

पुस्तिका में पृष्ठों की संख्या : 24

Number of Pages in Booklet : 24

पुस्तिका में प्रश्नों की संख्या : 180

No. of Questions in Booklet : 180

Paper Code : 08

SUBJECT : Radiological
Physics

समय : 3.00 घण्टे

Time : 3.00 Hours

प्रश्न-पत्र पुस्तिका संख्या /

Question Paper Booklet No.

5201393

BSAPRp-02

परीक्षा तिथि :- 11/08/2020

परीक्षा समय :- 9:00 To 12:00

अधिकतम अंक : 180

Maximum Marks : 180

प्रश्न-पत्र पुस्तिका एवं उत्तर पत्रक के पेपर सील/पॉलिथीन बैग को खोलने के बाद परीक्षार्थी प्रश्न-पत्र पुस्तिका संख्या को उत्तर पत्रक पर सावधानीपूर्वक अंकित करें। इसमें किसी भी प्रकार की त्रुटि होने पर जिम्मेदारी अभ्यर्थी की होगी।

The candidate fill the Question Paper Booklet No. on Answer Sheet carefully after opening the Paper Seal / Polythene bag. Candidate himself shall be responsible for any error.

परीक्षार्थियों के लिए निर्देश

1. सभी प्रश्नों के उत्तर दीजिए।
2. सभी प्रश्नों के अंक समान हैं।
3. प्रत्येक प्रश्न का केवल एक ही उत्तर दीजिए।
4. एक से अधिक उत्तर देने की दशा में प्रश्न के उत्तर को गलत माना जाएगा।
5. प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं, जिन्हें क्रमशः 1, 2, 3, 4 अंकित किया गया है। अभ्यर्थी को सही उत्तर निर्दिष्ट करते हुए उनमें से केवल एक गोले अथवा बबल को उत्तर पत्रक पर नीले बॉल प्वाइंट पेन से गहरा करना है।
6. OMR उत्तर पत्रक इस परीक्षा पुस्तिका के अन्दर रखा है। जब आपको परीक्षा पुस्तिका खोलने को कहा जाए, तो उत्तर-पत्र निकाल कर ध्यान से केवल नीले बॉल पॉइंट पेन से विवरण भरें।
7. प्रत्येक गलत उत्तर के लिए प्रश्न अंक का 1/3 भाग काटा जायेगा। गलत उत्तर से तात्पर्य अशुद्ध उत्तर अथवा किसी भी प्रश्न के एक से अधिक उत्तर से है। किसी भी प्रश्न से संबंधित गोले या बबल को खाली छोड़ना गलत उत्तर नहीं माना जायेगा।
8. मोबाइल फोन अथवा इलेक्ट्रॉनिक यंत्र का परीक्षा हॉल में प्रयोग पूर्णतया वर्जित है। यदि किसी अभ्यर्थी के पास ऐसी कोई वर्जित सामग्री मिलती है तो उसके विरुद्ध आयोग द्वारा नियमानुसार कार्यवाही की जायेगी।
9. कृपया अपना रोल नम्बर ओ.एम.आर. पत्रक पर सावधानीपूर्वक सही भरें। गलत अथवा अपूर्ण रोल नम्बर भरने पर 5 अंक कुल प्राप्तांकों में से काटे जा सकते हैं।

चेतावनी: अगर कोई अभ्यर्थी नकल करते पकड़ा जाता है या उसके पास से कोई अनधिकृत सामग्री पाई जाती है, तो उस अभ्यर्थी के विरुद्ध पुलिस में प्राथमिकी दर्ज कराते हुए विविध नियमों-प्रावधानों के तहत कार्यवाही की जाएगी। साथ ही विभाग ऐसे अभ्यर्थी को भविष्य में होने वाली विभाग की समस्त परीक्षाओं से विवर्जित कर सकता है।

INSTRUCTIONS FOR CANDIDATES

1. Answer all questions.
2. All questions carry equal marks.
3. Only one answer is to be given for each question.
4. If more than one answers are marked, it would be treated as wrong answer.
5. Each question has four alternative responses marked serially as 1, 2, 3, 4. You have to darken only one circle or bubble indicating the correct answer on the Answer Sheet using BLUE BALL POINT PEN.
6. The OMR Answer Sheet is inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully with blue ball point pen only.
7. 1/3 part of the mark(s) of each question will be deducted for each wrong answer. A wrong answer means an incorrect answer or more than one answers for any question. Leaving all the relevant circles or bubbles of any question blank will not be considered as wrong answer.
8. Mobile Phone or any other electronic gadget in the examination hall is strictly prohibited. A candidate found with any of such objectionable material with him/her will be strictly dealt as per rules.
9. Please correctly fill your Roll Number in O.M.R. Sheet. 5 Marks can be deducted for filling wrong or incomplete Roll Number.

Warning: If a candidate is found copying or if any unauthorized material is found in his/her possession, F.I.R. would be lodged against him/her in the Police Station and he/she would liable to be prosecuted. Department may also debar him/her permanently from all future examinations.

इस परीक्षा पुस्तिका को तब तक न खोलें जब तक कहा न जाए।

Do not open this Test Booklet until you are asked to do so.

