **effect of inertia of rest**.

10. The door can be easily opened or closed when you apply the force at a point far away from the fixed edge. Explain.

❖ **Turning effect is more when distance** between line of action and axis of rotation **is more**.

❖ So, door can easily be opened or closed when we apply force at a point far away from the fixed edge.

11. Explain, why is it difficult for a fireman to hold a hose, which ejects large amounts of water at a high velocity.

According to Newton's Third Law of Motion, when large amount of water is ejected from a hose at a high velocity, **water pushes the hose in backward direction with an equal amount of force**. Therefore, it is difficult for a fireman to hold a hose which ejects large amount of water at a high velocity.

12. Write short note on the working of Seasaw.

❖ There is a **difference in the weight** of the persons sitting on a seasaw.

❖ Thus, the heavier person lifts the lighter person.

❖ When **heavier person comes closer to pivot point**, distance decreases and **reduces torque.**

❖ This enables the lighter person to lift the heavier person.

13. What does steering wheel do?

A small **steering wheel enables** you **to turn** a vehicle easily by transferring a torque to the wheels **with less effort**.

Answer in detail

1. **Derive the relation between g and G.**

A body at rest on the surface of Earth is acted upon the gravitational force(G) of the Earth. The effect of G on the body is called **acceleration due to gravity (g).**

Relationship between g and G is computed as follows.

Let, M → mass of the earth (Entire mass of Earth is assumed to its centre)

m → mass of the object

R → radius of the earth

Radius of the object is negligibly small when compared to R.

Newton's law of gravitation, $F = \frac{GMm}{R^2}$ ……………… (1)

Newton's second law, $F = ma = mg$ ……………… (2)

On Comparing equation (1) and (2), $mg = \frac{GMm}{R^2} \Rightarrow g = \frac{GM}{R^2}$

Acceleration due to gravity $g = \frac{GM}{R^2}$
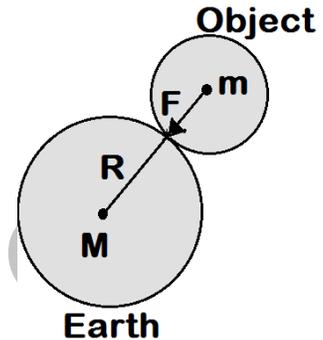
2. **Explain about Aristotle's and Galileo's statement of force and motion?**

Aristotle :

❖ The natural state of earthly bodies at rest.

❖ *Natural motion :* A moving body naturally comes to rest without any external influence of the force. (Force independent)

❖ *Violent motion :* A force is needed to make the bodies to move from their natural state and behave contrary to their own natural state. (Force dependent)

❖ The two different bodies are dropped from a height, the heavier body falls faster than the lighter one.

Galileo :

❖ The natural state of all earthly bodies is **either the state of rest or the state of uniform motion**.

❖ A body in motion will continue to be in the same state of motion as long as no external force is applied.

❖ When a force is applied on bodies, they **resist any change in their state**. This property is called inertia.

❖ When dropped from a height in vacuum, bodies of different size, shape and mass fall at the same rate and reach the ground at the same time.

Solve the given problems

1. **Calculate the mass of a moving body with velocity = 0.5 ms⁻¹; linear momentum = 2.5 kg ms⁻¹.**

Given : Velocity (v) = 0.5 m s⁻¹

Linear momentum (p) = 2.5 kg m s⁻¹

Solution : Linear Momentum, p = mv

$\Rightarrow m = \frac{p}{v} = \frac{2.5}{0.5} = \frac{25}{5}$

m = **5 kg**

2. **Calculate the force needed to speed up a car with an acceleration of 5 ms⁻², if the mass of the car is 1000 kg.**

Given : Acceleration, a = 5 m s⁻²

Mass, m = 1000 kg

Solution : Force, F = ma

F = 1000 × 5 = 5000 kg m s⁻²

F = **5000 N**

CHEMISTRY

UNIT – 7
ATOMS AND MOLECULES

O + O₂ ▸ O₃

POINTS TO REMEMBER

Atom	Atom is the *smallest particle that takes part in a chemical reaction.* Subatomic particles - protons, neutrons and electrons. ✳ *Atomic number : No. of protons (or) No. of electrons* ✳ *Mass number : Sum of the no. of protons and neutrons of an atom.*
Postulates	★ Atom is no longer indivisible. ★ **Isotopes :** Atoms of same elements having different atomic masses. *E.g:* $_{17}Cl^{35}$, $_{17}Cl^{37}$ ★ **Isobar :** Atoms of different elements having same atomic masses. *E.g:* $_{18}Ar^{40}$, $_{20}Ca^{40}$ ★ **Isotones :** Atoms of different elements having same number of neutrons. *E.g:* $_{6}C^{13}$, $_{7}N^{14}$ ★ One element can be transmuted into atoms of other elements. ★ Mass of an atom can be converted into energy.

Molecules
Combination of two or more atoms held together by strong chemical forces of attraction

Homoatomic molecule *(Similar kinds of atoms)* Eg: O_2	**Heteroatomic molecule** *(consist of atoms of different element)* Eg: HCl	**Polyatomic molecule** *(contains more than three atoms)* Eg: CH_4

Atomic Mass Unit (AMU)	**Average atomic mass (AAM)**
The mass of an atom is measured in **atomic mass unit** (amu). It is $\frac{1}{12}^{th}$ of the mass of a Carbon 12 atom.	It is weighted average of the masses of its naturally occurring isotopes.
Gram Atomic Mass (GAM)	**Gram Molecular Mass (GMM)**
Atomic mass of an element is expressed in grams, it is called gram atomic mass.	If the molecular mass of a compound is expressed in grams, it is called gram molecular mass.
Relative Atomic Mass (RAM)	**Relative Molecular Mass (RMM)**
It is the ratio between the average mass of its isotopes to $\frac{1}{12}^{th}$ of the mass of a Carbon 12 atom. It is also called as standard atomic weight.	It is the ratio between the mass of one molecule of the substance to $\frac{1}{12}^{th}$ of the mass of a Carbon 12 atom.

Atomicity	The number of atoms present in the molecule is called atomicity.
Mole	*Mole is the amount of a substance that contains as many elementary entities as there are atoms in exactly 12 gram of Carbon-12 isotope.* **Molar Volume :** It is the volume occupied by one mole of any gas. Its value is 22.4 litre at S.T.P. (Note: STP-Standard Temperature and Pressure (273.15 k, 1.00 atm)

Avogadro's law (or) hypothesis
"equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules"

Vapour density	It is the ratio of the mass of a certain volume of gas/vapour to the mass of an equal volume of hydrogen, measured under the same temperature and pressure.
Percentage composition	The percentage composition of a compound represents the mass of each element present in 100 g of the compound.

FORMULAE

★ Number of moles $= \dfrac{\text{Mass}}{\text{Atomic/molecular mass}}$ (OR) $\dfrac{\text{No. of atoms/molecules}}{\text{Avogadro's number}(N_A)}$

★ No. of atoms/molecules = No. of moles × N_A (OR) $\dfrac{\text{Mass}}{\text{Atomic/molecular mass}} \times N_A$

★ Percentage composition $= \dfrac{\text{mass of required element}}{\text{molecular mass of the compound}} \times 100$

★ STP – Standard Temperature and Pressure is 273.15 K, 1.00 atm

★ Molecular mass = 2 × Vapour density ★ Avogadro's number (N_A) = 6.023×10^{23}

★ Atomicity $= \dfrac{\text{Molecular mass}}{\text{Atomic mass}}$ ★ Molar volume = 22.4 litres (or) 22400 ml

Mass No. & Atomic No.

$$_{6}^{12}\text{C}$$

Mass Number **(A)**
(or)
Atomic masses
Atomic Number **(Z)**

Mass number = No. of protons + No. of neutrons	
Atomic number = No. of protons / No. of electrons	

Atomic Masses of commonly used elements

Hydrogen (H)	**1**	*Magnesium (Mg)*	**24**
Helium (He)	**4**	*Aluminium (Al)*	**27**
Carbon(C)	**12**	*Phosphorus (P)*	**31**
Nitrogen (N)	**14**	*Sulphur (S)*	**32**
Oxygen (O)	**16**	*Chlorine (Cl)*	**35.5**
Sodium (Na)	**23**	*Calcium (Ca)*	**40**

EVALUATION

Online Test

I. Choose the best answer

1. Which of the following has the smallest mass?
   a) 6.023×10^{23} atoms of He **b) 1 atom of He** c) 2 g of He d) 1 mole atoms of He

   > **Hint :** a) 6.023×10^{23} atoms of He = 1 mole of He **b) 1 atom of He** $= \dfrac{1}{6.023 \times 10^{23}}$ **moles of He**
   >
   > c) 2 g of He $= \dfrac{2}{4}$ = 0.5 moles of He d) 1 mole atoms of He

2. Which of the following is a triatomic molecule? **[MDL-19, PTA-1]**
   a) Glucose b) Helium **c) Carbon dioxide** d) Hydrogen

   > **Hint :** CO_2 → 1 Carbon atom + 2 Oxygen atoms ⇒ 3 atoms – Triatomic molecule

3. The volume occupied by 4.4 g of CO_2 at S.T.P
   a) 22.4 litre **b) 2.24 litre** c) 0.24 litre d) 0.1 litre

   > **Hint :** Molecular mass $= (1 \times 12) + (2 \times 16) = \mathbf{44}$
   >
   > Number of moles $= \dfrac{\text{Mass}}{\text{molecular mass}} = \dfrac{4.4}{44}$ = 0.1 mole
   >
   > Volume occupied by CO_2 = No. of moles × Molar volume = 0.1 × 22.4 = 2.24 litre

4. Mass of 1 mole of Nitrogen atom is

   a) 28 amu   b) 14 amu   c) 28 g   **d) 14 g**

   > **Hint :** Mass = No. of moles × Atomic mass = 1 × 14 = 14 g

5. Which of the following represents 1 amu?

   a) Mass of a C – 12 atom   b) Mass of a hydrogen atom

   c) $\frac{1}{12}$th of the mass of a C-12 atom   d) Mass of O – 16 atom

6. Which of the following statement is incorrect ?

   a) 12 gram of C – 12 contains Avogadro's number of atoms.

   b) One mole of oxygen gas contains Avogadro's number of molecules.

   c) One mole of hydrogen gas contains Avogadro's number of atoms.

   d) One mole of electrons stands for 6.023×10^{23} electrons.

   > **Correct statement:** *1 mole of hydrogen gas contains Avogadro's number of **molecules**.*

7. The volume occupied by 1 mole of a diatomic gas at S.T.P is

   a) 11.2 litre   b) 5.6 litre   **c) 22.4 litre**   d) 44.8 litre

   > **Hint:** *The volume occupied by 1 mole of any gas at S.T.P is 22.4 litre.*

8. In the nucleus of $_{20}Ca^{40}$, there are

   a) 20 protons and 40 neutrons   **b) 20 protons and 20 neutrons**

   c) 20 protons and 40 electrons   d) 40 protons and 20 electrons

   > **Hint:** *No. of protons = atomic number = 20*
   > *No. of neutrons = mass number – atomic number = 40 – 20 = 20*

9. The gram molecular mass of oxygen molecule is   **[AUG-22]**

   a) 16 g   b) 18 g   **c) 32 g**   d) 17 g

   > **Hint:** *GMM of O_2 = 2 × 16 = 32 g*

10. 1 mole of any substance contains _____ molecules.   **[APR-24]**

   a) 6.023×10^{23}   b) 6.023×10^{-23} c) 3.0115×10^{23} d) 12.046×10^{23}

Additional Govt Exam Questions

11. The gram molecular mass of water is: **[APR-23]**

   a) 2 g   b) 16 g   **c) 18 g**   d) 8 g

   > **Hint:** H_2O = (1 × 2) + 16 = 18

12. Analyse the following and choose the correct statement(s)   **[PTA-4]**

   i) An electron has considerable mass

   ii) A hetero atomic molecule is formed from different kinds of atoms.

   iii) Mass number and atomic mass of an element are same

   a) i, ii and iii are correct   b) i and iii are correct

   c) only (ii) is correct   d) only (iii) is correct

13. If a molecule is made of similar kind of atoms, then it is called _____. **[MAY-22, PTA-6]**

   a) mono atomic molecule   b) hetero atomic molecule

   c) homo atomic molecule   d) poly atomic molecule

II. Fill in the blanks

1. Atoms of different elements having **same** mass number, but **different** atomic numbers are called isobars.

2. Atoms of one element can be transmuted into atoms of other element by **artificial transmutation**.

3. The sum of the numbers of protons and neutrons of an atom is called its **mass number**.

4. Relative atomic mass is otherwise known as **standard atomic weight**.

5. The average atomic mass of hydrogen is **1.008** amu.

6. If a molecule is made of similar kind of atoms, then it is called **homo** atomic molecule.

7. The number of atoms present in a molecule is called its **atomicity**.   **[PTA-4]**

8. One mole of any gas occupies **22400** ml at S.T.P.

9. Atomicity of phosphorous is **4**.

Additional Govt Exam Question

10. Atoms of different elements having same number of **neutrons** are called isotones. **[PTA-4]**

III. Match the following

Column I	Column II	Answer	*Solution :* No. of moles = $\dfrac{\text{Mass}}{\text{Atomic/molecular mass}}$
1. 8 g of O_2	4 moles	**1) 0.25 moles**	1) 8 g of $O_2 = \dfrac{8}{32} = \mathbf{0.25}$ **moles**
2. 4 g of H_2	0.25 moles	**2) 2 moles**	2) 4 g of $H_2 = \dfrac{4}{2} = \mathbf{2}$ **moles**
3. 52 g of He	2 moles	**3) 13 moles**	3) 52 g of He $= \dfrac{52}{4} = \mathbf{13}$ **moles**
4. 112 g of N_2	0.5 moles	**4) 4 moles**	4) 112 g of $N_2 = \dfrac{112}{28} = \mathbf{4}$ **moles**
5. 35.5 g of Cl_2	13 moles	**5) 0.5 mole**	5) 35.5 g of $Cl_2 = \dfrac{35.5}{71} = \mathbf{0.5}$ **moles**

IV. True or False: (if false give the correct

1. Two elements sometimes can form more than one compound.   **[True]**
2. Noble gases are diatomic.   **[False]**

    > *Correct statement:* Noble gases are **monoatomic.**

3. The gram atomic mass of an element has no unit.   **[False]**

    > *Correct statement: The **relative** atomic mass of an element has no unit.*

4. 1 mole of Gold and Silver contain same number of atoms.   **[True]**
5. Molar mass of CO_2 is 42g.   **[False]**

    > *Correct statement: Molar mass of CO_2 = 12+(16 × 2) = **44 g**.*

V. Assertion & Reason

Answer the following questions using the data given below:

i) A and R are correct, R explains the A. ii) A is correct, R is wrong.

iii) A is wrong, R is correct.   iv) A and R are correct, R doesn't explains A.

1. **Assertion:** The Relative Atomic mass of aluminium is 27.

    Reason   : An atom of aluminium is 27 times heavier than $\frac{1}{12}$th of the mass of the C – 12 atom.

    Ans. (iv) *A and R are correct, R does not explains A.*

2. **Assertion:** The Relative Molecular Mass of Chlorine is 35.5 a.m.u.   **[PTA-3]**

    Reason   : The natural abundance of Chlorine isotopes are not equal.

    Ans. (iii) *A is wrong, R is correct.*

    Hint: *Relative **Atomic** Mass of chlorine is 35.5 (or) Relative **Molecular** Mass of chlorine is 71.*

VI. Short answer questions

1. Define: Relative atomic mass (or) Define Standard atomic weight.

[JUN-23, AUG-22, PTA-3]

Relative atomic mass (or) Standard atomic weight of an element is the **ratio** between the **average mass** of its isotope **to $\frac{1}{12}$th** part of the mass of a carbon-12 atom.

Relative Atomic Mass, A_r = $\dfrac{\text{Average mass of the isotopes of the element}}{\frac{1}{12}\text{th of the mass of one carbon}-12\text{ atom}}$

2. Write the different types of isotopes of oxygen and its percentage abundance. (OR) Oxygen exists as a mixture of three stable isotopes in nature. Calculate the atomic mass of oxygen.   **[Eg (1) – 94]**

Isotope	Atomic Mass (amu)	% abundance
$_8O^{16}$	15.9949	99.757
$_8O^{17}$	16.9991	0.038
$_8O^{18}$	17.9992	0.205

Atomic mass of oxygen = $(15.9949 \times 0.99757) + (16.9991 \times 0.00038) + (17.9992 \times 0.00205)$
= **15.999 amu**

3. Define: Atomicity. Give an example.   **[APR-23, AUG-22, MAY-22, SEP-21]**

❖ The **number of atoms** present **in the molecule** is called its atomicity.

