

SAMPLE CONTENT

Perfect



CHEMISTRY Vol. II



Boyle's law

As pressure decreases with altitude, air becomes less denser. Hence, mountaineers carry supplementary oxygen in order to prevent the effects of severe hypoxia.

STD. XI Sci.

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Target Publications® Pvt. Ltd.

PERFECT CHEMISTRY (Vol. II)

Std. XI Sci.

Salient Features

- ☞ Written as per the latest textbook
- ☞ Subtopic-wise segregation for powerful concept building
- ☞ Complete coverage of Textual Exercise Questions, Intext Questions, Textual Examples and Numericals
- ☞ ‘Quick Review’ of the chapter facilitates quick revision
- ☞ ‘Apply Your Knowledge’ section for application of concepts
- ☞ ‘Important Formulae’ and ‘Solved Examples’ provided to cover numerical aspect of the topic in detail
- ☞ ‘Competitive Corner’ presents recent questions from prominent competitive examinations
- ☞ Includes features like About the chapter, Reading Between the Lines, Enrich Your Knowledge, Gyan Guru, Strategy, Connections, Caution, NCERT Corner for holistic learning
- ☞ Includes Theory questions, Numericals, Miscellaneous questions (based on organic chemistry) and MCQs for practice
- ☞ Topic Test at the end of each chapter for self-assessment
- ☞ QR Codes to access the Video/pdf links, Solutions of Numericals and Miscellaneous questions for Practice

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PREFACE

“I never teach my pupils; I only attempt to provide the conditions in which they can learn.” – Albert Einstein

‘**Perfect Chemistry Vol. II, Std. XI Sci.**’ forms a part of ‘**Target Perfect Notes**’ prepared as per the new textbook of Maharashtra State Board. It focuses on active learning along with making the process of education more interesting and builds up the students’ knowledge quotient in the process.

Every chapter in this book begins with ‘**About the Chapter**’ that offers a brief introduction of the chapter. The chapter is **segregated subtopic-wise** and encompasses all textual content in the format of Question-Answers. The questions titled under ‘Use your brain power’, ‘Can you tell’, ‘Can you recall’, ‘Activity’, ‘Try this’ and various similar titles pave the way for a robust concept building. For the students to gain a better understanding of the concept lying behind the answer, ‘**Reading between the lines**’ (*not a part of the answer*) has been provided as deemed necessary. Numericals along with their step-wise solutions are covered under the heading of ‘**Solved Examples**’ at the end of each subtopic. Few selected numericals have also been solved using log-tables. Marks are allotted to give students insight about weightage of a question. **Quick Review** and **Important Formulae** are placed after covering last subtopic of the chapter. ‘**Exercise**’, ‘**Multiple Choice Questions**’ and ‘**Topic Test**’ (as per latest paper pattern) are added to enable students assess their range of preparation and knowledge of each topic. QR codes have been provided for students to access the ‘Solutions to Numericals for practice, Miscellaneous questions for Practice’ and ‘Answers’ given for the Topic Test. **Notes** are introduced to cover additional bits of relevant information on each topic as seemed required. **Log-table** has been provided for students’ use at the end of the book.

Our **Perfect Chemistry Vol. II, Std. XI Sci.** adheres to our vision and achieves several goals: **building concepts, developing competence to solve numerical, recapitulation, self-study, self-assessment and student engagement**—all while encouraging students toward cognitive thinking.

The flow chart on the adjacent page will walk you through the key features of the book and elucidate how they have been carefully designed to maximize the student learning.

We hope the book benefits the learner as we have envisioned.

Publisher

Edition: Fourth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we’ve nearly missed something or want to applaud us for our triumphs, we’d love to hear from you.

Please write to us on: mail@targetpublications.org

Disclaimer

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This work is purely inspired upon the course work as prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune. Every care has been taken in the publication of this reference book by the Authors while creating the contents. The Authors and the Publishers shall not be responsible for any loss or damages caused to any person on account of errors or omissions which might have crept in or disagreement of any third party on the point of view expressed in the reference book.

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KEY FEATURES

'About the Chapter' is a short introduction designed to stimulate students' appetite for the topic.

About the chapter

Reading between the lines

Reading between the lines provides elaboration or missing fragments of concept which is essential for complete understanding of the concept.

NCERT Corner covers information from NCERT textbook relevant to topic.

NCERT Corner

Connections

Connections enable students to interlink concepts covered in different chapters.

Caution helps students to be watchful against commonly made mistakes.

Caution

Strategy

Strategy provides a step-by-step process to break a complex numerical problem into simpler parts.

QR code provides:

- i. Access to a video/PDF in order to boost understanding of a concept or activity
- ii. Solutions of Numericals and Miscellaneous questions for Practice

QR Codes

Enrich Your Knowledge

Enrich Your Knowledge presents fascinating information about the concept covered.

Continued...

KEY FEATURES

Gyan Guru illustrates real life applications or examples related to the concept discussed.

**GG-Gyan
Guru**

**Apply
Your
Knowledge**

Apply Your Knowledge includes challenging questions.

Quick review includes tables/ flow chart to summarize the key points in chapter.

**Quick
Review**

**Important
Formulae**

Important Formulae includes all of the key formulae in the chapter.


Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main), NEET (Odisha), MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

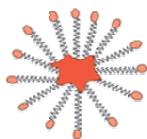
**Competitive
Corner**

CONTENTS

Chapter No.	Chapter Name	Marks	Marks with option	Page No.
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11	Adsorption and Colloids	3	4	49
12	Chemical Equilibrium	6	8	78
13	Nuclear Chemistry and Radioactivity	3	4	109
14	Basic Principles of Organic Chemistry	6	8	144
15	Hydrocarbons	8	11	200
16	Chemistry in Everyday Life	3	4	260
	Modern Periodic Table			283
	Electronic Configuration of Elements			284
	Log table			285

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04]

- Note:**
- * mark represents Textual Exercise question.
 - # mark represents Intext question.
 - + mark represents Textual examples and Numericals.
 -  symbol represents textual questions that need external reference for an answer.
 - Chapters 1 to 9 are a part of Perfect Chemistry Vol. I, Std. XI Sci.



Soap micelle

About the chapter...

Chemistry has an important role in all aspects of everyday life such as food, clothes, medicines, cleansing agents, etc. In this chapter we will study on food chemistry and medicinal chemistry, i.e., chemical compounds or drugs used in food and for therapeutic purposes. We will also study chemical compounds used for cleansing purpose. This chapter is allotted weightage of 4 marks with options and 3 marks without option.

CONTENTS AND CONCEPTS

- 16.1 Basics of food chemistry
- 16.2 Compounds with medicinal properties
- 16.3 Cleansing agents

16.1 BASICS OF FOOD CHEMISTRY

Q.1. Can you recall? (Textbook page no. 261)

i. What are the components of balanced diet?

[1 Mark]

Ans: Carbohydrates, proteins, lipids (fats and oil), vitamins, minerals and water are the components of balanced diet.

ii. Why is food cooked? What is the difference in the physical states of uncooked and cooked food?

[2 Marks]

Ans:

- a. Food is cooked in order to make it easy to digest.
- b. Also, the raw or uncooked food may contain harmful microorganisms which may cause illness. Cooking of food at high temperature kills most of these microorganisms.
- c. Raw/uncooked food materials like dried pulses, vegetables, meat, etc. are hard and thus, not easily chewable while cooked food is soft and tender, therefore, easily chewable.

iii. What are the chemicals that we come across in everyday life?

[1 Mark]

Ans: Detergents, shampoos, medicines, various food flavours, food colours, etc. are different types of chemicals that we come across in everyday life.

Q.2. Write a note on nutrients.

[3 Marks]

Ans: Nutrients:

- i. Nutrients are obtained from food and are used as a source of energy by the body.
- ii. The main nutrients obtained from food are carbohydrates, lipids, proteins, vitamins, minerals and water. Most nutrients are organic macromolecules.
- iii. Along with providing energy, these nutrients also regulate various body functions like growth, repair of damaged body tissues, etc.
- iv. The following table consists of different types of nutrients and their major sources.

Type of nutrient	Sources
Carbohydrates	Grains, fruits, vegetables, etc.
Proteins	Meat, fish, eggs, dairy products, pulses, etc.
Lipids	Dairy products, vegetable oil, animal fats, etc.
Vitamins	Grains, fruits, vegetables, meat, fish, eggs, dairy products, pulses, etc.

Page no. **261** to **268** are purposely left blank.

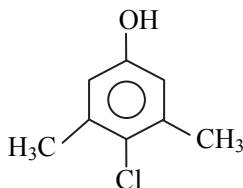
To see complete chapter buy **Target Notes** or **Target E-Notes**



*Q.57. Draw the structure of chloroxylenol.

[1 Mark]

Ans: Structure of chloroxylenol:



Q.58. State whether the following statements are TRUE or FALSE. Correct the statement, if false.