08-□



1. The relation between absorbed dose and Kerma ($\beta = D/k^{col}$) for mega voltage beam is greater than 1 at
 - (1) Build up region
 - (2) transient electronic equilibrium region
 - (3) Charge particle equilibrium
 - (4) Free air chamber

2. Roentgen to cGray conversion factor for air, under the conditions of electronic equilibrium, is
 - (1) 0.876
 - (2) 0.95
 - (3) 0.58
 - (4) 1.95

3. At what depth the personal dose equivalent is defined for photon energies above 15 keV ?
 - (1) 0.7 mm
 - (2) 0.07mm
 - (3) 3 mm
 - (4) 10 mm

4. The ICRU sphere is a 30 cm diameter tissue equivalent sphere which contains
 - (1) 76.2 % oxygen
 - (2) 86.2 % oxygen
 - (3) 66.2 % oxygen
 - (4) 56.2 % oxygen

5. How much average energy is required to produce 5 ion pair in dry air ?
 - (1) 69.85 eV
 - (2) 369.85 eV
 - (3) 269.85 eV
 - (4) 169.85 eV

6. The Mass Energy Absorption Coefficient for 0.01 MeV photon energy is maximum for
 - (1) Air
 - (2) Bone
 - (3) Water
 - (4) Muscle

7. Increase in temperature of water produced by 1 Gy is
 - (1) $1.39 \times 10^{-4} \text{ }^\circ\text{C}$
 - (2) $0.39 \times 10^{-4} \text{ }^\circ\text{C}$
 - (3) $2.39 \times 10^{-4} \text{ }^\circ\text{C}$
 - (4) $3.39 \times 10^{-4} \text{ }^\circ\text{C}$

8. Bragg-Gray cavity theory is
 - (1) Based on ionization produced in a gas-filled cavity placed in medium
 - (2) can measure accurately for photon beams of energy above 3 MeV
 - (3) basis of TRS- 398 protocol
 - (4) not valid for particle dosimetry

9. In calibration of Cobalt 60 gamma rays, as per TRS 398 protocol for non-waterproof chambers a waterproofing sleeve should be used, made of PMMA and preferably
- (1) not thicker than 1.0 mm
 - (2) not thicker than 0.5 mm
 - (3) not thicker than 1.5 mm
 - (4) not thicker than 2 mm
10. As per TRS 398 protocol for electron beam quality determination cylindrical chamber may be used if
- (1) $R_{50} \geq 7 \text{ gm cm}^{-2}$
 - (2) $R_{50} \leq 4 \text{ gm cm}^{-2}$
 - (3) $R_{50} \geq 4 \text{ gm cm}^{-2}$
 - (4) $R_{50} \leq 7 \text{ gm cm}^{-2}$
11. Calculate the reference depth (Z_{ref}) as per TRS 398 protocol for determination of absorbed dose to water in electron beam for R_{50} is 1.5 gm/cm².
- (1) 0.8 gm/cm²
 - (2) 0.9 gm/cm²
 - (3) 0.6 gm/cm²
 - (4) 1.1 gm/cm²
12. An instrument calibrated by comparison with a primary standard is called as
- (1) National Standard
 - (2) Reference Standard
 - (3) Field standard
 - (4) Secondary Standard
13. The effective point of measurement for a cylindrical chamber of internal radius (r) irradiated by a photon beam is displaced by
- (1) 0.6 r from its centre and toward the source
 - (2) 0.5 r from its centre and toward the source
 - (3) 0.75r from its centre and toward the source
 - (4) 0.3 r from its centre and toward the source
14. The electrode spacing of the parallel-plate chambers in the range of
- (1) 1 mm
 - (2) 3 mm
 - (3) 2 mm
 - (4) 5 mm
15. If the ion chamber is not sealed, the chamber reading for a given exposure will
- (1) increase as the temperature increases or as the pressure increases.
 - (2) increase as the temperature decreases or as the pressure increases.
 - (3) increase as the temperature decreases or as the pressure decreases.
 - (4) increase as the temperature increases or as the pressure decreases.

16. For any radiation beam quality, the polarity effect of a well-designed chamber should be
- (1) Less than 0.5%
 - (2) Less than 2%
 - (3) Less than 5%
 - (4) Less than 1%
17. The energy of thermal neutrons is about
- (1) 1 eV
 - (2) 0.025 eV
 - (3) 1 keV
 - (4) 100 keV
18. The radiation chemical yield (G-value) is number of chemical entities, produced, destroyed or changed by expenditure of radiation energy
- (1) 50 eV
 - (2) 150 eV
 - (3) 500 eV
 - (4) 100 eV
19. The linear dose range of Fricke dosimeter is
- (1) 1 to 4 Gy
 - (2) 40 to 400 Gy
 - (3) 14 to 40 Gy
 - (4) 4 – 10 Gy
20. A cyclotron used in radiotherapy is designed to generate proton beams of a maximum energy of about
- (1) 250 MeV
 - (2) 150 MeV
 - (3) 50 MeV
 - (4) 100 MeV
21. An absolute dosimeter is considered from following :
- (1) Semi conductor dosimeter
 - (2) Fricke ferrous sulfate dosimeter
 - (3) Thermo luminescence dosimeter
 - (4) Scintillation detector
22. Neutron source Cf-252 is having half life
- (1) 2.65 years
 - (2) 3.65 years
 - (3) 5.65 years
 - (4) 1.65 years
23. Neutron contamination becomes predominant in high energy X-rays produced in linear accelerator after
- (1) 4 MV X-rays beam
 - (2) 6 MV X-rays beam
 - (3) 10 MV X-rays beam
 - (4) 15 MV X-rays beam

