

MARKING SCHEME

KMTC/QP-08/EP2



**KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING**

SEPTEMBER 2021 CLASS

YEAR ONE END OF SEMESTER TWO EXAMINATION

PAPER: MEDICAL PHYSICS AND CHEMISTRY II(MPC 1209)

DATE: 5th July 2022 TIME: 3Hrs (9am-12pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
5. Any examination malpractices will be handled as per the college examination policy

REGISTRATION NUMBER:.....

SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)

- Among the following electromagnetic waves which has the highest frequency?
 - Radio waves
 - X-rays
 - ☒ Gamma rays
 - ultraviolet radiation
- During X- radiation production what percentage of energy is converted to x-rays?
 - ☒ 1.1%
 - 99%
 - 90%
 - 10%
- The process of addition or removal of electrons from an ion is called
 - Disintegration
 - Electrification
 - ☒ Ionization
 - Resistivity
- Which of the following is the largest source of natural environmental radiation?
 - Radium
 - ☒ Radon
 - Carbon
 - Helium
- Which of the following is a unit for absorbed dose?
 - ☒ Rad
 - Rem
 - Sievert
 - Becquerel
- The following terminologies are applied in radiation dosimetry except?
 - Accurate dose
 - Total dose
 - Skin dose
 - ☒ Absorbed dose
- Which component is added to the tungsten used in x-ray tube anode to reduce surface crazing?
 - Aluminum
 - ☒ Rhenium
 - Silver
 - Molybdenum
- The following are functions of anode part of the x-ray tube insert except?
 - To convert electron energy to x-radiation
 - To dissipate the heat created in the process of x-radiation production
 - To act as the positive electrode of the valve
 - ☒ Thermionic emission of electrons
- Electrons are emitted in the filament coil in the cathode of x-ray tube insert through _____ emission,
 - ☒ Thermionic emission
 - Photoelectric emission
 - Secondary emission
 - Field emission

10. The space between the housing and tube insert in the xray tube is filled with
 A. Vacuum
~~B. Oil~~
 C. Air
 D. Water
11. Deceleration of charged particles results in the emission of electromagnetic field called _____.
 A. X-radiation
 B. Characteristic radiation
~~C. bremsstrahlung radiation~~
 D. Gamma radiation
12. When electron change from one atomic shell to another _____ are produced.
 A. X-radiation
~~B. Characteristic radiation~~
 C. Bremsstrahlung radiation
 D. Gamma radiation
13. Ultrasound is sound with frequency greater than _____.
 A. 2 Hz
 B. 15 Hz
~~C. 20,000 Hz~~
 D. 1540 Hz
14. While frequency of ultrasound in soft tissues increase, the wavelength
 A. Weakens
 B. Is constant
 C. Increases
~~D. Decreases~~
15. The following are inherent filters in x-ray tube except?
~~A. Aluminum~~
 B. Cooling oil
 C. Glass envelope
 D. Widow of the x-ray tube
- ~~16.~~ The linear attenuation coefficient is affected by?
 A. Atomic number of the medium
~~B. Material density~~
 C. Photon energy
~~D. All of the above~~
17. Which of the following is not a principle which assist in maintaining low radiation dose during radiographic examination?
 A. Time
~~B. Compression band~~
 C. Distance
 D. Shielding
18. Which of the following statement best describe stochastic effects of ionizing radiation?

- A. Probability of occurrence and severity are increased with dose
 B. Probability of occurrence are increased with exposure
~~C.~~ Probability of occurrence increases with dose while its severity is independent of dose.
 D. Probability of occurrence is increased with exposure while its severity is decreased with dose.
19. Which of the following is not a stochastic effect of ionizing radiation?
 A. Teratogenesis
 B. Cognitive decline
 C. Heart disease
~~D.~~ Cataracts
20. Which of the following interactions contributes to most image fog
 A. Classical
 B. photoelectric
 C. pair production
~~D.~~ Compton

SECTION 2: SHORT ANSWER QUESTIONS (40 MARKS)

21. State the major properties of ultrasound (5marks)
 22. Which qualities of tungsten makes it a metal of choice to use in the making of x-ray tube anode (5marks)
 23. Define attenuation as used in diagnostic radiation and state the four processes of attenuation (5 marks)
 24. You measure 37 grams of strontium 90 (half-life = 28.8 years). How much was present 2 years before this? (5 marks)
 25. State the application of radioactivity (5 marks)
 26. Name five basic components of ultrasound equipment (5marks)
 27. Give five exams of deterministic effects of ionizing radiation (5 marks)
 28. Differentiate between excitation and ionization potential as used in atomic theory. (5marks)

SECTION 3: LONG ANSWER QUESTIONS (40 MARKS)

29. Describe the modes of ultrasound - (20 Marks)
~~30.~~ Describe the decay schemes in radioactivity (20 marks)

$$5 \text{ marks} \times 4 = 20$$

$$4 \text{ marks} \times 5 = 20$$

$$40$$

(2) x p

x 2

MARKING SCHEME
MPC II SEPT 2021 CLASS
SECTIONS

- | | |
|-----|----------------|
| 1. | C |
| 2. | A |
| 3. | C |
| 4. | B |
| 5. | A |
| 6. | A D |
| 7. | B |
| 8. | A D |
| 9. | A |
| 10. | B |
| 11. | C |
| 12. | B |
| 13. | C |
| 14. | D |
| 15. | A |
| 16. | B- |
| 17. | B |
| 18. | C |
| 19. | D |
| 20. | D |

SECTION 2

21

- ✓ Ultrasonic waves vibrate at a frequency greater than the audible range for humans (20 kHz).
- ✓ They have smaller wavelength. As a result, their penetrating power is high.
- ✓ They cannot travel through vacuum.
- ✓ Ultrasonic waves travel at the speed of sound in the medium.
- ✓ In a homogeneous medium, they travel at a constant velocity.
- ✓ In a low viscosity liquid, ultrasonic waves produce vibrations.
- ✓ They undergo reflection, refraction and absorption.
- ✓ They have high energy content. They can be transmitted over a large distance without much loss of energy.
- ✓ They produce intense heat when they are passed through objects.
- ✓ Like low sound waves, ultrasonic waves are longitudinal waves that produce alternate compressions and rarefactions.

(5 MKS)

22

- ✓ High melting point and generation X-rays when irradiated with a high-speed electron beam.
- ✓ Thermal conductivity (good).
- ✓ High melting point (3400°C).
- ✓ Mechanical strength.

23

- ✓ Attenuation is the reduction of the intensity of an X-ray beam as it traverses matter.
- ✓ The reduction may be caused by ~~absorption~~ or by ~~reflection~~ (scatter) of photons from the beam and can be affected by different factors such as beam energy.

- (i) Compton scattering
 (ii) photoelectric effect
 (iii) pair production
 (iv) pair production
 (v) classical scattering

(5 marks)

24

$$N = N_0 e^{-\lambda t} \quad \left| \quad N_0 = \frac{N}{e^{-\lambda t}} \right.$$

$$\lambda = 0.693$$

$$\lambda = \tau_{1/2} \times 0.693 = 28.8 \times 0.693 = 19.9584$$

$$N = N_0 e^{-\lambda t} \quad \lambda = 19.9584$$

$$N = 37$$

$$e^{-19.9584 \times 2}$$

$$N = N_0 e^{-\lambda t}$$

$$\lambda = 0.693 \quad \frac{0.693}{28.8} = 0.0241$$

$$N = 37 = N_0 e^{-\lambda t}$$

$$N_0 = \frac{37}{e^{-0.0241 \times 2}} = 18.95 \text{ grams}$$

Spikes $37 \times e^{-0.0241 \times 2}$

99^mTc - Brain thyroid Liver

- Sterilizing syringe - use medical equipment such as syringe, scalpels and dressings
- Security scanning using X-ray units
- X-rays scan to detect injury or the presence of foreign objects in patients
- CT scans to create a computer-generated 3D image of cross-sections of the body
- Nuclear medicine procedures where a patient is injected with radioactive material. This is used in conjunction with a radiation detection instrument to locate tumours and assess the health of organs

- Radiation is also used in radiotherapy where higher doses of radiation are used to kill cancerous cells during the treatment of tumours.

(i) Teletherapy which involves irradiating tumours or using beams of high-energy radiation focused specifically on the tumour to minimise damage to the surrounding tissue.

(ii) Brachytherapy which involves a highly localised dose by one of two methods:

either the insertion of sealed radioactive sources in the form of rods, wires or through hollow tubes into or close to the tumour or the swallowing by the patient of a radioactive liquid that is selectively absorbed by the tumour.

Radiation is also commonly used in research and education for a range of purposes including

- (i) labelling pharmaceuticals
- (ii) labelling in molecular biology
- (iii) using destructive analysis of samples for forensic and medical research

- carbon dating

^{99m}Tc - brain, thyroid, liver, bone marrow,
lung, heart and intestinal scanning,
blood volume determination.

^{131}I - Diagnosis and treatment of thyroid
function

^{133}Xe - lung imaging

^{198}Au - liver disease diagnosis

- radioisotope dating, irradiation of food
medical applications

^{32}P - Cancer detection and treatment,
especially in liver and skin.

Q. How does a probe convert electrical energy to sound waves?

- A transducer or probe which converts electrical energy to
- The processing unit including the controls and the display
- A receiver which detects, compresses and amplifies signals returning to the transducer.

Transducer probe - probe that sends and receives the sound waves

Central processing unit (CPU) - Computer that does all the calculations and contains the electrical power supply for itself and the transducer probe

Transducer probe control - changes the amplitude frequency and duration of the pulses emitted from the transducer probe

Display - displays image from the ultrasound data processed by the CPU

Keyboard/cursor - inputs data and takes command from the display

Disk storage device
Printer

Spiky

- cataracts	- Radiation induced skin burns
- erythema (skin reddening)	- Acute radiation syndrome
- sterility	- Radiation sickness
- Epilation (loss of hair)	
- Tumor necrosis	

Excitation - ~~the~~ loss of electron of electron energy to another

Ionization - ~~Electron~~ is completely removed from atom

Spiky

SECTION 3

① The Amplitude mode (A-mode)

- In this mode, the signals ~~are~~ returning echoes are displayed in the form of spikes on a Cathode ray oscilloscope (CRO) trace along a time base. On one axis (vertical axis) the amplitude of the signal (magnitude of the voltage pulse) is displayed and on the other axis (horizontal) the position of the signal or a time scale is represented.