❖ *Types :* Monoatomic, Diatomic, Triatomic or Polyatomic.

❖ *Eg :* Atomicity of Phosphorous(P_4) is 4, Atomicity of Hydrogen Chloride (HCl) is 2.

4. Give any two examples for heterodiatomic molecules.   **[AUG-22]**

Heterodiatomic molecules – Hydrogen Chloride *(HCl),* Hydrogen Fluoride *(HF)*

5. What is Molar volume of a gas?

One mole of any gas occupies 22.4 litre / 22400 ml at STP. This volume is called molar volume.

6. Find the percentage of nitrogen in ammonia.   **[PTA-1]**

Molecular mass of ammonia, NH_3 = $14 + (1 \times 3) = 17$ g

% of Nitrogen in NH_3 = $\dfrac{\text{Mass of Nitrogen}}{\text{Molecular mass of } NH_3} \times 100 = \dfrac{14}{17} \times 100 =$ **82.35 %**

Additional Govt Exam Questions

1. Distinguish between atoms and molecules.   [MAY-22]

Atom	Molecule
1. An atom is the **smallest particle** of an **element**.	1. A molecule is the **smallest particle** of an **element or compound**.
2. Atom does **not exist in free state** except in noble gas.	2. Molecule **exists in free state**.
3. Except some of noble gas, other atoms are **highly reactive**.	3. Molecules are **less reactive**.
4. Atom **does not have a chemical bond**.	4. Atoms in a molecule are **held by chemical bonds**.

2. What is Avogadro's Hypothesis? State its application.

Avogadro's law / Hypothesis: The law states that *"equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules"*.

Applications of Avogadro's law :   [APR-23, SEP-20]

    i) It explains **Gay-Lussac's law**.

    ii) It helps in the **determination of atomicity** of gases.

    iii) **Molecular formula** of gases can be **derived**.

    iv) It helps to **determine gram molar volume** of all gases.

    v) It determines the **relationship between molecular mass and vapour density.**

VII. Long answer questions

1. Calculate the number of water molecule present in one drop of water, which weighs 0.18 g.

Molecular mass of $H_2O = (1 \times 2) + 16 = 18$ g

$$\text{Number of molecules} = \frac{\text{Mass of water}}{\text{Molecular mass}} \times \text{Avogadro number}$$

$$= \frac{0.18}{18} \times 6.023 \times 10^{23}$$

∴ The No. of water molecules $= \mathbf{6.023 \times 10^{21}}$

2. $N_2 + 3 H_2 \rightarrow 2 NH_3$ (The atomic mass of nitrogen is 14, and that of hydrogen is 1)

1 mole of nitrogen (__g) + 3 moles of hydrogen (__ g) → 2 moles of ammonia (__ g)

$$\text{Mass} = \text{No. of moles} \times \text{Molecular mass}$$

$$\text{Mass of } N_2 = 1 \times (14 \times 2) = 28$$

$$\text{Mass of } H_2 = 3 \times (1 \times 2) = 6$$

$$\text{Mass of } NH_3 = 2 \times (14 + (3 \times 1)) = 34$$

1 mole of nitrogen (**28 g**) + 3 moles of hydrogen (**6 g**) → 2 moles of ammonia (**34 g**)

3. Calculate the number of moles in   [PTA-5]

i) 27g of Al :

$$\text{Number of moles} = \frac{\text{Mass of Molecules}}{\text{Atomic mass of Molecules}}$$

$$= \frac{27}{27} = \mathbf{1 \ mole}$$

ii) 1.51×10^{23} molecules of NH_4Cl :   [APR-24]

$$\text{Number of moles} = \frac{\text{Number of Molecules}}{\text{Avogadro number}}$$

$$= \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}} = \mathbf{0.25 \ moles}$$

4. Give the salient features of "Modern atomic theory". [APR-24, AUG-22, SEP-20, PTA-5]

❖ An **atom is no longer indivisible**. It is divided into electron, proton and neutron.

❖ *Isotope :* Atoms of the same element having different atomic mass. *Eg :* $_{17}Cl^{35}$, $_{17}Cl^{37}$

❖ *Isobars :* Atoms of different elements having same atomic masses. *Eg :* $_{18}Ar^{40}$, $_{20}Ca^{40}$

❖ *Artificial transmutation :* Atom of one element can be transmuted into atoms of other elements. Atom is no longer indestructible.

❖ Atoms may **not always** combine in a simple **whole number ratio**.
    Eg : Glucose $C_6H_{12}O_6$ C:H:O = 6:12:6 or 1:2:1

❖ **Atom is the smallest particle** that takes part in a chemical reaction.

❖ The mass of an atom can be converted into energy. **$E = mc^2$**

5. Derive the relationship between Relative molecular mass and Vapour density.
[PTA-6, MDL-19]

Relative Molecular Mass **(RMM) :** It is the ratio between the mass of one molecule of the gas (or) vapour to the mass of one atom of Hydrogen.

$$\text{Relative Molecular Mass} = \frac{\text{Mass of 1 molecule of gas (or) vapour at STP}}{\text{mass of 1 atom of hydrogen}} \text{…………..(1)}$$

Vapour Density: It is the ratio of the mass of a certain volume of a gas or vapour, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.

$$\text{Vapour Density (V.D)} = \frac{\text{Mass of a given volume of gas (or) Vapour at STP}}{\text{Mass of the same volume of Hydrogen}} \text{………(2)}$$

According to Avogadro's law, Equal volumes of all gases contain equal number of molecules.
Let, number of molecules in the considered volume = n

$$\therefore \text{Vapour Density (at STP)} = \frac{\text{Mass of 'n' molecules of a gas (or) Vapour at STP}}{\text{mass of 'n' molecules of hydrogen}}$$

$$\text{Let n = 1, then VD} = \frac{\text{Mass of 1 molecule of a gas (or) Vapour at STP}}{\text{mass of 1 molecule of hydrogen}}$$

Hydrogen is diatomic molecule so,

$$\text{Vapour Density} = \frac{\text{Mass of 1 molecule of gas (or)Vapour at STP}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

$$2 \times \text{Vapour density} = \frac{\text{Mass of 1 molecule of gas (or) Vapour at STP}}{\text{Mass of 1 atom of hydrogen}}$$

$2 \times \text{Vapour density}$ = Relative Molecular Mass [∵ By Eqn (1)]

Relative Molecular Mass = 2 × Vapour Density

VIII. HOT Questions

1. Calcium carbonate is decomposed on heating in the following reaction.
$$CaCO_3 \rightarrow CaO + CO_2$$

i) How many moles of Calcium carbonate are involved in this reaction?
    One mole of $CaCO_3$ is involved in the reaction.

ii) Calculate the gram molecular mass of calcium carbonate involved in this reaction.
    Gram Molecular Mass of $CaCO_3$ = (40 × 1) + (12 × 1) + (16 × 3)
                    = 40 + 12 + 48   = 100 g
    ∴ Gram Molecular Mass of $CaCO_3$ is = 1 × 100 g = **100 g**

iii) How many moles of CO2 are there in this equation?
    One mole of CO_2 is involved in this reaction.

IX. Solve the following problems

1. How many grams are there in the following? **[PTA-4]**

$Mass = No. of moles \times Molecular mass$	
i) 2 moles of hydrogen molecule, H_2 Molecular mass of $H_2 = 1 \times 2 = 2$ Mass of 2 moles of $H_2 = 2 \times 2 = $ **4 g**	**ii) 3 moles of chlorine molecule, Cl_2** Molecular mass of $Cl_2 = 35.5 \times 2 = 71$ Mass of 3 moles of $Cl_2 = 3 \times 71 = $ **213 g**
iii) 5 moles of sulphur molecule, S_8 Molecular mass of $S_8 = 32 \times 8 = 256$ Mass of 5 moles of $S_8 = 5 \times 256 = $ **1280 g**	**iv) 4 moles of phosphorous molecule, P_4** Molecular mass of $P_4 = 30 \times 4 = 120$ Mass of 4 moles of $P_4 = 4 \times 120 = $ **480 g**

> *Note :* In Text Book solved problems (Pg. no. 100, Q.No. I-3), atomic mass of Phosphorus is given as **30.** But, correct approximate value is **31.**

2. Calculate the (mass) % of each element in calcium carbonate. (Atomic mass: C-12, O-16, Ca-40)

Molecular mass of $CaCO_3 = 40 + 12 + (16 \times 3) = 100$ g **[JUN-23, PTA-2]**

Elements	Mass of Individual element	$\dfrac{\text{Mass of element}}{\text{Molecular mass}} \times 100$	Mass percentage of each element
Ca	40	$\dfrac{40}{100} \times 100$	40%
C	12	$\dfrac{12}{100} \times 100$	12%
O	48 ($3 \times 16 = 48$)	$\dfrac{48}{100} \times 100$	48%

3. Calculate the % of oxygen in $Al_2(SO_4)_3$. (Atomic mass: Al - 27, O - 16, S - 32). **[PTA-2]**

Molecular mass of $Al_2(SO_4)_3 = (2 \times 27) + (3 \times (32 + (4 \times 16)))$

$$= (2 \times 27) + (3 \times 96) = 54 + 288 = 342 \text{ g}$$

$$\% \text{ of O in } Al_2(SO_4)_3 = \frac{\text{Mass of Oxygen}}{\text{Molecular Mass of } Al_2(SO_4)_3} \times 100 = \frac{3 \times 4 \times 16}{342} \times 100$$

$$= \frac{192}{342} \times 100 = \textbf{56.14\%}$$

4. Calculate the % relative abundance of B -10 and B -11, if its average atomic mass is 10.804 amu.

Let a_1, a_2 be the % abundance of B-10 and B-11 respectively.

$$\text{Mass of B-10, } m_1 = 10 \qquad \text{Mass of B-11, } m_2 = 11$$

$$a_1 + a_2 = 100$$

$$a_1 = 100 - a_2$$

$$\text{Average Atomic Mass} = m_1 \times \frac{a_1}{100} + m_2 \times \frac{a_2}{100}$$

$$= 10 \times \frac{(100 - a_2)}{100} + 11 \times \frac{a_2}{100} \quad = 10 \times \left(1 - \frac{a_2}{100}\right) + \frac{11a_2}{100}$$

$$= 10 - \frac{10a_2}{100} + \frac{11a_2}{100}$$

$$10.804 = 10 + \frac{a_2}{100} \quad (\because \text{Average Atomic Mass of B} = 10.804 \text{ amu})$$

$$\frac{a_2}{100} = 10.804 - 10 = 0.804$$

$$a_2 = 0.804 \times 100 = 80.4\,\%$$

$$a_1 = 100 - 80.4 = 19.6\,\%$$

$$\therefore \% \text{ abundance of B-10} = \textbf{19.6 \%} \qquad \% \text{ abundance of B-11} = \textbf{80.4\%}$$

Example Problems

Calculation of Average Atomic Mass

5. The nature abundance of C-12 and C-3 are 98.90 % and 1.10 % respectively and calculate the average atomic mass of carbon. [TB – 93]

$$\text{Average atomic mass of carbon} = \left(12 \times \frac{98.9}{100}\right) + \left(13 \times \frac{1.1}{100}\right)$$
$$= (12 \times 0.989) + (13 \times 0.011)$$
$$= 11.868 + 0.143 = \textbf{12.011 amu}$$

6. Boron naturally occurs as a mixture of boron-10 (5 protons + 5 neutrons) and boron-11(5 protons + 6 neutrons) isotopes. The percentage abundance of B-10 is 20 and that of B-11 is 80. Calculate the atomic mass of boron. [TB – 94]

$$\text{Atomic mass of boron} = \left(10 \times \frac{20}{100}\right) + \left(11 \times \frac{80}{100}\right)$$
$$= (10 \times 0.20) + (11 \times 0.80)$$
$$= 2 + 8.8 = \textbf{10.8 amu}$$

Calculation of Relative Molecular Mass

7. Sulphuric acid contains 2 atoms of hydrogen, 1 atom of sulphur and 4 atoms of oxygen. Calculate the relative molecular mass of sulphuric acid (H_2SO_4). [TB – 96]

Relative Molecular Mass of H_2SO_4 = (2×mass of hydrogen)+(1×mass of sulphur)+(4×mass of oxygen)
$$= (2 \times 1) + (1 \times 32) + (4 \times 16) = \textbf{98}$$

∴ One molecule of H_2SO_4 is 98 times as heavy as $\frac{1}{12^{th}}$ of the mass of a carbon −12.

8. A water molecule is made of 2 atoms of hydrogen and one atom of oxygen. Calculate the relative molecular mass of water (H_2O). [TB – 96]

Relative Molecular Mass of water = (2 × mass of hydrogen) + (1 × mass of oxygen)
$$= (2 \times 1) + (1 \times 16) = \textbf{18}$$

∴ One molecule of H_2O is 18 times as heavy as $\frac{1}{12^{th}}$ of the mass of a carbon −12.

Calculation of Mass percentage composition

9. Find the mass percentage composition of Water (H_2O). [TB – 98]

$$\text{Molecular mass of } H_2O = 2(1) + 16 = 18 \text{ g}$$
$$\text{Mass \% of hydrogen} = \frac{2}{18} \times 100 = 11.11\%$$
$$\text{Mass \% of oxygen} = \frac{16}{18} \times 100 = 88.89\%$$

10. Find the mass percentage composition of methane (CH_4). [TB – 98]

$$\text{Molecular mass of } CH_4 = 12 + (1 \times 4) = 16 \text{ g}$$
$$\text{Mass \% of Carbon} = \frac{12}{16} \times 100 = 75\%$$
$$\text{Mass \% of Hydrogen} = \frac{4}{16} \times 100 = 25\%$$

Calculation of Molecular mass

11. Calculate the gram molecular mass of the following. i) H_2O ii) CO_2 iii) $Ca_3(PO_4)_2$

i) H_2O [TB – 99, 100]	ii) CO_2 [TB – 100] [SEP-2021]	iii) $Ca_3(PO_4)_2$ [TB – 100]
Atomic mass of H =1,O=16	Atomic mass of C=12,O=16	Atomic mass of Ca = 40, P =30, O =16
Gram Molecular Mass of H_2O	Gram Molecular Mass of CO_2	Gram Molecular Mass of $Ca_3(PO_4)_2$
$= (1 \times 2) + (16 \times 1)$	$= (12 \times 1) + (16 \times 2)$	$= (40 \times 3) + [30 + (16 \times 4)] \times 2$
$= 2 + 16 =$ **18 g**	$= 12 + 32 =$ **44 g**	$= 120 + (94 \times 2) = 120 + 188=$ **308 g**

> *Note :* *In Book example problem, atomic mass of Phosphorus is given as 30. But, correct approximation value is 31.*

Calculation based on number of moles from mass and volume

12. i) Calculate the number of moles in 46 g of sodium.   [TB – 100] [MDL-19]

$$\text{Number of moles of Sodium} = \frac{\text{Mass of the element}}{\text{Atomic mass of the element}} = \frac{46}{23} = \textbf{2 moles}$$

ii) Calculate the number of moles in 5.6 litre of oxygen at S.T.P. [TB – 100]

Number of moles of Oxygen

$$= \frac{\text{Given volume of } O_2 \text{ at S.T.P}}{\text{Molar volume at S.T.P}}$$

$$= \frac{5.6}{22.4} = \textbf{0.25 mole}$$

iii) Calculate the number of moles of a sample that contains 12.046×10^{23} atoms of iron.

Number of moles of Iron   [TB – 100]

$$= \frac{\text{Number of atoms of iron}}{\text{Avogadro's number}}$$

$$= \frac{12.046 \times 10^{23}}{6.023 \times 10^{23}} = \textbf{2 moles}$$

Calculation of mass from mole

13. Calculate the mass of the following :   [TB – 100, 101]

$$\textbf{No. of moles} = \frac{\text{Mass of Compound}}{\text{Molecular / atomic mass}} = \frac{\text{Number of atoms}}{\text{Avogadro's number}} = \frac{\text{Given volume at STP}}{\text{Molar Volume}}$$

i) 0.3 mole of Aluminium (Atomic mass of Al = 27)

Mass = No. of moles × Atomic mass = $0.3 \times 27 =$ **8.1 g**

ii) 2.24 litre of SO_2 gas at S.T.P

Molecular mass of $SO_2 = 32 + (16 \times 2) = 32 + 32 = 64$ g

Number of moles of $SO_2 = \frac{2.24}{22.4} = 0.1$ mole

Mass of SO_2 = No. of moles × Molecular mass = $0.1 \times 64 =$ **6.4 g**

iii) 1.51×10^{23} molecules of water [MDL-19]

Molecular mass of $H_2O = 18$

Number of moles $= \frac{1.51 \times 10^{23}}{6.023 \times 10^{23}} = \frac{1}{4} = 0.25$ mole

Number of moles $= \frac{\text{Mass}}{\text{Molecular mass}}$

$0.25 = \frac{\text{mass}}{18} \Rightarrow$ Mass $= 0.25 \times 18 =$ **4.5g**

iv) 5×10^{23} molecules of glucose?