[1 Mark Each]

- A concentrated solution of boric acid is used as an antiseptic for eyes.
- Iodoform is a powerful antiseptic.
- The active ingredient present in dettol is chloroxylenol.

Ans:

- False
A dilute aqueous solution of boric acid is used as an antiseptic for eyes.
- True
- True

Q.59. Instead of phenol, it's chloro derivatives are used as antiseptics. Explain.

[2 Marks]

Ans:

- A dilute aqueous solution of phenol has antiseptic properties but it is found to be corrosive in nature.
- Many chloro derivatives of phenol are more potent antiseptic and have less corrosive effects than phenol, if used in lower concentrations.
Thus, instead of phenol it's chloro derivatives are used as antiseptics.

*Q.60. Explain the following: A diluted solution (4.8% w/v) of 2,4,6-trichlorophenol is employed as antiseptic.

[2 Marks]

Ans:

- 2,4,6-Trichlorophenol (TCP) is more potent antiseptic than phenol.
- It has low corrosive effects as compared to phenol, if used in lower concentrations.
Hence, diluted solution (4.8% w/v) of 2,4,6-trichlorophenol is used as antiseptic.

*Q.61. Explain with examples: Disinfectant

[2 Marks]

Ans:

- Disinfectants are non-selective antimicrobials.
- They kill a wide range of microorganisms including bacteria.
- They are used on non-living surfaces for example, floors, instruments, sanitary ware, etc.
- Various phenols can be used as disinfectants.
e.g. p-Chloro-o-benzyl phenol is used as a disinfectant in all-purpose cleaners.



CAUTION

0.2 % solution of phenol acts as an antiseptic whereas its 1 % solution acts as disinfectant.

Q.62. Draw the structures of the following compounds and name the class of antimicrobials to which they belong.

[1 Mark Each]

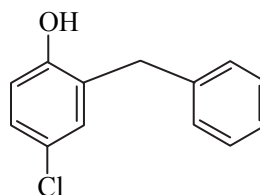
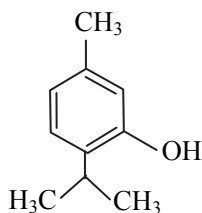
- Thymol
- p-Chloro-o-benzylphenol

iii. 2,4,6-Trichlorophenol

Ans:

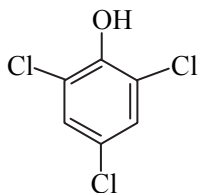
i. **Thymol:** It is an antiseptic.

ii. **p-Chloro-o-benzylphenol:** It is a disinfectant.





iii. **2,4,6-Trichlorophenol:** It is an antiseptic.



*Q.63. Give two differences between the following: Disinfectant and antiseptic

[2 Marks]

Ans:

No.	Disinfectant	Antiseptic
i.	Disinfectants are applied on non-living surfaces like floors, instruments, sanitary ware, etc. to kill wide range of microorganisms.	Antiseptics are applied on the surface of living tissues in order to sterilise them.
ii.	Disinfectants cannot be applied on wounds.	Antiseptics can be directly applied on wounds.
e.g.	p-chloro-o-benzyl phenol	Iodine, boric acid, iodoform, dettol, etc.

Q.64. What are antibiotics?

[1 Mark]

Ans: Antibiotics are drugs which are purely synthetic or obtained from microorganisms like bacteria, fungi or moulds.
e.g. Salvarsan, Prontosil

Q.65. Name the first effective drug used in treatment of syphilis.

[1 Mark]

Ans: Salvarsan was the first effective drug used in treatment of syphilis.

ENRICH YOUR KNOWLEDGE

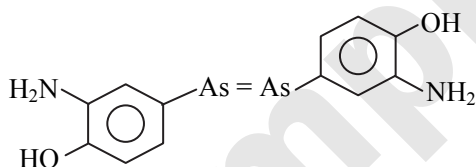


Arsenic compounds were known to be highly poisonous to humans since long. Paul Ehrlich, German bacteriologist investigated arsenic based organic compounds in order to produce less toxic substances for the treatment of syphilis. He discovered the first effective treatment of syphilis, the synthetic antibiotic named salvarsan. He was awarded the Nobel prize for medicine (1908) for this discovery.

*Q.66. Draw the structure of salvarsan.

[1 Mark]

Ans: Structure of salvarsan:



Q.67. Name the following:

[1 Mark Each]

i. An effective diazo antibacterial drug.

ii. One example of a sulpha drug.

Ans:

i. Prontosil

ii. Sulphapyridine

Q.68. Name the diazo antibacterial, which gets converted to sulphanilamide in the body.

[1 Mark]

Ans: Prontosil is an effective diazo antibacterial, which gets converted to a simpler compound, sulphanilamide, in the body.

Q.69. Draw the structure of the following:

[1 Mark Each]

i. An azodye

ii. Prontosil

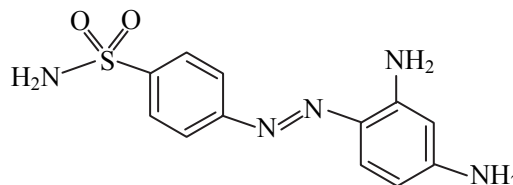
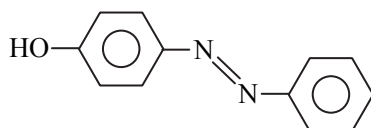
iii. Sulphapyridine

iv. Sulphanilamide

Ans:

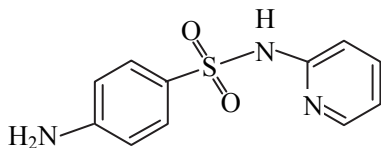
i. An azodye:

ii. Prontosil:

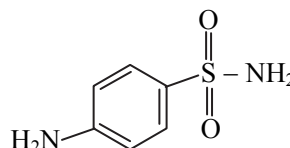




iii. Sulphapyridine:



iv. Sulphanilamide:



*Q.70. Who discovered penicillin?

[1 Mark]

Ans: Alexander Fleming discovered penicillin.

READING BETWEEN THE LINES

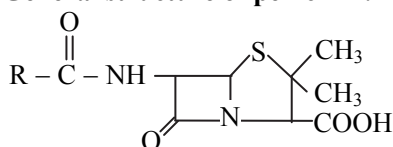


In 1929, Alexander Fleming discovered the antibacterial properties of a penicillium fungus. The clinical utility of the purified active ingredient, penicillin, as antibiotic drug was established in the next thirteen years. This is the first antibiotic of microbial origin. Chloramphenicol, isolated in 1947, is another antibiotic of microbial origin.

Q.71. Draw the general structure of penicillin.

[1 Mark]

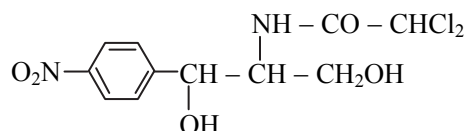
Ans: General structure of penicillin:



Q.72. Draw the structure of chloramphenicol.

[1 Mark]

Ans: Structure of chloramphenicol:



Q.73. Can you tell? (Textbook page no. 264)

What is meant by a broad spectrum antibiotic?

[1 Mark]

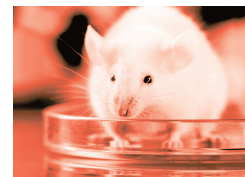
Ans: Antibiotics which are effective against wide range of bacteria are known as broad spectrum antibiotic.



GG - Gyan Guru

Prontosil became the first drug to treat bacterial infections!!

The observation on azo dyes led to assumptions that these dyes might become effective against bacteria. Numerous 'in vitro' experiments however, showed no antibacterial activity. Then, scientists decided to test dyes 'in vivo' on infected mice. Some dyes turned out to be effective against bacterial infections in mice. Prontosil (a least toxic of all dyes), became the first drug to treat bacterial infections!!



Q.74. Give classification of antibiotics.

[3 Marks]

Ans: Antibiotics can be of three types, which are as given below:

- Broad spectrum antibiotics:** They are effective against wide range of bacteria.
- Narrow spectrum antibiotics:** They are effective against one group of bacteria.
- Limited spectrum antibiotics:** They are effective against a single organism.

[Note: Antibiotics can be synthetic, semisynthetic or of microbial origin.]

*Q.75. What is meant by broad spectrum antibiotic and narrow spectrum antibiotics?

[1 Mark]

Ans: Antibiotics which are effective against wide range of bacteria are known as broad spectrum antibiotics, while antibiotics which are effective against one group of bacteria are known as narrow spectrum antibiotics.

Q.76. State the disadvantage of broad spectrum antibiotics.

[1 Mark]

Ans: The disadvantage of broad spectrum antibiotics is that they also kill the useful bacteria in the alimentary canal.