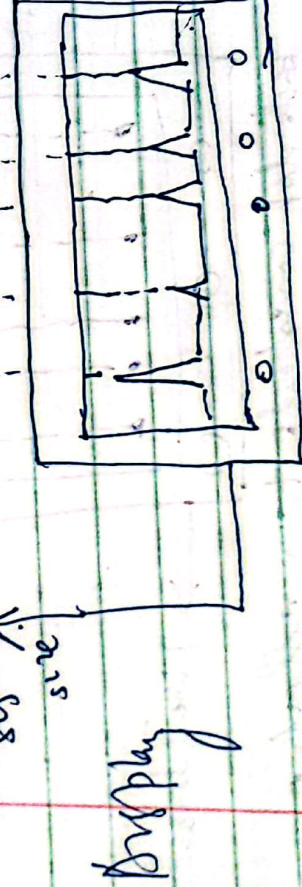
- The amplitude of a spike is a relative measure of echo size. Because the relationship between the distance of a reflector and the time of echo reception, the position of the spike along the time base is a measure of the distance of the associated reflecting boundary from the transducer.

Reflectors

ultrasound beam path

Generation of scan line data

Signal size



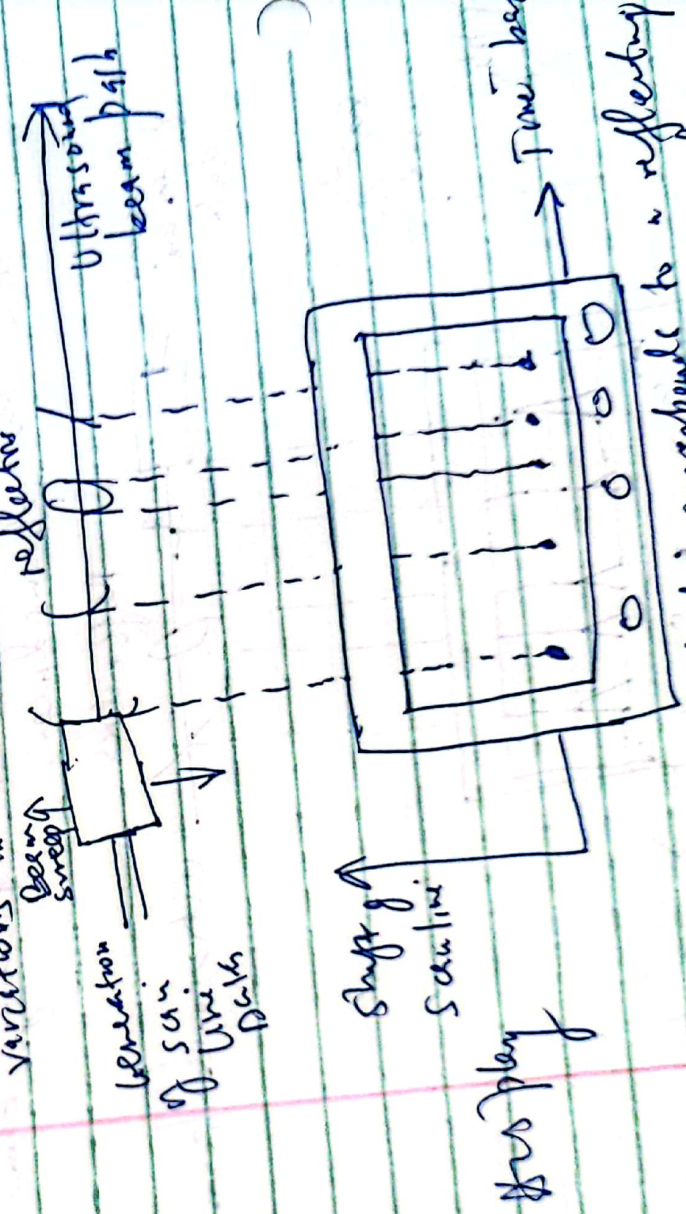
- suffers from limitation of display I-D information
- does not information does not constitute an image
- occupies a lot of space on CRO in relation with amount of information that it provides.

② The Brightness mode (B-mode)

- signals from returning echoes are displayed as dots of varying intensity. The size of the trace is replaced by a small dot which occupies much less space on the CRT. The intensity of a dot (the brightness) is a relative measure of echo size with target echoes appearing as very bright dots, while the other extreme non-reflectors appear totally dark.

- The position of a dot along the time base is a measure of the distance the associated reflector from the transducer.

- The combined information from different scan lines provides a 2-D image of the cross-section through which the beam sweeps. One dimension represents lateral depth information while the other represents lateral variations in the direction of beam sweep.

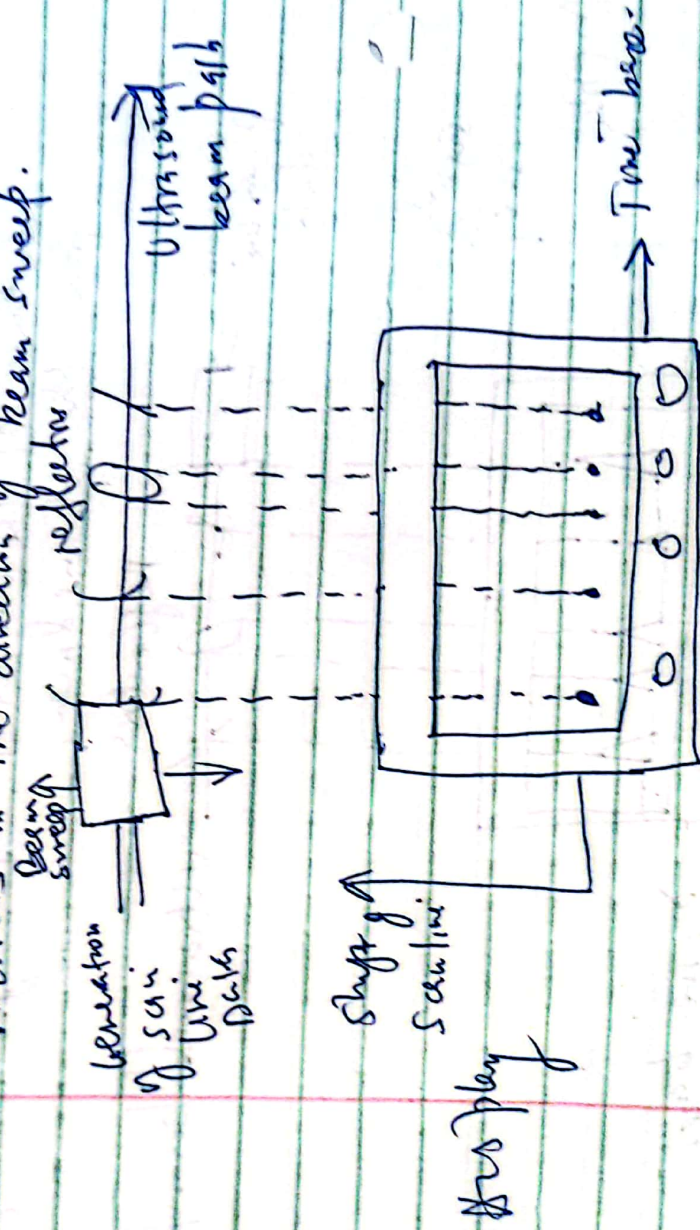


Each dot corresponds to a reflecting target along the scan line.

(110) The motion mode (M-mode) is used to generate an electronic trace of moving object lying along the path of ultrasound beam placed in one fixed

- Signals from returning echoes are displayed as dots of varying intensity. The 'spike' of the time is replaced by a small dot which occupies much less space on the CRO. The intensity of a dot (the brightness) is a relative measure of echo size, with large echoes appearing as very bright dots, while the other extreme, non-reflectors appear totally dark. The position of a dot along the time base is a measure of the distance the associated reflector is from the transducer.

- The combined information from different scans can provide a 2-D image of the cross-section through which the beam sweeps. One dimension represents depth information while the other represents lateral variations in the direction of beam sweep.

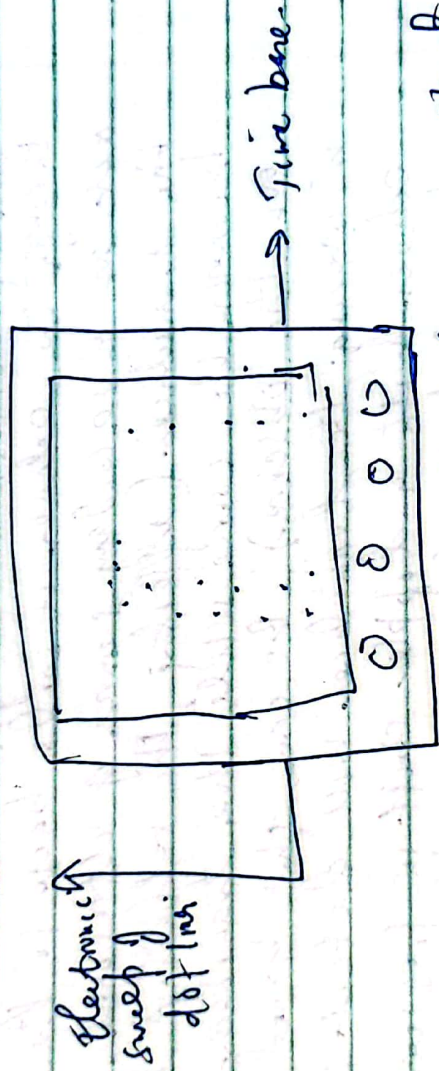


Each dot corresponds to a reflecting interface along the scan line.

- (10) The motion mode (M-mode)
- It is used to generate an electronic trace of a moving object lying along the path of the ultrasound beam.
 - The transducer is placed in one fixed position.

Q

In relation to the moving dot structure. Returning echoes are displayed in the form of dots of varying intensity along a time base in B-mode. Dots for stationary reflectors will remain in the same position along the time base, but dots for reflectors which move in the direction of the scan line will change their position along the time base because their distance from the transducer will be changing with time.