24. Thermal neutron absorbed by cadmium-113 is a reaction
- (1) Inelastic scattering
 - (2) Neutron capture
 - (3) Spallation
 - (4) Fission
25. If a radionuclide decays at a rate of 69.3 % per hour, what is its half-life ?
- (1) 10 hour
 - (2) 1 hour
 - (3) 0.1 hour
 - (4) 0.01 hour
26. The dose calibrator is an ionization chamber based instrument used for measuring the activity of radionuclides and radiopharmaceuticals in
- (1) Nuclear medicine
 - (2) Diagnostic radiology
 - (3) Radiotherapy
 - (4) Industrial radiography
27. For leakage testing and detection of radioactive contamination most common counter is used-
- (1) Ionization chamber
 - (2) G - M counter
 - (3) Thermo luminescence dosimeter
 - (4) Proportional counter
28. Charge amplification in Proportional counter-
- (1) $10^9 - 10^{10}$ fold
 - (2) $10^{12} - 10^{15}$ fold
 - (3) $10^6 - 10^8$ fold
 - (4) $10^3 - 10^4$ fold
29. Counter used for most precise measurements-
- (1) Ionization chamber
 - (2) G - M counter
 - (3) Semi conductor
 - (4) Proportional counter
30. The Sensitivity of solid state detectors is higher than gas filled detectors by
- (1) 10^4 times
 - (2) 10^9 times
 - (3) 10^2 times
 - (4) 10^7 times
31. The volume of a well type (re-entrant) ion chamber is about
- (1) 100 cm^3
 - (2) 50 cm^3
 - (3) 500 cm^3
 - (4) 250 cm^3
32. To enhanced thermal neutron sensitivity TL phosphor Lithium Fluoride (LiF) is enriched with-
- (1) ^6Li
 - (2) ^5Li
 - (3) ^9Li
 - (4) ^3Li
33. P-10 gas (90% Ar+ 10% methane) is used in
- (1) G - M counter
 - (2) Ion chamber
 - (3) Proportional counter
 - (4) Scintillation detector



34. What is effective atomic number of TL phosphor LiF: Mg, Ti
- (1) 7.4
 - (2) 16.3
 - (3) 15.3
 - (4) 8.2
35. The wall thickness of cylindrical ion chamber is made of low atomic number material and thickness is less than-
- (1) 0.1 gm/cm^2
 - (2) 2 gm/cm^2
 - (3) 1 gm/cm^2
 - (4) 0.5 gm/cm^2
36. For personal monitoring of radiation workers in India, TLD badges uses TL phosphor-
- (1) LiF : Mg, Ti
 - (2) LiF: Mg, Cu, P
 - (3) CaF₂ : Mn
 - (4) CaSO₄ : Dy
37. In semi conductor detector amount of energy required to create a electron-hole pair is
- (1) 3 eV
 - (2) 34 eV
 - (3) 43 eV
 - (4) 1.5 eV
38. The accuracy of the pocket dosimeter is about
- (1) $\pm 5\%$.
 - (2) $\pm 15\%$.
 - (3) $\pm 20\%$.
 - (4) $\pm 10\%$.
39. In CT simulator, tolerance limit of CT number accuracy for water is-
- (1) $0 \pm 5 \text{ HU}$
 - (2) $0 \pm 20 \text{ HU}$
 - (3) $0 \pm 10 \text{ HU}$
 - (4) $0 \pm 30 \text{ HU}$
40. As per AAPM TG-40 report consistency of annually output measurement of Cobalt 60 unit should be
- (1) 3%
 - (2) 2%
 - (3) 5%
 - (4) 1%
41. As per AAPM TG 40 report electron beam flatness consistency check of linear accelerator should be done
- (1) Annually and within 3%
 - (2) Monthly and within 2%
 - (3) Annually and within 2%
 - (4) Monthly and within 3%

42. Central axis parameter constancy (PDD, TAR) of a linear accelerator should be measured
- (1) Annually
 - (2) Monthly
 - (3) Daily
 - (4) Weekly
43. As per AAPM TG 40 report, coincidence of collimator, gantry, couch axes with isocenter of a linear accelerator should be within
- (1) 3 mm diameter
 - (2) 2 mm diameter
 - (3) 5 mm diameter
 - (4) 1 mm diameter
44. As per AAPM TG 40 report, Timer linearity and error for cobalt 60 unit should be within
- (1) 2%
 - (2) 1%
 - (3) 3%
 - (4) 5%
45. As per AAPM TG 40 report, The Optical distance indicator (ODI) of linear accelerator should be checked daily and within
- (1) 1 mm
 - (2) 0.5 mm
 - (3) 1.5 mm
 - (4) 2 mm
46. Field flatness of X-ray beam of Linear accelerator is defined as the variation of dose relative to the central axis over the central
- (1) 90% of the field size
 - (2) 100% of the field size
 - (3) 80% of the field size
 - (4) 50% of the field size
47. LET value (KeV/ μm) ranges for heavy charge particles
- (1) 0.2
 - (2) 2
 - (3) 12
 - (4) 100 – 200
48. Biological damage induced by X-rays is due to indirect action ?
- (1) 2/3
 - (2) 1/4
 - (3) 1/3
 - (4) 1
49. Which of the following is the most radiosensitive phase of the cell cycle ?
- (1) G1-S
 - (2) G2-M
 - (3) G1-M
 - (4) S-M
50. For sparsely ionizing radiation, OER is typically in the range of:
- (1) 2.5 – 3.5
 - (2) 1.5 – 2
 - (3) 1 – 2
 - (4) 3.5 – 5



51. Diameter of DNA Helix is

- (1) 5 nm
- (2) 2 nm
- (3) 3 nm
- (4) 4 nm

52. RBE varies critically with dose-rate effect for

- (1) Neutrons
- (2) X-rays
- (3) Protons
- (4) Alpha Particles

53. Life time of OH- radical in cell formed by X-ray irradiation

- (1) 10^{-15} sec
- (2) 10^{-9} sec
- (3) 10^{-5} sec
- (4) 10^{-7} sec

54. Potential lethal damage (PLD) and Sub lethal damage (SLD) repair are significant in

- (1) Fast neutron
- (2) X-ray
- (3) alpha particle
- (4) Slow Neutron

55. If 10^5 cells were irradiated according to single-hit kinetics so that the average number of hits per cell is one, how many cells would survive ?

