

Basic Science & Instrumentation

- 1. General NM Physics**
- 2. Basic Atomic & Nuclear Physics**
- 3. Modes of Radioactive Decay**
- 4. Decay of Radioactivity**
- 5. Radionuclide & Radiopharmaceuticals Production**
- 6. Interaction of Radiation with matter**
- 7. Radiation Detectors**
- 8. Electronic instrumentation for Radiation detection system**
- 9. Nuclear counting statistics**
- 10. Pulse –Height Spectrometer**
- 11. Problems in Radiation Detection & measurements**
- 12. counting systems**
- 13. Gamma camera Basic Principles**
- 14. Gamma camera performance & characteristics**
- 15. Image Quality in NM**
- 16. Tomographic reconstruction in NM**
- 17. SPECT**
- 18. PET**
- 19. Digital Imaging processing in NM**
- 20. Tracer kinetic modeling**
- 21. Internal Radiation dosimetry**
- 22. Radiation safety & Health Physics**

1) General NM Physics

Long question -

Short Question -

2) Basic Atomic & Nuclear Physics

Long question

1. Compare and contrast biological effect of alpha, beta, & gamma rays. Give suitable examples. (25- 2004)

Short Question

1. Auger electron(15-1993)
2. Auger electron (15-1994)
3. Alpha emitter & their uses. (15- 2004)
4. Characteristic X-rays (10- 1992)

3) Modes of Radioactive Decay

Long question

1. What is the basic unit of radio-activity? Define Radio-active decay. Describe in details, various processes of radioactive decay with examples. What do you understand by the terms probability of decay & half life? (25- 1989)

Short Question

1. Isomeric transition (15-1994)
2. Iso-baric transition (10-1994)
3. Isomeric Transition(15-1995)
- 4.

4) Decay of Radioactivity

Long question

Short Question

1. Derive equation of radioactive decay. Define decay constant, $T_{1/2}$. Calculate the mass of 1 Ci of carrier free iodine 131. (10-12/06)
2. Effective half life(15-1994)
3. What is a decay scheme? Exemplify with Decay scheme of ^{99}Mo - $^{99\text{m}}\text{Tc}$. (10-1997)
4. LET, half value layer, & effective half life. (15- 2004)

5. I-131 decay with half life of 8.05 days. Find out the probability of the disintegration of one atom of 131-I in one second. (15- 1991)
6. Effective half life. (15- 1991)
7. A dose of I-131 for a patient has to have an activity of 1 mCi at 18.00hrs on 22nd nov. The stock bottle states the activity is 3 mCi at 12.00hrs on 21st nov & that the activity is in 5 ml of solution. What volume of solution must be withdrawn from the bottle to give the correct activity for administration to patient? (15- 1991)
8. Half life (15- 1992)

5) Radionuclide & Radiopharmaceuticals Production

Short Question

1. Describe transit & secular equilibrium of radionuclide. Illustrate with routinely used generator system. (10-12/06)
2. Transient equilibrium (15-1994)
3. Radiochemical Purity. (10-1995)
4. N-gamma reaction. (10-1995)
5. Neutron activation analysis. (10-1996)
6. Cyclotron- produced generator systems. (10-1996)
7. Emergency preparedness in case of a Nuclear reactor accident. (10-1997)
8. Cyclotron(10-1997)
9. What is transient equilibrium & secular equilibrium? Give examples. (10- May 2005)
10. Principle of Radionuclide generators. Describe transient & secular equilibrium(10- Dec 2005)
11. Methods of RN production (10- Dec 2005)
12. Artificial production of RN. (10- Dec 2005)
13. Enumerate modes of production of RN. Name important RN in each mode of production. (15- 1990)
14. Radio-active equilibrium. (15- 1991)
15. What is the decay scheme? Exemplified with decay scheme of 99Mo-99mTc

6) Interaction of Radiation with matter

Long question

1. Discuss the events occur when alpha, beta, & gamma interact with matter & describe how these have been used to advantage in development of radiation detection & imaging system. (25- 1992)