*Q.77. Write two examples of the following:

[1 Mark Each]

- i. Analgesics ii. Antiseptics iii. Antibiotics iv. Disinfectant

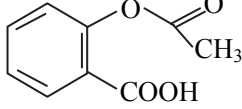
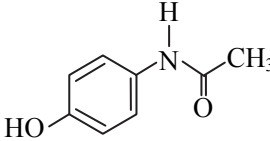
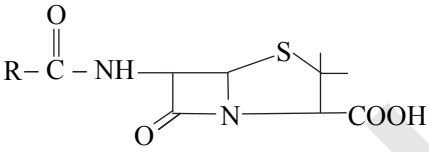
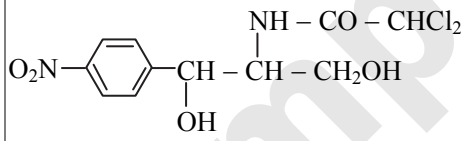

Ans:

No.	Drug type	Examples
i.	Analgesics	Aspirin, paracetamol
ii.	Antiseptics	Dettol, thymol
iii.	Antibiotics	Penicillin, sulphapyridine
iv.	Disinfectant	Phenol, p-Chloro-o-benzyl phenol

[Note: Phenol in high concentration (1%) acts as a disinfectant whereas in low concentration (0.2%) acts as an antiseptic.]

*Q.78. Identify the functional groups in the following molecule:

[1 Mark Each]

No.	Compound	Functional group present
i.	<p>Aspirin</p> 	Ester $\left(\text{R} - \overset{\text{O}}{\parallel}{\text{C}} - \text{O} - \text{R} \right)$ and carboxylic acid $(-\text{COOH})$ group.
ii.	<p>Paracetamol</p> 	Phenolic $(-\text{OH})$ group and secondary amide group $\left(\text{R} - \overset{\text{O}}{\parallel}{\text{C}} - \text{NH} - \right)$.
iii.	<p>Penicillin</p> 	Secondary amide group $(\text{R} - \overset{\text{O}}{\parallel}{\text{C}} - \text{NH} -)$, tertiary amide group $\left(- \overset{\text{O}}{\parallel}{\text{C}} - \text{N} - \right)$, carboxylic acid group $(-\text{COOH})$ and thioether $(\text{R} - \text{S} - \text{R})$.
iv.	<p>Chloramphenicol</p> 	Nitro group $(-\text{NO}_2)$, secondary alcoholic group $\left(- \overset{\text{OH}}{\underset{ }{\text{C}}H} - \right)$, primary alcoholic group $(-\text{CH}_2\text{OH})$, secondary amide group $\left(\text{R} - \overset{\text{O}}{\parallel}{\text{C}} - \text{NH} - \right)$ and halo group (chloro).
v.	<p>Sulphanilamide</p> 	Primary amine group $(-\text{NH}_2)$ and sulphonamide group $(-\text{SO}_2\text{NH}_2)$.
vi.	<p>Glycerine</p> $\begin{array}{c} \text{CH}_2 - \text{OH} \\ \\ \text{CH} - \text{OH} \\ \\ \text{CH}_2 - \text{OH} \end{array}$	Primary alcoholic group $(-\text{CH}_2\text{OH})$ and secondary alcoholic group $\left(- \overset{\text{OH}}{\underset{ }{\text{C}}H} - \right)$.

*Q.79. Explain the following: Turmeric powder can be used as antiseptic.

[2 Marks]

Ans:

- Turmeric powder contains an active ingredient called curcumin.
- Curcumin has antiseptic properties; thus, it is used for wound healing or applied on bruise. Hence, turmeric powder can be used as antiseptic.



ENRICH YOUR KNOWLEDGE



Do you know? (Textbook page no. 267)

The turmeric patent battle:

India won the legal against US patent and Trademark office (PTO) in 1997 and protected its intellectual property of traditional Indian knowledge about turmeric against patenting. Dr. Raghunath Mashelkar, then the Director General of the council of Scientific and Industrial Research, New Delhi, India led this case and upheld the national pride. In this yearlong battle, the CSIR argued that turmeric, a native Indian plant, had been used for centuries by its people for wound healing.

Q.80. Can you tell? (Textbook page no. 264)

What is the active principle ingredient of cinnamon bark?

[1 Mark]

Ans: Cinnamaldehyde is the principle active ingredient of cinnamon bark.

Q.81. Complete the following table.

[½ Mark Each]

Plant	Medicinal property	Active ingredient(s)
Cinnamon	Antimicrobial for cold	-----
-----	-----	Eugenol
Citrus fruits	Antioxidant	-----
Wintergreen	-----	-----
Indian gooseberry (amla)	Antidiabetic, antimicrobial, antioxidant	Vitamin C, Gallic acid

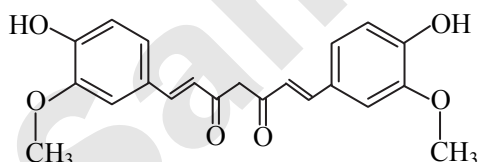
Ans:

Plant	Medicinal property	Active ingredient
Cinnamon	Antimicrobial for cold	Cinnamaldehyde
Clove	Antimicrobial and analgesic	Eugenol
Citrus fruits	Antioxidant	Vitamin C (ascorbic acid)
Wintergreen	Analgesic	Methyl salicylate
Indian gooseberry (amla)	Antidiabetic, antimicrobial, antioxidant	Vitamin C, Gallic acid

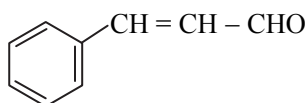
Q.82. Draw the structures of following:

[1 Mark Each]

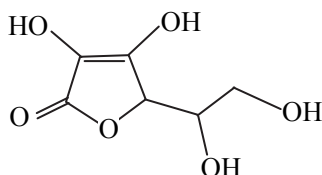
i. Curcumin



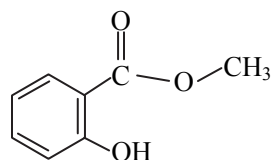
iii. Cinnamaldehyde



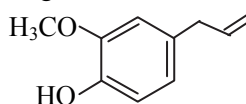
v. Vitamin C



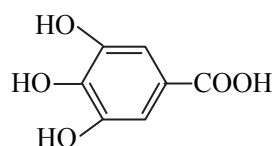
ii. Methyl salicylate



iv. Eugenol



vi. Gallic acid





NCERT Corner

- i. **Narcotic analgesics:** They instantly relieve pain and produce depression of the central nervous system.
e.g. Morphine, codeine, heroin, marijuana, etc.
- ii. **Tranquilizers:** The chemical substances used to relieve or reduce the stress, irritability, excitement and anxiety leading to calmness are called tranquilizers.
e.g. Iproniazid, phenelzine, serotonin, etc.
- iii. **Antifertility drugs:** The chemical substances used to control the pregnancy are called antifertility drugs or oral contraceptives or birth control pills.
e.g. Norethindrone, novestrol, etc.
- iv. **Antacids:** The chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns and gastric ulcers are called antacids.
e.g. Baking soda (sodium bicarbonate), aluminium hydroxide $[Al(OH)_3]$, etc.
- v. **Antihistamines:** These are chemical substances which diminish or abolish the main actions of histamine released in the body and hence, prevent the allergic reactions.
e.g. Benadryl, seldane, etc.

16.3 CLEANSING AGENTS

Q.83. What are cleansing agents?

[1 Mark]

Ans: Cleansing agents are substances which are used to remove stain, dirt or clutter on surfaces.

Q.84. Can you tell? (Textbook page no. 268)

[2 Marks Each]

i. Can we use the same soap for bathing as well as cleaning utensils or washing clothes? Why?

Ans: No, we cannot use the same soap for bathing as well as cleaning utensils or washing clothes due to the following reasons:

- a. Chemical composition of each type of soap or cleansing material is different.
- b. Nature, acidity, texture, reactivity towards water (i.e., hard water or soft water), reactivity towards microorganisms, stains are different for each type of soap.
- c. Depending on these qualities, soaps are classified and used accordingly.
e.g. pH of soaps used for bathing purpose is different than that of the soap which is used for cleaning utensils.

Thus, we cannot use the same soap for bathing as well as cleaning utensils or washing clothes.

ii. How will you differentiate between soaps and synthetic detergent using borewell water?

Ans: Borewell water is hard water. Soaps and synthetic detergents react differently with hard water.

- a. **Soap:** Soaps are insoluble in hard water. Borewell water (hard water) contains Ca^{2+} and Mg^{2+} ions. Soaps react with these ions to form insoluble magnesium and calcium salts of fatty acids. These salts precipitate out as gummy substance or form scum.
- b. **Synthetic detergents:** Synthetic detergents can be used in hard water as well. They contain molecules (components) which form soluble calcium and magnesium salts.

Thus, soaps will form scum in borewell water but synthetic detergents will not.