- (1) 2.7×10^2
- (2) 2.7×10^3
- (3) 3.7×10^4
- (4) 4.5×10^4

56. The average value of the effective dose required to reduce the fraction of surviving cells to 37% of its previous value (D_{01}) for the multifraction survival curve for human cells is about

- (1) 3 Gy
- (2) 2 Gy
- (3) 1 Gy
- (4) 5 Gy

57. The shortest latent period is found as per Hiroshima and Nagasaki radiation accident survivors for-

- (1) Leukemia
- (2) Lymphoma
- (3) Neuroblastoma
- (4) Glioma

58. The gastrointestinal syndrome results from a total-body exposure to about

- (1) 4 Gy
- (2) 15 Gy
- (3) 25 Gy
- (4) 10 Gy

59. Mental retardation from irradiation occurred primarily at
- (1) 0 to 9 days of gestational age
 - (2) 3 to 6 weeks of gestational age
 - (3) 8 to 15 weeks of gestational age
 - (4) 6 to 8 weeks of gestational age
60. Permanent sterility occurs in females prepuberty at
- (1) 6 Gy
 - (2) 12 Gy
 - (3) 3 Gy
 - (4) 4 Gy
61. LD_{50/60} of humans (young adults without medical intervention) estimated between
- (1) 3-4 Gy
 - (2) 1-2 Gy
 - (3) 7-9 Gy
 - (4) 5-6 Gy
62. Chromosomal aberrations are detectable at
- (1) Above 2 Gy
 - (2) Above 0.1 Gy
 - (3) Above 3 Gy
 - (4) Above 1 Gy
63. As per ICRP 2007 report detriment adjusted nominal risk coefficients for cancer for radiation worker is
- (1) 5.5 % per Sievert for radiation worker
 - (2) 4.1 % per Sievert for radiation worker
 - (3) 0.2 % per Sievert for radiation worker
 - (4) 6% per Sievert for radiation worker
64. Radiation Sickness like nausea, vomiting and diarrhea(NVD) syndrome occurred due to acute whole body exposure to low LET radiation-
- (1) Above 3 Gy
 - (2) Above 0.5 Gy
 - (3) Above 1 Gy
 - (4) Above 2 Gy
65. Due to radiation effects on the embryo and Fetus, Loss of IQ is estimated to be about-
- (1) 30 points per sievert
 - (2) 50 points per sievert
 - (3) 100 points per sievert
 - (4) 10 points per Sievert
66. A total-body dose on the order of 100 Gy of γ -rays or its equivalent of neutrons results in death in 24 to 48 hours due to-
- (1) Haematopoietic syndrome
 - (2) Gastrointestinal syndrome
 - (3) Cerebrovascular syndrome
 - (4) Nausea, Vomiting and Diarrhea (NVD) syndrome
67. The most common conventional fractionation for curative radiotherapy delivered at five fractions per week is approximately
- (1) 1.5 – 2 Gy
 - (2) 1.8 – 2.2 Gy
 - (3) 1.5 – 2.5 Gy
 - (4) 2 – 3Gy

68. Continuous hyperfractionated accelerated radiation therapy (CHART) includes

- (1) Three fraction/day
- (2) One fraction/day
- (3) Two fraction/day
- (4) Four fraction/day

69. In LQ model, the linear and quadratic components of cell killing are equal for late responsive tissues by about

- (1) 2.5 Gy
- (2) 3 Gy
- (3) 1 Gy
- (4) 2 Gy

70. A hyper fractionation regimen consisting of 2 fractions per day 6 hours apart, for a total of 60 fractions in 6 weeks is designed to be equivalent to 60 Gy in 30 fractions in 6 weeks. What dose per fraction is required? (Consider only for tumor $\alpha/\beta = 10$ Gy)

- (1) 1.21 Gy/fraction
- (2) 1.08 Gy/fraction
- (3) 1.12 Gy/fraction
- (4) 1.14 Gy/fraction

71. The ratio α/β for early effects and late-responding tissues is about

- (1) 10 Gy and 3 Gy respectively
- (2) 3 Gy and 10 Gy respectively
- (3) 10 Gy and 30 Gy respectively
- (4) 30 Gy and 10 Gy respectively

72. Which is not in 4R's of Radiotherapy?

- (1) Repair
- (2) Radioprotector
- (3) Repopulation
- (4) Reassortment

73. The protective effect of hypoxia in cell is greatly reduced in

- (1) Cobalt 60 gamma rays
- (2) 1 MeV electrons
- (3) 3 MeV X-rays
- (4) Heavy charged particles

74. Type of radiotherapy with intention to prevent possible metastases or recurrence is

- (1) Curative radiotherapy
- (2) Palliative radiotherapy
- (3) Prophylactic radiotherapy
- (4) Total body irradiation

75. How many cancer patients require radiotherapy at some stage during their treatment?

- (1) Approximately 50 – 60% of all cases
- (2) Approximately 20 – 30% of all cases
- (3) Approximately 70 – 80% of all cases
- (4) 100% cases

76. Drugs are administered before the course of radiation therapy is called-

- (1) Concomitant chemotherapy
- (2) Adjuvant chemotherapy
- (3) Neoadjuvant chemotherapy
- (4) Hormone Therapy

77. A region of processed film transmits 10% of the incident light. What is the optical density of the region ?

- (1) 1
- (2) 10
- (3) 2
- (4) 100

78. What is relation The Applied Voltage (kVp) and amount of radiation exposure produced from a X-ray tube ?

- (1) Amount of radiation produced proportional to $(kVp)^2$
- (2) Amount of radiation produced proportional to (kVp)
- (3) Amount of radiation produced inversely proportional to $(kVp)^2$
- (4) Amount of radiation produced proportional to $(kVp)^3$