Short Question

1. The interaction radiation with matter(10-12/06)
2. Cerenkov radiation. (15-1993)
3. Interaction Gamma radiation with matter (15-1994)
4. Pair production (15-1994)
5. Safe Handling of Beta Emitters. (10-1995)
6. Bremstrahlung. . (10-1995)
7. Interaction of radiation with matter(10-1997)
8. Mechanism of Excitation, Ionization, Bremsstrahlung production. (10- May 2005)
9. LET (10-12/06) (15-1994) (10- May 2005) (15-1994)
10. How does radiation interact with matter? (10- May 2005)
11. Interaction of radioactive emission from ¹³¹I with matter. (10- Dec 2005)
12. LET, half value layer, & effective half life. (15- 2004)
13. LET. (10- 2002)
14. Compton effect (10- 1989)
15. Interaction radiations with matter- give examples of each type in practice. (10- 2007)
16. Interaction radiation with matter (15- 1992)

7) Radiation Detectors

Long question

1. What are types of detectors used in nuclear imaging? Discuss their characteristics, merits & demerits. (25- 2004)

Short Question

1. Quenching in GM counter(10-12/06)
2. What is the role of “Hand-held” probes in detection of the radiotracer in patients. (15-1994)

3. Ionization chamber (10-1994)
4. Gas Filled Detectors. (10-1995)
5. Well type counter. (10-1995)
6. Thyroid probes. (10-1995)
7. Shadow shield type of whole body counter. (10-1996)
8. Scintillation detector. (10-1997)
9. Isotopes calibrators. (10- May 2005)
10. Neutron monitor. (10- Dec 2005)
11. Scintillation detector. (10- 1989)
12. Practical utility of various types of radiation detector devices used in NM. (10- 2007)
13. Principle of functioning ionization chamber & its application in NM. (15- 1990)
14. Radiation detector system. (15- 1991)
15. GM counters(10- 1992)
16. Liquid scintillation counting (15- 1992)
17. GM counters (15- 1993)

8) Electronic instrumentation for Radiation detection system

Short Question

1. Pulse height analyzers(15-1994)
2. Spectrometer (15- 1992)

9) Nuclear counting statistics

Short Question

1. Poisson's distribution(15-1994)
2. Standard deviation (15-1994)
3. Poisson distribution. (10-1995)
4. Counting statistics & its important in NM. (10-1997)
5. What is sensitivity, specificity, accuracy, predictive value? (10- May 2005)
6. Statistical error in radioactive counting. (10- Dec 2005)
7. Gaussian & Poisson distribution. (10- 2002)
8. Types of distribution & its relevance in statistical analysis. (10- 2007)

9. Chi-square test. (10- 2007)
10. Statistically consideration in counting radioactivity. (15- 1991)
11. Binominal, Gaussian & Poission distribution. (10- 1992)
12. Discuss the statistic of counting radiation. (25- 1993)
13. Chi square test (15- 1993)

10) Pulse –Height Spectrometer

Short Question

1. A swipe containing an unknown isotope is given to you. How will you identify what the isotope is with the help of spectrometer? (10- May 2005)
2. Spectrometer (15- 1992)

11) Problems in Radiation Detection & measurements

Short Question

1. What is attenuation? How attenuation correction done in SPECT and PET?
2. Attenuation correction. How frequently it is required. (15- 2004)

12) counting systems

Short Question

1. Radio-isotope dose calibrators. (15-1996)
2. QC of well counter. (10-1997)
3. Functions & principles of various components of instrumentation used in thyroid uptake measurement. (10-1997)
4. What are the QC parameters for any counting study with isotopes (10- May 2005)
5. Radio-isotope dose calibrator. (10- 1990)
6. Factors influencing the counting of radioactivity. (15- 1991)
7. Components of Rectilinear scanner. (15- 1991)
8. Detection & decontamination of low level Gamma, beta contamination. (10- 1992)

13) Gamma camera Basic Principles

Short Question

1. Fan beam collimator(10-12/06)
2. Different type of collimators used with gamma cameras & their utility in scintigraphy. (10-1996)

3. Collimators used in gamma cameras types & functions. (10-1997)
4. Collimators used in Nuclear cardiac imaging? (10- May 2005)
5. Types of collimator & their characteristics. (10- 2007)
6. Principles of scintillation cameras. (15- 1991)
7. Flat field collimator. (15- 1991)
8. PMT(15- 1991)
9. Collimators in Gamma cameras (10- 1992)
10. PMT (10- 1992)