Tracer of dot lines for moving structures and stationary structures

Stationary structures whose dots do not shift positions will trace straight line perpendicular to the time base, while moving structures will trace

zig-zag or sinusoidal patterns

The M-mode is particularly useful for examining cardiac motion

14 The Doppler mode

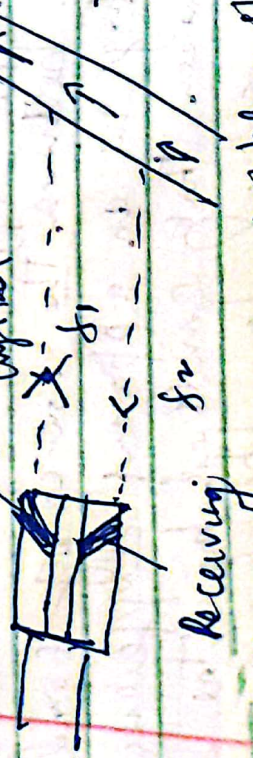
In a constant Doppler Effect is associated with relative motion between the source of sound and the receiver, resulting in an apparent difference in frequency between that emitted by the source and that perceived by the receiver. An

Approaching sound source is perceived to be emitting sound at higher frequency than it actually is, while a receding source appears to emit at a lower frequency. The apparent difference in frequency is called the Doppler shift.

In clinical ultrasound, the Doppler mode is used in studies of blood flow and cardiac movements when a beam of ultrasound emitted by a transducer at constant frequency interacts with moving acoustic boundary, the boundary will through the observer it sends back to the transducer act as a secondary source of ultrasound for the transducer (appearing the reflecting boundary becomes the source while the transducer serves as the observer). Because the boundary is moving, the transducer will detect the echoes with a Doppler shift in frequency, being of higher frequency if the interface is approaching or of lower frequency if the interface is moving away.

The greater the Doppler shift, the higher the velocity of the moving structure and a higher detected frequency implies relative motion towards the transducer, while a lower detected frequency implies a red receding reflector.

transmission
component



⑧

Real-time mode

Real-time mode is rapid B-mode scanning to generate images of a selected cross-section within the subject repetitively at a rate high enough to create the motion picture impression.

- A rapid succession of images of the same plane are generated and viewed as are acquired. Although in reality each image in the series represents an independent static image, the effect of rapid acquisition and viewing at rates exceeding about 25 image frames per second creates the impression of continuity in time.
- ~~When~~ we are unable to distinguish in time between events occurring at intervals shorter than about 40 milliseconds they appear to us to occur "at the same time".



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DIPLOMA IN RADIOGRAPHY AND IMAGING
MARCH 2022 CLASS
YEAR ONE END OF SEMESTER TWO EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY II (MPC1209)

DATE:13/2/2023

TIME:3HRS(2-5pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
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REGISTRATION NUMBER:.....

MEDICAL PHYSICS AND CHEMISTRY II

SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)

1. Up to what intensity of radiation is used for mammography?
 - A. < 10keV
 - B. < 70keV
 - C. < 30keV
 - D. < 40keV
2. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
 - A. Relatively big and heavy in atomic terms and a highly ionizing form of radiation able to penetrate the skin
 - B. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
 - C. Relatively small and light but able to penetrate the skin
 - D. Relatively small and light but unable to penetrate skin.
3. Which of the following statement is false about X-rays?
 - A. Most X-rays have a wavelength ranging from 10^{-8}m to 10^{-4}m ,
 - B. Most X-rays have frequencies in the range of $3 \times 10^{16}\text{ Hz}$ to $3 \times 10^{19}\text{ Hz}$
 - C. Most X-rays have energies in the range of 124 eV to 124 keV.
 - D. Most X-rays have frequencies in the range of 30 petahertz to 30 exahertz
4. The following are conditions necessary for X-ray to be produced except?
 - A. Exposure factors have to be selected.
 - B. The anode has to rotate to full speed
 - C. Electricity has to travel to the anode and cathode filament.
 - D. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
5. Which of the following statements is true about x-ray beam quantity
 - A. Beam quantity varies inversely as the square of the ratio of change in kVp.
 - B. Beam quantity varies directly as the square of distance.
 - C. The use of filtration decreases x-ray beam quantity to an extent that it depends on other factors
 - D. Beam quantity is inversely directly proportional to mAs.
6. An interaction with matter that occur throughout the diagnostic range involving moderate energy X-ray photons is known as:
 - A. Classical Interactions
 - B. Pair production
 - C. Photodisintegration interactions
 - D. Compton Interactions
7. The statements below describe the application of an electromagnetic waves.
 - i. Used to produce images of hot objects through the colours
 - ii. Produced by the amount of heat dissipated by an object.
 - iii. They are used in hospitals to detect illnesses (diagnosis)
 - iv. Used in warfare missiles and burglar alarm systems

SECTION 2: SHORT ANSWER QUESTIONS- 40MKS

21. With an aid of well labeled diagram, describe the process of coherent scattering (5mks)
22. State five (5) common properties of electromagnetic waves (5mks)
23. The half-life of a sample of a radioactive substance is 98 minutes. How long does it take for the activity of the sample to reduce to $1/32$ of its original value (5mks)
24. With an aid of a graph explain half-life (5 mks)
25. Define the following terminologies as used in radiation dosimetry
- Absorbed dose
 - Threshold dose
 - Exposure dose
 - Maximum permissible dose
 - Skin dose
26. State five (5) properties of gamma particles (5mks)
27. State five (5) characteristics of Tungsten that makes it a material of choice for target of the x-ray tube (5mks)
28. Define half value layer, and briefly describe how it can be determined (5mks)

SECTION 3: LONG ANSWER QUESTIONS (40MKS)

- 29.
- Explain 5 applications of radioactivity (10mks)
 - Describe the principles of Geiger Muller tube (10mks)
30. Discuss the principal factors influencing the shape of an x-ray spectrum (20 mks)

15. Which one of the following is a major source of occupational exposure
- A. Photodisintegration
 - B. Pair production
 - C. Photoelectric interactions
 - D. Compton interaction
16. The filtration of an atomic beam has the effect of
- A. Improving the quality of the transmitted X-ray beam
 - B. Increasing the quantity of the transmitted X-ray beam
 - C. Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - D. Improving the quality and increasing quantity of the transmitted X-ray beam
17. A specific combination of protons and neutrons in a nucleus is called
- A. Nucleus
 - B. Nuclide
 - C. Neutrino
 - D. Nucleolus
18. A photon of 10MeV colliding with a nuclear will likely result in which type of interaction
- A. Photoelectric
 - B. Photodisintegration
 - C. Thompson
 - D. Compton
19. Ultrasound is sound with frequency greater than
- A. 2 Hz
 - B. 15 Hz
 - C. 20,000 Hz
 - D. 1540 Hz
20. Which of the following statement is NOT true about beam of x-rays?
- A. Beam of x-ray pass through body tissue unaffected
 - B. Beam of x-ray may transfer all energy to matter and do not pass through the patient the film
 - C. Beam of x-ray may be diverted with or without energy loss
 - D. Beam of x-ray is monoenergetic

Identify the type of wave whose application is described above.

- A. Infra-red radiation
- B. Visible spectrum
- C. X-Rays
- D. Gamma rays

8. In order to obtain a higher-energy x-rays, one needs to change?

- A. Tube current
- B. Exposure time
- C. Tube voltage
- D. Filament voltage

9. Which of the following statements is true about non ionizing radiation?

- A. Deposits energy in the materials through which it passes.
- B. They have sufficient energy to break molecular bonds or remove electrons from atoms.
- C. Example include of non-ionizing radiation include; visible light, heat, beta, microwaves, and radio waves
- D. They are able to cause ionization

10. For X-ray to be produced, the following conditions have to be met except

- A. Exposure factors have to be selected.
- B. Electricity has to travel to the anode, cathode and filament.
- C. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
- D. The X-ray tube window has to be opened

11. During the process of X-ray production, the filament electrons penetrate the face of the target to a depth of approximately how many millimeters?

- A. 0.5 millimeters
- B. 0.2 millimeters
- C. 0.1 millimeters
- D. 0.3 millimeters

12. During x-ray production, what is the shortest binding energy of K-shell electrons in tungsten

- A. 40 Kev
- B. 20 Kev
- C. 70 Kev
- D. 10 Kev

13. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron. What would be the result of this type of interaction?

- A. K characteristic
- B. L characteristic
- C. No Interaction
- D. No X-ray produced

14. During x-ray production, in which interaction does the filament electron misses all the orbit electrons and interacts with the nucleus of the target atom.

- A. Characteristic interactions
- B. Bremsstrahlung interactions
- C. Compton interactions
- D. Classical interactions



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DIPLOMA IN RADIOGRAPHY AND IMAGING
SEPTEMBER 2021 CLASS
YEAR ONE END OF SEMESTER TWO SUPPLEMENTARY/SPECIAL
EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY II (MPC 1209)

DATE: 5/9/2022

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 - a. 99%
 - b. 5%
 - c. 95%
 - d. 1%
2. Up to what intensity of radiation is used for mammography?
 - a) < 10keV
 - b) < 70keV
 - c) < 30keV
 - d) < 40keV
3. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
 - a. Relatively big and heavy in atomic terms and a highly ionizing form of radiation able to penetrate the skin
 - b. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
 - c. Relatively small and light but able to penetrate the skin
 - d. Relatively small and light but unable to penetrate skin.
4. Radiation is categorized as ionizing and non-ionizing. Which one of the following is non Ionizing radiation?
 - a. X-Rays
 - b. Alpha Particles
 - c. Beta Particles
 - d. Microwaves
5. Which one of the following statement is false about X-rays?
 - a. Most X-rays have a wavelength ranging from 10^{-8}m to 10^{-4}m ,
 - b. Most X-rays have frequencies in the range of $3 \times 10^{16}\text{ Hz}$ to $3 \times 10^{19}\text{ Hz}$
 - c. Most X-rays have energies in the range of 124 eV to 124 keV.
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 - b. Beam quantity varies directly as the square of distance.
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 - Pair production
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 - Compton Interactions
9. The statements below describe the application of an electromagnetic waves.
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 - Produced by the amount of heat dissipated by an object.
 - They are used in hospitals to detect illnesses (diagnosis)
 - Used in warfare missiles and burglar alarm systems
- Identify the type of wave whose application is described above.
- Infra-red radiation
 - Visible spectrum
 - X-Rays
 - Gamma rays
10. In order to obtain a higher-energy x-rays, one needs to change?
- Tube current
 - Exposure time
 - Tube voltage
 - Filament voltage
11. Smallest radiation dose that produce a given effect is known as
- Tumor dose
 - Threshold dose
 - Absorbed dose
 - Depth dose
12. The energy imparted to matter per unit mass is known as _____.
- Depth dose
 - Maximum permissible dose
 - Absorbed dose
 - Exposure dose
13. Which of the following statements is true about non ionizing radiation?
- Deposits energy in the materials through which it passes.
 - They have sufficient energy to break molecular bonds or remove electrons from atoms.
 - Example include of non ionizing radiation include; visible light, heat, beta, microwaves, and radio waves
 - They are able to cause ionization
14. For X-ray to be produced, the following conditions have to be met except?
- Exposure factors have to be selected.
 - Electricity has to travel to the anode, cathode and filament.
 - Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
 - The X-ray tube window has to be opened