79. The space charge effect is over come after applied voltage (kVp) in a X-ray tube

- (1) Above 10 kVp
- (2) Above 40 kVp
- (3) Above 20 kVp
- (4) Above 60 kVp

80. Titanium dioxide or magnesium oxide is used in intensifying screen as-

- (1) Base
- (2) Phosphor
- (3) Reflecting Layer
- (4) Protective coating

81. What is thickness of protective coating used in intensifying screen ?

- (1) 10 – 20 μm
- (2) 30 – 40 μm
- (3) 0.5 – 10 μm
- (4) 60 – 70 μm

82. What is the speed of the X-ray film, if 10 mR is required to produce an optical density of 1.0 above base density ?

- (1) 50
- (2) 10
- (3) 100
- (4) 20

83. The dark room uses safe light of

- (1) Red lamp of > 50 watt
- (2) Red lamp of < 50 watt
- (3) Red lamp of > 15 watt
- (4) Red lamp of < 15 watt

84. What is not correct about a Grid ?

- (1) Increases image contrast
- (2) Placed between the film and patient
- (3) The scattered radiation can be removed
- (4) Grid ratio is ratio of width to the height of spacer between strips



85. The useful range of optical density in diagnostic radiology
- (1) 0.25 – 2.0
 - (2) 0.25 – 0.5
 - (3) 0.25 – 5.0
 - (4) 2.0 – 5.0
86. The leakage radiation through the X-ray tube housing at a distance of 1.0 metre from the target, when the tube is operating at the maximum kVp and maximum current shall not exceed an air kerma of
- (1) 10 mGy in one hour
 - (2) 1 mGy in one hour
 - (3) 100 mGy in one hour
 - (4) 0.1 mGy in one hour
87. Calculate the pixel size of a computed tomography image if field of view(FOV) = 250 mm and has a matrix element of 512.
- (1) 1 mm
 - (2) 0.25 mm
 - (3) 0.5 mm
 - (4) 1.28 mm
88. Ring artifacts are found in CT scanner with technology
- (1) Rotate/rotate
 - (2) Rotate/Translate
 - (3) Stationary/stationary
 - (4) Helical
89. Diagnostic ultrasound uses frequency range for imaging-
- (1) < 15 Hz
 - (2) 15 – 20000 Hz
 - (3) 1 – 20 MHz
 - (4) > 20 MHz
90. Calculate the pitch, if table moves 10 mm in one rotation of a gantry in 1 second to make a 5 mm slice thickness of a patient, then
- (1) Pitch = 50
 - (2) Pitch = 2
 - (3) Pitch = 10
 - (4) Pitch = 0.5
91. Unit of Magnetic field strength(B) used in Magnetic Resonance Imaging is Tesla. The 1 Tesla is equal to
- (1) 100 Gauss
 - (2) 0.01 Gauss
 - (3) 1000 Gauss
 - (4) 10000 Gauss
92. Find the resonance frequency for protons in a 3-tesla magnetic field. (Given Gyromagnetic ratio= 42.6 MHz/T)
- (1) 127.8 MHz
 - (2) 14.2 MHz
 - (3) 383.4 MHz
 - (4) 0.07 MHz

93. CT Number for water is
- (1) 1000
 - (2) -1000
 - (3) 0
 - (4) 1
94. Which is not a reconstruction algorithm used in CT imaging ?
- (1) Simple back projection
 - (2) Fourier transform
 - (3) Filtered back projection
 - (4) Spectral resolution
95. Which is natural piezoelectric crystal ?
- (1) Barium Titanate
 - (2) Lead Zirconate Titanate
 - (3) Quartz
 - (4) Lead Metaniobate
96. What is not correct for measurement of CT Dose Index (CTDI) ?
- (1) 16 cm diameter head phantom is used
 - (2) It quantify Patient risk
 - (3) 100 mm ion chamber is used
 - (4) 32 cm diameter body phantom is used
97. Which is a reactor produced radionuclide ?
- (1) Molybdenum-99
 - (2) Carbon-11
 - (3) Oxygen-15
 - (4) Iodine-123
98. For bone metabolism, which radionuclide is most commonly used ?
- (1) ^{13}N
 - (2) ^{131}I
 - (3) ^{111}In
 - (4) $^{99\text{m}}\text{Tc}$
99. Which is shortest lived radionuclide ?
- (1) Carbon-11
 - (2) Nitrogen-13
 - (3) Oxygen -15
 - (4) Fluorine-18
100. ^{99}Mo decays to $^{99\text{m}}\text{Tc}$ by decay mode
- (1) Electron capture
 - (2) Isomeric transition
 - (3) β^+ decay
 - (4) β^- decay
101. Most commonly detector used in Positron Emission Tomography(PET)-
- (1) BGO
 - (2) NaI(Tl)
 - (3) Plastic
 - (4) CsI(Tl)
102. Which radioactive is useful in both nuclear medicine imaging and therapy ?
- (1) ^{11}C
 - (2) $^{99\text{m}}\text{Tc}$
 - (3) ^{67}Ga
 - (4) ^{131}I

103. When a positron undergoes mutual annihilation with electron, their rest masses are converted into pair of photons and these photons emitted at-

- (1) 270 degree
- (2) 180 degree
- (3) 45 degree
- (4) 90 degree

104. Half life of ^{99m}Tc radionuclide is-

- (1) 8 days
- (2) 60 hrs
- (3) 68 hrs
- (4) 6 hrs

105. Radionuclide ^{13}N is most commonly used in

- (1) Thyroid function
- (2) Cerebral blood flow
- (3) Myocardial perfusion
- (4) Renal function

106. The average electron multiplication factor in photomultiplier tube is

- (1) $\times 9$ per dynode
- (2) $\times 12$ per dynode
- (3) $\times 3$ per dynode
- (4) $\times 6$ per dynode