14) Gamma camera performance & characteristics

Short Question

1. QC of SPECT (15-1994)
2. Discuss the problems in SPECT imaging & the strategies used to overcome them (15-1994)
3. QC of Gamma camera(10-1997)
4. Uniformity(10- 2002)
5. Intrinsic resolution (10- 2002)
6. QC of SPECT. (10- 2002)
7. QC in Gamma camera (10- 1992)

15) Image Quality in NM

Short Question

1. Modulation transfer function. (10-1995)
2. ROC curve. (10- Dec 2005)

16) Tomographic reconstruction in NM

Long question

1. Describe the underlying principles of functioning of a SPECT Gamma camera.
Describe various parameters used in reconstruction of data. (25- 1992)

17) SPECT

Short Question

1. Principle of SPECT instrumentation. (10-1995)
2. Difference between SPECT & PET. (15-1996)

3. Attenuation correction in SPECT. (10-1996)
4. Filters used in SPECT data processing. (10-1997)
5. Adv in SPECT imaging(10-1997)
6. SPECT analogues of PET agents (10- May 2005)
7. What is attenuation? How attenuation correction done in SPECT and PET?
8. What are the daily QC studies for a SPECT? (10- May 2005)
9. Positron technique in SPECT imaging (15- 1992)

18) PET

Short Question

1. The principle of PET imaging (10-12/06)
2. Developments in PET techniques. (10-1994)
3. Annihilation Radiation. (10-1995)
4. Principles of PET instrumentation. (10-1995)
5. Principle of PET. (10-1996)
6. PET Vs SPECT. (10- May 2005)
7. The principle of PET imaging. (10- Dec 2005)
8. Significance of attenuation correction for PET (10- Dec 2005)
9. Annihilation Radiation(10- Dec 2005)
10. Principle of PET (10- 1989)
11. Types of PET detectors- their merits & limitations. (10- 2007)

19) Digital Imaging processing in NM

Short Question

1. Clinical impact of co-registration imaging. (10-12/06)
2. Auto radiography(10-12/06)
3. Factors affecting image formation in NM. (10-1994)
4. Describe the features of an ideal computers in NM for imaging & report generation (25-1994)
5. Computer applications in image processing in NM. (10-1996)
6. Co-registration of NM images with other images. (10-1996)
7. Deconvolution analysis & its clinical utility. (10-1996)
8. Auto radiography. (10-1997)

9. Decision matrix & its applications. (10-1997)
10. Clinical utility of image fusion (10- May 2005)
11. Co-incidence imaging & its adv and pitfalls? (10- May 2005)
12. Auto-radiography. (10- Dec 2005)
13. Fusion imaging (15- 2004)
14. Salient criteria in selecting a work station for NMD. (10- 2007)
15. Computers in NM. (15- 1990)
16. Computers in NM. (15- 1990)
17. NM computers(15- 1992)
18. Data storage devices (15- 1993)

20) Tracer kinetic modeling

Long question

1. Outline the common methods of GFR estimation. Described briefly compartmental method of GFR estimation. Critically discuss their applications in routine clinical practice. (25-1995)
2. Describe the various aspect of compartmental analysis. Give examples of at least two compartmental models with full description. Describe the role of computers in developing such models & in compartmental analysis. (25- 1991)

Short Question

1. Radio-isotope dilution principle & its application. (10-1996)
2. Compartmental analysis. Examples of its applications. (10-1997)

21) Internal Radiation dosimetry

Long question

1. Define the term critical organ. Describe the various factors involved in calculating radiation dose to organs from internally administered RN with special reference to the MIRD method. List the uncertainties & limitation of such dosimetric calculations. (25- 1992)

Short Question

1. Units used in radiation science. (15-1996)
2. Radiation quantities & their units. (15-1995)
3. SI units of Radiation Quantities. (10-1995)
4. Radiation units. . (15-1996)
5. Limitations & uncertainties of medical internal radiation (MIRD) committee calculations. (15-1997)
6. Equilibrium absorbed dose fraction. (15-1997)
7. Define Roentgen, radiation absorbed dose. Gray, radiation weight factor, Sievert. (10- May 2005)
8. Absorb dose, equivalent dose, and effective dose. (10- Dec 2005)
9. Method to obtain beta dosimeter of RN (10- 2007)
10. Radiation units. (15- 1991)
11. SI units of Radiations.
12. Limitation of MIRD calculation (15- 1993)

