FRCR Part 1 Physics Exam Paper 3

1) Direct emission from radioactive decay includes:

A. Beta minus emission. T neutron XS
B. Characteristic X-rays. T internal conversion or K-shell capture
C. Bremsstrahlung. – F.
D. Alpha particles. – T
E. Positron emission. – T neutron deficit

2. Regarding scattered radiation:

A. More is measured on the tube side of the patient in diagnostic radiology. T most occur at LES. + forward ones are absorbed
B. A Compton scattered photon is deflected from its path with no loss of energy. F – this is elastic
C. There is no ionisation with elastic scattering. T
D. During a Compton interaction a photoelectron is produced. F – c PE
E. At higher kV more photons are deflected through large angles. F.

3. Regarding luminescence:

A. It is the process by which a material absorbs energy from an external source and re-emits it as light. T
B. Fluorescence is the delayed emission of light following energy input. F – phosphorescence is.
C. For light to be emitted from a phosphor, electrons in the electron traps must fall to the conduction band. F – to valence band.
D. After irradiation, a thermoluminescent phosphor must be stimulated with a laser for light to be emitted. F. Heat PSL requires light
E. Intensity of light emitted from a phosphor is proportional to the intensity of the irradiating x-ray beam. T

4. Effective dose:

A. Is derived from absorbed dose multiplied by a tissue weighting factor. F – x equivalent dose F.
B. Is measured in Gray. F SV
C. Takes in to consideration the different radiosensitivity of tissues T
D. Combines organ doses to give a whole body dose. T
E. In a dental radiograph is in the order of 0.001mSv. T

5. The units for the following terms are true:

A. Entrance surface dose(ESD) –Sv F (Gy)
B. Equivalent dose-Gy F (SV)
C. Dose area product (DAP)- Gy cm F $Gy\,cm^2$
D. Absorbed dose-Joules/kg – T
E. Effective dose- Gy F (SV.

6. Regarding the effects of ionizing radiation: 1:20,000 ; or 5% mSv

A. The risk of fatal cancer from a uniform whole body dose irradiation is 1 in 200,000 per mSv F
B. The risk of developing fatal childhood cancer from irradiation in utero is 1 in 50,000 per mGy. F. 1:33, wo per mGy 3%.
C. The cornea is more radiosensitive than the lens of the eye. F
D. Radiation dose to the hands of staff arises from the use of radionuclides as well as from x-rays. T
E. Deterministic effects are hereditary. F

7. The following annual dose limits apply:

A. The equivalent dose to the skin of a member of the public is 50mSv. T (1/10 : 1 mSv fetus = member stands.
B. The fetus of a pregnant employee should not receive more than 0.1mSv. F
C. The equivalent dose to the lens of a member of the public is 15mSv T
D. The equivalent dose to the extremities of a member of the public is 150mSv. F
E. The effective dose to an employee is 10mSv. F 20mSv.

8. Concerning IRR 99

A. The dose limits depends on the weighting factor of the radiation type to which the person is exposed. F
B. The annual dose limits for comforters and carers is 3mSv. F IRR dose constraint
C. The RPA must be present in the X-ray department during working hours. – F
D. The aim is to ensure that the radiation dose to employees and public is as low as is reasonably achievable. F. ALARP (A).
E. The regulations do not apply to radiation therapy. F,

9. Concerning radiation protection of staff and patients:

A. 2.5mm of lead equivalent filter should be used for routine radiological procedures F . 2.5mm Al.
B. Lead screen panels used in x-ray rooms to protect staff are usually 5mm thick. F. 2mm
C. In fluoroscopy, the scattered radiation to staff from an overcouch tube is less than an undercouch one. F . discuss
D. Thyroid collars used in radiology have a 0.5mm lead equivalence. T
E. For chest radiography, the film to focus distance should not be less than 30cm. F
60cm.