15. During the process of X-ray production, the filament electrons penetrate the face of the target to a depth of approximately how many millimeters?
- 0.5 millimeters
 - 0.2 millimeters
 - 0.1 millimeters
 - 0.3 millimeters
16. During x-ray production, what is the shortest binding energy of K-shell electrons in tungsten
- 40 Kev
 - 20 Kev
 - 70 Kev
 - 10 Kev
17. During characteristic interactions if an L shell electron is filling a K-shell, the photon produced is known as
- L characteristic
 - M characteristic
 - N characteristic
 - K characteristic.
18. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron. What would be the result of this type of interaction?
- K characteristic
 - L characteristic
 - No Interaction
 - No X-ray produced
19. During x-ray production, in which interaction does the filament electron misses all the orbital electrons and interacts with the nucleus of the target atom.
- Characteristic interactions
 - Bremstrahlung interactions
 - Compton interactions
 - Classical interactions
20. The process of addition or removal of electrons from an atom is known as?
- Disintegration
 - Electrification
 - Ionization
 - Resistivity
21. The SI unit for radiation exposure tom air is known as
- Absorbed dose
 - Effective dose
 - Rad
 - Air Kerma
22. Which one of the following is the largest source of natural environmental radiation?
- Radium
 - Radon
 - Carbon
 - Helium

23. Which one of the following is a unit for absorbed dose?
- Rad
 - Rem
 - Sievert
 - Becquerel
24. Elements with different mass number but equal atomic number are known as
- Isobar
 - Isomer
 - Isotone
 - Isotope
25. Which one of the following is a major source of occupational exposure?
- Photodisintegration
 - Pair production
 - Photoelectric interactions
 - Compton interaction
26. The filtration of an atomic beam has the effect of _____.
- Improving the quality of the transmitted X-ray beam
 - Increasing the quantity of the transmitted X-ray beam
 - Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - Improving the quality and increasing quantity of the transmitted X-ray beam
27. A specific combination of protons and neutrons in a nucleus is called?
- Nucleus
 - Nuclide
 - Neutrino
 - Nucleolus
28. B⁺ radiations are simply
- Protons
 - Neutrons
 - Electrons
 - Nucleus
29. The number of cycles that an acoustic variable goes through in second is known as
- Wavelength
 - Frequency
 - Amplitude
 - Propagation speed
30. Identify the unit of the quality of radiation
- Gray
 - Curie
 - Rem
 - Rad
31. The following elements fall into group VII in the periodic table apart from
- Iodine
 - Chloride
 - Manganese
 - Fluorine

32. The sum of both the protons and neutrons is known as ____.
- Atomic Number
 - Mass Number
 - Nuclide
 - Neutron Number
33. A process in which a nucleus splits into two or more light nuclei is known as
- Nuclear fission
 - Nuclear Fusion
 - Nuclear reaction
 - Radioactive isotopes
34. A photon of 10MeV colliding with a nuclear will likely result in which type of interaction?
- Photoelectric
 - Photodisintegration
 - Thompson
 - Compton
35. Which interaction within the diagnostic range does not involve the removal of an orbital electron?
- Pair production
 - Photoelectric effect
 - Compton effect
 - Classical scattering
36. The dose of radiation to the whole body that causes 50% of irradiated subject to die within 60 days is referred to
- LD₅₀
 - LD_{50/60}
 - LD₆₀
 - LD_{60/50}
37. Ultrasound is sound with frequency greater than
- 2 Hz
 - 15 Hz
 - 20,000 Hz
 - 1540 Hz
38. Which of the following statement is NOT true about beam of x-rays?
- Beam of x-ray pass through body tissue unaffected
 - Beam of x-ray may transfer all energy to matter and do not pass through the patient to the film
 - Beam of x-ray may be diverted with or without energy loss
 - Beam of x-ray is monoenergetic
39. Which of the following terminology is NOT applied in radiation dosimetry?
- Accurate dose
 - Total dose
 - Skin dose
 - Absorbed dose

40. Attenuation of the X-ray beam can be represented numerically by the following phrases except

- a. Half value layer
- b. Linear attenuation coefficient
- c. Mass attenuation coefficient
- d. Light attenuation coefficient

SECTION 2: SHORT ANSWER QUESTIONS (40MKS)

1. With an aid of well labeled diagram, describe the process of coherent scattering (5mks)
2. State 5 common properties of electromagnetic waves (5mks)
3. The half life of a sample of a radioactive substance is 98 minutes. How long does it take for the activity of the sample to reduce to 1/16 of its original value (5mks)
4. List 5 applications of radioactivity (5mks)
5. Define the following terminologies as used in radiation dosimetry (5mks)
 - i. Absorbed dose
 - ii. Threshold dose
 - iii. Exposure dose
 - iv. Maximum permissible dose
 - v. Skin dose

(5mks)
(5mks)
(5mks)

6. State 5 properties of gamma particles
7. Define Beam quantity and list four factors that affect beam quantity
8. Define half value layer, and briefly describe how it can be determined

SECTION 3: LONG ANSWER QUESTION (20MKS)

1. Discuss the two (2) main processes of production of X-rays as the filament electrons interact with the target on the anode of the x-ray tube



**KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF MEDICAL IMAGING SCIENCES**

**END OF SEMESTER EXAMINATION
FOR
DIPLOMA IN MEDICAL IMAGING
PAPER: MEDICAL PHYSICS AND CHEMISTRY II (MPC II)**

DATE: 17th February 2020

TIME: 3 HOURS (9:00AM – 12:00 PM)

INSTRUCTIONS

1. This paper consists of:
 - Section 1 (40 Multiple Choice Questions)
 - Section 2 (8 Short Answer Questions)
 - Section 3 (1 Long Answer Question)
2. Attempt **ALL** Questions
3. Write the **EXAMINATION NUMBER** given on all the answer sheets provided and on the question paper.
4. Ensure that all examination answer scripts are handed in at the end of the examination
5. Ensure you sign the examination register provided

EXAMINATION NUMBER

Section 1: Multiple Choice Questions (40 marks)

1. Define radioactivity

- The breakdown in nuclear coherence causing the ejection of an electron.
- Directly influenced by heat and temperature.
- Not influenced by external environmental factors such as heat or pressure and does NOT involve the electrons.
- Not influenced by external environmental factors such as heat or pressure and involves the ejection of electrons.

2. Radioactive emissions have different ability to penetrate materials. Alpha particles are?

- Relatively big and heavy in atomic terms and a highly ionising form of radiation able to penetrate the skin
- Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
- Relatively small and light but able to penetrate the skin
- Relatively small and light but unable to penetrate skin.

3. With reference to the interaction of electrons from the cathode with atoms of the anode, what percentage of heat typically occurs?

- 1 per cent
- 10 per cent
- 2 per cent
- 99 per cent.

4. The filtration of an X-ray beam has the effect of: *Aluminium*

- Improving the quality of the transmitted X-ray beam
- Increasing the quantity of the transmitted X-ray beam
- Reducing the quantity and decreasing quality of the transmitted X-ray beam
- Improving the quality and increasing quantity of the transmitted X-ray beam.

5. β^- radiations are simply

- protons *positive*
- neutrons *neutral*
- electrons
- nucleons

6. A specific combination of protons and neutrons in a nucleus is called

- nucleons
- nuclide
- neutrino
- nucleolus

7. Elements undergo radioactive decay when proton number becomes greater than Z_0

XRD Image
Phase 101 layer
Latent image
scanner (user beam)

- a. 50
- b. 40
- c. 83
- d. 75

8. If average kinetic energy of molecules is higher, then temperature of gas is

- a. high
- b. low
- c. zero
- d. infinite

9. Ideal gas law According to kinetic molecular model, in gases,

- a. The particles are closely packed together, they occupy minimum space and are usually arranged in a regular pattern
- b. The particles occur in clusters with molecules slightly further apart
- c. The molecules are very far apart and occupy all the space made available to them
- d. The particles vibrate about fixed positions and are held together by the strong intermolecular bonds between them

10. If Pressure of a fixed amount of gas is denoted as 'P' and volume is denoted as 'V' then Boyles law can be expressed as

- a. $P = k \times V$ (where 'k' is a proportionality constant)
- b. $P = k/V$ (where 'k' is a proportionality constant)
- c. $P = k \times V^2$ (where 'k' is a proportionality constant)
- d. $P = k/V^2$ (where 'k' is a proportionality constant)

11. Liquids have

- a. fixed volume but no fixed shape, high density and are incompressible
- b. fixed shape but no fixed volume, high density and are incompressible
- c. fixed volume but no fixed shape, high density and are compressible
- d. fixed volume but no fixed shape, low density and are compressible

12. Process in which acids (H^+) and bases (OH^-) react to form salts and water is called

- a. neutralization
- b. hydrogenation
- c. halogenation
- d. sublimation

13. The pH value for developer solution is

- a. acidic

- b. basic
- c. neutral
- d. salty

14. In pure water, concentrations of

- a. H^+ and OH^- ions are equal
- b. H^+ ions is more
- c. OH^- ions is more
- d. Cl^- is more

15. Acids ionize in water to produce

- a. OH^- ions
- b. H^+ ions
- c. SO_4^{2-} ions
- d. H_2O molecules

16. Salt among following is

- a. HCl
- b. KCl
- c. HNO_3
- d. H_3PO_4

17. Considering methods for making salt, reaction of acid and metal carbonate gives

- a. Salt and water
- b. Salt and hydrogen
- c. Salt, carbon dioxide and water
- d. Salt and salt

18. Which of following decreases when pH is less than 7?

- a. $[H^+]$
- b. $[OH^-]$
- c. Both A and B
- d. None of these

19. Which of following is used in making mortar, plasters, cement?

- a. Sodium hydroxide
- b. Potassium hydroxide
- c. Calcium hydroxide
- d. Magnesium hydroxide

20. What is effect of acid on skin?

- a. No effect
- b. Causes skin cancer
- c. Corrosive
- d. Causes harm to skin tissue

21. What is physical state of first four alkanes?

- a. Solid
- b. Liquid
- c. Gas
- d. Plasma

22. Which of following is true about alkanes?

- a. They are insoluble in water
- b. They are more dense than water
- c. They are essentially polar
- d. They are reactive towards most ionic compounds