Q.85. What are the different types of cleansing agents?

[1 Mark]

Ans: Commercially cleansing agents are of the following two main types, depending on their chemical composition:

- i. Soaps
- ii. Synthetic detergents

[Note: Cleansing agents may be natural or synthetically developed.]

Q.86. What are soaps? How soaps are prepared?

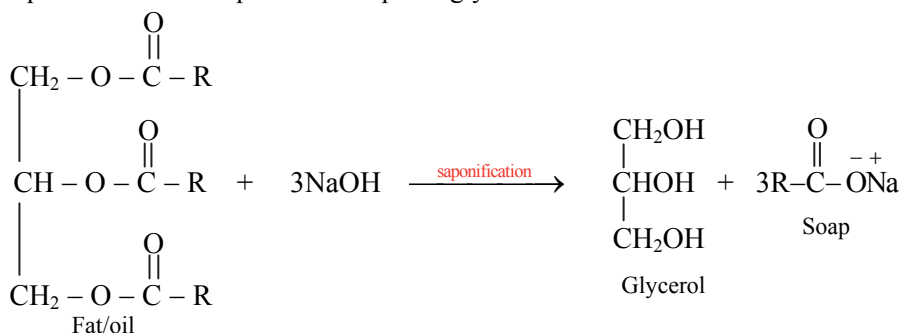
[3 Marks]

Ans: Soaps:

- i. Soaps are sodium or potassium salts of long chain fatty acids.
- ii. They are obtained by alkaline hydrolysis of natural oils and fats with NaOH or KOH. This is called saponification reaction.
- iii. Chemically, oils are triesters of long chain fatty acids and propane-1,2,3-triol (commonly known as glycerol or glycerin).



iv. Saponification of oil produces soap and glycerol as shown in the reaction below:



*Q.87. Write a chemical equation for saponification.

[1 Mark]

Ans: Refer Q.86.

Q.88. Give reason: Potassium soaps can be used for bathing purpose.

[2 Marks]

Ans:

- The quality of soap depends upon the nature of oil and alkali used.
- Potassium soaps (toilet soaps) are prepared by using better grades of oil and KOH. Therefore, they are soft to skin.
- Also, care is taken to remove excess of alkali which may otherwise cause skin irritation. Hence, potassium soaps can be used for bathing purpose.

Q.89. Laundry soaps are made using which alkali?

[1 Mark]

Ans: Laundry soaps are made using alkali NaOH (sodium hydroxide).

Q.90. Give examples of fillers used in making of laundry soaps.

[1 Mark]

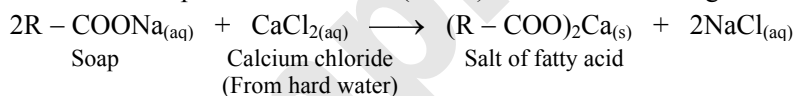
Ans: Laundry soaps contain fillers like sodium rosinate (a lathering agent), sodium silicate, borax, sodium and trisodium phosphate.

Q.91. Explain why soaps become inactive in hard water.

[2 Marks]

Ans:

- Soaps form scum in hard water and become inactive.
- This is because, hard water contains dissolved salts of calcium and magnesium. Soaps react with these salts to form insoluble calcium and magnesium salts of fatty acids.
- This insoluble substance is termed as scum which sticks to the fabric.
- Reaction of soap with calcium salt (CaCl_2) from hard water is given below:



Q.92. Which chemical can be used for softening of hard water? Why?

[2 Marks]

Ans:

- Washing soda (Na_2CO_3) can be used for softening of hard water.
- This is because, washing soda precipitates the dissolved calcium salts as carbonate and helps the soap action by softening of water.

Q.93. i. What are synthetic detergents?

[1 Mark]

ii. Mention their different types.

[1 Mark]

Ans:

- Synthetic detergents are manmade cleansing agents designed to use in soft water as well as in hard water.
- There are three types of synthetic detergents which are as follows:
 - Anionic detergents
 - Cationic detergents
 - Nonionic detergents

*Q.94. Explain with examples.

[2 Marks Each]

i. Cationic detergents

ii. Anionic detergents

iii. Nonionic detergents

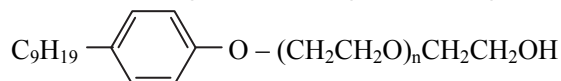
Ans:

- Cationic detergents:** These are quaternary ammonium salts having one long chain alkyl group.
e.g. Cetyltrimethylammonium bromide: $[\text{CH}_3(\text{CH}_2)_{15} - \text{N}^+(\text{CH}_3)_3]\text{Br}^-$
- Anionic detergents:** These are sodium salts of long chain alkyl sulphonic acids or long chain alkyl substituted benzene sulphonic acids.
e.g. Sodium lauryl sulphate: $\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OSO}_3^- \text{Na}^+$



iii. **Nonionic detergents:** These are ethers of polyethylene glycol with alkyl phenol or esters of polyethylene glycol with long chain fatty acid.

e.g. a. Nonionic detergent containing ether linkage:



b. Nonionic detergent containing ester linkage:



Q.95. Complete the following table:

[½ Mark Each]

No.	Type	Example	Use
i.	-----	$\text{C}_9\text{H}_{19} - \text{C}_6\text{H}_4 - \text{O} - (\text{CH}_2\text{CH}_2\text{O})_n\text{CH}_2\text{CH}_2\text{OH}$	-----
ii.	Anionic detergent	-----	-----
iii.		$\text{CH}_3(\text{CH}_2)_{16} - \text{COO}(\text{CH}_2\text{CH}_2\text{O})_n(\text{CH}_2)_2\text{OH}$	Liquid dishwash
iv.	-----	-----	Hair conditioner

Ans:

No.	Type	Example	Use
i.	Nonionic detergent (an ether)	$\text{C}_9\text{H}_{19} - \text{C}_6\text{H}_4 - \text{O} - (\text{CH}_2\text{CH}_2\text{O})_n\text{CH}_2\text{CH}_2\text{OH}$	Liquid detergent
ii.	Anionic detergent	$\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OSO}_3^- \text{Na}^+$	Household detergent, Additive in toothpaste
iii.	Nonionic detergent (an ester)	$\text{CH}_3(\text{CH}_2)_{16} - \text{COO}(\text{CH}_2\text{CH}_2\text{O})_n(\text{CH}_2)_2\text{OH}$	Liquid dishwash
iv.	Cationic detergent	$\text{CH}_3(\text{CH}_2)_{15} - \text{N}^+(\text{CH}_3)_3\text{Br}^-$	Hair conditioner

Q.96. Give an example of detergent used as:

[1 Mark Each]

i. **Additive in toothpaste**

ii. **Used as germicide**

Ans:

i. **Additive in toothpaste:** Sodium lauryl sulphate, $\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OSO}_3^- \text{Na}^+$.

ii. **Used as germicide:** Cetyltrimethylammonium bromide, $[\text{CH}_3(\text{CH}_2)_{15} - \text{N}^+(\text{CH}_3)_3]\text{Br}^-$.

***Q.97. Give two differences between the following: Soap and synthetic detergent**

[2 Marks]

Ans:

No.	Soap	Synthetic detergent
i.	Soaps can be broadly classified into two types, i.e., toilet soaps (prepared using KOH) and laundry soaps (prepared using NaOH).	Synthetic detergents are of three types, i.e., anionic, cationic and nonionic detergents.
ii.	Soaps cannot be used in hard water.	Synthetic detergents can be used in soft water as well as in hard water.

Q.98. Explain cleansing mechanism of soaps and detergents.

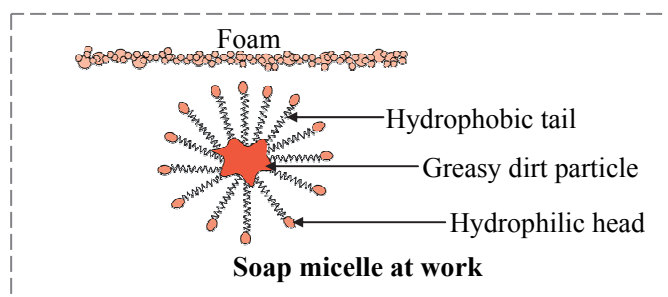
[3 Marks]

Ans:

- Soaps and detergents bring about cleansing of dirty, greasy surfaces by the same mechanism.
- Dirt is held at the surface by means of oily matter, and therefore cannot get washed with water.
- The molecules of soaps and detergent have two parts. One part is polar called head and the other part is long nonpolar chain of carbons called tail.
- The hydrophilic polar head can dissolve in water which is a polar solvent, while the hydrophobic nonpolar tail dissolve in oil/fat/grease.
- The molecules of soap/detergent are arranged around the oily droplet such that the nonpolar tail points towards the central oily drop while the polar head is directed towards the water.