22) Radiation safety & Health Physics**Long question**

1. You have been appointed as NM consultant cum RSO in new set up. Design your facilities from health physics points of view keeping the following points in mind: dept protection, health physics equipments would you like to purchase with justification & personal monitoring.(25-1993)
2. You have been appointed as NM consultant cum RSO in a set up which plans to perform static/dynamic imaging procedure along with radio-iodine therapy for cancer thyroid patients. Keeping in mind the above mentioned points justify the facilities you would like to plan in terms of location and space: Health Physics, equipments, Layout & staff. (25-1995)
3. Discuss the biological effect of the low level radiation with reference to carcinogenesis, teratogenesis & mutagenic changes. (25-1997)
4. Discuss the factors which modify radiation injury with specific reference to physical & biological modifiers & the role of sensitizers. (25-1997)

5. Compare and contrast biological effect of alpha, beta, & gamma rays. Give suitable examples. (25- 2004)
6. Discuss the stochastic & non- stochastic effect of ionization radiations. What is the relevance in Radiation protection? (25- 1989)
7. Discuss Radiation Syndrome. (25- 1990)
8. Enumerate the type of ionization radiation of biological importance. Describe briefly the radiation effect at molecular level of the cell such as DNA, enzyme & lipid composing cell membrane & their possible cellular effect. Give a brief account of Relative tissue radio sensitivity in the human being. (25- 1990)
9. Maximum permissible radiation dose to occupationally exposed radiation worker & general population at large. (15- 1990)
10. Describe the various types of interaction of radiation with matter. Enumerate the effects of ionization radiations at cellular level & describe relative radio-sensitivity of mammalian cells. (25- 1991)
11. Critically enumerate the components of emergency preparedness to deal with the health effect of radiation accidents. (25- 1991)
12. Describe the procedures involved in handling of cadavers with incorporated RN, with special reference to the rules & regulation governing their storage, embalming, burial, & autopsy. (25- 1991)

Short Question

1. Specific absorption fraction(10-12/06)
2. HVL & TVL of Radiation shield. (10-12/06)
3. Radioactive waste disposal (10-12/06)
4. The procedure minimizing Radiation hazards (10-12/06)
5. Radiation hormeosis(10-12/06)
6. Personal monitoring (10-12/06)
7. Neutron Monitoring. (10-12/06)
8. Oxygen enhancement Ratio. (10-12/06)
9. Salient features of ICRP-60(15-1993)
10. Cell survival curve (15-1993)

11. Repair of sub lethal damage(15-1993)
12. Oxygen enhancement ratio(15-1993)
13. Radiation protection aspect of iodination of biomolecule(15-1993)
14. TLD(15-1993)
15. Free radicals (15-1993)
16. Radiation sensitizer. (15-1993)
17. Health effect of low level radiation (15-1994)
18. Radio-immunotherapy(15-1994)
19. Dose response models. (10-1994)
20. Radiation dose limiting recommendations. (10-1994)
21. Institutional storage & disposal of radioactivity. (10-1994)
22. Disposal of Radioactive waste (15-1994)
23. Surface contamination limits in NM lab (10-1995)
24. Personal monitoring (10-1995)
25. ICRP-60. Recommendation for radiation workers, Public & pregnant women. (10-1995)
26. Transport of Radioactive waste material(10-1995)
27. Genetic effect of Radiation. (10-1995)
28. Acute radiation (whole body) effect. (10-1995)
29. Outline Radiation handling procedures. (10-1995)
30. Safe Handling of Beta Emitters. (10-1995)
31. Basic principle (Nuclear physics) of film badge. (10-1995)
32. Fallout effects of Chernobyl accidents. (10-1995)
33. Acute Radiation syndrome(15-1995)
34. ALI(15-1995)
35. Radio-protective drugs(15-1995)
36. TLD. (10-1995)
37. Management of radioactive spill in a big NM dept of the hospital. (10-1995)
38. Half value layer. (10-1995)
39. Describe various aspect of biological effect of radiation & how they can be enhanced for more effective treatment of malignant tumors (25-1996)
40. Acute radiation syndrome. (15-1996)