23. What is correct trend in reactivity of halogen with an alkane?

- a. $F_2 > Cl_2 > Br_2 > I_2$
- b. $I_2 > Cl_2 > Br_2 > F_2$
- c. $Br_2 > Cl_2 > F_2 > I_2$
- d. $F_2 > Br_2 > Cl_2 > I_2$

24. Which alkanes are widely used as fuel?

- a. Lighter alkanes
- b. Heavier alkanes
- c. All the alkanes
- d. None of these

25. Alcohols are formed by attachment of

- a. OH group to hydrocarbon chain
- b. COOH group to hydrocarbon chain
- c. O to hydrocarbon chain
- d. H to hydrocarbon chain

26. What is general formula of alkenes?

- a. C_nH_{2n+2}
- b. C_nH_{2n}
- c. C_nH_{2n-2}

d. None of these

27. Compounds in which one hydrogen atom of an alkane is substituted by one halogen atom are called

- a. Haloalkanes
 - b. Phenols
 - c. Ethers
 - d. Alcohols
28. Organic compounds include
- a. alkali metals
 - b. alkaline earth metals
 - c. hydrocarbons and their derivatives
 - d. halogens

29. Formula that shows arrangement of atoms in a compound is called

- a. molecular formula
- b. structural formula
- c. compound formula
- d. empirical formula

30. Molecular formula for Heptane is

- a. C_4H_{10}
- b. C_8H_{18}
- c. C_5H_{12}
- d. C_7H_{16}

31. Alkanes have

- a. carbon-carbon single bond
- b. carbon-carbon double bond
- c. carbon-carbon triple bond
- d. carbon-carbon quad bond

32. Compounds that have same molecular formula but different arrangement of atoms in molecules are called

- a. Isotopes
- b. Isomers
- c. Hydrocarbons
- d. Organic compounds

33. Which of following is used in preparation of polymers like film base?

- a. Ethylene
- b. Acetylene
- c. Phenol
- d. Methanol

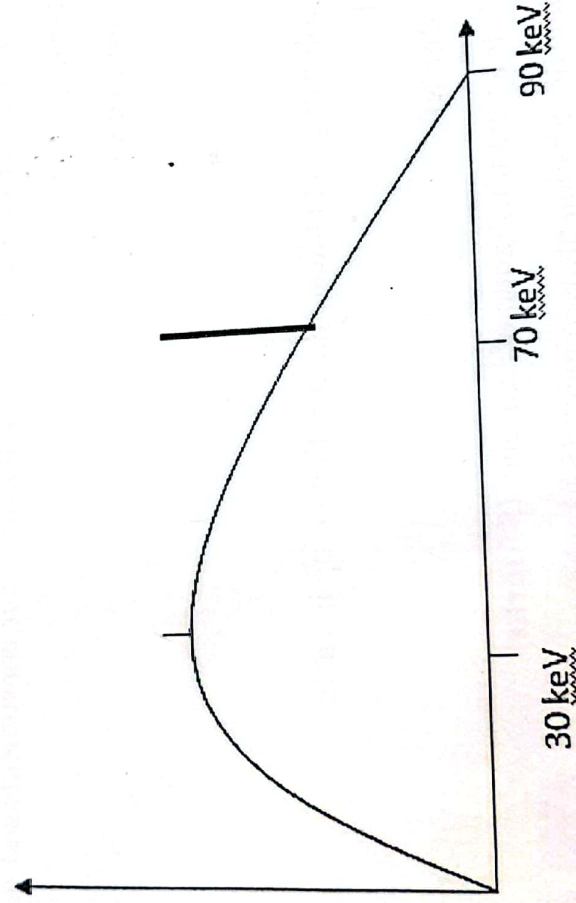
34. What is term used for an atom or group of atoms that provide a family of organic compounds its characteristic properties?

- a. Alkyl group
- b. Functional group
- c. Hydrocarbons
- d. None of these

35. Origin of carbon compounds is

- a. non- living beings
- b. living beings
- c. organic
- d. artificial

Use the figure below for Questions 36 to 40



36. The average energy of this beam is

- a. 30 keV
- b. 70 keV
- c. 90 keV
- d. 90 kVp

37. The maximum energy of this beam is

- a. 30 keV

- b. 70 keV
- c. 90 keV
- d. 90 kVp

38. The energy of the characteristic x-rays is

- a. 30 keV
- b. 70 keV
- c. 90 keV
- d. 90 kVp

39. The applied voltage that produced this beam is

- a. 30 keV
- b. 70 kVp
- c. 90 keV
- d. 90 kVp

40. The energy of the projectile electrons that produced this beam is

- a. 30 keV
- b. 70 keV
- c. 90 keV
- d. 90 kVp

SECTION B: (Short Answer Questions- 40 marks)

1. Identify the chemical associated with each of the following fixer constituents and describe

its function(s) (5 Marks)

- i. fixing and clearing agent
- ii. activator
- iii. hardener
- iv. preservative
- v. solvent

2. Write the name of the following and indicate the function group in each:

i. $\text{CH}_3\text{CH}_2\text{COOH}$

ii. $\text{CH}_3\text{CH}_2\text{Br}$ (5 Marks)

3. Write the molecular and structural illustration of benzene (5 Marks)

4. Explain the following units of radiation measurement; (5 Marks)

i. *Roentgen*

ii. *rad*

iii. *rem*

5. Explain Continuous spectrum and line spectrum as applied to a spectrum of x-ray beam (

marks)

- b. 70 keV
- c. 90 keV
- d. 90 kVp

38. The energy of the characteristic x-rays is

- a. 30 keV
- b. 70 keV
- c. 90 keV
- d. 90 kVp

39. The applied voltage that produced this beam is

- a. 30 keV
- b. 70 kVp
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- i. *Roentgen*
- ii. *rad*
- iii. *rem*

5. Explain Continuous spectrum and line spectrum as applied to a spectrum of x-ray beam (5 marks)

6. Sketch on the same diagram the spectra of x-rays emitted from a tungsten target when the applied voltage is 50 and 100 kVp (5 marks)
7. With an aid of a graph, explain half life (5 Marks)
8. State the characteristics of the ideal radionuclide for imaging (5 Marks)

SECTION 3: (Long Answer Question -20 marks)

1. Explain the principal factors influencing the shape of an x-ray spectrum (20 marks)

tube current, tube voltage, filtration, target material, voltage waveform



KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING
MARCH 2022 CLASS
YEAR ONE END OF SEMESTER TWO EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY II (MPC1209)

DATE:13/2/2023

TIME:3HRS(2-5pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
5. Any examination malpractices will be handled as per the college examination policy

REGISTRATION NUMBER:.....

MEDICAL PHYSICS AND CHEMISTRY II

SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)

1. Up to what intensity of radiation is used for mammography?
 - A. $< 10\text{keV}$
 - B. $< 70\text{keV}$
 - C. $< 30\text{keV}$
 - D. $< 40\text{keV}$
2. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
 - A. Relatively big and heavy in atomic terms and a highly ionizing form of radiation but able to penetrate the skin
 - B. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
 - C. Relatively small and light but able to penetrate the skin
 - D. Relatively small and light but unable to penetrate skin.
3. Which of the following statement is false about X-rays?
 - A. Most X-rays have a wavelength ranging from 10^{-8}m to 10^{-4}m ,
 - B. Most X-rays have frequencies in the range of $3 \times 10^{16}\text{ Hz}$ to $3 \times 10^{19}\text{ Hz}$
 - C. Most X-rays have energies in the range of 124 eV to 124 keV .
 - D. Most X-rays have frequencies in the range of 30 petahertz to 30 exahertz
4. The following are conditions necessary for X-ray to be produced except?
 - A. Exposure factors have to be selected.
 - B. The anode has to rotate to full speed
 - C. Electricity has to travel to the anode and cathode filament.
 - D. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
5. Which of the following statements is true about x-ray beam quantity
 - A. Beam quantity varies inversely as the square of the ratio of change in kVp.
 - B. Beam quantity varies directly as the square of distance.
 - C. The use of filtration decreases x-ray beam quantity to an extent that it depends on other factors
 - D. Beam quantity is inversely directly proportional to mAs.
6. An interaction with matter that occur throughout the diagnostic range involving moderate energy X-ray photons is known as:
 - A. Classical Interactions
 - B. Pair production
 - C. Photodisintegration interactions
 - D. Compton Interactions
7. The statements below describe the application of an electromagnetic waves.
 - i. Used to produce images of hot objects through the colours
 - ii. Produced by the amount of heat dissipated by an object.
 - iii. They are used in hospitals to detect illnesses (diagnosis) ✓
 - iv. Used in warfare missiles and burglar alarm systems ✓

Identify the type of wave whose application is described above.

- A. Infra-red radiation
- B. Visible spectrum
- C. X-Rays
- D. Gamma rays

8. In order to obtain a higher-energy x-rays, one needs to change?

- A. Tube current
- B. Exposure time
- C. Tube voltage
- D. Filament voltage

9. Which of the following statements is true about non ionizing radiation?

- A. Deposits energy in the materials through which it passes.
- B. They have sufficient energy to break molecular bonds or remove electrons from atoms.
- C. Example include of non-ionizing radiation include; visible light, heat, beta, microwaves, and radio waves
- D. They are able to cause ionization

10. For X-ray to be produced, the following conditions have to be met except

- A. Exposure factors have to be selected.
- B. Electricity has to travel to the anode, cathode and filament.
- C. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
- D. The X-ray tube window has to be opened

11. During the process of X-ray production, the filament electrons penetrate the face of the target to a depth of approximately how many millimeters?

- A. 0.5 millimeters
- B. 0.2 millimeters
- C. 0.1 millimeters
- D. 0.3 millimeters

12. During x-ray production, what is the shortest binding energy of K-shell electrons in tungsten

- A. 40 Kev
- B. 20 Kev
- C. 70 Kev
- D. 10 Kev

13. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron.

What would be the result of this type of interaction?

- A. K characteristic
- B. L characteristic
- C. No Interaction
- D. No X-ray produced

14. During x-ray production, in which interaction does the filament electron misses all the orbital electrons and interacts with the nucleus of the target atom.