107. In external beam radiotherapy, the maximum buildup region in water for-

- (1) Cobalt 60 beam
- (2) 6 MV X-ray beam
- (3) 25 MV X-ray beam
- (4) 10 MV X-ray beam

108. Calculate the equivalent field size of a $10 \times 15 \text{ cm}^2$ field by using simple rule-of-thumb method :

- (1) 13.3 cm^2
- (2) 12 cm^2
- (3) 14 cm^2
- (4) 11.7 cm^2

109. Calculate the Wedge angle (θ), if angle between the central axis of the two beams is 60 degree

- (1) 45 degree
- (2) 15 degree
- (3) 30 degree
- (4) 60 degree

110. Internal Target Volume (ITV) was defined in target volume definition in external photon beam in

- (1) ICRU report 50
- (2) ICRU report 38
- (3) ICRU report 62
- (4) ICRU report 29

111. In current recommendation, Wedge angle in external photon beam is defined at

- (1) 5 cm depth
- (2) 10 cm depth
- (3) At 50% isodose curve
- (4) 15 cm depth

112. The lateral distance between lateral distance between 90% and 20% isodose lines at the depth of D_{\max} is called-

- (1) Geometric Penumbra
- (2) Field Size
- (3) Field Symmetry
- (4) Physical Penumbra

113. The highest dose in the target area is called the maximum target dose, provided this dose covers a minimum area

- (1) 0.1 cm^2
- (2) 2 cm^2
- (3) 1 cm^2
- (4) 5 cm^2

114. Increase in dose to tissue beyond healthy lung for cobalt-60 gamma rays is

- (1) +4% / cm of lung
- (2) +5% / cm of lung
- (3) +10% / cm of lung
- (4) +2% / cm of lung

115. Lipowitz metal (Cerrobend) used for shielding material in radiotherapy is having density-

- (1) Around 93% of lead density at 20°C
- (2) Around 73% of lead density at 20°C
- (3) Around 83% of lead density at 20°C
- (4) Around 63% of lead density at 20°C

116. What is mean energy of the electron beam, \bar{E}_0 , at the phantom surface is related to $R_{50} = 3.86 \text{ cm}$. (Constant $C_4 = 2.33 \text{ MeV/cm}$)

- (1) 6 MeV
- (2) 9 MeV
- (3) 12 MeV
- (4) 4 MeV

117. In which implant system Basal dose points are used ?

- (1) Paterson-Parker system
- (2) Quimby System
- (3) Paris system
- (4) Memorial System

118. The dose function which accounts for angular dependence of photon absorption and scatter in the encapsulation and the medium ?

- (1) Air kerma strength
- (2) Anisotropy function
- (3) Radial dose function
- (4) Geometric factor

119. Which of the following match for average energy is not correct for the radioactive sources used in brachytherapy ?

- (1) Ir-192 0.38 MeV
- (2) Pd-103 0.021 MeV
- (3) Co-60 1.25 MeV
- (4) Ra-226 1.20 MeV



120. In planer implant as per Paterson-Parker System the spacing of the needles should not be more than

- (1) 0.5 cm from each other or from the crossing ends
- (2) 1.0 cm from each other or from the crossing ends
- (3) 1.5 cm from each other or from the crossing ends
- (4) 2.0 cm from each other or from the crossing ends

121. The maximum dose to bladder and rectum should be, as far as possible, less than the dose to point A in intracavitary brachytherapy-

- (1) 60%
- (2) 90%
- (3) 80%
- (4) 75%

122. The active length of commercially available HDR brachytherapy is in order of

- (1) 1 mm
- (2) 5 mm
- (3) 10 mm
- (4) 2 mm

123. Source distribution in interstitial implant systems is non uniform in

- (1) Paterson-Parker System
- (2) Quimby System
- (3) Paris System
- (4) Computer System

124. Which is not a suitable isotope for intravascular brachytherapy ?

- (1) Strontium/yttrium-90
- (2) Vanadium-48
- (3) Tungsten/rhenium-188
- (4) Cesium 137

125. In distorted application of intracavitary brachytherapy, the point B is defined as

- (1) 3 cm from the point A at the same level of point A
- (2) 5 cm from the patient's midline at the same level of point A
- (3) 2 cm from point A at the same level of point A
- (4) 3 cm from the patient's midline at the same level of point A

126. What is mono energetic Gamma Ray brachy therapy source ?

- (1) Ir-192
- (2) Pd-103
- (3) I-125
- (4) Au-198

127. The high-energy electrons loses energy in water or soft tissue at the rate of about

- (1) 4 MeV/cm
- (2) 2.5 MeV/cm
- (3) 3 MeV/cm
- (4) 2 MeV/cm

128. The correction-based algorithm used for dose calculation is limited in situations where -

- (1) Scatter corrections as a function of scattering volume, field size and shape applied
- (2) Attenuation corrections for beam intensity modifiers such as wedge filters, compensators and blocks applied
- (3) Attenuation corrections for contour irregularity applied
- (4) Electronic equilibrium is not fully established

129. Convolution-superposition method is class of

- (1) Model-based dose algorithm
- (2) Correction-based algorithm
- (3) Direct Monte Carlo
- (4) 3D heterogeneity corrections in tissue interfaces

130. Number of Cobalt 60 sources used in Gamma knife Perfexion

- (1) 158
- (2) 192
- (3) 101
- (4) 149

131. For dose reporting in Stereo tactic body radiotherapy (SBRT), the ratio of highest dose received by 5% of the Planning Target Volume(PTV) to the lowest dose received by 95% of PTV is called

- (1) Homogeneity Index
- (2) Plan conformity index
- (3) Heterogeneity Index
- (4) Unity index

