ANALYSIS OF COMMON ERRORS IN PHYSICS COMMITTED BY THE STUDENTS IN THE PRE-UNIVERSITY EXAMINATION OF KARNATAKA

REPORT

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PREFACE

The Regional Institute of Education (NCERT), Mysore is providing support systems in education to states of Karnataka, Kerala, Tamil Nadu, Andhra Pradesh and Union Territories of Lakshadweep and Pondicherry and is involved in framing policies and programmes in all aspects of school education. Accordingly, it conducts large number of academic projects every year. In the area of educational research and development, a project "Analysis of Common Errors in Physics made by Pupils in PUC Examination of Karnataka" was proposed for the academic year 1996-97.

The Pre-University Board of Karnataka provided us with 995 answer scripts of the Physics examination conducted in April 1995. These scripts were from different regions of the state. We gratefully acknowledge their help in this regard.

Two workshops were conducted in this project. First workshop of three-days duration was conducted in June 1996. Besides project staff members from RIE, five external resource persons participated. These resource persons have not only taught pre-university classes but also have long association with its examination work. In this workshop, the question paper was thoroughly analysed. Correct answers for the questions were listed and the marking scheme for the paper was prepared. Possible errors in each question were listed. A proforma was developed in which different types of

errors committed in each question could be readily ticked. Detailed instructions to fill up the proforma was also developed. Later eleven hundred copies of this proforma were got printed.

The second workshop was conducted for nine days in October 1996. Three more external resource persons joined us in this workshop. All the 995 answer scripts were carefully examined and one proforma was filled up for each of them. The errors committed by the students were discussed and remedial measures were suggested. It is with gratitude that we record our thanks to the resource persons for their very useful contributions.

Analysis of the data using computer was done by **Prof. S.N. PRASAD** and **Dr. R. NARAYANAN**. This information was carefully analysed separately both according to topic and types of errors. In the light of this analysis, remedial measures are suggested for students, teachers, paper-setters and examination board. It is hoped that these remedial measures will be of some help in reducing errors committed by the students in their examinations.

We sincerely acknowledge our gratitude to **Prof. S.T.V.G. ACHARYULU**, for taking keen interest in this project and for making some useful suggestions.

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INTRODUCTION

To error is human. But if the percentage of error is large, then the errors are no longer accidental. It provides Scope for analysing the types and causes of error and to suggest remedial measures. This is exactly the case with science paper in Pre-University Certificate Examination. Lakhs of students, amounting to more than 50% fail every year in Karnataka. This is true with other states also. What a colossal waste of manpower and money !

There are many factors which are responsible for these errors. Students, teachers, examiners are all responsible for it. This calls for careful analysis. So it was thought to closely scrutinize about 1000 answer books in Physics and the corresponding question paper. This number constitutes less than half per cent of the candidates taking examination every year in Karnataka. But the sample selected is fairly representative. Care has been taken to include papers from different regions of the State. Of course the sample has the inherent limitation that it is restricted to only question paper of one year. It would have been better if question papers and corresponding answer scripts of different years were considered. But still this is good beginning.

In general, in this examination students are mostly tested at the cognitive level, i.e. knowledge, understanding

and application level abilities. We thought it more appropriate to analyse the errors at the operative level, i.e. whether the errors are in definition, substitution, calculation, drawings, concepts, etc. Of course, factors other than students ability can cause the errors. This too has been examined here.

The remedial measures suggested concerns teaching-learning situation,framing of questions,general instructions given for the students, etc. These and other relevant aspects pertaining to evaluation are discussed and illustrated in this volume.

ANALYSIS OF THE QUESTION PAPER

The question paper has five parts A, B, C, D and E. Each part has number of questions (Appendix A).

Part A contains 20 multiple choice questions each carrying one mark. Students have to answer any eighteen of them. They have to write the serial number a, b, c or d of the correct answer. Fourteen of these questions test the cognitive ability at the knowledge level and six at understanding level. The type of error that led the student to give the wrong answer could not be identified in this part. It was observed that some of the terms used in the stem are not in common practice, i.e. angular spread instead of angular dispersion, extra nuclear particle instead of particle outside the nucleus, etc. Some questions have more than one possible answer, i.e. resistance of a conductor depends on length and also on volume. In some questions, the stem could have been better phrased, i.e. potential of the earth is zero, small, large or infinite. It would have been better to specify the potential as gravitational, electric or magnetic.