10. A focused grid:

A. May cause radiation cut-off at large field sizes F
B. Should be used within a defined range of focus to film distance. T
C. Requires an increase in patient dose to achieve the same film density as an exposure without the grid. T
D. Reduces geometric distortion of the image. F
E. Improves contrast by reducing the amount of scattered radiation reaching the film. T

11. In tomography:

A. The contrast is dependent on the slice thickness. T
B. Only structures at right angles to the film appear sharp. F
C. Tomography is most useful when imaging structures with low inherent contrast. F
D. Image unsharpness is unaffected by the use of tomography. F
E. Patient dose is higher than in conventional radiography. T

12. in the rotating anode x-ray tube:

A. The anode stem is made of tungsten. F
B. The effective focal spot size depends on the angle of the anode. T
C. Heat is removed from the anode mainly by thermal conduction. F
D. Heat is removed more efficiently when a low current is used. F
E. The anode heel effect occurs in a direction parallel to the anode-cathode axis. T

13. Extrafocal radiation:

A. In a metal tube can be limited by grounding the metal tube envelope. T
B. Can be completely removed from the beam by appropriate filtration. F
C. Is more prominent at low tube currents. F
D. has no effect on image quality. F
E. Is caused by secondary electrons from the target striking the anode outside the target area. T

14. Regarding the production of an x-ray image:

A. Low kV techniques increase the amount of forward scatter. F
B. In radiography of the hand, use of a grid is highly recommended. F
C. In macro-radiography an air gap is used primarily to decrease the amount of scatter. F
D. Geometric unsharpness depends on the tube target angle. T
E. The resolution limit of a system is equal to the spatial frequency that corresponds to an MTF of 1. F

15. in a mammographic x-ray set with a molybdenum target:

A. The x-ray spectrum is generally dominated by characteristic radiation. T
B. The typical tube potential for mammographic exposures is about 35kV. F too high
C. The anode does not rotate. F
D. The radiation detector for the automatic exposure control is between the grid and the cassette. F
E. The filter may also be molybdenum. T

16. Regarding digital radiography:

A. The charged coupled device converts photons into an electronic signal. T
B. The input phosphor is coupled to the charge coupled device by fibre optics. T
C. Both flat panel array detectors and charged coupled devices have dead areas. T
D. Resolution on a flat panel array is limited to the width of the detector elements. T
E. Image windowing can only be altered after the image has been taken. T

17. Modification of the image greyscale using a look-up-table (LUT) might be done for the following reasons:

A. To increase the visibility of small isolated structures. F
B. To improve the sharpness of edges. F
C. To improve presentation of fine texture patterns. F
D. To increase image contrast to improve the visibility of a subtle lesion. T
E. To improve the presentation of the overall greyscale range. T

18. The electron beam in an image intensifier:

A. Is accelerated from input to output screen. T
B. Is focused on to the output screen by magnets. F
C. Can be distorted by external magnetic fields. T
D. Contributes to brightness gain only through minification of the image. F amplification (flux gain) through increase in energy.
E. Is refocused when a magnified field of view is selected. T

19. Brightness gain in an image intensifier:

A. Is the ratio of input phosphor brightness to output phosphor brightness. F – output to input.
B. Is only through minification of the image. F
C. Is overall approximately 50 fold. F 5000.
D. Increases with increased voltage across the intensifier. T
E. Increases if the output phosphor size is increased. F minification gain ↓.

20. Regarding fluoroscopy:

A. Pulsed mode fluoroscopy offers much better spatio-temporal resolution than continuous mode fluoroscopy. T = coronary vessels / infants
B. In the UK, the maximum entrance dose rate limit for a standard patient is 100mGy per minute. True but 50mGy min. is adopted.
C. Automatic Brightness control (ABC) is the same as Automatic Exposure Control (AEC). F.
D. The purpose of ABC is to maintain stable viewing conditions independent of patient size, body sections and projection angle. T
E. The operator should not manually adjust collimation as this is done automatically. F manually in good practice.

3rd in state/ state.

