Chhatrapati Shahu Ji Maharaj
University, Kanpur

Answer Script Details
Barcode 12134845

Roll No. 24063001034
Total Mark 40/75.00

Exam M.SC-III_ODD_EXAM_NOV_2025
Subject B020906T - Analytical Chemistry (Elective)

Question wise Mark Summary

Q.No	Mark	Q.No	Mark	Q.No	Mark	Q.No	Mark
1A	2/5	6A	4/7				
1B	3/5	6B	4/7				
1C	3/5	7A	0/7				
1D	3/5	7B	0/7				
1E	3/5	8A	0/7				
1F	3/5	8B	0/7				
1G	3/5	9A	0/7				
1H	3/5	9B	0/7				
1I	3/5						
2A	0/7						
2B	0/7						
3A	3/7						
3B	3/7						
4A	0/7						
4B	0/7						
5A	0/7						
5B	0/7						

Chhatrapati Shahu Ji Maharaj University
Kanpur, Uttar Pradesh

PART-II

Date of Exam: 11/12/25 Shift: 3rd Room No. 23
Paper Code: B020906T Subject: Chemistry Year/Sem: 3rd
Name of Candidate: Priya Kumari Gupta
Roll No. 2406300103 4T

COE Facsimile
Signature of Invigilator
Signature of Candidate

MARKS OBTAINED

Q.	1	2	3	4	5	6	7	8	9	10
(a)										
(b)										
(c)										
(d)										
(e)										
(f)										
(g)										
(h)										
(i)										
(j)										
Total										

Total Marks in Figures — Max. Marks
Total Marks in Words

B020906T
Paper Code

Signature of Evaluator

Course: Analytical Chemistry
Session: 2024-26 Year/Semester: 3rd
Subject: Chemistry

Paper Code: B020906T
Exam Date: 11/12/2025
Name of Candidate: PRIYA KUMARI GUPTA
Father's Name: AMBHUNATHPRASAD

महाविद्यालय का कोड College Code: UN01
परीक्षा केन्द्र का कोड Exam Centre Code: UN01

परीक्षा का प्रकार Type of Exam
Regular ● Ex. Student ○
Private ○ Back paper Exam ○

ANSWER BOOKLET NO.
12134845

B020906T
Paper Code

नामांकन संख्या Enrollment Number: CSJMA24000063171

परीक्षार्थी अनुक्रमांक संख्या Candidate's Roll Number: 2406300103 4
पेपर कोड Paper Code: B020906T

Signature of Candidate
Signature of Invigilator
C.S Facsimile
COE Facsimile

नोट : 1. परीक्षार्थी को निर्देशित किया जाता है कि आवरण पृष्ठ के पृष्ठ भाग पर अंकित सभी निर्देशों को सावधानी पूर्वक पढ़ें।
2. बॉक्स में भरी जाने वाली प्रविष्टियाँ काली स्याही से शुरू की जायें। 3. गोलों को काले या नीले बॉलपेन से भरा जायें।

INSTRUCTIONS TO THE CANDIDATE FOR FILLING PART-I

1. Read the instructions carefully given on the answer script and admit card.
2. Write Date of Exam, Shift, Paper Code & Name of Subject Correctly.
3. Write Name & Roll No. Correctly.
4. Write Semester & Branch Correctly.

INSTRUCTIONS TO THE CANDIDATE FOR FILLING PART-III

1. Use blue or black ball point pen for writing alphabets & numerals in ☐ Boxes.
2. Carefully study the example before you start marking.
3. As shown in the example below blacken the circles completely.

Correct method	Incorrect method
① ● ③ ④	✓ ✗ ◉ ⓪

4. Make no Stray marks on this sheet.
5. **DO NOT WRITE OR MARK ON THE BAR CODE.**

IN ORDER TO AVOID UFM (UNFAIR MEANS) :

1. The Roll No. and Answer Book no. found elsewhere or any other symbol found in the answer book will be treated as unfair means.
2. Any tempering of Bar Code and Booklet no shall be treated as Unfair Means.
3. Do Not bring the materials like slip of paper/mobile/digital diaries/ study material/ revision notes in examination hall. Possession of the mobiles/ digital diaries/ electronic watch and any other electronic gadget except memory less scientific calculator shall be considered as UFM case.
4. Do not keep or paste currency note in answer script it shall be consider as UFM.