Part B contains eight questions of three marks each. Students have to answer any six of them. Most of the questions are at the knowledge level involving statements, definitions and simple derivations. There is possibility of students committing errors in (i) drawing diagrams, eg.

indicating directions, labelling, using symbols, etc. (ii) stating relations and formulae, (iii) derivations, (iv) statement of laws and theorems, (v) elaborating their answers with illustrations, or (vi) in their concept itself. The topic of each question and possible errors in each of them were identified.

Part C contains essay type questions and students have to answer two out of three questions of nine marks each. It involves drawing diagrams, derivation and explanation. Since the details of most of them are given in usual textbooks, they may be classified to be at knowledge level only and possible errors are same as in part B above.

Part D has four numericals of six marks each and students have to answer any three of them. The possible sources of errors in these questions are in (i) drawing diagrams, (ii) selecting proper formula, (iii) substitution, (iv) calculations or (v) in writing proper units and dimensions. These questions test students cognitive ability at knowledge, understanding and application level.

Part E deals with the experiments. Students have to attempt two out of three questions of nine marks each. Besides the possible errors listed in Part D, students may error in stating proper procedure in the description of the experiment or in stating the precautions. These questions can evaluate, at best, the cognitive ability at the

understanding level because they are supposed to have done these experiments in the laboratory.

The possible types of error for the questions for the five sections are suitably tabulated in the proforma (Appendix B). The evaluators of the answer scripts have only to tick the proper columns in the proforma with the help of the instruction sheet (Appendix C).

The marking scheme for correcting the answer sheet was also identified (Appendix D). in all the 38 questions in the 5 sections of the question paper.

ANALYSIS OF THE ANSWER SCRIPTS

All the answers in the answer scripts were scrutinized. It is obvious that the answers which were awarded marks less than the allotted maximum marks had some errors. These errors were identified and proper columns in the proforma were ticked. The data for 995 answer scripts were computerised.

This data can be analysed in different ways. Here, it has been analysed according (i) types of errors and (ii) errors in different topics.

I. Analysis according to types of errors

A. Errors in calculation

By far, this is found to be the biggest source of error. This is mainly due to error in

1. numerical calculations
2. writing decimal positions
3. using logarithm tables

As many as 61% of the students have lost marks because of errors in calculations. This source of error involves more of mathematical skills than cognitive abilities in Physics.

B. Errors in diagrams

Errors are made in drawing ray - diagrams, circuit diagrams or in other diagrams such as graphs, sketches, etc.

These errors are due to

1. diagrams not being drawn
2. incomplete diagram
3. directions indicated by the arrow head is wrong
4. labelling is wrong or incomplete
5. symbols used are wrong
6. shape of the graph is wrong
7. totally wrong

When students commit one or more of these, errors, it was marked in column C.

Our calculation shows that 56% of the students have made errors in drawing diagrams. This large percentage of errors certainly calls for remedial measures.

C. Errors in procedures and precautions

These errors are committed while describing experimental work in the answer scripts. They are committed while selecting the apparatus or using them for taking readings. The errors may be in

1. choosing appropriate apparatus
2. adjustment of the apparatus
3. using precautions to avoid parallex
4. keeping the apparatus in appropriate position, say while keeping magnets at equal distances, etc.
5. Choosing proper range of deflection

6. Circuit connections as in connecting positive terminal to the anode, etc.
7. connecting ammeter in series.

It is found from our analysis that 50% of the students have lost marks because of this type of error.

D. Errors in derivations

When students are asked to derive certain relations or obtain one relation from the other, they are found to make errors while

1. converting simple laws into equations
2. substituting one relation into another
3. using trignometric relations
4. using arithmetic processes such as addition, subtraction multiplication and division
5. writing expressions by jumping steps

It is found from our analysis that as many as 44% students have lost marks because of these types of errors.