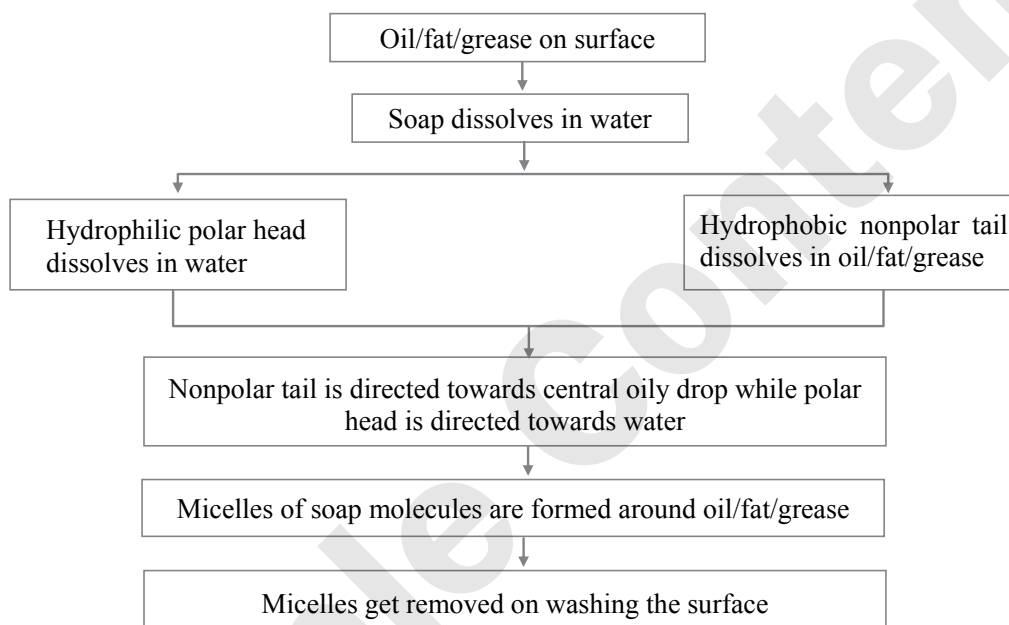
- vi. Thus, micelles of soap/detergent are formed surrounding the oil drops, which are removed in the washing process.



*Q.99. Explain: Mechanism of cleansing action of soap with flow chart.

[3 Marks]

Ans: The following flow chart shows mechanism of cleansing action of soap:



*Q.100. Match the pairs.

[½ Mark Each]

	A group		B group
i.	Paracetamol	a.	Antibiotic
ii.	Chloramphenicol	b.	Synthetic detergent
iii.	BHT	c.	Soap
iv.	Sodium stearate	d.	Antioxidant
		e.	Analgesic

Ans: i – e, ii – a, iii – d, iv – c

*Q.101. Activity:

Collect information about different chemical compounds as per their applications in day-to-day life.

Ans:

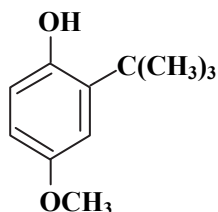
No.	Chemical compound	Applications
i.	Vinegar (CH_3COOH)	Preservation of food, salad dressing, sauces, etc.
ii.	Magnesium hydroxide [$\text{Mg}(\text{OH})_2$]	Common component of antacids (used to relieve heartburn, acid indigestion and stomach upset.)
iii.	Baking soda (NaHCO_3)	Cooking, antacid, toothpaste, etc.
iv.	Sodium benzoate ($\text{C}_6\text{H}_5\text{COONa}$)	Used as food preservative

[Note: Students can use the above information as reference and collect additional information on their own.]



APPLY YOUR KNOWLEDGE

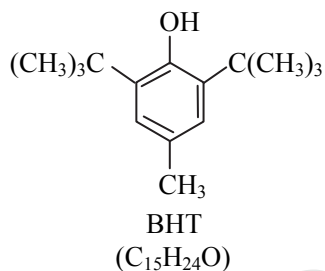
Q.102. Compound “X” having the following structure is used as synthetic antioxidant to increase the shelf life of packed foods.



- What is the molecular formula of compound “X”?
- Identify the structural unit responsible for antioxidant activity of “X”.
- Give one example of a compound with structure, similar to compound “X”, which is commonly used as synthetic antioxidant.
- Give the IUPAC name of compound “X”.

Ans:

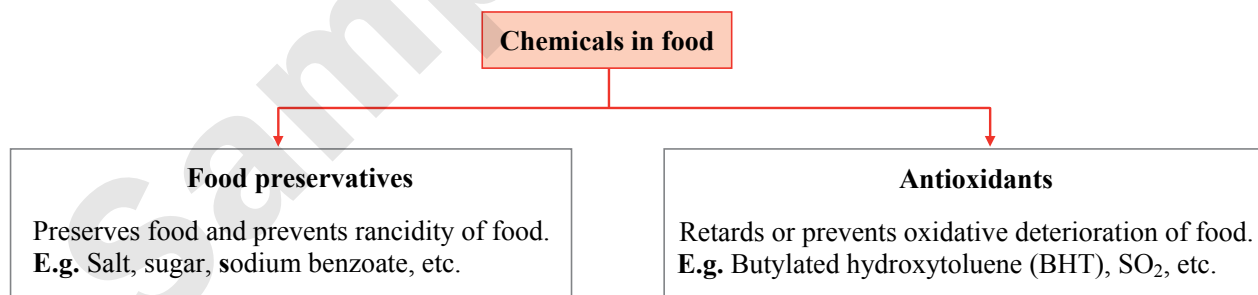
- Molecular formula: $C_{11}H_{16}O_2$
- Structural unit responsible for antioxidant activity of compound “X” is phenolic $-OH$ group.
- Butylated hydroxytoluene (BHT) is commonly used synthetic antioxidant similar to compound “X”.



- The IUPAC name of compound “X” is 2-tert-butyl-4-methoxyphenol.

QUICK REVIEW

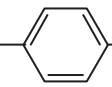
➤ Chemicals in food:



➤ Compounds with medicinal properties:

Class of compound	Examples
Analgesics (Pain killer)	Aspirin, paracetamol
Antiseptics (On the body)	Iodine, boric acid, dettol, iodoform, tincture of iodine, trichlorophenol (TCP), chloroxylenol, thymol.
Disinfectant (Not on the body)	p-chloro-o-benzylphenol
Antibiotics (In the body)	Salvarsan, prontosil, sulphapyridine, sulphanilamide, penicillin, chloramphenicol

➤ **Cleansing agents:**

Cleansing agents		Examples
Soaps		Sodium or potassium salts of higher fatty acids (for example, sodium stearate) RCOONa – Laundry soap, RCOOK – Toilet soap
Detergents	i. Cationic detergent	Cetyltrimethylammonium bromide: [CH ₃ (CH ₂) ₁₅ – N ⁺ (CH ₃) ₃]Br ⁻
	ii. Anionic detergent	Sodium lauryl sulphate: CH ₃ (CH ₂) ₁₀ CH ₂ OSO ₃ ⁻ Na ⁺
	iii. Nonionic detergent	a. Nonionic detergent containing ether linkage: C ₉ H ₁₉ –  – O – (CH ₂ CH ₂ O) _n CH ₂ CH ₂ OH b. Nonionic detergent containing ester linkage: CH ₃ (CH ₂) ₁₆ – COO(CH ₂ CH ₂ O) _n CH ₂ CH ₂ OH

EXERCISE**16.1 Basics of food chemistry**

1. How tannins are produced? Explain with chemical reaction. **[2 Marks]**

Ans: Refer Q.11.

2. Give examples of agents that can be used to slow down the browning of chopped fruits and vegetables. **[1 Mark]**

Ans: Refer Q.12. (i)

3. Lemon juice acts as an antioxidant for apple. Explain. **[2 Marks]**

Ans: Refer Q.13.

4. Explain the term rancidity. **[1 Mark]**

Ans: Refer Q.14. (i)

5. Write a short note on oxidative rancidity.

[3 Marks]

Ans: Refer Q.18.

6. Unsaturated fats melt at lower temperature as compared to saturated fats. Justify. **[2 Marks]**

Ans: Refer Q.21.

7. Give one point of difference between cis and trans forms of unsaturated fats. **[1 Mark]**

Ans: Refer Q.23.

8. Explain the antioxidant nature of vitamin E.

[2 Marks]

Ans: Refer Q.30. (i) and Q.31. (i), (ii)

9. Name the sources from which tocopherol is obtained. **[1 Mark]**

Ans: Refer Q.33.

16.2 Compounds with medicinal properties

10. Give an example of analgesic and draw its structure. **[1 Mark]**

Ans: Refer Q.49. (Any one).

11. Write a short note on antiseptics. **[3 Marks]**

Ans: Refer Q.54.

12. Name the active ingredient present in dettol.

[1 Mark]

Ans: Refer Q.56.