Molecular mass of $C_6H_{12}O_6$(glucose)

$= (12 \times 6) + (1 \times 12) + (16 \times 6) = 180$

Mass of glucose $= \frac{\text{Molecular mass} \times \text{Number of particles}}{\text{Avogadro's number}}$

$= \frac{180 \times 5 \times 10^{23}}{6.023 \times 10^{23}} = 149.43 =$ **149.43 g**

Calculation based on number of atoms / molecules

$$\text{No. of moles} = \frac{\text{Mass of Compound}}{\text{Molecular / atomic mass}} = \frac{\text{Number of atoms}}{\text{Avogadro's number}} = \frac{\text{given volume at STP}}{\text{Molar Volume}}$$

14. i) Calculate the number of molecules in 11.2 litre of CO_2 at S.T.P [TB – 101]

$$\text{Number of moles of } CO_2 = \frac{\text{volume at S.T.P}}{\text{Molar volume}} = \frac{11.2}{22.4} = 0.5 \text{ mole}$$

Number of molecules of CO_2 = Number of moles of CO_2 × Avogadro's number

$$= 0.5 \times 6.023 \times 10^{23} = \mathbf{3.011 \times 10^{23} \text{ molecules}}$$

ii) Calculate the number of atoms present in 1 gram of gold (Atomic mass of Au = 198)

Number of atoms of Au

$$= \frac{\text{Mass of Au} \times \text{Avogadro's number}}{\text{Atomic mass of Au}}$$

$$= \frac{1}{198} \times 6.023 \times 10^{23}$$

$$= \mathbf{3.042 \times 10^{21}}$$

iii) Calculate the number of molecules in 54 g of H_2O.

Number of molecules of water

$$= \frac{\text{Avogadro number} \times \text{Given mass}}{\text{Gram molecular mass}}$$

$$= \frac{6.023 \times 10^{23} \times 54}{18}$$

$$= \mathbf{18.069 \times 10^{23} \text{ molecules}}$$

iv) Calculate the number of atoms of oxygen and carbon in 5 moles of CO_2.

1 mole of CO_2 contains 2 moles of oxygen $\Rightarrow$ 5 moles of CO_2 contain 10 moles of oxygen

Number of atoms of oxygen = Number of moles of oxygen × Avogadro's number

$$= 10 \times 6.023 \times 10^{23}$$

$$= \mathbf{6.023 \times 10^{24} \text{ atoms of oxygen}}$$

1 mole of CO_2 contains 1 mole of Carbon $\Rightarrow$ 5 moles of CO_2 contain 5 moles of Carbon

$$= 5 \times 6.023 \times 10^{23} = \mathbf{3.011 \times 10^{24} \text{ atoms of carbon}}$$

Calculation based on molar volume

15. Calculate the volume occupied by : [TB – 101]

$$\text{No. of moles} = \frac{\text{Mass of Compound}}{\text{Molecular / atomic mass}} = \frac{\text{Number of atoms}}{\text{Avogadro's number}} = \frac{\text{Given volume at STP}}{\text{Molar Volume}}$$

i) 2.5 mole of CO_2 at S.T.P.

$$2.5 \text{ mole of } CO_2 = \frac{\text{Volume of } CO_2 \text{ at S.T.P}}{22.4}$$

Volume of CO_2 at S.T.P = 22.4×2.5 = **56 litres**

ii) 12.046×10^{23} of ammonia gas molecules.

$$\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro's number}}$$

$$= \frac{12.046 \times 10^{23}}{6.023 \times 10^{23}}$$

$$= 2 \text{ moles}$$

Volume occupied by NH_3

$$= \text{Number of moles} \times \text{Molar volume}$$

$$= 2 \times 22.4 = \mathbf{44.8 \text{ litres at S.T.P}}$$

iii) 14 g nitrogen gas.

$$\text{Number of moles} = \frac{14}{28}$$

$$= 0.5 \text{ mole}$$

Volume occupied by N_2 at S.T.P,

$$= \text{number of moles} \times \text{molar volume}$$

$$= 0.5 \times 22.4$$

$$= \mathbf{11.2 \text{ litres}}$$

Calculation based on % composition

16. Calculate % of S in H₂SO₄.   **[TB – 102] [APR-23]**

Molecular mass of $H_2SO_4 = (1 \times 2) + (32 \times 1) + (16 \times 4) = 2 + 32 + 64 = 98$ g

% of S in $H_2SO_4 = \dfrac{\text{Mass of Sulphur}}{\text{Molecular Mass of } H_2SO_4} \times 100 = \dfrac{32}{98} \times 100 = \mathbf{32.65\%}$

Additional Govt Exam Questions

17. Calculate the number of molecules present in the 36 g water.   **[MDL -19]**

Number of molecules of water $= \dfrac{\text{Given mass}}{\text{Gram Molecular Mass}} \times$ Avogadro number

$= \dfrac{36}{18} \times 6.023 \times 10^{23} = \mathbf{12.046 \times 10^{23}}$

18. The mass percentage of carbon is 27.28% and the mass percentage of oxygen is 72.73%. Calculate the molecular mass of that compound.   **[PTA-4]**

Mass % of Carbon = 27.28 = Mass of C

Mass % of Oxygen = 72.73 = Mass of O

No. of moles of C $= \dfrac{Mass\ \%\ of\ Carbon}{Atomic\ mass\ of\ Carbon} = \dfrac{27.28}{12} = 2.27 \cong 2$

No. of moles of O $= \dfrac{Mass\ \%\ of\ Oxygen}{Atomic\ mass\ of\ Oxygen} = \dfrac{72.73}{16} = 4.54 \cong 4$

Molecular formula : C_2O_4 (or) $2\ CO_2$

Molecular mass $= (2 \times 12) + (4 \times 16) = \mathbf{88g}$

19. In chemical industries, the following chemical reaction is used to produce ammonia in large scale.$N_2 + 3H_2 \rightleftharpoons 2NH_3$ **[PTA-3]**

Based on mole concept, calculate the mass of nitrogen gas and hydrogen gas required in kilogram to produce 1000kg of ammonia by using the above chemical equation.

Mass of NH_3 to be produced $= 1000$ kg $= 10^6$ g

Molecular mass of $NH_3 = 14 + (3 \times 1) = 17$ g

No. of moles of $NH_3 = \dfrac{mass\ of\ NH_3\ to\ be\ produced}{molecular\ mass\ of\ NH_3} = \dfrac{10^6}{17}$

2 moles of NH₃ is produced from 3 moles of H₂

$\therefore \dfrac{10^6}{17}$ moles of NH_3 is produced from $\dfrac{10^6}{17} \times \dfrac{3}{2}$ moles of H_2

Required Mass of H₂ = No. of moles of H_2 × Molecular mass

$= \dfrac{10^6}{17} \times \dfrac{3}{2} \times (2 \times 1) = \mathbf{176.47\ kg\ of\ H_2}$

2 moles of NH₃ is produced from 1 mole of N₂

$\therefore \dfrac{10^6}{17}$ moles of NH_3 is produced from $\dfrac{10^6}{17} \times \dfrac{1}{2}$ moles of N_2

Required Mass of N₂ = No. of moles of N_2 × Molecular mass

$= \dfrac{10^6}{17} \times \dfrac{1}{2} \times (14 \times 2) = \dfrac{28}{34} \times 10^6$

$= 0.82353 \times 10^6$ g $= \mathbf{823.53\ kg\ of\ N_2}$

$\therefore$ Required mass of Nitrogen gas $= \mathbf{823.53\ kg}$

Required mass of Hydrogen gas $= \mathbf{176.47\ kg}$

Other Text Book Exercise

Activity

1. **Complete the following table by filling the appropriate values/terms.** [Activity : 7.1, TB-95]

Element	No. of Protons	No. of Neutrons	Mass Number	Stable Isotopes (abundance)	Atomic Mass (amu)
Nitrogen	7	7	**14**	N-14 (99.6%)	= (14 × 0.996) + (15 × 0.004)
	7	8	**15**	N-15 (0.4%)	= 13.944 + 0.06 = **14.004 amu**
Silicon	14	14	28	Si-28 (92.2%)	= (28 × 0.922) + (29 × 0.047)
	14	15	29	Si-29 (4.7%)	+ (30 × 0.031)
	14	16	30	Si-30 (3.1%)	= 25.816 + 1.363 + 0.93 = **28.109 amu**
Chlorine	17	18	35	Cl-35 (75%)	= (35 × 0.75) + (37 × 0.25)
	17	20	37	Cl-37 (25%)	= 26.25 + 9.25 = **35.5 amu**

2. **Classify the following molecules based on their atomicity.** [Activity : 7.2, TB -95]

Hydrogen Chloride(HCl), Fluorine (F_2), Carbon dioxide (CO_2), Phosphorous (P_4), Sulphur (S_8), Ammonia (NH_3), Hydrogen iodide (HI), Sulphuric Acid (H_2SO_4), Methane (CH_4), Glucose ($C_6H_{12}O_6$), Carbon monoxide (CO).

Molecule	Di atomic Atomicity = 2	Tri atomic Atomicity = 3	Poly atomic Molecule	Atomicity
Homo	Fluorine (F_2)	-	Phosphorous (P_4)	4
			Sulphur (S_8)	8
Hetero	Hydrogen Chloride(HCl) Hydrogen Iodide (HI) Carbon monoxide (CO)	Carbon dioxide (CO_2)	Ammonia (NH_3)	4
			Methane (CH_4)	5
			Sulphuric Acid (H_2SO_4)	7
			Glucose ($C_6H_{12}O_6$)	24

3. **Under same conditions of temperature and pressure if you collect 3 litre of O_2, 5 litre of Cl_2 and 6 litre of H_2.** [APR – 24] [Activity : 7.3, TB - 98]

   i) **Which has the highest number of molecules?**

   ii) **Which has the lowest number of molecules?**

> No. of moles of = $\dfrac{\text{Volume of STP}}{\text{Molar Volume}}$ No. of molecules = No. of moles × Avogadro number

For O_2 : No. of moles $= \dfrac{3}{22.4} = 0.1339$ moles

   No. of molecules $= 0.1339 × 6.023 × 10^{23} = 8.064 × 10^{22}$ O_2 molecules

For Cl_2 : No. of moles $= \dfrac{5}{22.4} = 0.2232$ moles

   No. of molecules $= 0.2232 × 6.023 × 10^{23} = 1.344 × 10^{23}$ Cl_2 molecules

For H_2 : No. of moles   Number of moles of H_2 $= \dfrac{6}{22.4} = 0.2678$ moles

   No. of molecules $= 0.2678 × 6.023 × 10^{23} = 1.6129 × 10^{23}$ H_2 molecules

i) 6 litres of H_2 has the highest number of molecules.   ii) 3 litres of O_2 has the lowest number of molecules.

Conceptual Thoughts

1. All compounds are molecules; but, all molecules are not compounds why? [TB - 94]

❖ Compounds contain atoms of two or more different elements. Molecules contain atoms of two or more same or different elements. A molecule may be an element or a compound.

❖ Thus, all compounds are molecules but all molecules are not compounds.

❖ **Example:** H_2 is a molecule, not a compound. H_2O is a compound as well as a molecule.

QR Code Questions

1. How many molecules are present in 1 g of Hydrogen _____ .
    a) 6.023×10^{23} **b) 3.0115×10^{23}**   c) 1.511×10^{23} d) 2.511×10^{23}

   Hint : *No. of H_2 molecules* $= \frac{1}{2} \times 6.023 \times 10^{23} = 3.0115 \times 10^{23}$ *molecules*

2. Which of the following has largest number of particles?
    a) 8 g of CH_4 b) 4.4 g of CO_2 c) 34.2 g of $C_{12}H_{22}O_{11}$ **d) 2 g of H_2**

   Hint : a) 8 g of CH_4 molecule $= \frac{8}{16} \times 6.023 \times 10^{23} = 3.0115 \times 10^{23}$ molecules

   b) 4.4 g of CO_2 molecule $= \frac{4.4}{44} \times 6.023 \times 10^{23} = 0.6023 \times 10^{23}$ molecules

   c) 34.2 g of $C_{12}H_{22}O_{11}$ molecule $= \frac{34.2}{342} \times 6.023 \times 10^{23} = 0.6023 \times 10^{23}$ molecules

   d) 2 g of H_2 molecule $= \frac{2}{2} \times 6.023 \times 10^{23} = 6.023 \times 10^{23}$ molecules

3. Number of molecules in 16 g of Oxygen is
    a) 6.023×10^{23} b) 6.023×10^{-23} **c) 3.011×10^{23}**   d) 3.011×10^{-23}

   Hint : *Gram Molecular Mass of* $O_2 = 16 \times 2 = $ **32g**

   No. of molecules of $O_2 = \frac{16}{32} \times 6.023 \times 10^{23} = \frac{1}{2} \times 6.023 \times 10^{23} = $ **3.0115×10^{23} molecules**

4. The mass of Sodium in 11.7 g of NaCl is _____ . a) 2.3 g   **b) 4.6 g**   c) 6.9 g   d) 7.1 g

   Hint :   Molecular Mass of NaCl $= 23 + 35.5 = 58.5$ g

   ∴ Mass of Na in 11.7g of NaCl $= \frac{23}{58.5} \times 11.7 = $ **4.6 g**

5. Which of the following contains the largest number of molecules?
    a) 0.2 moles of H_2 **b) 8.0 g of H_2**   c) 17 g of H_2O d) 6.0 g of CO_2

   Hint : a) No. of molecules in 0.2 moles of $H_2 = 0.2 \times 6.023 \times 10^{23}$

   b) **No. of molecules in 8.0 g of H_2 $= \frac{8}{2} \times 6.023 \times 10^{23} = 4 \times 6.023 \times 10^{23}$**

   c) No. of molecules in 17 g of H_2O $= \frac{17}{18} \times 6.023 \times 10^{23} = 0.94 \times 6.023 \times 10^{23}$

   d) No. of molecules in 6.0 g of CO_2 $= \frac{6}{44} \times 6.023 \times 10^{23} = 0.136 \times 6.023 \times 10^{23}$

6. The mass of one C atom is   a) 6.023×10^{23} b) 1.99×10^{23} c) 2.0 g   **d) 12 g**

7. $_{17}Cl^{35}$ and $_{17}Cl^{37}$ are   **a) isotopes**   b) isobars   c) isotones   d) none of these

   Hint :   *Two or more forms of an element having the same atomic number, but different mass number is called* ***isotopes.***

8. Which one has no unit? a) AAM   b) GAM   **c) RAM**   d) GMM

   Hint : *Relative Atomic Mass* (**RAM**) *is only a Ratio, so it has no unit.*

9. One gram of which of the following contains largest number of Oxygen atom.

a) O b) O_2 c) O_3 **d) All contains Same**

Hint :

a) molecular mass of O = 16 g	b) molecular mass of O_2 = 32 g	c) molecular mass of O_3 = 48 g
No. of atoms in O $= \frac{1}{16} \times 6.023 \times 10^{23}$	No. of atoms in $O_2 = \frac{1}{32} \times 6.023 \times 10^{23} \times 2$	No. of atoms in $O_3 = \frac{1}{48} \times 6.023 \times 10^{23} \times 3$
$= \frac{6.023 \times 10^{23}}{16}$	$= \frac{6.023 \times 10^{23}}{16}$	$= \frac{6.023 \times 10^{23}}{16}$

Additional Questions

Choose the best answer

1. The relative atomic mass of Carbon is :   **a) 12**   b) 14   c) 16   d) 23

2. Which one of the following has the highest Gram Molecular Mass?

a) H_2O **b) CO₂**   c) NH_3 d) HCl

Hint: $H_2O = (1 \times 2) + 16 = 18$ g **$CO_2 = 12 + (16 \times 2) = 44$ g**
$NH_3 = 14 + (1 \times 3) = 17$ g $HCl = 1 + 35.5 = 36.5$ g

3. Which of the following is a heteroatomic molecule   a) H_2 b) N_2 c) O_2 **d) HCl**

Hint: *Heteroatomic molecule is a molecule that consist of atoms of different elements.*

4. Which of the following is not a diatomic molecules _____.

a) Nitrogen   b) fluorine   c) bromine   **d) Phosphorous**

Hint: Nitrogen (N_2), Fluorine (F_2), Bromine (Br_2) each molecule contain 2 atoms so they are diatomic molecules. Whereas, Phosphorous (P_4) contains 4 atoms so it is a polyatomic molecules.