अनुचित साधन से बचने हेतु:

1. उत्तर पुस्तिका के निर्दैशित स्थान को छोड़कर अनुक्रमांक एवं उत्तरपुस्तिका का क्रमांक कही और न लिखे तथा कोई भी चिन्ह न बनायें क्योंकि यह अनुचित साधन प्रयोग की परिधि में आता है।
2. उत्तर पुस्तिका के बारकोड अथवा उत्तर पुस्तिका संख्या पर छेड़ करने पर अनुचित साधन प्रयोग माना जायेगा।
3. परीक्षा कक्ष में निम्न वस्तुएं साथ न लावें, जैसे लिखे हुए कागज के टुकड़े, मोबाईल, डिजिटल डायरी, कोपी, पुस्तक यह सभी वस्तुएं जो अनुचित साधन के अन्तर्गत आती है। केवल संबंधित प्रश्नपत्र में ही मेमोरी लैस साइंटफिक कैल्कुलेटर ले जाने की अनुमन्यता होगी।
4. उत्तर पुस्तिकाओं में रूपये न रखें न ही उत्तर पुस्तिका में चित्रकारी। ऐसा करना अनुचित साधन प्रयोग की परिधि में आता है।

परीक्षार्थी के लिए निर्देश

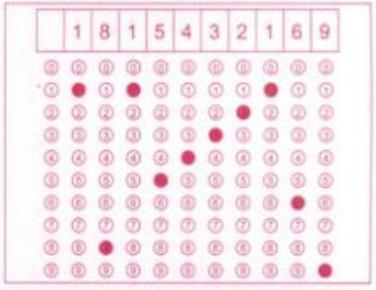
1. प्रवेश पत्र एवं उत्तर पुस्तिका पर दिये गये निर्देशों को ध्यान से पढ़ें।
2. कवर पृष्ठ के दूसरी तरफ कुछ न लिखें।
3. उत्तर पुस्तिका के पृष्ठों पर दोनों तरफ लिखें।
4. प्रश्न पत्र पर अपने अनुक्रमांक के अतिरिक्त कुछ न लिखें।
5. प्रश्न पत्र कोड एवं प्रश्न पत्र कोड सावधानी पूर्वक लिखें।
6. अपनी स्थिति स्पष्ट लिखें।
7. उत्तर पुस्तिका के पृष्ठों की संख्या देखें। अगर उत्तर पुस्तिका में पृ (1–24) से कम है या फटे हुए है, तो परीक्षा शुरू होने के पूर्व दूसरी उ पुस्तिका ले लें।
8. प्रश्नपत्र को देख, यदि प्रश्नपत्र के विषय कोड, विषय का नाम तथा प्र में कोई त्रुटि है तो उसके परीक्षा शुरू होने के 30 मिनट के अन्दर व निरीक्षक को तत्काल सूचित करें, उसके बाद विश्वविद्यालय द्वारा क कार्यवाही नहीं की जायेगी।
9. प्रश्नों के उत्तर लिखने के लिये पैंसिल का प्रयोग न करें।
10. B कोपी या अतिरिक्त ग्राफ नहीं दिया जायेगा।

INSTRUCTIONS TO THE CANDIDATE

1. Read the instructions carefully given on the Question Pap Admit Card & Answer Script.
2. Do not write anything on back side of the cover page.
3. Write on both sides of pages of answer book.
4. Do not write anything on question paper except Roll Number.
5. Write Paper Code & Question Paper Id carefully.
6. CHECK the number of pages (1-32) or any other kind of dama in your answer script, if found than change the answer scr immediately before the commencement of examination.
7. CHECK the Question Paper for any kind of discrepancy e. Subject Code, Subject Name and Question of the Questi Paper during first THIRTY MINUTES of the commencement the exam, so that it can be corrected in TIME. After that r corrections shall be entertained by the university.
8. Do not use pencil for answering the question.
9. Write status correctly e.g. those appearing in carry over pape should fill in status as Carry Over. Those appearing as E Students should fill in status as ex.
10. No supplementary answer book & graph paper will be provided.