- A. Characteristic interactions
- B. Bremsstrahlung interactions
- C. Compton interactions
- D. Classical interactions

15. Which one of the following is a major source of occupational exposure

- A. Photodisintegration
- B. Pair production
- C. Photoelectric interactions
- D. Compton interaction

16. The filtration of an atomic beam has the effect of

- A. Improving the quality of the transmitted X-ray beam
- B. Increasing the quantity of the transmitted X-ray beam
- C. Reducing the quantity and decreasing quality of the transmitted X-ray beam
- D. Improving the quality and increasing quantity of the transmitted X-ray beam

17. A specific combination of protons and neutrons in a nucleus is called

- A. Nucleus
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- C. Neutrino
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With an aid of well labeled diagram, describe the process of coherent scattering

22. State five (5) common properties of electromagnetic waves (5mks)

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the activity of the sample to reduce to $1/32$ of its original value

24. With an aid of a graph explain half-life (5mks)

25. Define the following terminologies as used in radiation dosimetry (5 mks)

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(5mks)

26. State five (5) properties of gamma particles (5mks)

27. State five (5) characteristics of Tungsten that makes it a material of choice for target of the ray tube (5mks)

28. Define half value layer, and briefly describe how it can be determined (5mks)

SECTION 3: LONG ANSWER QUESTIONS (40MKS)

29.

(10mks)

A. Explain 5 applications of radioactivity

(10mks)

B. Describe the principles of Geiger Muller tube

(20 mks)

30. Discuss the principal factors influencing the shape of an x-ray spectrum

SECTION 1: MULTIPLE CHOICE QUESTIONS (40 MARKS)

1. Approximately what proportion of the kinetic energy of the filament electrons is converted to x-rays at the target
 - a. 99%
 - b. 5%
 - c. 95%
 - ☒ d. 1%
2. Up to what intensity of radiation is used for mammography?
 - a) < 10keV
 - b) < 70keV
 - c) < 30keV
 - ☒ d) < 40keV
3. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
 - a. Relatively big and heavy in atomic terms and a highly ionizing form of radiation able to penetrate the skin
 - b. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
 - ☒ c. Relatively small and light but able to penetrate the skin
 - d. Relatively small and light but unable to penetrate skin.
4. Radiation is categorized as ionizing and non-ionizing. Which one of the following is non ionizing radiation
 - a. X-Rays
 - b. Alpha Particles
 - c. Beta Particles
 - ☒ d. Microwaves
5. Which one of the following statement is false about X-rays
 - ☒ a. Most X-rays have a wavelength ranging from 10^{-8} m to 10^{-4} m,
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- X-Rays
- Gamma rays

10. In order to obtain a higher-energy x-rays, one needs to change?

- Tube current
- Exposure time
- ☒ Tube voltage
- Filament voltage

11. Smallest radiation dose that produces a given effect is known as

- Tumor dose
- ☒ Threshold dose
- Absorbed dose
- Depth dose

12. The energy imparted to matter per unit mass is known as

- Depth dose
- Maximum permissible dose
- ☒ Absorbed dose
- Exposure dose

13. Which of the following statements is true about non-ionizing radiation

- Deposits energy in the materials through which it passes.
- They have sufficient energy to break molecular bonds or remove electrons from atoms.

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 - ☐ 20 Kev
 - ☒ 70 Kev
 - ☒ 10 Kev
17. During characteristic interactions if an L shell electron is filling a K-shell, the photon produced is known as
- ☐ L characteristic
 - ☐ M characteristic
 - ☐ N characteristic
 - ☒ K characteristic.
18. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron. What would be the result of this type of interaction
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 - ☐ L characteristic
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21. The SI unit for radiation exposure tom air is known as
- ☐ Absorbed dose
 - ☐ Effective dose
 - ☒ Rad
 - ☐ Air Kerma
22. Which one of the following is the largest source of natural environmental radiation
- ☐ Radium
 - ☒ Radon

- c. Carbon
- d. Helium

23. Which one of the following is a unit for absorbed dose

- ☒ a. Rad
- b. Rem
- c. Sievert
- d. Becquerel

24. Elements with different mass number but equal atomic number are known as

- a. Isobar
- b. Isomer
- c. Isotone
- ☒ d. Isotope

25. Which one of the following is a major source of occupational exposure

- a. Photodisintegration
- b. Pair production
- c. Photoelectric interactions
- ☒ d. Compton interaction

26. The filtration of an atomic beam has the effect of

- ☒ a. Improving the quality of the transmitted X-ray beam
- b. Increasing the quantity of the transmitted X-ray beam
- c. Reducing the quantity and decreasing quality of the transmitted X-ray beam
- d. Improving the quality and increasing quantity of the transmitted X-ray beam

27. A specific combination of protons and neutrons in a nucleus is called

- ☒ a. Nucleus
- b. Nuclide
- c. Neutrino
- d. Nucleolus

28. β^- radiations are simply

- a. Protons
- b. Neutrons
- ☒ c. Electrons
- d. Nucleous

29. The number of cycles that an acoustic variable goes through in second is known as

- a. Wavelength
- ☒ b. Frequency
- c. Amplitude
- d. Propagation speed

30. Identify the unit of the quality of radiation

- a. Gray
- b. Curie
- ☒ c. Rem
- d. Rad

31. The following elements fall into group VII in the periodic table apart from

- a. Iodine
- b. Chloride

- ☒ c. Manganese
d. Fluorine

32. The sum of both the protons and neutrons is known as

- a. Atomic Number
☒ b. Mass Number
c. Nuclide

d. Neutron Number

33. A process in which a nucleus splits into two or more light nuclei is known as

- ☒ a. Nuclear fission
b. Nuclear Fusion
c. Nuclear reaction

d. Radioactive isotopes

34. A photon of 10MeV colliding with a nucleus will likely result in which type of interaction

- a. Photoelectric
☒ b. Photodisintegration
c. Thompson
d. Compton

35. Which interaction within the diagnostic range does not involve the removal of an orbital electron

- a. Pair production
b. Photoelectric effect
c. Compton effect

☒ d. Classical scattering

36. The dose of radiation to the whole body that causes 50% of irradiated subject to die within 60 days is referred to

- a. LD₅₀
☒ b. LD_{50/60}
c. LD₆₀
d. LD_{60/50}

37. Ultrasound is sound with frequency greater than

- a. 2 Hz
b. 15 Hz
☒ c. 20,000 Hz
d. 1540 Hz

38. Which of the following statement is NOT true about beam of x-rays

- a. Beam of x-ray pass through body tissue unaffected
b. Beam of x-ray may transfer all energy to matter and do not pass through the patient to the film
c. Beam of x-ray may diverted with or without energy loss

☒ d. Beam of x-ray is monoenergetic

39. Which of the following terminology is NOT applied in radiation dosimetry

- ☒ a. Accurate dose
b. Total dose
c. Skin dose

- d. Absorbed dose
40. Attenuation of the X-ray beam can be represented numerically by the following phrases except
- Half value layer
 - Linear attenuation coefficient
 - Mass attenuation coefficient
 - ~~Light attenuation coefficient~~

SECTION 2: SHORT ANSWER QUESTIONS – 40MKS

1. With an aid of well labeled diagram, describe the process of coherent scattering (5mks)
2. State 5 common properties of electromagnetic waves (5mks)
3. The half life of a sample of a radioactive substance is 98 minutes. How long does it take for the activity of the sample to reduce to 1/16 of its original value (5mks)
4. List 5 applications of radioactivity (5mks)
5. Define the following terminologies as used in radiation dosimetry
 - i. Absorbed dose
 - ii. Threshold dose
 - iii. Exposure dose
 - iv. Maximum permissible dose
 - v. Skin dose
6. State 5 properties of gamma particles (5mks)
7. Define Beam quantity and list four factors that affect beam quantity (5mks)
8. Define half value layer, and briefly describe how it can be determined (5mks)

SECTION 3: LONG ANSWER QUESTION – 20MKS

1. Discuss the two main processes of production of X-rays as the filament electron interact with the target on the anode of the x-ray tube

①

SECTION 1

- | | |
|----------|----------|
| 1. D | 21. C |
| 2. D | 22. B |
| 3. C | 23. A |
| 4. D | 24. D |
| 5. A | 25. D |
| 6. A | 26. A |
| 7. C | 27. A |
| 8. D | 28. C |
| 9. A | 29. B |
| 10. C | 30. free |
| 11. B | 31. C |
| 12. C | 32. B |
| 13. free | 33. A |
| 34. D | 34. B |
| 15. A | 35. D |
| 16. C | 36. B |
| 17. D | 37. C |
| 18. A | 38. D |
| 19. B | 39. A |
| 20. C | 40. D |



SECTION 2 (40m15)

1. Coherent scattering (Elastic, Relativistic scattering)
 - Occurs when the energy of the X-ray or gamma photon is smaller than the binding energy of an electron in the atom. It occurs at low energy.

2. - They are transverse waves

- Can travel through a vacuum

- Travel at speed of light ($3.0 \times 10^8 \text{ m/s}$)

- They can transfer energy from one place to another

- They can be reflected

- They can be refracted

$$3. \quad t_{1/2} = \frac{0.693}{\lambda}$$

$$K = \frac{0.693}{98} = 7.07 \times 10^{-3} \text{ min}^{-1}$$

$$N = N_0 e^{-\lambda t}$$

$$\frac{1}{16} = e^{-7.07 \times 10^{-3} \times t}$$

$$\ln 0.0625 = e^{-7.07 \times 10^{-3} \times t}$$

$$\log_e 0.0625 = -7.07 \times 10^{-3} \times t$$

$$-2.777 = -7.07 \times 10^{-3} \times t$$

3

4. ^{99m}Tc - brain thyroid, liver bone marrow, lung, heart & intestinal, scanning, blood volume determination.

^{131}I - Diagnostic and treatment of thyroid gland.

^{133}Xe - lung imaging

^{148}Au - Liver disease diagnosis

- Radioactive dating, irradiation of food, medical applications

^{32}P - Cancer detection and treatment, especially in eyes and skin.

(5 marks)

5. Absorbed dose

- Is the concentration of energy deposited in tissue as a result of an exposure to ionizing radiation.

- equal to energy deposited per unit unit mass of the medium.

~~5 marks~~

(11) threshold dose is a dose level below which there is no effect of radiation on the biological response

- threshold dose is the dose at which a toxic effect is first encountered

- The point at which

(14) Exposure dose - The measure of the ionization of air due to ionizing radiation from α , β , γ and X-rays.