5. _____ is not an example of polyatomic molecule.

a) Phosphorous   **b) Hydrogen iodide**   c) Glucose   d) Sucrose

Hint: Phosphorous (P_4) – Homo polyatomic molecule; Hydrogen iodide (HI) – Hetero diatomic molecule; Glucose ($C_6H_{12}O_6$), Sucrose ($C_{12}H_{22}O_{11}$) – Hetero polyatomic molecules

6. One molar volume of NH_3 gas occupies   a) 2.24 litre   **b) 22.4 litre**   c) 224 litre   d) 0.224 litre

7. Unified atomic mass is denoted as _____.   a) amu   b) Au   **c) U**   d) Am

8. Molar mass of H_2SO_4 is   a) 9.8 g   **b) 98 g**   c) 0.98 g   d) 0.098 g

Hint: Molar mass = $(1 \times 2) + 32 + (16 \times 4) = 98$ g

9. The molecular mass of $Ca_3(PO_4)_2$ is _____.

a) 300 g   **b) 310 g**   c) 301 g   d) 210 g

Hint: Molecular mass = $(40 \times 3) + \left(\left(31 + (16 \times 4) \right) \times 2 \right) = 310$ g

10. The Average of atomic mass of oxygen is _____.

a) 16.999 amu   **b) 15.999 amu**   c) 15.899 amu   d) 15.888 amu

11. Ozone is a _____ and its atomicity is _____.

a) homo monoatomic molecule, 1   b) homo diatomic molecule, 2
c) homo triatomic molecule, 3   d) hetero triatomic molecule, 3

Hint: *Ozone (O_3) contains 3 oxygen atoms. ∴ Its atomicity is 3.*

12. In the nucleus of $_{15}P^{31}$ contains

a) 15 proton 16 neutron   b) 15 neutron 16 proton   c) 15 neutron 31 Proton   d) 15 Proton 31 neutron

Hint: *No. of protons = atomic number = 15; No. of neutrons = mass number – atomic number = 31 – 15 = 16*

13. Percentage composition of Carbon in methane is: **a) 75 %**   b) 60 %   c) 90 %   d) 25 %

> **Hint :** Molecular Mass of $CH_4 = 12 + (1 \times 4) = 16$ g
>
> Percentage Composition $= \dfrac{\text{mass of required element}}{\text{Molecular Mass of the compound}} \times 100 = \dfrac{12}{16} \times 100 = 75$ %

14. The number of moles in 11.2 litre of CO_2 at STP is

    a) 1 mole   b) 2 moles   c) 3 moles   **d) 0.5 mole**

> **Hint :** Number of moles of $CO_2 = \dfrac{\text{Volume at S.T.P}}{\text{Molar volume}} = \dfrac{11.2}{22.4} = 0.5$ mole

15. The number of molecules in 36 g of H_2O is _____ .

    a) 12.046×10^{23}   b) 6.023×10^{23} c) 18.069×10^{23} d) 3.011×10^{23}

> **Hint :** Molecular Mass of $H_2O = (1 \times 2) + 16 = 18$ g
>
> No. of moles of $H_2O = \dfrac{\text{Mass}}{\text{Molecular Mass}} = \dfrac{36}{18} = 2$ moles
>
> No. of molecules of $H_2O =$ No. of moles $\times N_A = 2 \times 6.023 \times 10^{23} = 12.046 \times 10^{23}$ molecules

16. Isotopes have same number of _____ .

    a) electrons   b) neutrons   **c) protons**   d) positron

17. Isotopes of oxygen are _____ .

    a) $_8O^{16}, _8O^{17}, _8O^{18}$ b) $_8O^{15}, _8O^{16}, _8O^{17}$ c) $_7O^{16}, _7O^{17}, _7O^{18}$ d) $_8O^{17}, _8O^{18}, _8O^{19}$

18. Isotopes of Hydrogen are _____ .

    a) $_1H^1, _2H^1, _3H^1$ b) $_2H^2, _1H^2, _3H^1$ c) $_1H^1, _2H^1, _1H^3$ **d) $_1H^1, _1H^2, _1H^3$**

19. The standard temperature and pressure is _____ .

    a) 283.15 K, 1.00 atm   **b) 273.15 K, 1.00 atm**   c) 293.15 K, 1.00 atm   d) 270.15 K, 1.00 atm

20.

Column I	Column II	**Solution :** No. of atoms $= \dfrac{\text{Mass}}{\text{Molecular Mass}} \times N_A$
1. 128 g of O_2	i) 0.5 N_A atoms	1) $\dfrac{128}{32} \times 6.023 \times 10^{23} = $ **4 N_A atoms (ii)**
2. 17 g of NH_3	ii) 4 N_A atoms	2) $\dfrac{17}{17} \times 6.023 \times 10^{23} = $ **1 N_A atoms (iv)**
3. 160 g of CH_4	iii) 2 N_A atoms	3) $\dfrac{160}{16} \times 6.023 \times 10^{23} = $ **10 N_A atoms (v)**
4. 50 g of $CaCO_3$	iv) N_A atoms	4) $\dfrac{50}{100} \times 6.023 \times 10^{23} = $ **0.5 N_A atoms (i)**
5. 142 g of Cl_2	v) 10 N_A atoms	5) $\dfrac{142}{71} \times 6.023 \times 10^{23} = $ **2 N_A atoms (iii)**

    a) 1.iv 2.v 3.i 4.iii 5.ii   **b) 1.ii 2.iv 3.v 4.i 5.iii**   c) 1.v 2.i 3.iii 4.ii 5.iv   d) 1.iii 2.v 3.iv 4.i 5.ii

21.

Elements	Atomic Mass (amu)	Answer
1. Helium	i) 10.811	1. ii) 4.003
2. Lithium	ii) 4.003	2. iii) 6.941
3. Beryllium	iii) 6.941	3. iv) 9.012
4. Boron	iv) 9.012	4. i) 10.811

    a) 1.iv 2.ii 3.i 4.iii   b) 1.ii 2.iv 3.iii 4.i   **c) 1.ii 2.iii 3.iv 4.i**   d) 1.iii 2.ii 3.iv 4.i

◄ Short answer questions ►

1. Differentiate Isotopes, Isobars and Isotones.

Isotopes	Isobars	Isotones
Atoms of the **same element** that have **different atomic mass** are called Isotopes.	Atoms of **different elements** may have **same atomic masses** are called Isobars.	Atoms of **different elements** having **same number of neutrons**, but different atomic & mass number.
Eg: $_{17}Cl^{35}, _{17}Cl^{37}$	**Eg:** $_{18}Ar^{40}, _{20}Ca^{40}$	**Eg:** $_6C^{13}, _7N^{14}$

2. What is Average Atomic Mass (AAM)?

Average atomic mass of an element is the **weighted average of masses** of its naturally occurring isotopes.

3. Define Atomic Mass Unit (AMU) and Gram Atomic Mass (GAM).

Atomic Mass Unit : The mass of an atom is measured in atomic mass unit (amu). It is **1/12ᵗʰ of the mass of a Carbon 12 atom**; an isotope of carbon, which contains 6 protons and 6 neutrons.

Gram Atomic Mass : If the **atomic mass** of an element is **expressed in grams**, it is called gram atomic mass. *Eg* : Gram atomic mass of carbon = 12 g

4. Define Relative Molecular mass and Gram Molecular Mass.

Relative Molecular Mass : It is the **ratio** between the **mass of one molecule** of the substance to **1/12ᵗʰ of the mass of a Carbon 12 atom**.

Gram Molecular Mass : If the molecular mass of a **compound is expressed in grams**, it is called gram molecular mass. *Eg* : Gram molecular mass of water = 18 g

5. What is Avogadro's number?

❖ The actual **number of atoms in 12 g of Carbon-12** is called Avogadro's Number (N_A).

❖ Its value is 6.023×10^{23}. One mole of any substance contains 6.023×10^{23} entities.

Long answer questions

1. Define molecule and explain its classification.

A **molecule** is a combination of two or more atoms held together by a strong chemical bond.

Classification of molecules

a) Based on types of atoms	
i) Homoatomic molecules	These are molecules made of similar kind of atoms. *Eg :* H_2
ii) Heteroatomic molecules	These are molecules with atoms of different elements. *Eg : HCl*
b) Based on atomicity	
i) Monoatomic molecules	It contains one atom, so its atomicity is one. *Eg :* He
ii) Diatomic molecules	It contains two atoms, so its atomicity is two. *Eg :* CO, F_2
iii) Triatomic molecules	It contains three atoms, so its atomicity is three. *Eg :* O_3, CO_2
iv) Polyatomic molecules	It contains more than three atoms. *Eg :* CH_4

2. Define mole and write various concepts of mole.

Mole: Mole is the amount of a substance that contains as many elementary entities as there are atoms in exactly **12 gram of the carbon-12 isotope**.

Mole concept : The study of the collection of particles by using **mole as the counting unit**, in order to express the mass and volume of unit particles in a bulk of matter is known as mole concept.

❖ *Mole of atoms :*

One mole of an element **contain 6.023×10^{23} atoms** and it is **equal to its gram atomic mass**. *Eg:* One mole of oxygen contains 6.023×10^{23} atoms of oxygen and its mass is 16 g.

❖ *Mole of Molecules :*

One mole of matter **contains 6.023×10^{23} molecules** and it is **equal to its gram molecular mass**. *Eg:* One mole of oxygen gas/molecule contains 6.023×10^{23} molecules of oxygen and its mass is 32 g.

❖ *Molar Volume :*

One mole of any gas occupies **22.4 litre or 22400 ml at STP**. This volume is called as molar volume.

Problems

1. $PCl_5 \leftrightharpoons PCl_3 + Cl_2$ is a decomposition reaction,

   (i) How many moles of PCl_5 are involved in the reaction?

   1 mole of PCl_5 is involved.

   (ii) Calculate the gram molecular mass of PCl_5.

   Gram Molecular Mass of $PCl_5 = (31 \times 1) + (35.5 \times 5)$

   $= 31 + 177.5 = 208.5$ g

   (iii) How many moles of Cl_2 gas evolved during the reaction?

   One mole of Cl_2 gas is evolved.

2. **Calculate the number of Ammonia molecules present in 44.8 litres of ammonia gas.**

   Number of moles of $NH_3 = \dfrac{\text{Volume at STP}}{\text{Molar Volume}} = \dfrac{44.8}{22.4} = 2$ moles

   Number of molecules of NH_3 = Number of moles of $NH_3 \times$ Avogadro's number

   $= 2 \times 6.023 \times 10^{23}$

   $= \mathbf{12.046 \times 10^{23}}$ **molecules of Ammonia gas**

3. **Calculate the number of moles of the following (i) 2.24 litres of PCl_5 gas at S.T.P**

   (ii) 12.046×10^{23} atoms of Fe (iii) 400 g of $CaCO_3$ (iv) 3.0115×10^{23} molecules of glucose

   > **No. of moles** $= \dfrac{\text{Mass of Compound}}{\text{Molecular Mass}} = \dfrac{\text{Number of atoms /molecules}}{\text{Avogadro's number}} = \dfrac{\text{Given Volume at STP}}{\text{Molar Volume}}$

   (i) 2.24 litres of PCl_5 gas at S.T.P

   Number of moles $= \dfrac{\text{Given volume at STP}}{\text{Molar Volume}}$

   $= \dfrac{2.24}{22.4}$

   Number of moles $= \mathbf{0.1}$ **mole**

   (ii) 12.046×10^{23} atoms of Fe:

   Number of moles $= \dfrac{\text{Number of atoms}}{\text{Avogadro's number}}$

   $= \dfrac{12.046 \times 10^{23}}{6.023 \times 10^{23}}$

   Number of moles $= \mathbf{2}$ **moles**

   (iii) 400 g of $CaCO_3$:

   Molecular mass $= 40 + 12 + (16 \times 3) = 100$g

   Number of moles $= \dfrac{\text{Mass of Compound}}{\text{Molecular Mass}}$

   $= \dfrac{400}{100}$

   Number of moles $= \mathbf{4}$ **moles**

   (iv) 3.0115×10^{23} molecules of glucose.

   Number of moles $= \dfrac{\text{Number of molecules}}{\text{Avogadro's number}}$

   $= \dfrac{3.0115 \times 10^{23}}{6.023 \times 10^{23}}$

   Number of moles $= \mathbf{0.5}$ **moles**

4. **Calculate the % of oxygen in NaOH (Atomic mass of Na = 23, O = 16, H = 1).**

   Molecular Mass $= (23 \times 1) + (16 \times 1) + (1 \times 1)$

   $= 23 + 16 + 1 = 40$ g

   Mass Percentage of Oxygen $= \dfrac{16}{40} \times 100$

   $= \mathbf{40}$ **%**

BIOLOGY

S.No	TITLES
12.	Plant Anatomy and Plant Physiology
13.	Structural Organisation of Animals
14.	Transportation in Plants and Circulation in Animals
15.	Nervous System
16.	Plant and Animal Hormones
17.	Reproduction in Plants and Animals
18.	Genetics
19.	Origin and Evolution of Life
20.	Breeding and Biotechnology
21.	Health and Diseases
22.	Environmental management

UNIT - 12
PLANT ANATOMY AND PLANT PHYSIOLOGY
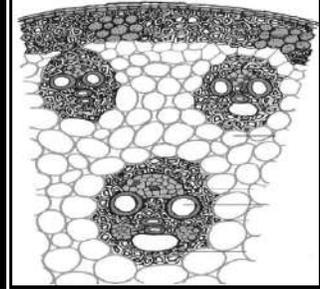
POINTS TO REMEMBER

| Tissue System	
Tissues are the group of cells that are similar or dissimilar in structure and origin, but perform similar function.	
Dermal / Epidermal tissue system	It consists of epidermis(protects the inner tissues), stomata (helps in transpiration), Cuticle(checks evaporation of water), Root hair (absorption of water of minerals).
Ground tissue system	It includes all the tissues of the plant body except epidermal and vascular tissues. i) Cortex ii) Endodermis iii) Pericycle iv) Pith

Vascular tissue system	*Vascular bundles :* Xylem and Phloem in the form of bundles.
	Xylem conducts water and minerals and phloem conducts food materials.
	(i) Radial Bundles : Bundles are in different radii, alternating with each other. *Eg : Roots*
	(ii) Conjoint bundles : Xylem and phloem lie on the same radius.
	    a)Collateral : Xylem towards the centre and Phloem towards the periphery.
	        • If cambium is present it is called open. *Eg: Dicot stem*
	        • If cambium is absent it is called closed. *Eg: Monocot stem*
	    b)Bicollateral : Phloem is on both outer and inner side of xylem. *Eg: Cucurbita*
	(iii) Concentric Bundles : Xylem completely surrounds the phloem or viceversa.
	    a) Amphivasal: Xylem surrounds phloem. *Eg: Dracaena*
	    b) Amphicribral: Phloem surrounds xylem. *Eg: Ferns*
	Endarch: Protoxylem towards centre; metaxylem towards periphery. *Eg: Stem.*
	Exarch : Protoxylem towards periphery; metaxylem towards centre. *Eg: Roots.*

Plastids	
Plastids are double membrane bound organelles that are responsible for preparation & storage of food.	
Types	1) Chloroplast - Green coloured plastids (green pigment – chlorophyll). 2) Chromoplast - Yellow, red, orange coloured plastids. 3) Leucoplast - Colourless plastids
Structure of Chloroplast	*1.Envelope:* Outer and inner membranes which is seperated by intermembrane space. *2.Stroma:* Matrix present inside to the membrane is called *stroma.* *3.Thylakoids:* Stroma consists of thylakoids that have photosynthetic pigments. *4.Grana:* Thylakoids are arranged like discs stacked one above the other called *grana.*
Functions of Chloroplast	1) Photosynthesis 2) Storage of starch 3) Synthesis of fatty acids 4) Storage of lipids 5) Formation of chloroplasts

| Photosynthesis	
Carbon dioxide combines with water in the presence of sunlight and chlorophyll to form carbohydrates. $$6CO_2 \ + \ 6H_2O \ \xrightarrow[\text{Chlorophyll}]{\text{Light}} \ C_6H_{12}O_6 \ + \ 6O_2 \uparrow$$ *Glucose* *Oxygen*	
Photosynthetic Pigments	Pigments involved in photosynthesis are called ***Photosynthetic pigments.*** *i)* ***Primary pigments / Reaction centre:*** *'Chlorophyll a'* – It traps solar energy and converts it into electrical and chemical energy. *ii)* ***Accessory pigments/Harvesting centre:*** Chlorophyll b and Carotenoids - They pass on the absorbed energy to 'chlorophyll a'
Role of Sunlight in photosynthesis	**1)** *Light dependent photosynthesis (Hill reaction / Light reaction)* Photosynthetic pigments absorb light & convert it to chemical energy ATP & NADPH$_2$ **2)** *Light independent reactions (Calvin cycle / Dark reaction / Biosynthetic phase)* CO_2 is reduced into Carbohydrates with the help of ATP and NADPH$_2$.
Factors affecting photosynthesis	**a)** *Internal Factors:* i) Pigments ii) Leaf age iii) Accumulation of carbohydrates iv) Hormones **b)** *External Factors:* i) Light ii) Carbon dioxide iii) Temperature iv) Water v) Mineral elements

Mitochondria (Power house of the cell)	
Mitochondria are filamentous or granular cytoplasmic organelles present in cells.	
Structure of Mitrochondria	It consists of two membranes called inner and outer membrane. ✸*Outer membrane :* Smooth & freely permeable. Porin molecules forms passage channel. ✸*Inner membrane :* Semi-permeable membrane. Regulates the material passage *Cristae* finger like projections that holds variety of enzymes. *Oxysomes :* Tennis racket shaped particles that involve in ATP synthesis. *Mitochondrial matrix* - It is a complex mixture of proteins and lipids.
Functions of Mitochondria	• It acts as the ATP factory of a cell. • It helps the cells to maintain normal concentration of calcium ions. • It regulates the metabolic activity of the cell.