21. Regarding modern CT scanners:

A. They can use thousands of detector elements. T
B. Scattered radiation is controlled by detector collimation. T
C. The efficiency of sodium iodide crystals is about 50%. F 100%
D. The effective dose to the patient is measured for every CT scan. F
E. Ring artefacts are caused by the miscalibration of detectors in third-generation scanners.
T – Size of radius of any determin the portion in the detector array.

22. Regarding partial volume effect:

A. A thin high-contrast structure that crosses the transaxial plane at an oblique angle might disappear completely. F – will appear larger e.g. CA filled vessel.
B. It is increased when the slices get thinner. – F reduced
C. It reduces the visibility of low contrast detail. – T
D. A high contrast object that is smaller than a voxel will appear larger on an image. T
E. It is due to the averaging of CT numbers in each voxel. T

23. The following are effective dose reduction methods in cardiac CT:

A. Tube current modulation. T mA on the pure arterial phase
B. Reducing pitch. F
C. Decreasing tube current during phases of cardiac cycle. T ↑ 50%
D. Matching the pitch to the patient's heart rate. T
E. Increasing the scanning time. F.

24. Regarding a Technetium generator:

A. The generator is shielded with lead or depleted uranium. T
B. The parent ^{131}I is absorbed within the exchange column of aluminium beads. F – ^{99}Mo in
C. In transient equilibrium, the daughter and the parent appear to decay together with the half life of the parent. T
D. Technetium is eluted with sterile water. F Sterile Saline
E. The lead shielding and the metal container are reusable. T

25. In single-photon emission computed tomography (SPECT):

A. It consists of a gamma camera with a collimator rotating around a patient on a couch. T
B. The camera rotates continuously to acquire images. T
C. It requires fewer counts than conventional static imaging. T
D. The same number of counts can be acquired in half the time by using a double headed camera. T
E. Sensitivity decreases when a double or triple- headed camera is used. F it will ↑

26. Concerning ultrasound:

A. Ultrasound is converted to thermal energy as it propagates through tissue. T
B. Fluid absorbs ultrasound to a greater degree than soft tissue. F Fluid att ↓ ST
C. Increased beam frequency decreases tissue absorption. F
D. High frequency ultrasound is less penetrative than low frequency ultrasound. T (f ↑ – penetration ↓)
E. For a given beam frequency, lung attenuates more than blood. T

27. Ultrasound transducer:

A. Ultrasound is generated and detected by thin piezoelectric discs, commonly made of lead zirconate titante (PZT). T
B. The transducer thickness is chosen to guarantee resonance at the required frequency. T
C. A backing layer is included to ensure rapid damping of the transducer vibration. T
D. An impedance matching layer is incorporated to achieve maximum energy transfer in and out of the patient. T
E. The impedance matching layer results in a longer pulse and therefore has an adverse effect on pulse damping. F.

28. Concerning the Doppler effect:

A. It produces a change in the velocity of sound reflected off a moving object. F — the frequency changes
B. A US beam parallel to the direction of movement gives the largest change in frequency. T
C. It produces a change in frequency which is inversely proportional to the velocity of sound in the medium. T
D. It causes an increase in frequency when the object is moving towards the transducer. T
E. It requires a higher frequency than would be used in imaging. F.

29. Regarding T1-weighted images:

A. Fat appears as a high signal. T
B. Slow flowing blood appears as a low signal. F – high signal.
C. Water appears as a low signal. T
D. Typical time to echo (TE) is 70ms. F 10 – 30ms.
E. Typical TR is 300=600ms. T.

30. Regarding chemical shift artefacts:

A. It occurs in the frequency encoding direction. T
B. It can be remedied by using a stronger magnetic field. F – makes it work
C. It is decreased by decreasing receiving bandwidth. F
D. It manifests as signal enhancement between areas of fat and water. F. ~~between~~ areas of signal void
E. It can be combated by using short tau inversion recovery (STIR) sequences. T
removes fat signal.