E. Errors in concepts

What is meant by conceptual error is that the student does not have the correct knowledge and understanding of the topic. He has some vague knowledge as described below: He may not be aware of difference between deviation and dispersion while writing about spectrum. He may not able to indicate that light bends towards the normal while going from rarer to denser medium, or while converting a

galvanometer into an ammeter he does not know the proper value of resistance, whether it should be large or small or whether it should be in series or parallel. Again while discussing atomic structure, he may not be able to discriminate between ionisation and excitation levels, etc. It is found that as many as 43% of the students have committed this type of error.

F. Error in substitutions

About 40% of the students have made this type of error. These errors are because of the mistakes they commit while

1. substituting the given values in the formula.
2. using given values in the same system of units say in centimeters or in meters.
3. using correct value for angstrom, acceleration due to gravity, etc.

Besides the errors described above, students have committed many other types of errors. They can be summarised as follows:

G. Errors in using proper formula and relations (38%)

H. Errors in statement of laws and principles (36%)

I. Errors in giving suitable illustrations and examples (34%)

J. Errors in stating proper units in the final answer (28%)

Of course, besides the above, errors are also committed because of unfamiliarity with English language, improper numbering of the question, etc.

II. Analysis according to errors in different topics

By the weightage given to different topics in the question paper in terms of marks allotted, the content can be broadly divided into four groups as follows:

A. Optics

B. Magnetism

C. Electricity

D. Modern Physics

Each of the above group has many subtopics. Accordingly in what follows, errors in such topics are briefly discussed.

A. Optics

In optics, errors are mostly in drawing and labelling diagrams and in calculations.

a. Errors in diagrams - 70%

Errors are common in diagrams depicting light propagation through prisms, in describing deviation, dispersion, etc. So also are errors in showing reflected and refracted rays in critical angle positions or at polarising angle. The errors are mostly in showing the direction of rays, or in depicting amount of deviation for different rays.

b. Errors in calculation - 60%

Errors are common in calculating refractive index or focal length using numerical values in the given formula.

Errors are also common while calculating wavelength in Young's interference experiment.

B. Magnetism

The errors are mainly due to their lack of understanding of the simultaneous effect of earth's magnetic field and a bar magnet on a magnetic needle. As many as 70% students have made errors in calculations involving deflection magnetometer. About 50% students have made errors in questions involving angle of dip, earth's horizontal components, etc.

C. Electricity

As many as 40% of the marks in the question paper are allotted to questions on subtopics in electricity. Coulombs law, Gauss law, Kirchoffs law, electromagnetic induction, electric and magnetic effects of electric current, thermo-emf measuring instruments, etc. are covered in this topic.

As many as 80% have made mistakes in calculating self-inductance from the given data and about 70% have made mistakes in correctly stating laws of electromagnetic induction.

70% students have made mistakes in diagrams and calculations related to electrochemical equivalence.

Whereas 70% students have made errors in calculations involving Kirchoff law, 60% have made errors in calculations involving Coulombs law. Nearly 70% students

have made errors in questions involving conversion of galvanometer into an ammeter.

50% students have made errors in derivations using Gauss's law and 40% students have made errors in calculating magnetic field due to a current carrying conductor. In questions related to capacitors, series and parallel connections and thermo emf, about 20%, 30% and 40% of students have made errors, respectively.

D. Modern Physics

This topic is covered by questions on atomic structure, radioactivity, semi-conductors and mass energy relation.

More than 70% students have made errors in giving illustrations for Einstein's mass-energy relation.

60% students have made errors in stating Bohr's postulates and another 60% in calculations involving excitation and ionisation potentials.

Only 15% students have made mistakes in answering questions on radioactivity and semiconductors which are at the knowledge level.

In the discussion above, errors made by the students in their answer scripts have been analysed in detail. Next task will be to make use of this information for suggesting remedial measures.