Respiration	
Respiration involves exchange of gases between the organism and the external environment.	
1) Aerobic respiration	Organic food is completely oxidized with the help of oxygen into CO_2, water & energy. $$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ATP$$ ***Stages of Aerobic respiration :*** *i)* ***Glycolysis (Glucose splitting):*** It takes place in cytoplasm. Glucose → Pyruvic acid *ii)* ***Krebs Cycle/ Tricarboxylic Acid Cycle (TCA):*** Occurs in mitochondria matrix. Pyruvic acid → CO_2 & H_2O *iii)* ***Electron Transport Chain:*** Through a system of electron carrier complex. NADH$_2$ & FADH$_2$ → NAD$^+$ & FAD$^+$
2) Anaerobic respiration	It takes place without oxygen. Glucose is converted into ethanol or lactic acid. $$C_6H_{12}O_6 \longrightarrow 2\,CO_2 + 2C_2H_5OH + Energy\ (ATP)$$
Respiratory Quotient (R.Q)	Ratio of volume of carbondioxide liberated to the volume of oxygen consumed during respiration to release energy via electron. $$RQ = \frac{\text{Volume of } CO_2 \text{ liberated}}{\text{Volume of } O_2 \text{ consumed}}$$

Monocot root	Dicot root	Monocot Stem	Dicot Stem
Root hair, Piliferous layer, Cortex, Endodermis, Pith	Root hair, Cortex, Phloem, Xylem, Piliferous layer	Epidermis, Ground tissue, Vascular bundles	Epidermal hair, Epidermis, Hypodermis, Cortex, Endodermis, Vascular bundle, Pith
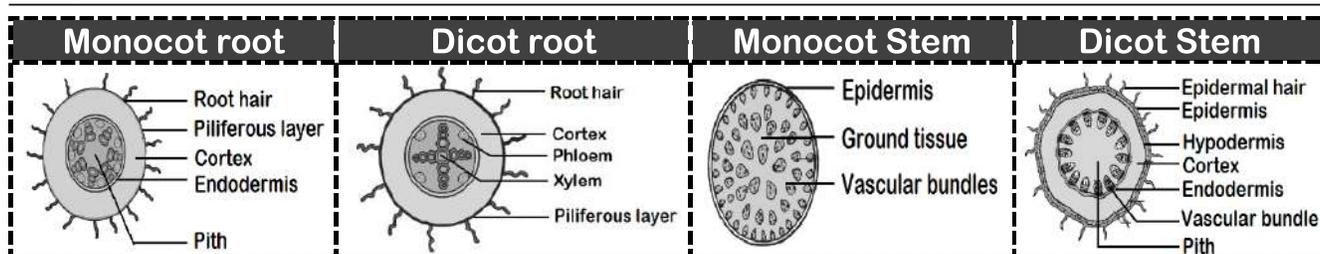
Vascular Tissue System

★ **Dicot Root** – Radial, Xylem is Exarch and Tetrach. *Eg : Bean*

★ **Monocot Root** – Radial, Xylem is Exarch and Polyarch. *Eg : Maize*

★ **Dicot stem** – Conjoint - Collateral, Endarch and Open. *Eg : Sunflower*

★ **Monocot Stem** – Conjoint – Collateral, Endarch and Closed. *Eg : Maize*

★ **Monocot** *(Grass)* & **Dicot Leaf** *(Mango)* – Conjoint - Collateral and Closed

> **Note :** For Internal structure of **Monocot and Dicot – Root, Stem, Leaf** refer Page No.: **210 to 213**

EVALUATION

Online Test

I. Choose the correct answer

1. Casparian strips are present in the _____ of the root. **[JUN-23, MDL-19]**
   a) cortex   b) pith   c) pericycle   **d) endodermis**

2. The endarch condition is the characteristic feature of **[APR-24, AUG-22, MAY-22]**
   a) root   **b) stem**   c) leaves   d) flower

3. The xylem and phloem arranged side by side on same radius is called
   a) radial   b) amphivasal   **c) conjoint**   d) None of these

4. Which is formed during anaerobic respiration **[SEP-20, MDL-19]**
   a) Carbohydrate   **b) Ethyl alcohol**   c) Acetyl CoA   d) Pyruvate

5. Kreb's cycle takes place in **[APR-23, PTA-3]**
   a) chloroplast   **b) mitochondrial matrix**
   c) stomata   d) inner mitochondrial membrane

6. Oxygen is produced at what point during photosynthesis? (or) During photosynthesis at which of the following state, oxygen is produced. **[PTA-4]**
   a) when ATP is converted to ADP   b) when CO_2 is fixed
   c) when H_2O is splitted   d) all of these

II. Fill in the blanks

1. The innermost layer of cortex in root is called **endodermis.**

2. Xylem & phloem are arranged in an alternate radii constitute a vascular bundle called **radial bundles**.

3. Glycolysis takes place in **cytoplasm**.

4. The source of O_2 liberated in photosynthesis is **water**.

5. **Mitochondria** is ATP factory of the cells.

III. True or false. Correct the statement if it is false.

1. Phloem tissue is involved in the transport of water in plant. **[False]**

   Correct statement: ***Xylem*** *tissue is involved in the transport of water in plant.*

2. The waxy protective covering of a plant is called as cuticle. **[True]**

3. In monocot stem, cambium is present in between xylem and phloem. **[False]**

   Correct statement: *In **dicot** stem, cambium is present in between xylem & phloem.*

4. Palisade parenchyma cells occur below upper epidermis in dicot root. **[False]**

   Correct statement: *Palisade parenchyma cells occur below upper epidermis in dicot **leaf**.*

5. Mesophyll contains chlorophyll. **[True]**

6. Anaerobic respiration produces more ATP than aerobic respiration. **[False]**

   Correct statement: *Anaerobic respiration produces **less** ATP than aerobic respiration.*

IV. Match the following

Column I	Column II	Answer
1. Amphicribal	*Dracaena*	1. **Fern**
2. Cambium	Translocation of food	2. **Secondary growth**
3. Amphivasal	Fern	3. **Dracaena**
4. Xylem	Secondary growth	4. **Conduction of water**
5. Phloem	Conduction of water	5. **Translocation of food**

V. Answer in a sentence

1. **What is collateral vascular bundle?**

   Vascular bundle in which, **xylem** lies **towards** the **centre** and **phloem** lies **towards** the **periphery** is called collateral vascular bundle.

   Related Additional Question: **What is conjoint vascular bundle?**

   Xylem and phloem lie on the same radius is called conjoint vascular bundle.

2. **Where does the carbon that is used in photosynthesis come from?**

   Carbon that is used in photosynthesis comes from **atmosphere** in the form of CO_2.

3. **What is the common step in aerobic and anaerobic pathway and where is it occur in a cell?** **[PTA-5]**

   ❖ **Glycolysis** is the first common step in aerobic and anaerobic pathway.

   ❖ It takes place in **cytoplasm** of the cell.

4. **Name the phenomenon by which carbohydrates are oxidized to release ethyl alcohol.**

   The phenomenon by which carbohydrates are oxidized to release ethyl alcohol is called **Fermentation** (Anaerobic respiration).

Additional Govt Exam Questions

5. **What are the factors affecting photosynthesis?** **[APR-23, AUG-22]**

   ❖ **Internal factors** → Pigments, leaf age, accumulation of carbohydrates and hormones.

   ❖ **External factors** → Light, Carbon dioxide, temperature, water and mineral elements.

VI. Short answer Questions

**1. Give an account on vascular bundle of dicot stem.**
- ❖ Vascular bundles of dicot stem are **conjoint, collateral, endarch** and **open**.
- ❖ They are arranged in the form of **a ring around the pith**.

2. Write a short note on mesophyll.

Tissue between **upper & lower epidermis** of leaf is called mesophyll. It is differentiated into,
- ❖ **Palisade parenchyma:** It is found **below upper epidermis**. These are elongated cells with **more chloroplasts**. Cells do not have intercellular spaces. Helps in **photosynthesis**.
- ❖ **Spongy parenchyma:** It is found **below the palisade parenchyma**. These are spherical or oval cells and arranged irregularly with **intercellular spaces**. Helps in **gaseous exchange.**

3. Draw and label the structure of oxysomes.   [JUN-23]

- → F_1 Head
- → Stalk
- → F_0 Base
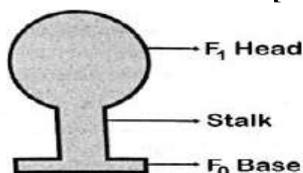
4. Name the three basic tissues system in flowering plants.   [APR-23]
- ◆ Dermal (or) Epidermal tissue system
- ◆ Ground tissue system
- ◆ Vascular tissue system

5. What is photosynthesis and where in a cell does it occur?   [SEP-21, PTA-3]
- ❖ Photosynthesis is a process by which autotrophic organisms like plants, algae utilize the energy from sunlight to **synthesize their own food**.

$$6CO_2 \ + \ 12H_2O \ \xrightarrow[\text{Chlorophyll}]{\text{Light}} \ C_6H_{12}O_6 \ + 6H_2O + 6O_2 \uparrow$$
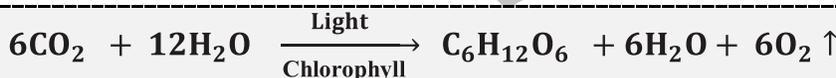
- ❖ Here, CO_2 combines with water in the presence of sunlight & chlorophyll to form carbohydrates. It occurs in the **chloroplast**.

**6. What is Respiratory quotient?**   [APR-24, AUG-22, MAY-22, SEP-21, PTA-1]

Respiratory Quotient (R.Q.) is the **ratio** of **volume of carbon dioxide liberated** and the **volume of oxygen consumed** during respiration.

$$R.Q = \frac{\text{volume of } CO_2 \text{ liberated}}{\text{volume of } O_2 \text{ consumed}}$$

7. Why should the light dependent reaction occur before the light independent reaction?   [APR-24]
- ❖ During light dependent reaction, ATP & $NADPH_2$ are formed using sunlight & chlorophyll.
- ❖ During light independent reactions, CO_2 is reduced into carbohydrates with the help of **ATP and $NADPH_2$** produced during light dependent reaction.
- ❖ So, light dependent reaction should occur before the light independent reaction.

8. Write the reaction for photosynthesis.   [MAY-22]

$$\underset{\textit{Carbon di oxide}}{6CO_2} \ + \ \underset{\textit{Water}}{12H_2O} \ \xrightarrow[\text{Chlorophyll}]{\text{Light}} \ \underset{\textit{Glucose}}{C_6H_{12}O_6} \ + \underset{\textit{Water}}{6H_2O} + \underset{\textit{Oxygen}}{6O_2} \uparrow$$
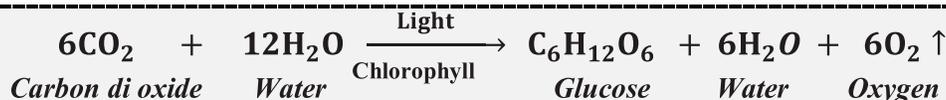
VII. Long Answer Questions

1. Differentiate the following.

a) Monocot root and Dicot root: [SEP-20, MDL-19]

S.No	Tissues	Dicot Root (Bean)	Monocot Root (Maize)
1.	*Number of xylem*	*Tetrarch*	*Polyarch*
2.	*Cambium*	*Present (during secondary growth only)*	*Absent*
3.	*Secondary growth*	*Present*	*Absent*
4.	*Pith*	*Absent*	*Present*
5.	*Conjunctive tissue*	*Parenchyma*	*Sclerenchyma*
6.	*Example*	*Bean*	*Maize*

b) Aerobic and Anaerobic respiration: [AUG-22, SEP-21, MDL-19]

Aerobic respiration	Anaerobic respiration
1) It takes place in **presence of oxygen**.	1) It takes place in the **absence of oxygen**.
2) It occurs in most **plants** and **animals**	2) It occurs in **some bacteria**.
3) Carbohydrate is completely oxidized into **carbon dioxide, water** and **energy**.	3) Glucose is converted into **ethanol** or **lactic acid**.
4) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$	4) $C_6H_{12}O_6 \rightarrow 2\ CO_2 + 2\ C_2H_5OH + Energy\ (ATP)$

2. Describe and name three stages of cellular respiration that aerobic organisms use to obtain energy from glucose.

Cellular Respiration : It is the biochemical process in cells where food is oxidized to obtain energy.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

Stages of Aerobic Cellular Respiration :

Glycolysis:

❖ It is the **first step** of both aerobic and anaerobic respiration.

❖ One **glucose** molecule breakdown **into** two molecules of **pyruvic acid** in **cytoplasm**.

Krebs cycle (or) Tricarboxylic Acid cycle (TCA):

❖ After glycolysis, oxidation of two molecules of pyruvic acid into CO_2 and water takes place in mitochondria matrix. This cycle is called as Tricarboxylic Acid Cycle (or) Krebs cycle.

Electron Transport chain (ETC):

❖ It occurs through **electron carrier complex** in the inner membrane of mitochondria.

❖ **NADH₂ and FADH₂** molecules formed during glycolysis and Krebs cycle are oxidised to **NAD⁺ and FAD⁺** to release the energy via electrons.

❖ The electrons release energy, which is trapped by ADP to synthesize ATP.

❖ This is **oxidative phosphorylation**. Here O_2, acceptor of electrons, is reduced to water.

3. **How does the light dependent reaction differ from the light independent reaction? What are the end products and reactants in each? Where does each reaction occur within the chloroplast?**

Light dependent (Light) Reaction	Light independent (Dark) Reaction
It takes place in the **presence of light** energy.	It takes place in the **absence of light**.
Photosynthetic pigments absorb light energy and **convert it into ATP & NADPH₂**	CO_2 is reduced into carbohydrates with the help of light **generated ATP & NADPH₂**
Reactants : Chlorophyll, sunlight, water, NADP$^+$, ADP	*Reactants :* CO_2, ATP, NADPH₂
End products : ATP, NADPH₂, O_2	*End products :* Carbohydrate/Glucose
Place of Occurrence in the chloroplast	
It occurs in *thylakoid membrane* (grana) of the chloroplast.	It occurs in the *stroma* of the chloroplast.

Additional Govt Exam Questions

4. **What is vascular bundle?** [PTA-1]
   - ❖ **Xylem and phloem tissues** are present in the form of bundles called vascular bundles.
   - ❖ **Xylem** conducts **water** and minerals to different parts of the plant.
   - ❖ **Phloem** conducts **food** materials to different parts of the plant.