132. Overall accuracy is commonly accepted standard in the coverage of intended target for the SRS and SRT procedures

- (1) ± 2 mm
- (2) ± 3 mm
- (3) ± 0.5 mm
- (4) ± 1 mm

133. The technique Simulated annealing is used in

- (1) Plan optimization in IMRT Planning
- (2) Gamma Knife planning
- (3) Motion management in IGRT
- (4) Patient immobilization

134. Respiratory gating technique should be considered if significant normal tissue sparing can be gained and
- (1) range of motion is greater than 10 mm in any direction.
 - (2) range of motion is greater than 5 mm in any direction.
 - (3) range of motion is greater than 3 mm in any direction.
 - (4) range of motion is greater than 15 mm in any direction.
135. Cyber Knife, A stereotactic radio surgery system uses
- (1) 10 MV linear accelerator
 - (2) 4 MV linear accelerator
 - (3) 15 MV linear accelerator
 - (4) 6 MV linear accelerator
136. Before first treatment in Intensity Modulated Radiotherapy(IMRT) Plan verification, point dose should be within
- (1) 3%
 - (2) 2%
 - (3) 5%
 - (4) 1%
137. What is annual equivalent dose limit for lens of the eye of occupational radiation worker ?
- (1) 150 mSv/year
 - (2) 500 mSv/year
 - (3) 50 mSv/year
 - (4) 15 mSv/year
138. What is thickness of viewing window of lead glass of diagnostic X-ray room ?
- (1) 0.5 mm thick lead equivalent
 - (2) 1 mm thick lead equivalent
 - (3) 1.5 mm thick lead equivalent
 - (4) 2.5 mm thick lead equivalent
139. Calculate the effective dose of a person, if his different body parts has received radiation dose from different radiation sources, his gonads receive 0.15 mGy from X-rays, Lung receive 0.3 mGy from proton and skin 0.12 mGy from Alpha radiation.
- (1) 0.108 mSv
 - (2) 0.084 mSv
 - (3) 0.036 mSv
 - (4) 0.072 mSv
140. What is radiation dose limit for occupational radiation worker if she is pregnant woman ?
- (1) 2 mSv to the embryo/fetus
 - (2) 5 mSv to the embryo/fetus
 - (3) 1 mSv to the embryo/fetus
 - (4) 0.5 mSv to the embryo/fetus
141. To assess the overall effect of radiation dose on a large group of people, the individual dose may be multiplied by population number exposed, the quantity is called
- (1) Collective dose
 - (2) Committed dose
 - (3) Effective dose
 - (4) Equivalent dose

142. If exposure rate is 200 mR/hr at 1 metre from a cobalt 60 source, if one half value thickness (HVT) of lead is imposed in path, what is exposure rate at 2 metre ?

- (1) 12.5 mR/hr
- (2) 25 mR/hr
- (3) 6.25 mR/hr
- (4) 50 mR/hr

143. What is relation between half value thickness (HVT) and Tenth value thickness (TVT)-

- (1) $TVT = 2.32 HVT$
- (2) $HVT = 1.32 TVT$
- (3) $TVT = 3.32 HVT$
- (4) $TVT = 4.32 HVT$

144. What is permissible dose limit for occupational radiation worker ?

- (1) 10 mr/week
- (2) 20mR/Week
- (3) 2 mR/week
- (4) 40 mR/week

145. Calculate the work load (W) for linear accelerator if 50 patients are treated per day for 5 days per week. The delivered dose for each patient is 4 Gy at 1 metre.

- (1) 1.5×10^3 Gy/week
- (2) 1×10^3 Gy/week
- (3) 0.5×10^3 Gy/week
- (4) 10×10^3 Gy/week

146. The thickness 218 mm of concrete (2.35 gm/cm^3) is the Tenth value thickness (TVT) of-

- (1) Primary beam of 15 MV X rays
- (2) Primary beam of 6 MV X rays
- (3) Primary beam of Cobalt-60 gamma rays
- (4) Primary beam of 10 MV X rays

147. If radiation level at the surface of the package is 0.005mSv/Hr and transport index is between 0-1 then this a

- (1) I-White
- (2) III-Yellow
- (3) II-Yellow
- (4) Special arrangement

148. Which test is not recommended to perform for type-B package ?

- (1) Mechanical test
- (2) Thermal test
- (3) Water Immersion test
- (4) Free drop test

149. Which is not a method of disposal of solid waste of radioactive material ?

- (1) Incineration
- (2) Chemical Treatment
- (3) Burial of solid waste in the ground
- (4) Sea dumping



150. In free drop test the height of drop, measured from lowest point of specimen to the upper surface of the target must not be-

- (1) Less than 0.9 metre for package weight up to 5000 Kg
- (2) Less than 2.2 metre for package weight up to 5000 Kg
- (3) Less than 1.2 metre for package weight up to 5000 Kg
- (4) Less than 0.6 metre for package weight up to 5000 Kg

151. In trefoil radiation symbol, what is angle between two foils ?

- (1) 30 degree
- (2) 60 degree
- (3) 45 degree
- (4) 75 degree

152. Gross weight of package should be marked on package if

- (1) it exceeds 30 Kg for domestic transport.
- (2) it exceeds 20 Kg for domestic transport.
- (3) it exceeds 60 Kg for domestic transport.
- (4) it exceeds 40 Kg for domestic transport.