REMEDIAL MEASURES

In the light of the analysis of the errors some remedial steps are suggested below. The suggestions are described separately for (A) students, (B) teachers, (C) paper setters and (D) examination board. It is hoped that State Government authorities will see to it that these suggestions are discussed in their inservice programmes and in science clubs.

A. Suggestion for students

Certainly, sincere efforts by the students will go a long way in minimising errors. In this connection it is suggested that:

1. Students should avoid answering different parts of question in different places. They should compulsorily write the number of the questions and their subsections clearly. This will minimise errors by the evaluators.

2. Students must practice (i) indicating directions in the diagrams with arrow heads, (ii) using proper symbols in the diagrams, and (iii) labelling the diagrams.

3. Students must practice drawing graphs with proper labelling of the axis and with proportional scale.

4. Students should practice using logarithm tables.

5. While solving numericals, the rough work for calculations should be shown side by side with the solution

and not separately on back page. This will decrease the errors.

6. Students should not skip steps in the derivations and they have been found to make mistakes while jumping steps.

7. Students should use only S.I. system of units and should be familiar with their subunits like micro, milli, etc.

8. Students should make it a point to solve model question papers and get them corrected.

B. Suggestions for teachers

The role of the teacher is very important in helping students to minimise errors. Teachers are requested to consider the following suggestions.

1. The PUC Board has not specified any single book as Textbook. As a result, there are many good books available in the market. Teachers are requested to carefully study the syllabus and previous year question papers and select appropriate books for different topics and subtopics.

2. Laws and principle should be explained once again whenever they are used in derivations or in solving numericals.

3. Teachers should ensure that students (i) draw neat labelled diagrams, (ii) plot graphs with axis and scale marked appropriately, (iii) know how to use the logarithm tables and (iv) solve large number of numericals using logarithm tables and S.I. units.

Of course teachers will not have time to correct these assignments. It is suggested they take help from students and make them correct one another's answers with the help of the solutions provided to them.

4. It is obvious from the large number of errors in the answers to questions on laboratory work that many students have not satisfactorily done the practicals in laboratory. Teachers should see how best they can help the students in the laboratory work. Teachers should make it a point to show different apparatus and explain their use with the help of neat labelled diagrams. These diagrams can be purchased or prepared before hand. Of course, it will be better if they can demonstrate the use of the apparatus.

5. Teachers should prepare model question papers and ensure that students solve them. They should clearly explain the instructions to the students printed on front page of the answer books.

C. Suggestions for Paper Setters

On the basis of the scrutiny of the question paper and answer books following suggestions are made for the paper setters.

1. A suitable blue print be prepared with adequate weightage given to understanding and application level questions. They should avoid questions for which solutions are discussed in common textbooks or in classrooms,otherwise most of the questions will test only cognitive ability at the knowledge level.

2. The questions should be precise and unambigious. In multiple choice questions, they should ensure that there is only one correct answer. The alternatives given for the multiple choice questions should not be totally irrelevant. The alternatives be listed as A, B, C and D instead of (a), (b), (c) and (d).

3. Though the questions are listed in different sections, they should follow the same serial order for the entire paper, say 1 to 38 and not A-1, B-1, C-1 or C-3, D-3, etc.

4. Questions on same subtopic should not be repeated in different sections in one form or the other.

5. When questions have alternate approaches say in numericals or in derivations, all the approaches should be indicated in the marking scheme.

D. Suggestion for Examination Board

1. The Board should develop and maintain a pool of large number of excellent test items and use this while setting the question paper.

2. In multiple choice questions, the alternatives be listed as A, B, C and D and not (a), (b), (c) and (d).

3. The questions should be numbered serially though they are in different sections.

4. Following instructions be printed on the top of the question paper.

(i) Use S.I. units only.

(ii) Calculations should be shown along with the answer on the R.H.S. of the answer sheet.

(iii) Draw self-contained labelled diagram wherever necessary. Description of the diagram is not necessary.

5. The instructions given above and also those usually printed on the front page of the answer book be given wide publicity in schools before-hand to ensure their better compliance.