VIII. Higher Order Thinking Skills (HOTS)

1. **The reactions of photosynthesis make up a biochemical pathway.**

   A) What are the reactants and end products of light and dark reaction of photosynthesis? [PTA – 5]

	Light Reaction	Dark Reaction
Reactants	Chlorophyll, Sunlight, H_2O, NADP$^+$, ADP	CO_2, ATP and NADPH₂
Products	ATP, NADPH₂ and O_2	Carbohydrate/Glucose

   B) Explain how the biochemical pathway of photosynthesis recycles many of its own reactions and identify the recycled reactants.
   - ❖ Steps of photosynthesis are Light reactions and Dark reactions (or) Calvin cycle.
   - ❖ **ATP and NADPH₂** are formed during **light reactions** using sunlight.
   - ❖ They are used by **Calvin cycle** to produce glucose and oxidized to *NADP$^+$ & ADP*.
   - ❖ They are again reduced to **NADPH₂ & ATP** with the help of water in light reaction.
   - ❖ Thus, photosynthesis recycles its own reaction.
   - ❖ The Recycled reactants are **ATP, NADPH₂, ADP & NADP$^+$** .

2. **Where do the light dependent reaction and the Calvin cycle occur in the chloroplast?**
   - ❖ Light dependent reaction takes place in *thylakoid membranes (grana)* of chloroplast.
   - ❖ Calvin cycle or Light independent reaction takes place in *stroma* of chloroplast.

QR Code Questions

1. During light dependent reaction which of the following molecules are formed?
   a) ATP   **b) ATP and NADPH₂**   c) NADPH₂   d) None of these

2. In photosynthesis, energy from light reaction to dark reaction is transferred in the form of
   a) RUDP   b) ADP   **c) ATP**   d) both ATP and ADP

3. The first product of photosynthesis is sugar and it is converted into
   a) Starch   b) Protein   c) Glycogen   **d) None of these**

4. The dark reaction in photosynthesis is called so because it is
   a) Light dependent   **b) Light independent**   c) Can't occur in day time   d) All of these

5. Photosynthesis in green algae and bacteria is respectively
   a) oxygenic and anoxygenic   b) oxygenic in both
   c) anoxygenic in both   d) anoxygenic and oxygenic

   > **Hint :** *Photosynthesis in green algae occurs via chloroplast. Hence, it is oxygenic. Photosynthesis in bacteria occurs via cytoplasm. Hence, it is anoxygenic.*

6. The first step in glucose breakdown in an cell is
   a) ETC   b) Acetyl COA   c) Krebs cycle   **d) Glycolysis**

7. Respiration is
   a) Anabolic process   b) Catabolic process   **c) Both a and b**   d) Endothermic process

   > **Hint :** *Cellular respiration is catabolic but respiration is both anabolic & catabolic process.*

8. Respiration occurs in the presence of oxygen is called
   a) Fermentation   b) Anaerobic respiration   c) Glycolysis   **d) Aerobic respiration**

9. End product of aerobic respiration in plants are
   a) Sugar and Oxygen   **b) CO₂, Water, energy**
   c) CO₂ and energy   d) Water and energy

10. R.Q. is
    a) C/B   b) N/C   **c) CO₂/ O₂**   d) O₂ /CO₂

11. Which of the following is the key intermediate compound linking glycolysis to the Krebs cycle?
    a) Pyruvic acid   b) Malic acid   **c) Acetyl COA**   d) None of these

    > **Hint :** *Though end product of glycolysis is two molecules of pyruvic acid. They combine to form Acetyl COA. It is the key intermediate compound that links glycolysis & Kreb' s cycle.*

12. ETC can produce a total of
    a) 6 ATP   b) 8 ATP   c) 24 ATP   **d) 38 ATP**

13. Ground tissue system includes
    a) xylem and phloem   b) stomata, epidermis, trichomes
    c) cortex, endodermis, pericycle, pith   d) meristems

14. Which is not a function of epidermis?
    a) Gaseous exchange   **b) conduction of water**   c) transpiration   d) protection

15. Conjoint, collateral, open and endarch vascular bundles found in
    a) monocot stem   **b) dicot stem**   c) monocot root   d) dicot root

Additional Questions

Choose the correct answer

1. Who is the Father of Plant Anatomy?
   a) Nehemiah Grew   b) C.N.R Rao   c) Sachs   d) D.H. Scott

2. The mitochondria was first discovered by _____.
   a) C.N.R. Rao   b) Melvin Calvin   **c) Kolliker**   d) Waldeyer

3. Light dependent reaction was discovered by _____.
   a) C.N.R. Rao   b) Melvin Calvin   **c) Robin Hill**   d) Sachs

4. Who discovered the chemical pathway for photosynthesis and got Nobel Prize for the same?
   a) Waldeyer   **b) Melvin Calvin**   c) C.N.R. Rao   d) Nehemiah Grew

5. Who classified tissue system into three types?
   a) Nehemiah Grew   **b) Sachs**   c) Edward C. Kendal d) Melvin Calvin

6. _____ is referred to as the power house of the cell or ATP factory of the cell.
   a) DNA   b) Chloroplast   **c) Mitochondria**   d) RNA

7. _____ is otherwise known as Tricarboxylic Acid cycle.
   a) glycolysis   **b) krebs cycle**   c) calvin cycle   d) Electron Transport Chain

8. The outer layer of root, Epiblema is also known as _____.
   a) Rhizodermis   b) Rhibodermis   c) Rhizolema   d) Epidermis

9. Phloem conducts _____ and Xylem conducts _____ to different parts of the plant.
   a) water & minerals, food material   b) food material & water, minerals
   c) food material, water & minerals   d) oxygen & water, food material

10. Skull shaped vascular arrangement with Y or V shaped xylem is found in _____.
    a) monocot root   b) dicot stem   **c) monocot stem**   d) dicot root

11. The vascular bundle in monocot leaf is _____.
    a) Conjoint, Open, Endarch   b) Conjoint, Collateral, Open
    b) Conjoint, Collateral, Closed   c) Collateral, Endarch, Closed

12. All tissues inner to endodermis constitute _____.
    a) Epidermis   b) Casparian strips   **c) Stele**   d) Pericycle

13. In Endodermis, casparian strips are band like thickening made of_____.
    a) starch   b) pith   **c) suberin**   d) cambium

14. _____ is present at the center of the dicot stem.
    a) Cortex   **b) Pith**   c) Vascular bundle   d) Hypodermis

15. In vascular bundle, if xylem surrounds phloem, it is called _____ and its example is _____.
    a) amphicribal, dracaena b) amphicribal, ferns **c) amphivasal, dracaena** d) amphivasal, ferns

16. In vascular bundle, if phloem surrounds xylem, it is called _____ and its example is _____.
    a) amphicribal, dracaena b) amphivasal, dracaena **c) amphicribal, ferns** d) amphivasal, ferns

17. _____ on the wall of epidermis, checks evaporation of water.
    a) Cuticle   b) root hair   c) cortex   d) xylem

18. The cavity formed in mature vascular bundle of monocot stem is called _____.
    a) bundle sheath   b) Casparian strips   **c) protoxylem lacuna**   d) cambium

19. Identify the wrong statement.
    i. Chloroplast – green coloured plastids
    ii. Chromoplast – yellow, red, orange coloured plastids
    iii. Leucoplast – red plastids
    a) ii only   b) i & ii only   **c) iii only**   d) i only

> **Correct statement :**   *Leucoplast – colourless plastids*

20. In chloroplast, matrix present inside the membrane is called_____.
    a) thylakoids   **b) stroma**   c) envelope   d) grana

21. Dark reaction takes place in _____ whereas light reaction takes place in_____.
    a) stroma, chloroplast   b) thylakoids, chromoplast
    c) grana, leucoplast   d) chloroplast, stroma

22. Where does photosynthesis occur?
    a) Leaves   b) Stems   c) Floral buds   **d) All of them**

23. _____ involve in ATP synthesis.
    a) Matrix   **b) Oxysomes**   c) Ribosomes   d) DNA

24. Chlorophyll a is the _____ and Chlorophyll b & carotenoids are the ___
    a) controlling centre, harvesting centre   b) harvesting centre, conducting centre
    c) reaction centre, harvesting centre   d) reaction centre, controlling centre

25. Which of the following statement is wrong about Mitochondria.
    i. Its size vary from 0.5 mm to 2.0 mm.
    ii. It contain 60-70% protein, 25-30% lipids, 5-7% RNA and small amount of DNA and minerals.
    iii. The inner mitochondrial membrane gives rise to finger like projections called cristae.
    iv. Tennis racket shaped particles present in mitochondrial membrane is known as Oxysomes.
    a) i & ii only   **b) i only**   c) iii only   d) ii only

> **Correct statement :**   Its size vary from **0.5 µm to 2.0 µm.**

Short answer Questions

1. **Why endodermis of Dicot stem is called starch sheath?**
   Endodermis of Dicot stem consists of **single layer of barrel shaped cells**, which contain **starch grains**. Hence, endodermis of dicot stem is also known as starch sheath.

2. **What is called bundle sheath?**
   A layer of cells in plant leaves & stems that forms a sheath surrounding the vascular bundle is called bundle sheath

3. **What are bulliform cells?**
   In monocot leaf, some cells of upper epidermis are **large and thin walled**. These cells are known as bulliform cells.

4. **Define Plastids and mention its types.**
   Plastids are double membrane bound organelles found in plants & some algae. They are responsible for **preparation & storage of food**. There are three types of plastids.
   - ❖ Chloroplast → Green coloured plastids
   - ❖ Chromoplast → Yellow, red, orange coloured plastids
   - ❖ Leucoplast → Colourless plastids

5. **Identify the parts A, B, C, D, E in the given figure.**
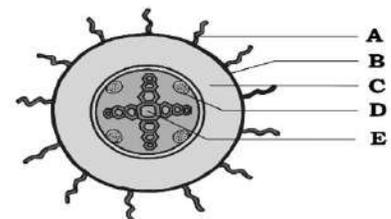
| A – Root hair |
| B – Piliferous layer |
| C – Cortex |
| D – Phloem |
| E – Xylem |

6. What is called Protoxylem lacuna?

In mature vascular bundle of monocot stem, the lower most **protoxylem disintegrates** and forms a cavity. This cavity is called as Protoxylem lacuna.

7. Why 'Chlorophyll a' is called reaction centre?

'Chlorophyll a' is called reaction centre because, it is the primary pigment that traps **solar energy** and **converts it into electrical and chemical energy**.

8. What are grana? How are they interconnected?

❖ In chloroplast, **thylakoids** forms a **stack** of disc like structures called grana.

❖ They are interconnected by **stroma lamella.**

9. What is oxidative phosphorylation?

The electrons move through the system and release energy, which is **trapped by ADP to synthesize ATP**. This is called oxidative phosphorylation.

10. Explain the 3 regions of the cortex of a Dicot stem.

1) Hypodermis: It consists of 3 - 6 layers of collenchyma cells. It gives **mechanical support**.

2) Middle cortex: It is made up of few layers of chlorenchyma cells.

It is involved in **photosynthesis** due to the presence of chloroplast.

3) Inner cortex: It is made up of few layers of parenchyma cells.

It helps in **gaseous exchange** and **stores food materials**.

11. Write short notes on Endarch and Exarch.

Endarch: Protoxylem lies towards **centre** and metaxylem lies towards **periphery**. *Eg:* Stem.

Exarch : Protoxylem lies towards **periphery** and metaxylem lies towards **centre**. *Eg:* Roots.

12. What is tissue? List the types of plant tissue?

Tissues are **group of cells** that are similar or dissimilar in structure & origin, but perform similar function. Plant tissues are classified based on their ability to divide, i) Meristamatic tissue ii) Permanent tissue.

13. How do a cell get energy from glucose?

In cellular respiration, glucose is converted to ATP (Adenosine Triphosphate) which provides energy to the cell. Hence, a cell gets its energy **indirectly from glucose via ATP**.

14. Write a short note about artificial photosynthesis?

❖ Artificial photosynthesis is a method for producing renewable energy by the use of sunlight.

❖ Indian scientist C.N.R. Rao was conferred the Bharat Ratna for his work on artificial photosynthesis to produce - Hydrogen fuel (renewable energy).

15. Expand the following. (i) ATP   (ii) ADP   (iii) NAD   (iv) NADP   (v) ETC

(i) **ATP**	–	Adenosine Tri Phosphate
(ii) **ADP**	–	Adenosine Di Phosphate
(iii) **NAD**	–	Nicotinamide Adenine Dinucleotide
(iv) **NADP**	–	Nicotinamide Adenine Dinucleotide Phosphate
(v) **ETC**	–	Electron Transport Chain
(vi) **TCA**	–	Tricarboxylic Acid Cycle

16. What is photosynthetic pigments and write its types.

Pigments involved in photosynthesis are called Photosynthetic pigments.

i) Primary pigments / Reaction centre - 'Chlorophyll a'.

It traps solar energy and converts it into electrical and chemical energy.

ii) Accessory pigments / Harvesting centre - chlorophyll b and carotenoids.

They pass on the absorbed energy to 'chlorophyll a'.

17. What is respiration and write its types.

Respiration involves exchange of gases between the organism and the external environment.

i) External respiration :

❖ It is a physical process. The exchange of gases is known as external respiration.

❖ Plants obtain oxygen from environment and release carbon dioxide and water vapour.

ii) Cellular respiration :

❖ It is a Biochemical process.

❖ Food is oxidized to obtain energy, this is known as cellular respiration.

18. Why mitochondria is referred as the power house of the cell.

Mitochondria are organelles within eukaryotic cells that produce adenosine triphosphate (ATP) which is the energy currency of the cell. Hence, mitochondria is called as the "**Power house of the cell**"

19. Differentiate Palisade parenchyma and Spongy parenchyma.

Palisade Parenchyma	Spongy Parenchyma
1. It is found just below the upper epidermis.	1. It is found below the palisade parenchyma tissue.
2. Cells are elongated.	2. Cells are oval or spherical & arranged irregularly.
3. The cells do not have intercellular space.	3. The cells have intercellular spaces.
4. They take part in photosynthesis.	4. It helps in gaseous exchange.
5. They have **more chloroplasts**.	5. They have **less chloroplasts**.

Long answer Questions

1. Explain different types of vascular bundles with the neat diagram.

There are three different types of vascular bundles namely

(i) Radial (ii) Conjoint (iii) Concentric

(i) Radial Bundles: Xylem and phloem are present in different radii alternating with each other. *Eg :* Roots	 Xylem Phloem Radial
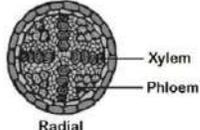
(ii) Conjoint bundles: Xylem and phloem lie on the same radius.
    a) Collateral:
        • Xylem lies towards the centre.
        • Phloem lies towards the periphery.
        • If cambium is present, it is called open. *Eg :* Dicot stem
        • If cambium is absent, it is called closed. *Eg :* Monocot stem
    b) Bicollateral:
        The phloem is present on both inner and outer side of xylem.
        Eg : Cucurbita
	[PTA-4]
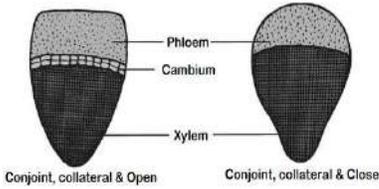	
	Phloem — Cambium — Xylem
	Conjoint, collateral & Open Conjoint, collateral & Closed
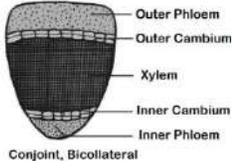	
	Outer Phloem — Outer Cambium — Xylem — Inner Cambium — Inner Phloem
	Conjoint, Bicollateral

(iii) Concentric Bundles: In concentric bundles, xylem surrounds the phloem or viceversa.
    1) Amphivasal : Xylem surrounds phloem. *Eg : Dracaena*
    2) Amphicribral : Phloem surrounds xylem. *Eg :* Ferns
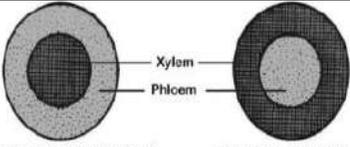	
	Xylem — Phloem
	Concentric & Amphicribral Concentric & Amphivasal

❇ **Endarch:** Protoxylem lies towards centre and metaxylem lies towards periphery. *Eg :* Stem ❇ **Exarch :** Protoxylem lies towards periphery and metaxylem lies towards centre. *Eg :* Roots	

2. Explain the internal structure of a Dicot (or) Bean root.

(i)Epiblema / Rhizodermis / Piliferous layer:
- It is the **outermost layer**.
- Unicellular root hairs are present.
- **Cuticle and stomata are absent**.

(ii)Cortex:
- It is a **multilayered** large zone made of thin-walled parenchymatous cells with intercellular spaces.
- It **stores food and water**.

(iii)Endodermis:
- It is the **innermost layer of cortex**.
- Cells are barrel-shaped, closely packed.
- It show band like thickenings called **casparian strips**.
- **Passage cell** opposite to protoxylem are thin and helps in movement of water & dissolved salts.