(7)

- Q/m

(10) Maximum permissible dose is the upper limit of allowed radiation dose that one may receive without the risk of significant side effects

(11) The entrance skin dose is the measure of the radiation dose that is absorbed (mGy) by the skin as it reaches the patient. It is measured by thermoluminescent dosimeter (TLD)

SMKS

6. - Not deflected by electric & magnetic fields
- Are electromagnetic waves
- Travel with speed of light
- The rest mass of gamma, γ -photon is zero
- Have very large penetrating power

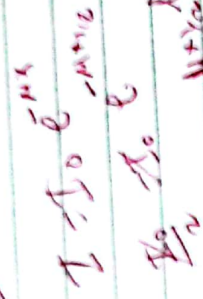
SMKS
7. - Affect a photographic plate more than β -particles
- Can knock out electrons from the surface of material
- Produce nuclear reactions

7. Quantity refers to the number of X-ray photons in the beam
- Peak Voltage (kVp)
- Exposure time (seconds)
- Current (mA)
- Anode material

8 HVL - Thickness that will reduce the intensity of the x-ray by half.

$$HVL = 0.693 / \mu$$

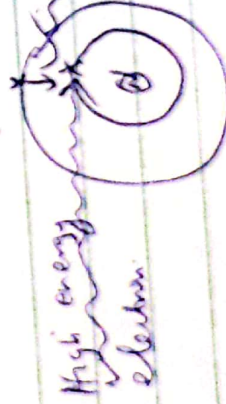
μ - attenuation coefficient (S/mk)



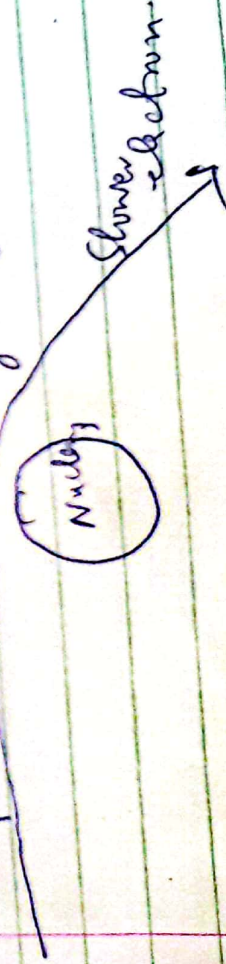
SECTION 3 (20 MARKS)

$\ln 2 = \mu x$
 $\ln 2 = \mu x$
 $\ln 2 = \mu x$

1. Characteristic X-ray generation
 - When a high energy electron collides with an inner shell electron both the electron from the inner shell leaving a hole in the inner layer. This layer is filled by an outer shell electron with a loss of energy emitted as an X-ray photon.
 outer drops $\rightarrow$ excited inner electron $\rightarrow$ X-ray generated.



Braking radiation | Braking X-ray generation
 Fast electron $\rightarrow$ braking $\rightarrow$ X-ray generated.



6
When an electron passes near the nucleus it
slowed and its path is deflected. Energy lost is
emitted as a ~~Bremsstrahlung~~ X-ray photon.
- Bremsstrahlung = Braking radiation.
- Approximately 80% of the population of
X-rays within the 20 X-ray beam consists of
X-rays generated in this way

(10 mG)



KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
YEAR ONE END OF SEMESTER TWO EXAMINATION
DIPLOMA IN RADIOGRAPHY AND IMAGING- MARCH 2021

PAPER: MEDICAL PHYSICS AND CHEMISTRY II(MPC 1209)

DATE: 7th February 2022

TIME: 3 HOURS

INSTRUCTIONS

1. This paper consists of:

- Section 1 (40 Multiple Choice Questions)
 - Section 2 (8 Short Answer Questions)
 - Section 3 (1 Long Answer Question)
2. Attempt ALL Questions

3. Write the **EXAMINATION NUMBER** given on all the answer sheets provided and on the question paper.

4. Ensure that all examination answer scripts are handed in at the end of the examination

5. Ensure you sign the examination register provided

EXAMINATION NUMBER

SECTION I: MULTIPLE CHOICE QUESTIONS (40 MARKS)

- 1) Which one of the following is a major source of occupational exposure?
 - a) Photodisintegration
 - b) Pair production
 - c) Photoelectric interactions
 - d) Compton interactions
- 2) Which interaction within the diagnostic range does not involve the removal of an orbital electron
 - a) Pair production
 - b) Photoelectric effect
 - c) Compton effect
 - d) Classical scattering
- 3) A photon of 10 meV colliding with a nuclear will likely result in what type of interaction
 - a) Photoelectric
 - b) photodisintegration
 - c) Thompson
 - d) Compton
- 4) Which of the following interactions contributes to most image fog
 - a) Classical
 - b) Photoelectric
 - c) Pair production
 - d) Compton
- 5) The process of addition or removal of electrons from an atom is called?
 - a) Disintegration
 - b) Electrification
 - c) Ionization
 - d) Resistivity
- 6) The SI unit for radiation exposure to air is
 - a) Absorbed dose
 - b) Effective dose
 - c) Rad
 - d) Air kerma
- 7) Which one of the following is the largest source of natural environmental radiation
 - a) Radium
 - b) Radon
 - c) Carbon
 - d) Helium
- 8) Which one of the following is a unit for absorbed dose
 - a) Rad
 - b) Rem
 - c) Sievert
 - d) Becquerel
- 9) Identify the unit of the quantity of radioactive material
 - a) Gray
 - b) Curie
 - c) Rem

d) Rad

10) The following terminologies are applied in radiation dosimetry except

- a) Accurate dose
- b) Total dose
- c) Skin dose
- d) Absorbed dose

11) Identify one of the following elements that does not fall into group VII in the periodic table

- a) Iodine
- b) Chloride
- c) Manganese
- d) Astatine

12) Which one of the following statement is FALSE about voltaic and electrolytic cell?

- a) Electrons flow from anode to cathode in the external circuit
 - b) The electrode at which oxidation occurs is the anode
 - c) The electrode at which reduction occurs is the cathode
 - d) Cathode is the negative electrode while anode is the positive electrode
- 13) Chemical change caused by passing electric current through a compound which is either molten or in solution is known as

- a) Electrolysis
- b) Electrochemistry
- c) Electrochemical
- d) Electrolytic cell

14) What is the mass of one electron?

- a) 1.0073
- b) 1.0087
- c) 5.48588×10^{-4}
- d) 5.588×10^{-4}

15) Which one of the following is not a property of acid

- a) They are sour to taste
- b) They turn red litmus paper blue
- c) They do not change the colour of turmeric indicator
- d) They turn blue litmus paper red

16) Ultrasound is sound with frequency greater than

- a) 2 Hz
- b) 15 Hz
- c) 20,000 Hz
- d) 1540 Hz

17) The number of cycles that an acoustic variable goes through in second is known as

- a) Wavelength
- b) Frequency
- c) Amplitude
- d) Propagation speed

18) Place the following classifications of matter in order of increasing sound propagation speed

I. Gas

- II. Solid
III. Liquid

- a) I,ii,iii
b) I,iii,i
c) I,iii,ii
d) Iii,ii,i

19) While frequency of ultrasound in soft tissue increases, the wavelength

- a) Weakens
b) Is constant
c) Increases
d) Decreases

20) Propagation speed in bone is -----that in soft tissue

- a) Lower than
b) Equal to
c) Higher than
d) 10m/s greater than

21) Process by which an electron is emitted from an atom and immediately falls back

- a) Ionization
b) Excitation
c) Electrification
d) None of the above

22) Type of x-radiation produced by breaking a projectile electron by a nucleus

- a) Characteristic x-ray
b) K-shell x-ray

c) Bremmstrahlung

d) L-shell x-ray

23) Which of the following material is not used as anode target surface?

- a) Copper
b) Molybdenum
c) Rhodium
d) Tungsten

24) Which of the following is not a factor that determines the quality or quantity of X-ray beam from the anode?

- a) kVp
b) mA
c) exposure time
d) filtration

Match the following statements with the appropriate term (Q25-30)

- | | | |
|----|------|---|
| 25 | i) | it's the source of electrons in xray tube |
| 26 | ii) | causes acceleration of electrons within the xray tube |
| 27 | iii) | source of current supply to the cathode |
| 28 | iv) | source of voltage to the high tension transformer |
| 29 | v) | ability of a material to be drawn into thin wire |
| 30 | vi) | production of electrons at the cathode |
| | a) | malleability ✓ |

- b) thermal emission ✓
- c) space charge ✓
- d) autotransformer ✓
- e) potential difference ✓
- f) filament heating circuit ✓

31. The primary x-ray beam penetration (percent) through a patient can be increased by increasing the:

- a. KV. Yes
- b. MAS. No
- c. Filtration. Yes
- d. Beam area. No

32. The maximum MA which can be used for a single radiographic exposure is related to the following except:

- a. filtration.
- b. Exposure time.
- c. Focal spot size.
- d. Anode rotation speed.

33. The maximum field of view which can be obtained with a specific radiographic system is generally limited by the:

- a. Focal spot size.
- b. Anode size.
- c. Anode angle.
- d. Anode speed

34. Relatively low KV values are used in some x-ray procedures for the purpose of:

- a. Increasing penetration.
- b. Increasing contrast sensitivity.
- c. Decreasing patient exposure.
- d. Decreasing area contrast.

35) A small focal spot is used to:

- a. Reduce patient exposure.
- b. Decrease image noise.
- c. Increase visibility of detail.

d. Increase image blurring.