The error analysis and remedial measures suggested above are based on answer scripts for one particular question paper. Ofcourse, some more useful details may arise if more question papers and answer scripts are analysed. But the types of errors will not change and broad suggestions made above will remain the same. It is hoped that the implementation of the above suggestions will reduce the errors committed by the students in their examination.

APPENDIX A

QUESTIONS

PART-A

I. Note: (i) There are four answers for each question. One of them is the correct answer. You are required to write the serial number of the correct answer as well as the correct answer only on the first two pages of the main answer book.

(ii) You can answer 18 questions.

(iii) Each question carries 1 mark.

1. During dispersion of white light by prism placed in air

   (a) only angular spread takes place

   (b) only angular deviation takes place

   (c) both angular deviation and angular spread take place

   (d) either angular spread or angular deviation for the mean colour takes place depending on the angle of the prism

2. For a given distance between an object and image screen magnification is 3 for a certain position of convex lens. On moving the lens through 0.2 m towards screen magnification is 1/3. Focal length of the lens is

   (a) 0.075 m

   (b) 0.01 m

   (c) 1 m

   (d) 0.15 m

3. Luminous intensity of a source is measured in S.I. units.

   (a) Lux

   (b) Candela

   (c) Lumen

   (d) Phot.

4. The phenomenon that confirms light waves are transverse waves is

   (a) Interference

   (b) Polarisation

   (c) Total internal reflection

   (d) Photo-electric effect

5. A plane mirror provided on the dial of a magnetometer helps

   (a) taking readings directly

   (b) to give magnetometer good look

   (c) clear sight of the pointer

   (d) taking readings avoiding error due to parallax

6. Area contained within the hysteresis loop represents

   (a) magnetic energy of the specimen

   (b) loss of energy of the specimen

   (c) loss of energy/unit volume/cycle

   (d) none of the above

7. Which of the following is not true ?

   (a) $B_H = B_V \cos\theta$

   (b) $B_V = B_H \tan\theta$

   (c) $B_V = B \sin\theta$

   (d) $B = \sqrt{B_H^2 + B_V^2}$

8. Above Curie temperature ferromagnetic specimen

   (a) remains ferromagnetic

   (b) becomes ferromagnetic

   (c) becomes paramagnetic

   (d) becomes diamagnetic

9. Force between two charges is 0.5 N. If the distance between them is doubled then the force will be

   (a) 1.0 N

   (b) 0.025 N

   (c) 0.25 N

   (d) 0.5 N

10. Potential of the earth is

   (a) zero

   (b) small finite value

   (c) large finite value

   (d) infinite

11. If ten capacitors of capacitance 2F are joined in series then the equivalent capacitance is

   (a) 10 F

   (b) 20 F

   (c) 0.2 F

   (d) 0.1 F

12. Resistance of a conductor depends on

   (a) length

   (b) volume

   (c) density

   (d) mass

13. Magnitude of the magnetic intensity at a point due to current in a conductor is given by

   (a) Biot-Savart Rule

   (b) Right hand Clasp rule

   (c) Fleming's left-hand rule

   (d) Coulomb's law

14. Shunt required to convert a galvanometer of resistance G with F.S.D. current I_a into ammeter to measure upto I is

(a) $\frac{(I-I_g)G}{I_g}$

(b) $\frac{I_g G}{I-I_g}$

(c) $\frac{(I-I_g)G}{I_g}$

(d) $\frac{I_g G}{I}$

15. Equivalent resistance of resistance in the following network between points A and B is

(a) 13Ω

(b) 19Ω

(c) 10Ω

(d) none of the above

16. S.I. Unit of Self Inductance is

(a) Farad

(b) Faraday

(c) Henry

(d) Tesla

17. Extra-nuclear particle of an atom is

(a) electron

(b) proton

(c) neutron

(d) positron

18. The graph of thermo e.m.f. (e) versus temperature difference (θ) in a thermocouple is

    (a) straight (b) parabola

    (c) hyperbola (d) half ellipse

19. Which of the following has the highest penetrating power ?

    (a) α-particle (b) β-particle

    (c) γ-particle (d) proton

20. Pick from the following a semi-conductor:

    Cu, Diamond, Ge, Fe.