INSTRUCTIONS TO THE CANDIDATE FOR FILLING PART-IV

1. Use blue or black ball point pen for writing alphabets & numberals in ☐ Boxes.
2. Use blue or black ball point pen for filling the circles.



Note - If your Roll No. is of 10 digits. Please leave first three column

Section-B.

Q(a) Classical (Wet Chemical) Method :-

Fundamental Principle

Classical methods depend on observable chemical reactions and the stoichiometry between analyte and reagent.
Measurement is based on mass (gravity) or volume (titrimetry) rather than electronic signals.

Key Features :-

1) No advance instruments required.
2) Relies on precipitation, colour change, formation of complexes, redox reactions, etc.
3) Accuracy depends heavily on human skill.
4) Time consuming

Examples

- Gravimetric analysis
- Volumetric analysis (acid-base, redox, complexometric titrations).
- Qualitative tests (precipitation, flame test).

Instrumental Methods of Analysis

Fundamental Principle :-

Instrumental methods rely on measuring a physical property of the analyte, such as:

- Absorption or emission of EM radiation (spectroscopy)
- Electrical properties (potentiometry, conductometry)
- Mass to charge ratio (mass spectrometry)
- Chromatographic separation (HPLC, GC).

The physical property is converted into an electrical signal that is processed and used to determine the analyte's concentration.

Key Features:-

1) Higher sensitivity and precision.
2) Can detect very low concentrations.
3) Fast and suitable for complex mixtures.
4) Requires instruments, calibration and trained operator.

Examples

- UV-Visible spectroscopy
- IR spectroscopy
- NMR.
- Chromatography
- Conductometry

Comparison Table :-

Basis	Classical methods	Instrumental method
Principle	Chemical reactions + stoichiometry, measure mass/vol	Physical properties convert to electrical signal.
Nature	Wet chemical, manual operations	Automated, electronic, data handling.
Sensitivity	Moderate	Very high
Accuracy & Precision	Good but operator dependent	Very high, reproducible
Time required	Slow	Fast
Sample size	Large amount	Very small amount needed.

(b) Analytical chemistry plays a critical role in protecting human health, the environment and ensuring product reliability. It provides accurate identification, qualification and monitoring of chemical substances in real world samples.

* Essential Role in Public Safety :-

Analytical chemistry ensures public safety by detecting

harmful contaminants, monitoring pollutants and checking the purity of food, water, air and medicines.
It helps regulatory authorities maintain safe limits of toxins and prevents exposure that can lead to disease or environmental damage.

Example (Public Safety) — Testing of Drinking water for Fluoride and Heavy metals.

Drinking water is routinely analyzed for fluoride, lead, arsenic using techniques like AAS, ICP-MS, UV-Vis spectroscopy, etc.

If the fluoride level exceeds permissible limits it can cause fluorosis.

Essential role in Industrial Quality Control.

In Industry, analytical chemistry is vital for maintaining product consistency, ensuring purity of raw material, optimizing processes, and meeting national / international quality standards.

Example (Industrial Quality Control) — Pharmaceutical Tablet Assay —

Before a drug is sold, each batch of tablets is analyzed using HPLC or UV-Spectrophotometry to confirm that it contains the correct ingredient.

Section - C.

6(a) A competitive binding immunoassay is based on the competition between labeled antigen and unlabeled antigen for a limited number of antibody binding sites.

Key Principles

1) Antigen - antibody specificity :-

The assay relies on the highly specific interaction between an antibody and its antigen.

2) Competition for binding sites :-

A known amount of labeled antigen and the unknown antigen from the sample compete to bind to the same antibody.

3) Inverse relationship :-

When the amount of antigen in the sample is high, less labeled antigen binds to the antibody.
When the sample has low antigen, more labeled antibody binds.

4) Measurement :-

After separating bound from free antigen the radioactivity (Rth) of the bound fraction is measured.

Applications of RIA in Clinical Chemistry:-

Major Applications are:-

1) Hormone measurement

- Thyroid hormones
- Thyroid-stimulating hormone (TSH)
- Insulin

2) Detection of Viral and Bacterial Antigens:

- Hepatitis B surface antigen (HBsAg)
- HIV viral components.

3) Therapeutic Drug monitoring

- Measurement of drugs, such as digoxin and anticonvulsants.