(iv)Stele: All tissues inner to endodermis constitute stele.
- **(a)Pericycle:** It is inner to endodermis and the origin of lateral roots.
- **(b)Vascular bundle:**
  - It is radial, Xylem is **exarch** and **tetrach**.
  - Conjunctive tissue is made up of parenchyma.
- **(c) Pith: Young root contains pith** whereas in **old root pith is absent**.

3. Draw the internal structure of a Dicot (or) Bean root and label the parts. [PTA-6]
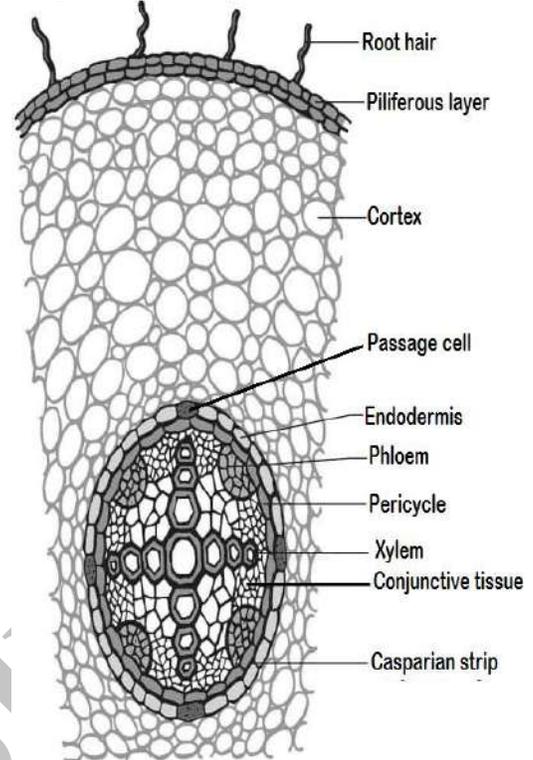
4. Explain the internal structure of a Monocot (or) Maize root.

i) Epiblema or Rhizodermis:
- It is the **outermost layer of the root**, and is made up of parenchymatous cell.
- **Stomata and cuticle are absent**.
- Root hair helps in absorption of water and minerals from soil and protects the inner tissues.

ii) Cortex: It is **multilayered** large zone, composed of parenchymatous cells with intercellular spaces.
- It **stores water** and **food** material.

iii) Endodermis:
It is the **innermost layer with casparian strips** and **passage cells**. Casparian strips are band like thickening made of suberin.

iv) Stele: All the tissues inner to endodermis constitute stele.

a)Pericycle: It is a single layer of thin walled cells. The lateral roots originate from this layer.

b)Vascular tissues:
- It is radial, Xylem is **exarch** and **polyarch**.
- Conjunctive tissue is made up of sclerenchyma.

c)Pith: It is **present at the center**. It is made up of parenchyma cells with intercellular spaces and contains abundant amount of **starch grains**. It **stores food**.

5. Draw the internal structure of a Monocot (or) Maize root and label the parts.
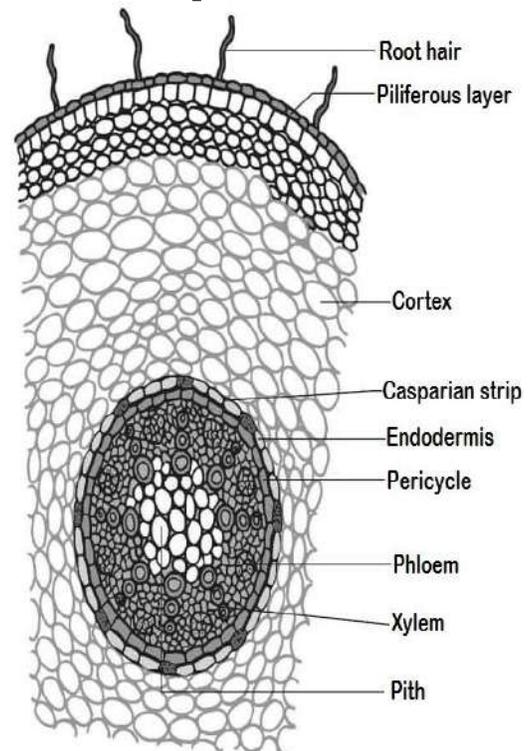
6. **Explain the internal structure of a Dicot (or) Sunflower stem.**

   1) Epidermis:
   - It is the **outermost layer** made of parenchyma cells and covered with **cuticle**.
   - It **protects the inner tissues**.

   2) Cortex:
   - *(i)Hypodermis:* It consists of **3 – 6 layers** of collenchyma cells to give **mechanical support**.
   - *(ii) Middle cortex:* It is made of few layers of chlorenchyma cells and involved in **photosynthesis**
   - *(iii)Inner cortex:* It is made of parenchyma cells. It helps in **gaseous exchange** & **stores food** materials.

   3) Endodermis (or) starch sheath :
   It is the **inner most layer** of cortex and consists of single layer of barrel shaped cells, that contain **starch grains**.

   4) Stele:
   - *(i)Pericycle:* It is multilayered, parenchymatous with alternating patches of sclerenchyma.
   - *(ii)Vascular bundle:* They are **conjoint, collateral, endarch & open**. They are in a ring around the pith.
   - *(iii)Pith:* It is the **large central parenchymatous zone** with intercellular spaces that helps in **food storage**.

7. **Draw the internal structure of a Dicot (or) Sunflower stem and label the parts.**
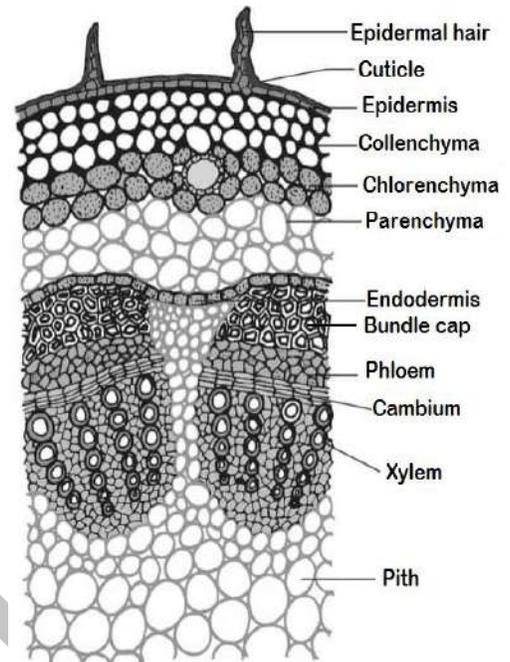
8. **Explain the internal structure of a Monocot (or) Maize stem.**

   1) Epidermis:
   - It is the outermost layer covered with **thick cuticle**.
   - Multicellular **hairs are absent** & **stomata are less** in number.

   2) Hypodermis:
   - It is made of sclerenchyma cells interrupted by chlorenchyma.
   - Sclerenchyma provides **mechanical support**.

   3) Ground tissue:
   - Entire mass of parenchyma cells next to hypodermis extending to the centre is called ground tissue.
   - It is not differentiated into endodermis, cortex, pericycle and pith

   4) Vascular Bundle:
   - They are **skull shaped** and scattered in the ground tissue.
   - They are **conjoint, collateral, endarch** and **closed**.
   - It is surrounded by sclerenchyma cells called **bundle sheath**.
   - *(a) Xylem:* They are arranged in V or Y shape. It consists of metaxylem and protoxylem. In mature vascular bundle, protoxylem disintegrates to form **protoxylem lacuna.**
   - *(b)Phloem:* It consists of **sieve tube elements** and companion cells. **Phloem parenchyma and phloem fibers are absent**.

   5) Pith: Pith is **absent**.

9. **Draw the internal structure of a Monocot (or) Maize stem and label the parts.**
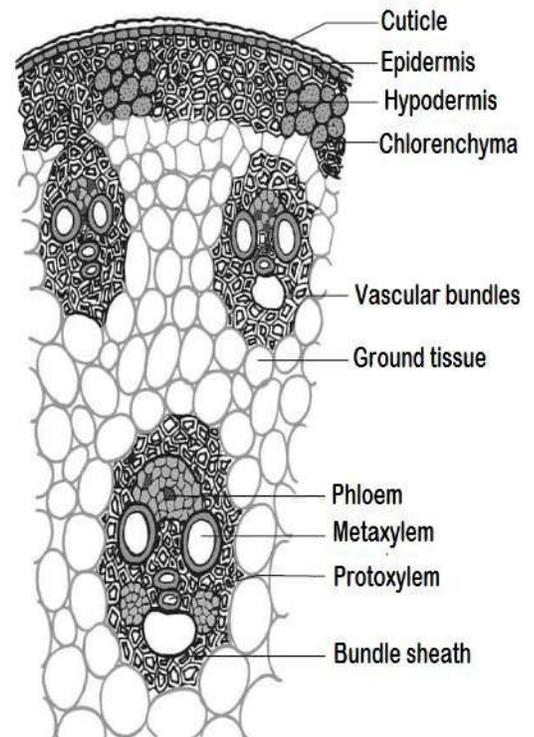
10. Differentiate between Dicot and Monocot stem.

S.No	Tissues	Dicot Stem (Sunflower)	Monocot Stem (Maize)
1.	Hypodermis	Collenchymatous	Sclerenchymatous
2.	Ground tissue	Differentiated into cortex, endodermis, pericycle & pith	Undifferentiated
3.	Vascular bundles	i) Less in number ii) Uniform in size iii) Arranged in a ring iv) Open (Cambium present) v) Bundle sheath absent	i) Numerous ii) Smaller near periphery, bigger in the centre iii) Scattered iv) Closed (Cambium absent) v) Bundle sheath present
4.	Secondary growth	Present	Mostly absent
5.	Pith	Present	Absent
6.	Medullary rays	Present	Absent

11. Explain the internal structure of a Dicot (or) Dorsiventral (or) Mango leaf.

(i) Upper epidermis:
- This is the **outermost layer** made of parenchymatous cells **without intercellular spaces**.
- The outerwall of the cells are cuticularized. **Stomata are less** in number.

(ii) Lower epidermis:
- It is made of **single layer** of parenchymatous cells with a thin cuticle
- It helps in the exchange of gases. The loss of water vapour occurs through this chamber.
- It contains **numerous stomata**. Chloroplasts are present only in guard cells.

(iii) Mesophyll:
The tissue present **between the upper and lower epidermis** is called mesophyll.
   a) Palisade parenchyma:
- These are **elongated cells**, found just below the upper epidermis that **helps in photosynthesis**.
- They have **more chloroplasts** and do not have intercellular spaces
   b) Spongy parenchyma:
- These are **spherical** or oval, **irregularly arranged** cells found below the palisade parenchyma.
- Cells have intercellular spaces. It helps in **gaseous exchange**.

(iv) Vascular bundles:
- Vascular bundles are **conjoint, collateral, closed** and **found in mid-rib** and **lateral veins**.
- It is surrounded by a sheath of parenchymatous cells called **bundle sheath**.
- Xylem lies towards the upper epidermis and phloem towards the lower epidermis.

12. Draw the internal structure of a Dicot (or) Dorsiventral (or) Mango leaf and label the parts.

Labels: Cuticle, Upper epidermis, Palisade parenchyma, Xylem, Spongy parenchyma, Phloem, Bundle sheath, Stoma, Epidermal hair, Lower epidermis
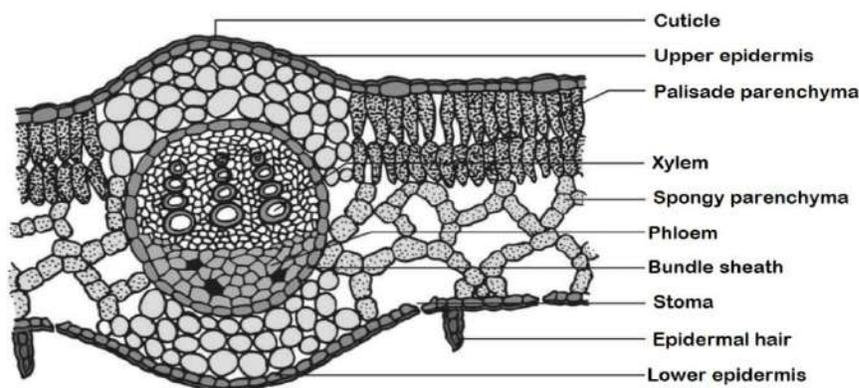
13. Explain the internal structure of a Monocot (or) Isobilateral (or) Grass leaf.

(i) Epidermis:

- It has **upper and lower epidermis** and made up of parenchyma cells.
- Cuticle is present on outer wall. Stomata are present on upper and lower epidermis.
- Some cells of upper epidermis are large and thin walled they are known as **bulliform cells**.

(ii) Mesophyll:

- It is present **between both epidermal layers**.
- They are irregularly arranged with **inter-cellular spaces**. These cells contain chloroplasts.
- Mesophyll is not differentiated into palisade and spongy parenchyma.

(iii) Vascular bundles:

- Large number of vascular bundles are present, some are small and some are large.
- Vascular bundles are **conjoint, collateral, closed & surrounded by parenchymatous bundle sheath**.
- Xylem is present towards upper epidermis and phloem towards lower epidermis.

14. Draw the internal structure of a Monocot (or) Isobilateral (or) Grass leaf and label the parts.
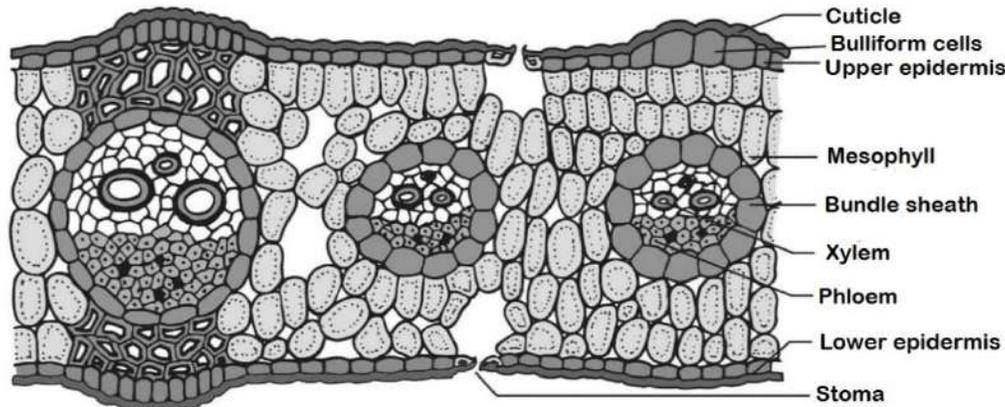
15. Differentiate between Dicot and Monocot leaf.

Dicot Leaf (Mango)	Monocot Leaf (Grass)
1. Dorsiventral leaf	1. Isobilateral leaf
2. Mesophyll is differentiated into palisade and spongy parenchyma	2. Mesophyll is not differentiated into palisade and spongy parenchyma.

16. Mention the components and functions of the 3 tissue systems.

Tissue System	Components	Functions
Dermal Tissue System	• Epidermis • Periderm	• Protection • Prevention of water loss
Ground Tissue System	• Parenchyma tissue • Chlorenchyma • Collenchyma tissue • Sclerenchyma tissue	• Food storage • Photosynthesis • Support, protection • Support, rigidity
Vascular Tissue System	• Xylem tissue • Phloem tissue	• Transport of water and minerals • Transport of food

17. Explain the structure and function of mitochondria with a suitable diagram.

❖ Mitochondria is the **power house of the cell.**

❖ It is a filamentous or granular cytoplasmic organelle present in cells.

Mitochondrial Membranes :

❖ *Outer Mitochondrial Membrane :*

- It is **smooth and freely permeable** to most small molecules.
- It has porin molecules, which form channels for passage of molecules.
- It contains **enzymes, proteins** and **lipids**.

❖ *Inner Mitochondrial Membrane :*

- It is **semi permeable membrane**.
- It regulates the passage of materials into and out of the mitochondria.
- It is **rich in enzymes** and **carrier proteins**. It consists of **80% proteins** and **lipids**.

Cristae are **finger like projections** that increases the surface area of mitochondria to hold various enzymes.

Oxysomes are minute regularly spaced tennis racket shaped particles that involve in **ATP synthesis**.