    (a) Diamond (b) Ge

    (c) Fe (d) Cu

PART-B

II. Note: (i) Answer any six questions

(ii) Each question carries 3 marks

1. Derive the relation between critical angle and refractive index of the medium.

2. Show that when a light ray is incident at the polarising angle the reflected ray is at right angle to the refracted ray.

3. For a convex lens producing real image, show that

$$f = \frac{D^2 - S^2}{4D}$$ where the symbols have usual meaning

4. Obtain an expression for the magnetic field at the centre of a circular coil carrying current.

5. State Gauss theorem in Electrostatics. Obtain Coulomb's law of inverse squares from Gauss Theorem.

6. State the Laws of Electromagnetic Induction.

7. Explain Einstein's mass-energy relation.

8. Define neutral temperature and inversion temperature of a thermo couple and give a relation between them.

PART-C

III. Note: (i) Answer any two questions

(ii) Each question carries 9 marks

1. (a) Derive the relation $\mu = \dfrac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$ for the refraction through prism. 6

(b) Explain the method of obtaining a pure spectrum with a neat diagram. 3

2. With a neat diagram explain the theory of a suspended coil galvanometer with necessary derivation. Explain how a moving coil galvanometer is converted into an ammeter. 6+3

3. (a) Assuming Bohr's postulates derive the expression for the radius and energy of nth orbit of hydrogen atom.

(b) What are ionisation and excitation potentials ? 7+2

PART-D

IV. Note: (i) Answer any three questions

(ii) Each question carries 6 marks

1. In a Young's double slit arrangement the slits are 1.5 mm apart. When the slits are illuminated by a monochromatic source, and the screen is kept 1 m apart from the slits, width of 10 fringes are measured as 3.93 mm. Calculate the wavelength of light used. What will be the width of 10 fringes when the distance between the slits and the screen is increased by 0.5 m, when the same source of light is used.

2. Two identical pith balls each weighing 30 mg are hung from the same point of a rigid support by two inextensible threads each of 0.10 m. When equal amounts of identical charges are given to the pith balls they get separated by 0.10 m. Calculate the charge on each of them ($g=10\ m/s^2$).

3. Two cells, one of 2V and internal resistance 1 Ω and another of 1.5V and internal resistance 3 Ω, drive the current through an external resistor of 10 connected between that common positive and negative terminals. Find the p.d. across the external resistor.

4. In an experiment to measure the self inductance of a coil using D.C. and A.C. meters, the following readings were recorded:

Final	D.C. part		A.C. part	
	I_{dc} in A	V_{dc} in V	I_{ac} in mA	V_{ac} in V
1	0.5	5.1	300	10.5
2	0.8	7.9	500	18
3	1.0	9.8	700	25

Frequency of A.C. supply is 50 Hz. Calculate the self inductance of the coil.

PART-E

V. Note: (i) Answer any two questions

(ii) Each question carries 9 marks

1. Assuming the preliminary adjustments of a spectrometer, describe an experiment to determine the dispersive power of the material of the prism.

Calculate the dispersive power of the material of the prism from the following data:

Least Count = 1'; $\angle$ A = 60°

Direct reading = 64°26'

Colour	Readings	
	M.S.R.	C.V.D.
Yellow	16°	12
Blue	14°	26

5+4

2. Describe an experiment to compare the magnetic moments of two short bar magnets using deflection magnetometer in tan A position by equal distance method.

   In the above experiment following observations were recorded. Compare the magnetic moments of the two short bar magnets:

	Deflections in degrees							
	1	2	3	4	5	6	7	8
First	40	40	41	41	40	40	41	41
Second	50	50	51	51	50	50	51	51

5+3

3. Describe in detail an experiment to determine e.c.e. of copper. The following readings were recorded during the experiment. Calculate e.c.e. of copper

Current	Time for which current passed	Initial mass	Final mass
1A	30 mins	0.05123 kg	0.0518 kg