4) Measurements of Tumor markers

- α-fetoprotein (AFP)
- Carcinoembryonic antigen (CEA)

5) Vitamin and Steroid Analysis

- Vitamin B12
- Cortisol
- Steroid hormones in blood and urine.

07

(b) Heavy metals like mercury and chromium are major environmental pollutants because they are toxic, persistent, bioaccumulative and capable of causing long-term health hazards.

Mercury (Hg) :-

> Public Health Significance :-

Mercury exists in elemental, inorganic and organic forms; methylmercury is the most toxic.
It possess serious health risks because it easily enters the bloodstream and crosses the blood-brain barrier.

Health Effects :-

> Neurological damage :- tremors, memory loss.
> Developmental defects in children :- impaired brain development, IQ reduction, etc.
> Kidney damage from inorganic mercury salts.
> Cardiovascular effects :- Increased blood pressure and risk of heart disease.

Environmental Impact :-

- Bioaccumulation and biomagnification in aquatic ecosystems : small organisms → fish → humans.
- Toxic to aquatic life, causing impaired reproduction

growth retardation and mortality.
- Persistent in sediments as methylmercury.
- Enters the atmosphere and spreads globally due to volatility.

Chromium (Cr)

Cr :) Public Health significance

Health effects of Cr.

- Carcinogenic : lung cancer due to inhalation
- skin irritation and ulcers, dermatitis from direct contact.
- Respiratory problems: asthma, nasal perforation due to chronic exposure.
- Kidney and liver damage at high levels.
- Genotoxic (DNA damage) and mutagenic

Environmental Impacts:-

- Cr (VI) causes soil and water contamination highly soluble and mobile in water.
- Toxic to plants : inhibits seed germination, reduces chlorophyll, stunts growth.
- Affects aquatic organisms : damage to fish gills.

reduced reproduction.

- Long persistence in the environment unless reduced to Cr(III).
- Bioaccumulates in plants and animals species, entering the food chain.

In short mercury and chromium are hazardous pollutants of public health concern.

Both metals possess serious ecological and health risks due to their toxicity, persistence, and biomagnification.

Paper Code

Section - A

1. (A) Classical Method (Wet Method) :

Fundamental Principle :-

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Measurement is based on mass (gravity) or volume (titrimetry) rather than electric signals.

Key features :-

1) No advance instruments required.
2) Relies on precipitation, colour, charge, formation of complexes, redox reactions.
3) Time accurate.

example :- 1) Gravimetric analysis
2) Volumetric analysis.

Instrumental methods of Analysis :-

Fundamental Principle :-

Instrumental method rely on measuring a physical property of the analyte such as

- Absorption or emission of EM radiation.
- Electrical properties
- Mass to charge ratio
- Chromatography.

The physical property is converted into an electrical signal that is processed and used to determine the analytic concentration.

Key features:-

1) Higher sensitivity and precision.
2) Can detect very low concentration
3) Fast and easy suitable for complex mixtures.

Eg. 1) UV - visible spectroscopy.
2) NMR.

(B) The important reasons are as follows:-

1) Ensures Responsibility :-

A well-maintained notebook allows us to repeat the experiment exactly. It includes methods, conditions, observations, that are not always captured in final reports.

2) Act as a Legal Document :-
In many scientific and industrial settings, lab notebooks

are legal records used in:-
- Intellectual property and patent applications
- Resolving scientific disputes.

3) Record Data Analy Accurately:-

It captures raw data, calculations, instrument settings, and results - essential for
- Data verification
- Statistical analysis

4) Supports Good Scientific Practice

Maintaining detailed honest records is a core part of scientific integrity.

5) Facilitates Communication

Laboratory notebook provide a clear record that can be understood by:
- Supervisors
- Collaborators
- Future students.

(6) Required for Academic and Industrial Compliance

(C) Accuracy :	Precision
• Defination :- Accuracy refers to how close a measured value is to the true or accepted value.	• Precision refers to how close repeated measurements are to each other, regardless of the true value.
• It indicates the correctness of a measurement.	• It indicates the reproducibility or consistency of the true value.
• It is affected by systematic errors.	• It is affected by random error.
• It obtains unbiased true value.	• It achieve consistent measurements.
• E.g. 10.0 g (true value) measured value is 10.1 g.	8.5, 8.6, 8.5 g (close to each other).