13. Draw the structure of antiseptic TCP and thymol.

[1 Mark Each]

Ans: Refer Q.62. (iii) and (i)

14. What is the difference between broad spectrum and narrow spectrum antibiotics? **[1 Mark]**

Ans: Refer Q.75.

15. An active ingredient present in wintergreen has analgesic property. Name this ingredient.

[1 Mark]

Ans: Refer Q.81.

16.3 Cleansing agents

16. Explain the method for the preparation of soaps with chemical reaction. **[3 Marks]**

Ans: Refer Q.86.

17. What is saponification reaction? **[1 Mark]**

Ans: Refer Q.86. (ii)

18. Soaps form scum in hard water. Explain.

[2 Marks]

Ans: Refer Q.91.

19. Explain the following terms with examples.

[2 Marks Each]

i. Cationic detergents

ii. Anionic detergents

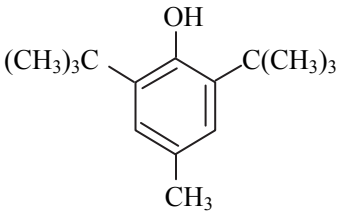
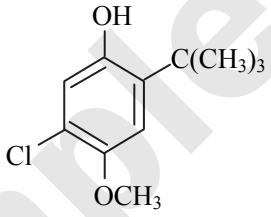
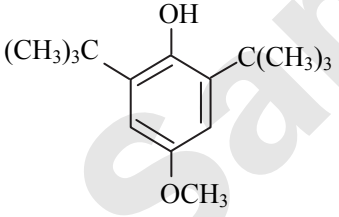
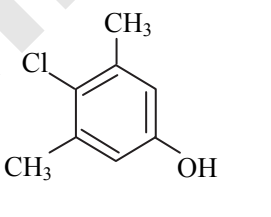
iii. Nonionic detergents

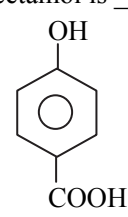
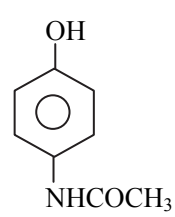
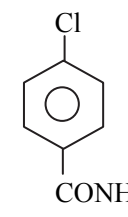
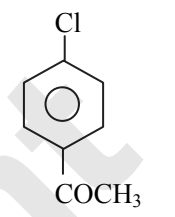
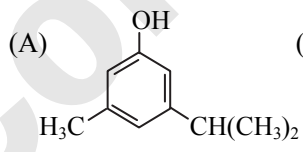
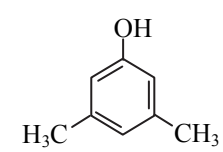
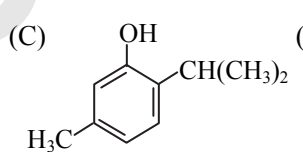
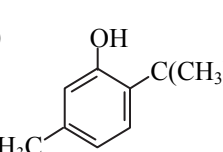
Ans: Refer Q.94.

20. Explain how micelle formation by soap/detergent molecules removes stains/dirt in the washing process. **[3 Marks]**

Ans: Refer Q.98.


MULTIPLE CHOICE QUESTIONS
[1 Mark Each]

- *1. The chemical used to slow down the browning action of cut fruit is _____.
 (A) SO_3 (B) SO_2
 (C) H_2SO_4 (D) Na_2CO_3
- *2. The chemical responsible for the rancid flavour of fats is _____.
 (A) butyric acid (B) glycerol
 (C) protein (D) saturated fat
- *3. Oxidative rancidity is _____ reaction.
 (A) addition (B) substitution
 (C) free radical (D) combination
- *4. Health benefits are obtained by consumption of _____.
 (A) saturated fats
 (B) trans fat
 (C) monounsaturated fats
 (D) all of these
5. BHT as a food additive act as _____.
 (A) antioxidant
 (B) flavouring agent
 (C) colouring agent
 (D) emulsifier
6. The structure of antioxidant BHT is _____.
 (A)  (B) 
- (C)  (D) 
- *7. Aspirin is chemically named as _____.
 (A) salicylic acid
 (B) acetyl salicylic acid
 (C) chloroxylenol
 (D) thymol
8. The molecular formula of aspirin is _____.
 (A) $\text{C}_8\text{H}_8\text{O}_3$ (B) $\text{C}_9\text{H}_8\text{O}_4$
 (C) $\text{C}_9\text{H}_{10}\text{O}_4$ (D) $\text{C}_9\text{H}_8\text{O}_3$
9. Aspirin is a/an _____.
 (A) antibiotic (B) analgesic
 (C) antimicrobial (D) disinfectant

10. The CORRECT structure of the drug paracetamol is _____.
 (A)  (B) 
- (C)  (D) 
11. Which of the following is used as a weak antiseptic for eyes?
 (A) Tincture of iodine
 (B) Dilute solution of dettol
 (C) Iodoform
 (D) Dilute aqueous solution of boric acid
12. The structure of thymol is _____.
 (A)  (B) 
- (C)  (D) 
- *13. Find odd man out from the following.
 (A) Dettol (B) Chloroxylenol
 (C) Paracetamol (D) Trichlorophenol
14. Salvarsan is arsenic containing drug which was first used for the treatment of _____.
 (A) syphilis (B) typhoid
 (C) ulcer (D) dysentery
- *15. Arsenic based antibiotic is _____.
 (A) azodye (B) prontosil
 (C) salvarsan (D) sulphapyridine
16. The linkage present in salvarsan is _____.
 (A) $-\text{N}=\text{N}-$ (B) $-\text{As}=\text{As}-$
 (C) $-\text{S}-\text{S}-$ (D) $-\text{O}-\text{O}-$
17. Which of following contains $-\text{N}=\text{N}-$ in its structure?
 (A) Chloramphenicol (B) Sulphapyridine
 (C) Salvarsan (D) Prontosil
18. Which of the following contains $-\text{As}=\text{As}-$ linkage?
 (A) Salvarsan (B) Prontosil
 (C) Sulphanilamide (D) Sulphapyridine



19. Which of the following element is NOT present in penicillin?
(A) O (B) S (C) P (D) N
20. Methyl salicylate having analgesic properties is obtained from which of the following plant?
(A) Clove (B) Indian gooseberry
(C) Wintergreen (D) Cinnamon
21. Hydrolysis of oil by aqueous alkali is called _____.
(A) esterification (B) saponification
(C) acetylation (D) carboxylation
- *22. Saponification is carried out by _____.
(A) oxidation
(B) alkaline hydrolysis
(C) polymerisation
(D) free radical formation
23. Sodium lauryl sulphate is an example of _____.
(A) soap
(B) cationic detergent
(C) anionic detergent
(D) nonionic detergent

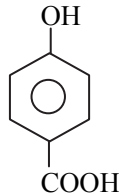
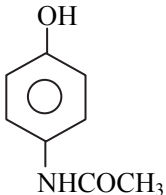
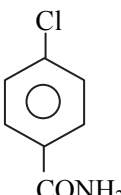
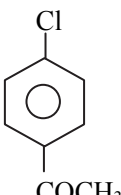
ANSWERS TO MULTIPLE CHOICE QUESTIONS

1. (B) 2. (A) 3. (C) 4. (C)
5. (A) 6. (A) 7. (B) 8. (B)
9. (B) 10. (B) 11. (D) 12. (C)
13. (C) 14. (A) 15. (C) 16. (B)
17. (D) 18. (A) 19. (C) 20. (C)
21. (B) 22. (B) 23. (C)

COMPETITIVE CORNER

1. Which of the following is an anionic detergent? [JEE (Main) 2016]
(A) Sodium stearate (B) **Sodium lauryl sulphate**
(C) Cetyltrimethylammonium bromide (D) Glyceryl oleate
2. Which of the following processes is NOT used to preserve the food? [MHT CET 2017]
(A) Irradiation (B) Addition of salts
(C) Addition of heat (D) **Hydration**
3. The acid which contains both – OH and – COOH groups is _____. [MHT CET 2017]
(A) phthalic acid (B) adipic acid
(C) glutaric acid (D) **salicylic acid**
4. Among the following, the narrow spectrum antibiotic is _____. [NEET (UG) 2019]
(A) ampicillin (B) amoxicillin
(C) chloramphenicol (D) **penicillin G**
5. Which of the following is a cationic detergent? [NEET (UG) P-I 2020]
(A) Sodium stearate (B) **Cetyltrimethyl ammonium bromide**
(C) Sodium dodecylbenzene sulphonate (D) Sodium lauryl sulphate

Time: 1 Hour 30 Min**TOPIC TEST****Total Marks: 25****SECTION A****Q.1. Select and write the correct answer:****[04]**

- i. The linkage present in salvarsan is _____.
(A) – N = N – (B) – As = As – (C) – S – S – (D) – O – O –
- ii. Oxidative rancidity is _____ reaction.
(A) addition (B) substitution (C) free radical (D) combination
- iii. The CORRECT structure of the drug paracetamol is _____.
(A)  (B)  (C)  (D) 
- iv. Saponification is carried out by _____.
(A) oxidation (B) alkaline hydrolysis
(C) polymerisation (D) free radical formation

**Q.2. Answer the following:****[03]**

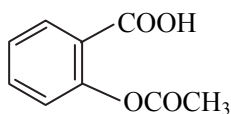
- i. Name the two poly-unsaturated fats.
- ii. What is the tincture of iodine?
- iii. Give a chemical equation for saponification.