5+3

APPENDIX B

TYPES OF ERRORS

PART-A

Q.No.	Max. marks	Unit	Topic	Type of error*
A1	1	Optics	Dispersion by prism	E
A2	1	Optics	Lens-Magnification	D
A3	1	Optics	Photometry Intensity	K
A4	1	Optics	Transverse waves	E
A5	1	Magnetism	Magnetometer	L
A6	1	Magnetism	Hysteresis	E
A7	1	Magnetism	Magnetic Elements	D
A8	1	Magnetism	Magnetic Materials	E
A9	1	Electrostatics	Coulomb's Law	D
A10	1	Electrostatics	Electric Potential	E
A11	1	Electrostatics	Capacitor-Parallel	D
A12	1	Current Electricity	Resistance	E
A13	1	Current Electricity	Magnetic field	E
A14	1	Current Electricity	Galvanometer-Ammeter	D
A15	1	Current Electricity	Resistance - Series and Parallel	J
A16	1	Electromagnetic Induction	Self-Inductance	K
A17	1	Modern Physics	Atomic Structure	E
A18	1	Thermo-Electricity	Thermo-EMF	C
A19	1	Modern Physics	Radioactivity	E
A20	1	Modern Physics	Semiconductor	H

* For details of notation see next page.

PART B & C

1	2	3	4	B	C	D	E	F	G	H
Q. No.	Max. Marks	Unit	Topic	Not attempted	Diagram	Relations/ formula	Concept	Derivation	Statement/ Law/Theorem	Illustrations
B1	3	Optics	Refraction		✓	✓		✓		
B2	3	Optics	Polarisation		✓	✓		✓	✓	
B3	3	Optics	Lens		✓	✓		✓		
B4	3	Current electricity	Magnetic Intensity		✓			✓	✓	
B5	3	Current electricity	Gauss Theorem		✓			✓	✓	
B6	3	Current electricity	Electromagnetic Induction						✓	
B7	3	Modern Physics	Einstein's Mass Law						✓	✓
B8	3	Thermo-Electricity	Thermo emf			✓			✓	
C1	9	Optics	Prism a/b		✓	✓	✓	✓	✓	
C2	9	Electro-statics	Galvano-meter a/b		✓	✓	✓	✓		
C3	9	Modern Physics	Atomic Structure					✓	✓	

1	2	3	4	B	C	D	I	J	K	L
Q. No.	Max. Marks	Unit	Topic	Not attempted	Diagram	Relations/ formula	Substitution with units	Calcuation	Units (Dimensions)	Procedure & precautions
D1	6	Optics	Interference			✓	✓	✓	✓	
D2	6	Electro-statics	Coulomb's Law		✓	✓	✓	✓	✓	
D3	6	Current Electricity	Kirchoff's Law		✓	✓	✓	✓	✓	
D4	6	Current Electricity	Self-Inductance			✓	✓	✓	✓	
E1	9	Optics	Spectrometer		✓	✓	✓	✓	✓	✓
E2	9	Magnetism	Deflection Magnetometer		✓	✓	✓	✓	✓	✓
E3	9	Current Electricity	e.c.e.		✓	✓	✓	✓	✓	✓

APPENDIX C

INSTRUCTIONS TO EVALUATORS

The answer book has five parts A, B, C, D and E. Please use the following guidelines to fill the proforma.

Part A: 1. Columns 1, 2, 3 and 4 are already filled up.

2. If the answer is wrong, in the column under alternatives indicate the students' answer by a code 1, 2, 3 or 4.

Parts B, C, D & E:

1. Columns 1, 2, 3 and 4 are already filled up.

2. If the student has not attempted the question, then write the code '1' in the column 'not attempted'. If the answer is irrelevant then enter the code '2' in the column 'not attempted'.

3. If the student has got less than the maximum marks, then carefully go through the answer and identify the error with reference to the check list given and write the correct code in the appropriate column.