Mitochondrial Matrix :

- It is a complex mixture of **proteins and lipids**.
- It contains enzymes for Krebs cycle, mitochondrial Ribosomes & DNA and tRNAs.
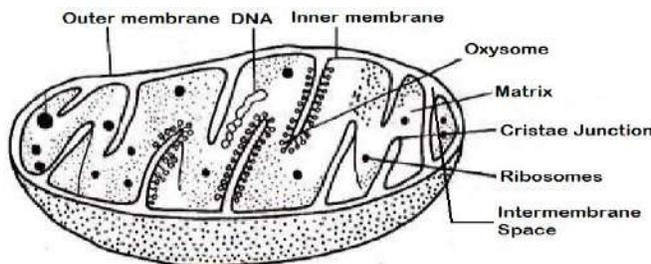
Functions of Mitochondria :

- *It is the main organelle of cell respiration.*
- *It produces a large number of ATP molecules.*
- *They are the power house or ATP factory of cell.*
- *It helps the cells to maintain normal concentration of calcium ions.*
- *It regulates the metabolic activity of the cell.*

18. Explain the structure and function of chloroplast with a suitable diagram.

❖ Chloroplasts are green plastids containing green pigment called **chlorophyll**.

❖ They are oval shaped organelles having a diameter of 2-10 μm and a thickness of 1-2 μm.

✳ *Envelope :*

Chloroplast envelope has **outer and inner membranes**, separated by intermembrane space.

✳ *Stroma :*

- **Matrix** present **inside the membrane** is called stroma.
- It contains DNA, 70 S ribosomes and other molecules required for protein synthesis.

✳ *Thylakoids :*

- It consists of thylakoid membrane that encloses thylakoid lumen.
- **Photosynthetic pigments** are present in thylakoids.

✳ *Grana :*

- Thylakoids are **stacked one above** the other in the form of discs called grana (or) granum.
- Grana are inter connected by stroma lamella.
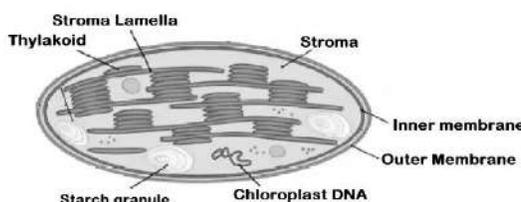
Functions of chloroplast :

- *Photosynthesis*
- *Storage of starch*
- *Synthesis of fatty acids*
- *Storage of lipids*

DIAGRAMS FOR ALL UNITS

Note : Practice all Lens diagrams. Refer Page No : 31

2 – Optics

Converging Lenses	Diverging Lenses	Human eye	Vision with Myopia
Biconvex lens, Plano-convex lens, Positive meniscus	Biconcave lens, Plano-concave lens, Negative meniscus	Sclera, Ciliary body, Retina, Lens, Cornea, Optic disc, Iris, Pupil, Optic nerve	
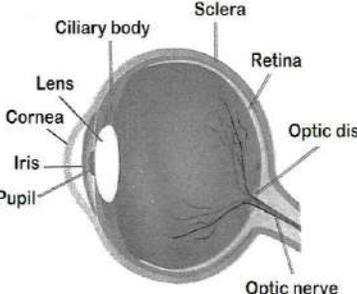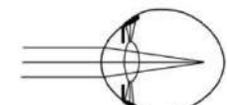
Corrected vision using a concave lens
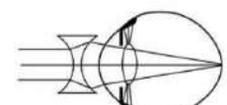
Image formation in simple microscope [PTA-2]	Image formation in compound microscope	Vision with Hypermetropia
Human Eye	Objective, Eyepiece	
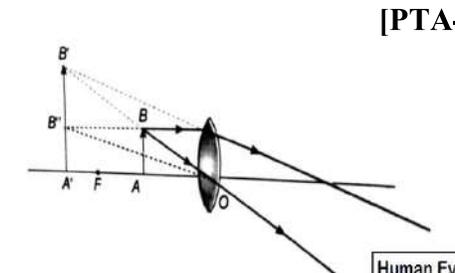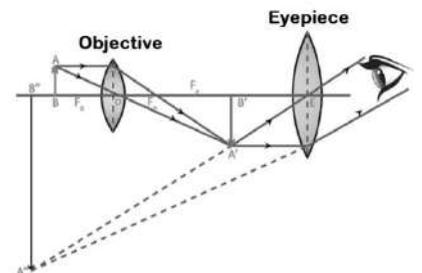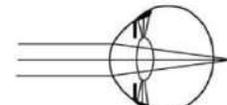
Corrected vision using a convex lens
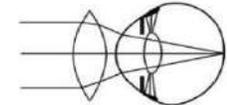
3 – Thermal Physics   5 – Acoustics

Linear Expansion	Superficial Expansion	Cubical Expansion	Laws of reflection
	A_0, ΔA	V_0, ΔV	Barrier, Original Wave, Normal, Reflected Wave, i, r
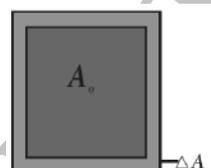
4 – Electricity

A Simple Electric Circuit	Series Connection	Parallel Connections
4Ω, 6V, LED, Key, A, I	R_1, R_2, R_3, V_1, V_2, V_3, Bt, Key, A	R_1, R_2, R_3, I_1, I_2, I_3, I, Key, A
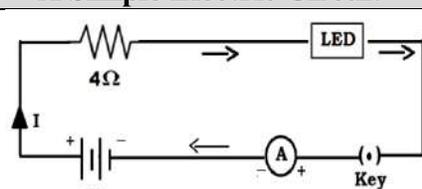
Series-Parallel Combination	Parallel-Series Combination	10 – Types of Chemical Reactions
R_2, R_4, R_1, R_3, Bt	R_3, R_4, R_1, R_2, Bt	
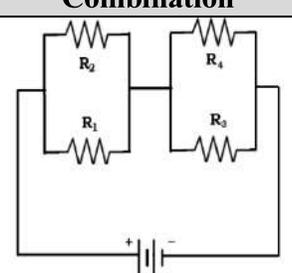
10 – Types of Chemical Reactions

Combination reactions	Decomposition reactions
A + B → A B	A-B → A + B

Single Displacement Reactions	Double Displacement Reactions
A + B C → A C + B Element, Compound, Compound, Element	A B + C D → A D + C B

GUIDANCE FOR PRACTICALS
PHYSICS

1. DETERMINATION OF WEIGHT OF AN OBJECT USING THE PRINCIPLE OF MOMENTS

Marks	Formula	Procedure	Diagram	Table	Result
	1	1	1	1	1

Aim:
To determine the weight of an object using the principle of moments.

Apparatus required:
    i) A metre scale   ii) a knife edge   iii) slotted weights   iv) thread

Formula:
Anticlockwise moment = clockwise moment

Unknown weight, $W_1 = \dfrac{W_2 \times d_2}{d_1}$ (g)

Where, $w_2 \rightarrow$ Known weight (g)

    $d_1 \rightarrow$ Unknown object distance from the centre of the scale (cm)

    $d_2 \rightarrow$ Known object distance from the centre of the scale (cm)

Procedure:
* A metre scale is supported at its centre of gravity by a knife edge.
* A known weight W_2 and an unknown weight W_1 are suspended from to either side of the scale using the weight hangers.
* Fix the position of known weight hanger and adjust the position of the unknown weight hanger such that the scale is in equilibrium.
* Measure the distance d_1 and d_2 noted in the table.
* Repeat the readings for different positions and tabulate.
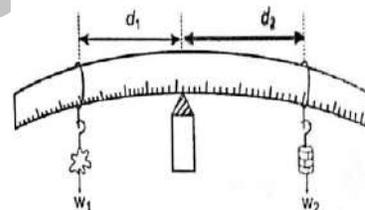
Observation :

S.No.	Known weight W_2 (g)	Distance d_1 (cm)	Distance d_2 (cm)	$W_2 \times d_2$ (g / cm)	Unknown weight $W_1 = \frac{w_2 \times d_2}{d_1}$ (g)
1	100	20	10	2000	200
2	100	30	15	3000	200
3	100	40	20	4000	200
				Mean	200

Note: In practicals, it is easy to measure values in g & cm and not in kg & m.

Result:
Using the principle of moments, the weight of the unknown body, $\mathbf{W_1 = 200g = 0.2\ kg}$

2. DETERMINATION OF FOCAL LENGTH OF A CONVEX LENS

Marks	Formula	Procedure	Table	Result
	1	1+1	1	1

Aim:
To determine the focal length of a convex lens by using 1) Distance object method   2) UV – method.

Apparatus Required:
    i) A convex lens   ii) stand   iii) wire gauze object   iv) screen   v) measuring scale

Formula:
Focal length, $f = \dfrac{uv}{u+v}$ (cm)

Here, $u \rightarrow$ distance between the object and the convex lens (cm)

    $v \rightarrow$ distance between the image and the convex lens (cm)

    $f \rightarrow$ focal length of the convex lens (cm)

Table:

i) To find the resistance :

S.No	I (ampere)	V (volt)	$R = \frac{V}{I}$ ohm
1	0.5	2	4
2	1.0	4	4
3	1.5	6	4
		Mean	4 ohms

ii) To find the diameter of the wire using screw gauge :

S.No	PSR (mm)	HSC (div)	HSR = (HSC ×LC)(mm)	TR = PSR +HSR (mm)
1	0	50	0.50	0.50
2	0	51	0.51	0.51
3	0	50	0.50	0.50
			Mean Diameter	0.50 mm

Calculation:

Radius of the wire, $r = \frac{diameter}{2} = \frac{0.50}{2} = 0.25$ mm $\Rightarrow$ $r = 0.25\ mm = 0.25 \times 10^{-3} m$

Area of cross section $A = \pi r^2 = 3.14 \times (0.25 \times 10^{-3})^2$ $\Rightarrow$ $A = 0.196 \times 10^{-6} m^2$

Length of the wire $L = 100\ cm = 1m$

$$\rho = \left(\frac{A}{L}\right) R = \frac{0.196 \times 10^{-6}}{1} \times 4$$

$$\rho = 0.784 \times 10^{-6} \Omega\ m$$

Result:

The resistivity of the material of the wire $\boldsymbol{\rho = 0.784 \times 10^{-6} \Omega\ m}$

CHEMISTRY

4. IDENTIFY THE DISSOLUTION OF THE GIVEN SALT WHETHER IT IS EXOTHERMIC OR ENDOTHERMIC

Marks	Aim	Procedure	Observation	Result
	1	1	1	2

for Practical

Aim:

To test the dissolution of given salt is exothermic or endothermic.

Principle:

* If the reaction or process liberates the heat, then it is called exothermic.
* If the reaction or process absorbs the heat, then it is called endothermic.

Apparatus Required:

i) Two beakers ii) Thermometer   iii) Stirrer iv) Weighed amount of two samples

Procedure:

* Take 50 ml of water in two beakers A and B.
* Note the temperature of the water from beaker A and B.
* Add 5g of sample A into the beaker A & stir well until it dissolve completely. Record find temperature of the solution.
* Repeat the same for the sample B. Record the Observation.

Observation:

S.No	Sample	Temperature before addition of sample ($°C$)	Temperature after addition of sample ($°C$)	Inference
1	A	30	35	Increase
2	B	30	25	Decrease

Result:

From the inference, made,

* The dissolution of sample A is **Exothermic reaction.**
* The dissolution of sample B is **Endothermic reaction.**

BOTANY

Marks	Aim	Procedure / Observation	Result
	1	2	2

for Practical

Aim:

To prove that oxygen is evolved during photosynthesis.

Materials required:

i) Test tube   ii) funnel   iii) beaker   iv) pond water   v) hydrilla plant

Procedure:

* Take a few twigs of Hydrilla plant in a beaker containing pond water.
* Place an inverted funnel over the plant.
* Invert a test tube filled with water over the stem of the funnel.
* Keep the apparatus in the sunlight for few hours.
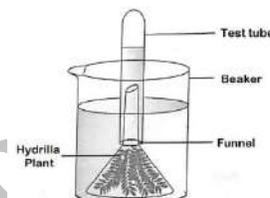
Observation:

After one hour, it is noted that water gets displaced down from the test tube.

Inference:

* During photosynthesis, oxygen is evolved as a by-product. Gas bubbles liberated from the Hydrilla plant reach the top of the test tube and it displaces the water downwards.
* Take the test tube and keep the burning stick near the mouth of the test tube. Increased flame will appear.
* Hence, it is proved that oxygen is evolved during photosynthesis.

9. PARTS OF A FLOWER

Marks	Dissection	Display	Diagram + Parts
	1½	1½	1 + 1

Aim:

To dissect and display the floral parts like Calyx, Corolla, Androecium and Gynoecium of the given flower.

Materials Required:

i) Given flower : Hibiscus rosa-sinensis / Datura / Clitoria / Thespesia.
ii)Needle   iii) White paper

Procedure:

* With the help of the needle dissect the different whorls of the flower.
* Calyx, corolla – Accessory organ
* Androecium – Male part ⎤ Reproductive
* Gynoecium – Female part ⎦ organ

Dissection
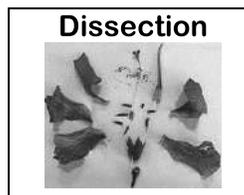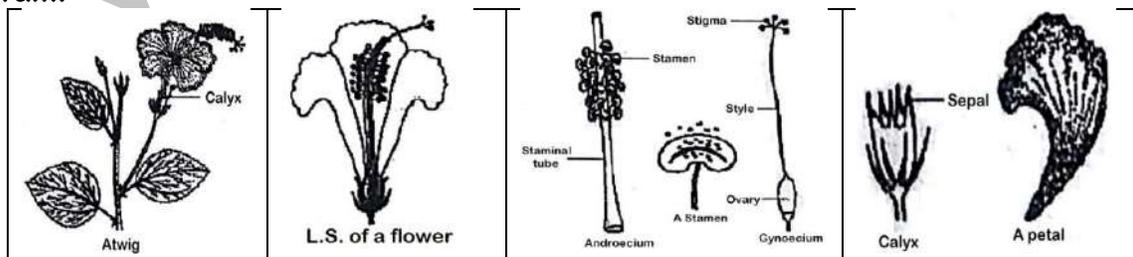
Diagram:

Result:

Calyx, corolla, Androecium and Gynoecium of the given flower are separated and displayed.
The parts of the flower are drawn and labelled.

ZOOLOGY

Marks	Identification	Diagram + Parts	Notes
	1	1 + 1	2

a) Human Heart:

Aim:

To identify the given model, draw labelled diagram and write a note on it.

Materials Required:

Model showing the L.S of human heart.

Identification:

The given model is identified as L.S. of **Human Heart.**

Diagram:

Superior vena cava — Aorta — Pulmonary artery — Pulmonary vein — Left atrium — Mitral valve — Aortic valve — Left ventricle — Right atrium — Pulmnary valve — Tricuspid valve — Right ventricle
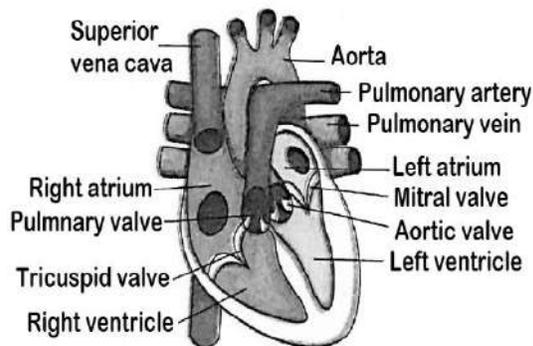
Notes:

1. It has four chambers namely two auricles and two ventricles.
2. The auricles are separated by interauricular septum and ventricles are separated by interventricular septum. It prevents the mixing of oxygenated and deoxygenated blood.
3. Tricuspid valve – It is located between the right auricle and the right ventricle.
4. Bicuspid valve – It is located between the left auricle and the left ventricle.
5. The heart is covered by a protective double walled membrane called pericardium.
6. Heart is a pumping organ which pumps blood to all parts of the body.

Result:

The given model is identified as L.S. of **Human Heart.**

b) Human Brain:

Aim:

To identify the given model, draw labelled diagram and write a note on it.

Materials Required:

Model showing the L.S of human brain.

Identification:

The given model is identified as L.S. of **Human Brain.**

Diagram:

Cerebrum — Corpus callosum — Ventricles — Hypothalamus — Pituitary gland — Midbrain — Pons — Cerebellum — Medulla — Brain stem
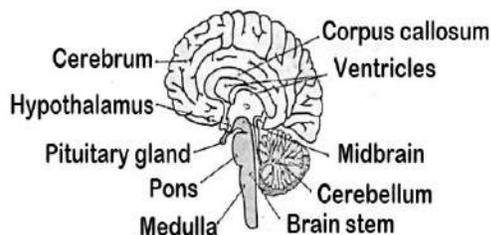
Notes:

1. Human brain is placed inside the cranial cavity.
2. It is the controlling centre of all the body activities.
3. It is covered by three protective coverings called meninges. (Duramater, Arachnoid, Piamater)
4. Human brain is divided into three major parts namely forebrain, midbrain and hind brain.

Result:

The given model is identified as L.S. of **Human Brain.**