153. T-rod is used in emergency condition to restoring the source

- (1) To ON position in HDR Brachytherapy machine
- (2) To OFF position in Tele cobalt machine
- (3) To OFF position in HDR Brachytherapy machine
- (4) To ON position in Tele cobalt machine

154. United Nations(UN) has classified radioactive material as dangerous goods in UN class

- (1) 9
- (2) 1
- (3) 5
- (4) 7

155. Period of validity of license issued by Atomic Energy Regulatory Board(AERB), India is

- (1) 5 years from the date of issue
- (2) 3 years from the date of issue
- (3) 1 year from the date of issue
- (4) 2 years from the date of issue

156. TREMCARD is used during

- (1) Radioactive waste disposal
- (2) Radiation emergency in radiotherapy treatment
- (3) Radiation emergency in nuclear medicine procedures
- (4) Transport of radioactive material

157. Cobalt 60 radioactive source emits 99% beta particle of energy (E_{\max})

- (1) 1.48 MeV
- (2) 0.48 meV
- (3) 1.32 MeV
- (4) 0.32 MeV

158. In Ortho voltage therapy SSD is usually kept as-

- (1) 15-20 cm
- (2) 50 cm
- (3) 2 cm
- (4) 80 cm

159. In Conventional radiography the recommended filtration above 100 KVp is

- (1) 1.5 mm Al
- (2) 0.5 mm Al
- (3) 2 mm Al
- (4) 2.5 mm Al

160. The efficiency of X-ray production for high-energy accelerator beams which depending upon energy is-

- (1) Less than 1%
- (2) Around 99%
- (3) Around 30-95%
- (4) Around 100%

161. The probability of bremsstrahlung production varies with the Atomic Number(Z) of the target material-

- (1) Z^2
- (2) Z
- (3) Z^3
- (4) $1/Z$

162. How long it take for 50 percent of a sample of radon-222 to decay ?

- (1) 4.05 Days
- (2) 3.82 Days
- (3) 1.91 Days
- (4) 4.82 Days

163. All nuclei after which atomic number(Z) are unstable and undergo radioactive decay until they reach a stable configuration-

- (1) $Z > 92$
- (2) $Z > 74$
- (3) $Z > 83$
- (4) $Z > 90$

164. One Curie of Cobalt 60 radioactive source can be expressed as-

- (1) 37 GBq
- (2) 370 GBq
- (3) 3.7 GBq
- (4) 0.37 GBq



165. Radiation therapy accelerate electrons by electromagnetic waves of frequency in the microwave region-
- (1) 2000 mega cycles/sec
 - (2) 4500 mega cycles/sec
 - (3) 1500 mega cycles/sec
 - (4) 3000 mega cycles/sec
166. Calculate the total number of electrons bombarding the target of an x-ray tube operated at 160 mA for 0.1 sec.
- (1) 1×10^{17} electrons
 - (2) 1×10^{19} electrons
 - (3) 1×10^{10} electrons
 - (4) 1×10^{14} electrons
167. A narrow beam containing 500 monoenergetic photons is reduced to 250 photons by a slab of copper 10^{-2} metre thick. What is the total linear attenuation coefficient of the copper slab for these photons ?
- (1) 0.693 metre^{-1}
 - (2) 6.93 metre^{-1}
 - (3) 69.3 metre^{-1}
 - (4) $0.0693 \text{ metre}^{-1}$
168. Which interaction of radiation with matter is only depends only on number of electrons per gram ?
- (1) Pair Production
 - (2) Photo electric absorption
 - (3) Coherent Scattering
 - (4) Compton effect
169. The threshold energy for triplet Production is
- (1) 0.511 MeV
 - (2) 1.02 MeV
 - (3) 2.04 MeV
 - (4) 0.255 MeV
170. X and gamma rays with energy between 30 keV and 30 MeV interact in soft tissue predominantly by-
- (1) Incoherent scattering
 - (2) Pair Production
 - (3) Rayleigh Scattering
 - (4) Photo electric effect
171. In Compton Scattering, the maximum value of energy of a photon scattered is at
- (1) 180 degree
 - (2) 0 degree
 - (3) 90 degree
 - (4) 45 degree
172. Photoelectric attenuation depends strongly on the atomic number (Z) of the absorbing material, mass photoelectric attenuation coefficient is proportional to-
- (1) Z^3
 - (2) Z^2
 - (3) Z
 - (4) $1/Z^2$

173. At what phonon energy relative number of interactions with water are same for photoelectric and Compton effect-

- (1) 0.01 MeV
- (2) 0.06 MeV
- (3) 4 MeV
- (4) 0.026 MeV

174. An X-ray beam produced by an X-ray tube operated at about 90 kVp is considered as equivalent to monoenergetic beam of-

- (1) 30 KeV
- (2) 60 KeV
- (3) 90 KeV
- (4) 45 KeV

175. The stopping power caused by ionization interactions for charged particles is proportional to-

- (1) Square of particle velocity
- (2) Square of the particle charge
- (3) Inversely square of the particle charge
- (4) Particle charge

176. What is the kinetic energy of a photoelectron ejected from the K shell of lead ($E_B = 88 \text{ keV}$) by photoelectric absorption of a photon of 110 keV ?

- (1) 12 keV
- (2) 198 keV
- (3) 22 keV
- (4) 110 keV

177. In a normal distribution, 95.5% of all measured values fall within either side of the mean-

- (1) 1σ
- (2) 3σ
- (3) 0.5σ
- (4) 2σ

178. A method used to determine the "goodness of fit" of measured data to an expected probability distribution.

- (1) Student's t-test
- (2) Chi-Square Test
- (3) F- distribution
- (4) Sign test

179. What quantity cannot be measured accurately above photon energies 3 MeV ?

- (1) Rontgen
- (2) Absorbed Dose
- (3) Kerma
- (4) Equivalent Dose

180. 100 pico Rontgen in air is equal to

- (1) $2.58 \times 10^{-10} \text{ C/kg}$
- (2) $2.58 \times 10^{-4} \text{ C/kg}$
- (3) $2.58 \times 10^{-24} \text{ C/kg}$
- (4) $2.58 \times 10^{-14} \text{ C/kg}$



रफ कार्य के लिए स्थान / SPACE FOR ROUGH WORK