INFORMATION ON CODES

A. Alternatives

1	a
2	b
3	c
4	d

B. Not attempted

1. Not answered
2. Irrelevant

C. Diagram

Ray diagrams:

1. Not at all drawn
2. Directions are wrong
3. Labelling (angles, refractive index, etc.) is wrong/ missing details
4. Incomplete diagram
5. Any other omissions/wrong

Circuit diagrams:

6. Symbols are not proper
7. Polarity and direction are wrong
8. Incomplete and missing details

Other diagrams:

9. Labelling wrong
10. Incomplete/Missing details
11. Direction (vector quantities) wrong

D. Relations/Formula

1. Symbol is not explained
2. Incomplete formula
3. Wrong relation/formula

E. Concept

1. Not clear

F. Derivation

1. Steps missing
2. Simplification wrong
3. Substitution wrong

G. Statement/Law/Theorem

1. Wrong

H. Illustrations

1. Wrong

I. Substitution with units

1. Wrong

J. Calculation

1. Wrong

K. Units

1. Units of different variables wrong
2. Units in the final answer wrong
3. Dimensions wrong

L. Procedure

1. Arrangement wrong
2. Precautions wrong
3. Descriptions wrong
4. Tabulation wrong

APPENDIX D

SCHEME OF VALUATION

PUC APRIL 1995
(one mark for correct alternative)

PART-A

Q.No.	Correct alternative
1	c
2	a
3	b
4	b
5	d
6	c
7	a
8	c
9	b
10	a
11	c
12	a
13	a
14	b
15	c
16	c
17	a
18	b
19	c
20	b

PART B

Q.No.	Value Points	Marks
1	Correct figure with arrowhead and representation of media	1
	Derivation	1
	Final formula	1
2	Brewster's law with figure	1
	Drivation	1
	Final formula	1
3	Figure	1
	Derivation	1
	Formula	1
4	Figure	1
	Derivation	2
5	Statement	1
	Derivation of Coulomb's law	2
6	Faraday's two laws	2
	Lenz's law	1
7	Equation	1
	Illustration	2
8	Definitions (two)	2
	Relation	1

PART-C

Q.No.	Value points	Marks
1.(a)	Diagram	1
	Angle of the prism	1
	Angle of minimum deviation	1
	Minimum deviation - Either graph or statement	1
	Angle of incidence in terms of A and D min Angle of refraction in terms of A --	1
	Relation	1
(b)	Figure	1
	Explanation	2
2.	Neat diagram (schematic)	1
	Description of the instrument	2
	Deflecting couple Restoring couple --	1
	Obtaining the expression ($I=K\theta=lOC/nHA$)	2
	Figure	1
	Principle and explanation	2
3.(a)	Stationary state condition for circulating electron and substitution (centripetal force = Coulomb force)	1
	Expression for ω^2 using Bohr's postulate	1
	Expression for radius	1
	Expression for velocity of an electron	1
	Total energy of proton-electron system	2
	Interpretation of 'sign' in the expression	1
(b)	Definitions (two)	2

PART D

Q.No.	Value points	Marks
1.	Formula (Fringe with B = (λD/d)	1
	Correct substitution	1
	Calculation and unit in the final answer B α D	2
	Calculation and unit in the final answer	1
2.	Figure with directions	1
	Lamis theorem or law of triangle of forces	1
	Calculation and unit in the final answer	4
3.	Circuit diagram with correct circuit symbols	1
	Finding current I_1	1
	Finding current I_2	1
	Finding total current I	1
	Potential difference across the external resistor	1
	Unit	1
4.	Finding resistance	1
	Average resistance	1
	Finding impedance	1
	Average impedance	1
	Self-inductance equation	1
	Substitution, calculation and unit	1

PART E

Q.No.	Value points	Marks
1.	Angle of the prism with explanation	2
	Angle of minimum deviation with explanation	2
	Expression for refractive index and dispersive power	1
	Calculation of refractive index of yellow and blue light	3
	Calculation of dispersive power	1
2.	Arrangement	1
	Figure	1
	Formula	1
	Procedure	2
	Tabulation	1
	Average deflections (in two cases)	1
	Formula	1
	Calculation	1
3.	Circuit diagram	1
	Procedure	2
	Precaution	1
	Formula	1
	Observation	1
	Formula	1
	Substitution	1
	Calculation	1