SECTION B**Attempt any Four:****[08]**

- Q.3. Give two differences between the following: Rice flour and cooked rice
- Q.4. What are antiseptics? Give two examples.
- Q.5. Explain with examples: Nonionic detergents
- Q.6. Turmeric powder can be used as antiseptic. Explain.
- Q.7. Browning of cut apple can be prolonged by applying lemon juice.
- Q.8.
 - i. What is meant by broad spectrum antibiotic and narrow spectrum antibiotics?
 - ii. Draw the structure of BHT.

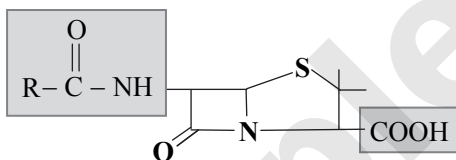
SECTION C**Attempt any Two:****[06]**

- Q.9. i. Write the molecular formula and name of



- ii. Give two differences between the following: Soap and synthetic detergent.

- Q.10. i. Identify the highlighted functional groups in the following molecule:



- ii. Complete the following table:

No.	Type	Example	Use
a.	Anionic detergent	-----	-----
b.	-----	-----	Hair conditioner

- Q.11. Explain: Mechanism of cleansing action of soap with flow chart.

SECTION D**Attempt any One:****[04]**

- Q.12.
 - i. Explain: On cutting, some fruits and vegetables turn brown.
 - ii. Explain with examples: Disinfectant
- Q.13.
 - i. Explain why soaps become inactive in hard water.
 - ii. Give two differences between the following: Saturated and unsaturated fats

Scan the given Q. R. Code in *Quill - The Padhai App* to view the solutions of the Topic Test.





Modern Periodic Table



Periods	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Atomic Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Symbol	Symbol																	
Name	Name																	
Atomic Mass	Atomic Mass																	
1	H Hydrogen 1.008																	
2	Li Lithium 6.941	Be Beryllium 9.012																
3	Na Sodium 22.990	Mg Magnesium 24.305																
4	K Potassium 39.098	Ca Calcium 40.078	Sc Scandium 44.956	Ti Titanium 47.867	V Vanadium 50.942	Cr Chromium 51.996	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.933	Ni Nickel 58.693	Cu Copper 63.546	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.631	As Arsenic 74.922	Se Selenium 78.972	Br Bromine 79.904	Kr Krypton 83.798
5	Rb Rubidium 85.468	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.95	Tc Technetium 98.907	Ru Ruthenium 101.07	Rh Rhodium 102.906	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.411	In Indium 114.818	Sn Tin 118.711	Sb Antimony 121.760	Te Tellurium 127.6	I Iodine 126.904	Xe Xenon 131.294
6	Cs Cesium 132.905	Ba Barium 137.328	* #	Hf Hafnium 178.49	Ta Tantalum 180.948	W Tungsten 183.84	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.227	Pt Platinum 195.085	Au Gold 196.967	Hg Mercury 200.592	Tl Thallium 204.383	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium [208.982]	At Astatine 209.987	Rn Radon 222.018
7	Fr Francium 223.020	Ra Radium 226.025	#	Rf Rutherfordium [261]	Db Dubnium [262]	Sg Seaborgium [266]	Bh Bohrium [264]	Hs Hassium [269]	Mt Meitnerium [278]	Ds Darmstadtium [281]	Rg Roentgenium [280]	Cn Copernicium [285]	Nh Nihonium [286]	Fl Flerovium [289]	Mc Moscovium [289]	Lv Livermorium [293]	Ts Tennessine [294]	Og Oganesson [294]

Atomic Number	Symbol	Name	Atomic Mass
---------------	--------	------	-------------

57	La Lanthanum 138.905	Ce Cerium 140.116	Pr Praseodymium 140.908	Nd Neodymium 144.242	Pm Promethium [144.913]	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.925	Dy Dysprosium 162.500	Ho Holmium 164.930	Er Erbium 167.259	Tm Thulium 168.934	Yb Ytterbium 173.055	Lu Lutetium 174.967
89	Ac Actinium 227.028	Th Thorium 232.038	Pa Protactinium 231.036	U Uranium 238.029	Np Neptunium 237.048	Pu Plutonium 244.064	Am Americium 243.061	Cm Curium 247.070	Bk Berkelium 247.070	Cf Californium 251.080	Es Einsteinium [254]	Fm Fermium 257.095	Md Mendelevium 258.1	No Nobelium 259.101	Lr Lawrencium [262]

* Lanthanide Series

Actinide Series



Electronic Configuration of Elements

Symbol with atomic number	Name of Element	Electronic configuration
¹ H	Hydrogen	1s ¹
² He	Helium	1s ²
³ Li	Lithium	[He] 2s ¹
⁴ Be	Beryllium	[He] 2s ²
⁵ B	Boron	[He] 2s ² 2p ¹
⁶ C	Carbon	[He] 2s ² 2p ²
⁷ N	Nitrogen	[He] 2s ² 2p ³
⁸ O	Oxygen	[He] 2s ² 2p ⁴
⁹ F	Fluorine	[He] 2s ² 2p ⁵
¹⁰ Ne	Neon	[He] 2s ² 2p ⁶
¹¹ Na	Sodium	[Ne] 3s ¹
¹² Mg	Magnesium	[Ne] 3s ²
¹³ Al	Aluminium	[Ne] 3s ² 3p ¹
¹⁴ Si	Silicon	[Ne] 3s ² 3p ²
¹⁵ P	Phosphorus	[Ne] 3s ² 3p ³
¹⁶ S	Sulphur	[Ne] 3s ² 3p ⁴
¹⁷ Cl	Chlorine	[Ne] 3s ² 3p ⁵
¹⁸ Ar	Argon	[Ne] 3s ² 3p ⁶
¹⁹ K	Potassium	[Ar] 4s ¹
²⁰ Ca	Calcium	[Ar] 4s ²
²¹ Sc	Scandium	[Ar] 3d ¹ 4s ²
²² Ti	Titanium	[Ar] 3d ² 4s ²
²³ V	Vanadium	[Ar] 3d ³ 4s ²
²⁴ Cr	Chromium	[Ar] 3d ⁵ 4s ¹
²⁵ Mn	Manganese	[Ar] 3d ⁵ 4s ²
²⁶ Fe	Iron	[Ar] 3d ⁶ 4s ²
²⁷ Co	Cobalt	[Ar] 3d ⁷ 4s ²
²⁸ Ni	Nickel	[Ar] 3d ⁸ 4s ²
²⁹ Cu	Copper	[Ar] 3d ¹⁰ 4s ¹
³⁰ Zn	Zinc	[Ar] 3d ¹⁰ 4s ²
³¹ Ga	Gallium	[Ar] 3d ¹⁰ 4s ² 4p ¹
³² Ge	Germanium	[Ar] 3d ¹⁰ 4s ² 4p ²
³³ As	Arsenic	[Ar] 3d ¹⁰ 4s ² 4p ³
³⁴ Se	Selenium	[Ar] 3d ¹⁰ 4s ² 4p ⁴
³⁵ Br	Bromine	[Ar] 3d ¹⁰ 4s ² 4p ⁵
³⁶ Kr	Krypton	[Ar] 3d ¹⁰ 4s ² 4p ⁶
³⁷ Rb	Rubidium	[Kr] 5s ¹
³⁸ Sr	Strontium	[Kr] 5s ²
³⁹ Y	Yttrium	[Kr] 4d ¹ 5s ²
⁴⁰ Zr	Zirconium	[Kr] 4d ² 5s ²
⁴¹ Nb	Niobium	[Kr] 4d ⁴ 5s ¹
⁴² Mo	Molybdenum	[Kr] 4d ⁵ 5s ¹
⁴³ Tc	Technetium	[Kr] 4d ⁵ 5s ²
⁴⁴ Ru	Ruthenium	[Kr] 4d ⁷ 5s ¹
⁴⁵ Rh	Rhodium	[Kr] 4d ⁸ 5s ¹
⁴⁶ Pd	Palladium	[Kr] 4d ¹⁰
⁴⁷ Ag	Silver	[Kr] 4d ¹⁰ 5s ¹
⁴⁸ Cd	Cadmium	[Kr] 4d ¹⁰ 5s ²
⁴⁹ In	Indium	[Kr] 4d ¹⁰ 5s ² 5p ¹
⁵⁰ Sn	Tin	[Kr] 4d ¹⁰ 5s ² 5p ²
⁵¹ Sb	Antimony	[Kr] 4d ¹⁰ 5s ² 5p ³
⁵² Te	Tellurium	[Kr] 4d ¹⁰ 5s ² 5p ⁴
⁵³ I	Iodine	[Kr] 4d ¹⁰ 5s ² 5p ⁵
⁵⁴ Xe	Xenon	[Kr] 4d ¹⁰ 5s ² 5p ⁶
⁵⁵ Cs	Cesium	[Xe] 6s ¹
⁵⁶ Ba	Barium	[Xe] 6s ²
⁵⁷ La	Lanthanum	[Xe] 5d ¹ 6s ²
⁵⁸ Ce	Cerium	[Xe] 4f ¹ 5d ¹ 6s ²
⁵⁹ Pr	Praseodymium	[Xe] 4f ³ 6s ²