41. ALARA. (15-1996)
42. Personal monitoring by film badge & TLD. Merits & demerits of these two methods. . (15-1996)
43. Concept of radiation hormeosis. (10-1996)
44. Discuss radiation syndrome (25-1996)
45. Maximum permissible radiation dose to occupationally exposed radiation worker and general population at large. (15-1996)
46. Methods of radioactive waste disposal. (15-1996)
47. Genetic effect of radiation. (15-1996)
48. Current ICRP recommendations for radiation workers & general population. (15-1997)
49. Radio protector drugs. (15-1997)
50. ALI. (15-1997)
51. Relative biologic effectiveness. (15-1997)
52. Radiobiological changes at the cellular level. (10-1997)
53. Radiation protection of personnel handling radioactivity. (10-1997)
54. Acute radiation syndrome. (15-1997)
55. ALARA. (15-1997)
56. Dose response models for radiation risk. (15-1997)
57. Personal dosimeters(10-1997)
58. Principle of ALARA. (10- May 2005)
59. ICRP recommendation of annual dose limits. (10- May 2005)
60. Acute and delayed effect of ionization radiation. (10- May 2005)
61. Radiation hormeosis & its significance. (10- May 2005)
62. Different types of Radiation protection measures taken in busy NMD? (10- May 2005)
63. Radioactive waste disposal. (10- Dec 2005)
64. Neutron monitor. (10- Dec 2005)
65. Radio-protectors. (10- Dec 2005)
66. ALALRA. (10- Dec 2005)
67. The concept of Radiation hormeosis. (10- Dec 2005)
68. TLD personal monitoring. (10- Dec 2005)

69. Radioactive waste disposal (10- Dec 2005)
70. Neutron monitors and its use (10- 2004)
71. oxygen enhancement ratio(10- 2004)
72. Personal monitoring (10- 2004)
73. ALARA (10- 2004)
74. Radiation waste disposal(10- 2004)
75. Describe the mechanism of Radio-sensitizer & discuss their clinical application.
(25- 2002)
76. RBE (10- 2002)
77. Effective dose (10- 2002)
78. Critical organ (10- 2002)
79. Health physics monitoring of NM workers. (10- 2002)
80. ALI. (10- 1989)
81. Effects on haemopoietic system after acute radiation exposure to whole body. (10- 1989)
82. Adv of using ^{99m}Tc RPs in NM from radiation protection point of view. (10- 1989)
83. Maximum permissible dose to occupationally exposed radiation worker. (10- 1989)
84. Various sources of Radiation exposure. (10- 1989)
85. Method to obtain beta dosimeter of RN (10- 2007)
86. Relation between CET & RBE & its relevance(10- 2007)
87. Dose limit prescribe by AERB and ICRP(10- 2007)
88. Biological effect of Radiation(10- 2007)
89. Describe in details the method to ascertain critical organ of a new RPs. (10- 2007)
90. Dose response curve. (10- 2007)
91. Factors affecting the outcome of any radiation therapy. (10- 2007)
92. Monitoring and preventive practices in a PET-cyclotron facility for radiation exposure. (10- 2007)
93. Radio-protector- examples, mode of action & their application. (10- 2007)
94. Radio-sensitizer- examples, mode of action & their application. (10- 2007)
95. Waste management in NMD. (10- 2007)

96. How would you plan management of nuclear accident in reactor as a NM physician? (10- 2007)
97. Isotope effect. (10- 1990)
98. Relative radio-sensitivity. (10- 1990)
99. Radiation protection problem arising from patients treated for cancer thyroid with ^{131}I . (15- 1990)
100. Genetic effect of Radiation. (15- 1990)
101. Acute radiation syndrome. (15- 1990)
102. Current philosophy of radiation protection, including recommendations of the international commission of radiation protection (ICRP). (15- 1991)
103. Genetic effect caused by ionizing radiation. (15- 1991)
104. Effects of radiation on developing embryo & fetus. (15- 1991)
105. TLD. (15- 1991)
106. Institutional storage & disposal of radioactivity (15- 1992)
107. Stochastic & non- stochastic effect of radiation (15- 1992)
108. TLD. (15- 1992)
109. Radiosensitizer. (15- 1992)
110. Dosimeter (15- 1992)
111. Detection & decontamination of low level Gamma, beta contamination. (10- 1992)
112. Radiation Casualties (15- 1993)
113. Radioactive decontamination. (15- 1992)
114. Acute Radiation Syndrome (15- 1992)
115. Radioprotectors (15- 1993)
116. Radio-sensitivity & cell cycles (15- 1993)
117. Radiation induced chromosomal aberration (15- 1993)
118. ALI (15- 1993)
119. Radiological prospect of using short lived RN in therapy (15- 1993)