31. Regarding MRI:

A. Shim coils are used to minimise magnetic field inhomogeneities. T
B. For imaging purposes, homogeneity in the order of 30 parts per million is required. F 10 ppm
C. For spectroscopy, more homogenous an environment is required than for standard imaging. T 1 ppm.
D. Small stray fields are present in resistive magnets compared with superconductive electromagnets. F Significant for both
E. Insignificant stray fields are present in superconductive electromagnets. F.

32. When tube potential increases:

A. There is an increase in the relative proportion of photoelectric interactions. F.
B. There is an increase in the total number of Compton interactions. T
C. The patient exit dose increases approximately to the fourth power of the kVp. F - mean energy ↑
D. The dose area product remains roughly constant. F - it is related to beam intensity. $\propto kVp^2$
E. The patient dose increases. T

33. Practical applications relying on the photoelectric effect alone include:

A. The anode heel effect. F
B. Photographic exposure. T
C. Dose area product meters. F both PE + Comp E. → Insignificant
D. Rare earth filters. T K edge. energies slightly above the K edge.
E. TLDs. F Valence electrons raised by compton interactions

34. The effective focal spot size for a rotating anode:

A. Depends on anode angle T smaller ∠ = foreshortened EFS
B. Depends on filament size. T
C. Depends on anode diameter. F
D. Depends on speed of anode rotation. F
E. Is smaller than the actual focal spot size. T.

35. Regarding radionuclide safety in nuclear medicine investigations:

A. Generally as the activity is low, no special precautions need to be taken administering radionuclides to women of reproductive age. F · ~~Can~~ counselled; Pregnancy test
B. A high activity patient should be treated on a general ward as an inpatient. F.
C. A high activity patient needing emergency surgery must be refused an operation as the surgeon would be at increased risk of radiation exposure. F
D. Solid waste from high activity patients should be disposed of by incineration at the hospital. F
E. All radionuclides must be administered in a controlled area. F may not always be needed.

36. The Geiger-Muller tube:

A. Measures absorbed dose directly. F. Ionising events — not energy (can measure)
B. Is not used in dose rate monitoring. F Can be calibrated — cheaper
C. Contains a central thin wire cathode. F. Central wire in the anode
D. Requires a quenching agent. T. alcohol or bromine added to counting gas Ar/He
E. Has a dead time of approximately 300 seconds. F 300 μS. Wtype to reduce.

37. Regarding overexposure of patients:

A. Exposure much greater than intended resulting from equipment faults must be reported directly to the HSE. T → MDA
B. An incident in which a patient receives 3 times the intended dose for a chest x-ray must be reported. F. Factor of 20
C. An incident in which a patient receives 5 times the intended dose for a CT abdomen should be reported. T. 3× for a high dose
D. An incident in which a patient receives 10 times the intended dose for a mammogram must be reported. T — this is a medium dose organ.
E. An incident in which a patient receives 1.5 times the intended dose for a treatment fraction in radiotherapy should be reported. T — 20%. Of a single fraction.

38. In macro radiography:

A. The tube effective focal spot should be less than one centimetre. T
B. The film-patient distance should be as small as possible. F
C. The mA should be relatively small. F
D. The resolution of the final image is generally limited by grain size. F
E. Magnification reduces the MTF of the screen. F MTF is improved more depending on the actual effect

39. Regarding ionizing radiation:

A. Neutrons are low LET radiation. F — high LET
B. The radiation weighting factor (RWF) for alpha particles is 20. T
C. X-rays and beta particles have the same RWF. T = 1
D. The RWF for neutrons is unity. F S-20
E. For x-rays absorbed dose is equal to equivalent dose. T

40. The following tissues have a high carcinogenic risk from radiation (more than or equal to 0.12 tissue-specific weighting factor):

A. Skin. ~~T~~ F → low 0.01
B. Gonads. T → 0.2
C. Lung. T — 0.12
D. Breast. T — 0.12
E. Bone. F — 0.01.