Symbol with atomic number	Name of Element	Electronic configuration
⁶⁰ Nd	Neodymium	[Xe] 4f ⁴ 6s ²
⁶¹ Pm	Promethium	[Xe] 4f ⁵ 6s ²
⁶² Sm	Samarium	[Xe] 4f ⁶ 6s ²
⁶³ Eu	Europium	[Xe] 4f ⁷ 6s ²
⁶⁴ Gd	Gadolinium	[Xe] 4f ⁷ 5d ¹ 6s ²
⁶⁵ Tb	Terbium	[Xe] 4f ⁹ 6s ²
⁶⁶ Dy	Dysprosium	[Xe] 4f ¹⁰ 6s ²
⁶⁷ Ho	Holmium	[Xe] 4f ¹¹ 6s ²
⁶⁸ Er	Erbium	[Xe] 4f ¹² 6s ²
⁶⁹ Tm	Thulium	[Xe] 4f ¹³ 6s ²
⁷⁰ Yb	Ytterbium	[Xe] 4f ¹⁴ 6s ²
⁷¹ Lu	Lutetium	[Xe] 4f ¹⁴ 5d ¹ 6s ²
⁷² Hf	Hafnium	[Xe] 4f ¹⁴ 5d ² 6s ²
⁷³ Ta	Tantalum	[Xe] 4f ¹⁴ 5d ³ 6s ²
⁷⁴ W	Tungsten	[Xe] 4f ¹⁴ 5d ⁴ 6s ²
⁷⁵ Re	Rhenium	[Xe] 4f ¹⁴ 5d ⁵ 6s ²
⁷⁶ Os	Osmium	[Xe] 4f ¹⁴ 5d ⁶ 6s ²
⁷⁷ Ir	Iridium	[Xe] 4f ¹⁴ 5d ⁷ 6s ²
⁷⁸ Pt	Platinum	[Xe] 4f ¹⁴ 5d ⁹ 6s ¹
⁷⁹ Au	Gold	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ¹
⁸⁰ Hg	Mercury	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ²
⁸¹ Tl	Thallium	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ¹
⁸² Pb	Lead	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ²
⁸³ Bi	Bismuth	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ³
⁸⁴ Po	Polonium	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁴
⁸⁵ At	Astatine	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁵
⁸⁶ Rn	Radon	[Xe] 4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁶
⁸⁷ Fr	Francium	[Rn] 7s ¹
⁸⁸ Ra	Radium	[Rn] 7s ²
⁸⁹ Ac	Actinium	[Rn] 6d ¹ 7s ²
⁹⁰ Th	Thorium	[Rn] 6d ² 7s ²
⁹¹ Pa	Protactinium	[Rn] 5f ² 6d ¹ 7s ²
⁹² U	Uranium	[Rn] 5f ³ 6d ¹ 7s ²
⁹³ Np	Neptunium	[Rn] 5f ⁴ 6d ¹ 7s ²
⁹⁴ Pu	Plutonium	[Rn] 5f ⁶ 7s ²
⁹⁵ Am	Americium	[Rn] 5f ⁷ 7s ²
⁹⁶ Cm	Curium	[Rn] 5f ⁷ 6d ¹ 7s ²
⁹⁷ Bk	Berkelium	[Rn] 5f ⁹ 7s ²
⁹⁸ Cf	Californium	[Rn] 5f ¹⁰ 7s ²
⁹⁹ Es	Einsteinium	[Rn] 5f ¹¹ 7s ²
¹⁰⁰ Fm	Fermium	[Rn] 5f ¹² 7s ²
¹⁰¹ Md	Mendelevium	[Rn] 5f ¹³ 7s ²
¹⁰² No	Nobelium	[Rn] 5f ¹⁴ 7s ²
¹⁰³ Lr	Lawrencium	[Rn] 5f ¹⁴ 6d ¹ 7s ²
¹⁰⁴ Rf	Rutherfordium	[Rn] 5f ¹⁴ 6d ² 7s ²
¹⁰⁵ Db	Dubnium	[Rn] 5f ¹⁴ 6d ³ 7s ²
¹⁰⁶ Sg	Seaborgium	[Rn] 5f ¹⁴ 6d ⁴ 7s ²
¹⁰⁷ Bh	Bohrium	[Rn] 5f ¹⁴ 6d ⁵ 7s ²
¹⁰⁸ Hs	Hassium	[Rn] 5f ¹⁴ 6d ⁶ 7s ²
¹⁰⁹ Mt	Meitnerium	[Rn] 5f ¹⁴ 6d ⁷ 7s ²
¹¹⁰ Ds	Darmstadtium	[Rn] 5f ¹⁴ 6d ⁸ 7s ²
¹¹¹ Rg	Rontgenium	[Rn] 5f ¹⁴ 6d ⁹ 7s ²
¹¹² Cn	Copernicium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ²
¹¹³ Uut	Ununtrium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ¹
¹¹⁴ Uuq	Ununquadium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ²
¹¹⁵ Uup	Ununpentium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ³
¹¹⁶ Uuh	Ununhexium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁴
¹¹⁷ Uus	Ununseptium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁵
¹¹⁸ Uuo	Ununoctium	[Rn] 5f ¹⁴ 6d ¹⁰ 7s ² 7p ⁶



LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7



LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	Mean Differences								
											1	2	3	4	5	6	7	8	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
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96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	1	2	2	3	3	3	4



ANTILOGARITHMS

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.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
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.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	2	2	2	2	3
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.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	2	2	2	3	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	2	2	2	3	3
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	2	2	2	3	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	2	2	2	3	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	2	2	3	3	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	2	2	3	3	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	2	2	2	3	3	3
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.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	2	2	2	3	3	4
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	2	2	2	3	3	4
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	2	2	2	3	3	4
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	2	2	3	3	3	4
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	2	2	3	3	3	4
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	2	2	3	3	4	4
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.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	2	2	3	3	4	4
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	2	2	3	3	4	4
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	2	2	3	3	4	4
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	2	2	3	3	4	4
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	3	3	4	4	5
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.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	3	3	4	4	5
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	3	3	4	4	5
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	3	3	4	5	5
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	3	4	4	5	5
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.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	3	3	4	4	5	6
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	3	3	4	5	5	6
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.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	3	3	4	5	5	6
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	3	4	4	5	6	6
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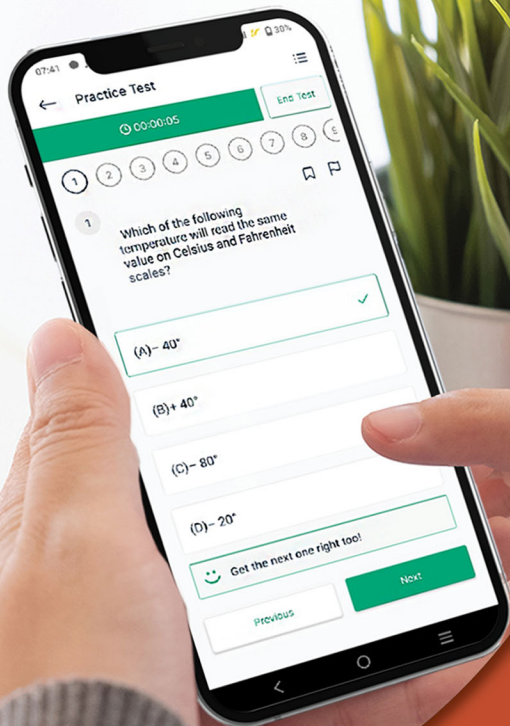
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.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
.60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
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.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
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.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
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.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
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.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
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.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
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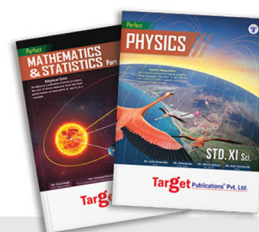
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