(D) Mean :-

Defination :- The mean is the sum of all values divided by the number of values.

It uses every value, so it is affected strongly by extreme values.

Median :-

Defination :- The median is the middle value when the data is arranged in order.

It is not affected by extremely high or low values.

Basis	Mean	Median.
Define:-	Sum of all values ÷ no. of values.	Middle value of ordered data
Sensitivity	Highly affected by outliers	Not affected by outliers.
Type of average	Arthemetic average	Positional average
Used for	Data is symmetric, no extreme values.	Data has skewness or outliers.

(E) Determining crude protein in food is an important step in food analyses because it gives an estimate of total protein content present in a food sample.

i) Nutritional Evaluation :-

Protein is an essential nutrient for growth, repair. Measuring crude protein helps assess the nutritional

quality of food such as cereals, pulses, meat, etc.

2) Quality Control in Food Industry :-

Food manufacturers use crude protein analysis to:
- Ensure raw material meet standard
- Maintain uniformity in product formulations.

3) Regulatory and Labelling Requirements :-

Food laws require that packaged food include protein content on labels. Crude protein analysis provides the value reported on nutritional labels.

4) Economic Value Determination :-

Protein content is often linked to the market price of foods and feeds.
e.g. high protein grains and flours have high value.

5) Assessment of Animal Feed :-

In animal nutrition, crude protein analysis helps determine if feed contains adequate protein for:
- Growth
- Milk production.

(F) The most common and standard method for determining moisture in food is the oven-drying method (gravimetric method).

1) Gravimetric Method:

Moisture is removed by heating the sample at a controlled temperature and the loss in weight represents the moisture content.

Calculation

$$\text{Moisture (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

$W_2 - W_1$ = initial wt. of sample

$W_2 - W_3$ = water lost during drying.

2) Vacuum Oven method:

Drying at a lower temperature under vacuum. Used for heat-sensitive foods.

3) Karl-Fisher Titration

Chemical method that measures water specifically using iodine reagent. Very accurate and used for low-moisture foods.

(G) Primary Cause of Temporary Hardness:

Temporary hardness is caused by the presence of bicarbonates of Ca and Mg.

Ions responsible:-

- Calcium bicarbonate
- Magnesium bicarbonate.

- It can be removed by boiling, because of bicarbonate of Ca and Mg get decomposed to form insoluble carbonates.

Primary Cause of Permanent Hardness:-

Permanent hardness is caused by chlorides, sulfate and nitrate of calcium and magnesium, which do not decompose on boiling.

Ions responsible:-

- $CaCl_2$ - $MgCl_2$ - $CaSO_4$ - $MgSO_4$

Cannot be removed by boiling; requires chemical treatment.

(H) Radioimmunoassay is a competitive binding immunoassay used to measure extremely small concentrations of hormones, drugs and other biological molecules. It is based on the interaction between antigen, antibody and a radioactively labeled antigen.

Antigen - Antibody Specificity :-

RIA relies on the highly specific binding between an antigen and its antibody. Only the molecule of interest binds to the antibody.

Use of RIA :-

A known quantity of antigen is tagged with a radioisotope. This labeled antigen competes with the unlabeled antigen from the sample.

(I) The octane number of a fuel indicates its resistance to knocking or auto-ignition in a spark-ignition engine. A higher octane number means the fuel can withstand greater compression without prematurely igniting.

⇒ Indicates Resistance to Engine Knocking :-

Knocking occurs when fuel-air mixture ignites before the spark plug fires.

2) Ensures Efficient Engine Performance:

Engine designed for high compression ratios requires high-octane fuel.

3) Protects Engine Components:

- Knocking can damage pistons, valves, cylinder walls, and spark plugs.

4) Determines Fuel Quality

- Octane number is a key quality parameter of gasoline

5) Allows Engine Design optimization:-

High octane fuels allow engineers to design cars:-

- High compression ratios.
- Better performances.

Do Not Write anything in this Portion

Paper Code

Do Not Write anything in this Portion

Paper Code

X

Do Not Write anything in this Portion

Paper Code