36) X-ray and gamma have significance penetrative power because of

- a. short wavelength
- b. medium wavelength
- c. long wavelength
- d. wide range of wavelengths

37) X-rays and gamma are often referred to as photons because

- a. they possess no charge
- b. they possess no mass
- c. they carry bundles of energy
- d. none of the above

38) rate at which radioisotope changes to a stable atom

- a. isotope decay rate
- b. half life
- c. radioactivity
- d. attenuation

39) attenuation of radiation is due to:

- a. absorption
- b. scattering
- c. radioactivity
- d. all of the above

40) the thickness of any material that 50% of incident radiation is attenuated

- a. half-life
- b. half value layer
- c. half linear attenuation
- d. half attenuation coefficient

SECTION II: SHORT ANSWER QUESTIONS (40 MARKS)

1. Define the following terminologies as used in radiation

(5 marks)

- I. Absorbed dose
- II. Threshold dose
- III. Exposure dose
- IV. Maximum permissible dose
- V. Skin dose

2. State 5 applications of radioactivity

(5 marks)

3. Explain two types of anode tubes and their uses

(4marks)

4. Briefly describe ultrasound as applied in medical imaging

(5 marks)

5. List five types of radioactivity decay processes

(5 marks)

6. State the SI equivalent of the following radiologic units of measurement (6marks)

I. Roentgen

II. Rad

III. Rem

7. Briefly describe classical interaction as one of the ways in which x-ray interact with

matter

(5 marks)

(5 marks)

8. State five properties of gamma particles

SECTION 3: ANSWER ALL QUESTIONS (20MRKS)

1. Discuss the two main processes of production of x-ray as the filament electron interact with the target on the anode of the x-ray tube (20marks)

SECTION I

①

1. ~~d~~ 21. b
2. ~~a~~ 22. c
3. b 23. a
4. d free 24. d
5. c 25. f
6. ~~d~~ free 26. ~~c~~
7. b 27. ~~e~~ free
8. a 28. ~~d~~
9. ~~a~~ b 29. a
10. ~~d~~ a 30. b
11. c, d 31. a, b
12. a, free 32. ~~d~~
13. a 33. ~~a~~
14. free 34. b
15. ~~c~~ free 35. c
16. c 36. a
17. b 37. c
18. b 38. ~~a~~ c
19. d, b 39. a, b
20. c 40. b

1. (i) Absorbed dose

- Is the concentration of energy deposited in tissue as a result of an exposure to ionizing radiation
- Equal to the energy deposited per unit mass of medium

(ii) Threshold dose

- Is the dose level below which there is no effect of radiation on the biological response
- Is the dose at which toxic effect is first encountered
- Is the point at which effects are first seen

(iii) Exposure dose

- The measure of the ionization of air due to ionizing radiation from photons, that is, gamma rays and X-rays
- Electric charge freed by such radiation in a specified volume of air divided by the mass of that air

(iv) Maximum permissible dose

- Is the upper limit of allowed radiation dose that one may receive without the risk of significant side effects

(v) Skin dose

- The entrance skin dose is the measure of the radiation dose that is absorbed (by the skin) as it reaches the patient
- Measured by thermoluminescent dosimeter (TLD)

2. Isotope

use

^{99m}Tc

- Brain, thyroid, liver, bone marrow, lung, heart and intestinal scanning
- blood volume determination, diagnosis and treatment of thyroid dysfunction

^{131}I

Diagnosis and treatment of thyroid function

^{133}Xe

- lung imaging

^{198}Au

- liver disease diagnosis

^{32}P

- Cancer detection and treatment, especially in eyes and skin.

^{59}Fe

- anemia diagnosis

^{60}Co

- gamma ray irradiation of tumours

3.

- Rotating anode
- Fixed anode

4. - Ultrasound is sound with frequency $> 20\text{ kHz}$ & ultrasound scan, sometimes called a sonogram

is a procedure that uses high frequency sound waves to create an image of part of the inside of the body. An ultrasound scan can be used to monitor an unborn baby, diagnose a condition, or guide a surgeon during certain procedures.

④

- 5 - alpha decay ✓
- Beta decay ✓
- Gamma decay ✓
- positron emission ✓
- Beta plus ✓
- annihilation ✓

- 6
- | | | | | |
|-------|----------|---|------|---|
| | Roentgen | - | C/kg | ✓ |
| (i) | Rad | = | Gy | ✓ |
| (ii) | Rem | = | Sv | ✓ |
| (iii) | | | | |

- 7
- Elastic scatter
 - Incoming photon has less energy than the binding electrons

- 8
- Gamma rays are not deflected by electric and magnetic field
 - Gamma rays are electromagnetic waves like x-rays
 - The rest mass of a gamma ray = photon is zero
 - Gamma rays travel at speed of light
 - Gamma rays have very large penetrating power

L.C



KENYA MEDICAL TRAINING COLLEGE
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DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING
MARCH 2022 CLASS
YEAR ONE END OF SEMESTER TWO EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY II (MPC1209)

DATE:13/2/2023

TIME:3HRS(2-5pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
5. Any examination malpractices will be handled as per the college examination policy

REGISTRATION NUMBER:.....

MEDICAL PHYSICS AND CHEMISTRY II**SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)**

1. Up to what intensity of radiation is used for mammography?
 - A. < 10keV
 - B. < 70keV
 - C. < 30keV
 - D. < 40keV
2. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
 - A. Relatively big and heavy in atomic terms and a highly ionizing form of radiation able to penetrate the skin
 - B. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
 - C. Relatively small and light but able to penetrate the skin
 - D. Relatively small and light but unable to penetrate skin.
3. Which of the following statement is false about X-rays?
 - A. Most X-rays have a wavelength ranging from 10^{-8}m to 10^{-4}m ,
 - B. Most X-rays have frequencies in the range of $3 \times 10^{16}\text{ Hz}$ to $3 \times 10^{19}\text{ Hz}$
 - C. Most X-rays have energies in the range of 124 eV to 124 keV.
 - D. Most X-rays have frequencies in the range of 30 petahertz to 30 exahertz
4. The following are conditions necessary for X-ray to be produced except?
 - A. Exposure factors have to be selected.
 - B. The anode has to rotate to full speed
 - C. Electricity has to travel to the anode and cathode filament.
 - D. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
5. Which of the following statements is true about x-ray beam quantity
 - A. Beam quantity varies inversely as the square of the ratio of change in kVp.
 - B. Beam quantity varies directly as the square of distance.
 - C. The use of filtration decreases x-ray beam quantity to an extent that it depends on other factors
 - D. Beam quantity is inversely directly proportional to mAs.
6. An interaction with matter that occur throughout the diagnostic range involving moderate energy X-ray photons is known as:
 - A. Classical Interactions
 - B. Pair production
 - C. Photodisintegration interactions
 - D. Compton Interactions
7. The statements below describe the application of an electromagnetic waves.
 - i. Used to produce images of hot objects through the colours
 - ii. Produced by the amount of heat dissipated by an object.
 - iii. They are used in hospitals to detect illnesses (diagnosis)
 - iv. Used in warfare missiles and burglar alarm systems

Identify the type of wave whose application is described above.

- A. Infra-red radiation
- B. Visible spectrum
- C. X-Rays
- D. Gamma rays

8. In order to obtain a higher-energy x-rays, one needs to change?

- A. Tube current
- B. Exposure time
- C. Tube voltage
- D. Filament voltage

9. Which of the following statements is true about non ionizing radiation?

- A. Deposits energy in the materials through which it passes.
- B. They have sufficient energy to break molecular bonds or remove electrons from atoms.

C. Example include of non-ionizing radiation include; visible light, heat, beta, microwaves, and radio waves

D. They are able to cause ionization

10. For X-ray to be produced, the following conditions have to be met except

- A. Exposure factors have to be selected.
- B. Electricity has to travel to the anode, cathode and filament.
- C. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.

D. The X-ray tube window has to be opened

11. During the process of X-ray production, the filament electrons penetrate the face of the target to a depth of approximately how many millimeters?

- A. 0.5 millimeters
- B. 0.2 millimeters
- C. 0.1 millimeters
- D. 0.3 millimeters

12. During x-ray production, what is the shortest binding energy of K-shell electrons in tungsten

- A. 40 Kev
- B. 20 Kev
- C. 70 Kev
- D. 10 Kev

13. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron.

What would be the result of this type of interaction?

- A. K characteristic
- B. L characteristic
- C. No Interaction
- D. No X-ray produced

14. During x-ray production, in which interaction does the filament electron misses all the orbital electrons and interacts with the nucleus of the target atom.

- A. Characteristic interactions
- B. Bremsstrahlung interactions
- C. Compton interactions
- D. Classical interactions

15. Which one of the following is a major source of occupational exposure
 - A. Photodisintegration
 - B. Pair production
 - C. Photoelectric interactions
 - D. Compton interaction
16. The filtration of an atomic beam has the effect of
 - A. Improving the quality of the transmitted X-ray beam
 - B. Increasing the quantity of the transmitted X-ray beam
 - C. Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - D. Improving the quality and increasing quantity of the transmitted X-ray beam
17. A specific combination of protons and neutrons in a nucleus is called
 - A. Nucleus
 - B. Nuclide
 - C. Neutrino
 - D. Nucleolus
18. A photon of 10Mev colliding with a nuclear will likely result in which type of interaction
 - A. Photoelectric
 - B. Photodisintegration
 - C. Thompson
 - D. Compton
19. Ultrasound is sound with frequency greater than
 - A. 2 Hz
 - B. 15 Hz
 - C. 20,000 Hz
 - D. 1540 Hz
20. Which of the following statement is NOT true about beam of x-rays?
 - A. Beam of x-ray pass through body tissue unaffected
 - B. Beam of x-ray may transfer all energy to matter and do not pass through the patient to the film
 - C. Beam of x-ray may be diverted with or without energy loss
 - D. Beam of x-ray is monoenergetic

SECTION 2: SHORT ANSWER QUESTIONS- 40MKS

21. With an aid of well labeled diagram, describe the process of coherent scattering (5mks)
22. State five (5) common properties of electromagnetic waves (5mks)
23. The half-life of a sample of a radioactive substance is 98 minutes. How long does it take for the activity of the sample to reduce to $1/32$ of its original value (5mks)
24. With an aid of a graph explain half-life (5 mks)
25. Define the following terminologies as used in radiation dosimetry
- Absorbed dose
 - Threshold dose
 - Exposure dose
 - Maximum permissible dose (5mks)
 - Skin dose (5mks)
26. State five (5) properties of gamma particles (5mks)
27. State five (5) characteristics of Tungsten that makes it a material of choice for target of the x-ray tube (5mks)
28. Define half value layer, and briefly describe how it can be determined (5mks)

SECTION 3: LONG ANSWER QUESTIONS (40MKS)

- 29.
- Explain 5 applications of radioactivity (10mks)
 - Describe the principles of Geiger Muller tube (10mks)
30. Discuss the principal factors influencing the shape of an x-ray spectrum (20 mks)

II Hysteresis loss (Lagging loss)

Found in core of transformer. Occurs because energy is expended as the continually changing AC current magnetizes, demagnetizes and remagnetizes the core material. Demagnetization leaves some dipoles in the original orientation and this residual magnetism causes the remagnetization to lag this producing more heat loss. This characteristic is called Coercivity and can be minimized by using core material such as Silicon Iron.

III Eddy current loss - found in the core as a result of currents opposing the cause which produced them according to Lenz's law. Produced in any conducting material subjected to changing magnetic fields.

minimized by laminating the transformer core by dividing the core into thin layers. This reduces strength of eddy currents.

NB. Lenz's law

IV Flux leakage - ~~prim~~ NOT all the flux links up with the secondary coil.

47. - move conductor through a stationary unchanging strength magnetic field
- move magnetic lines of force through a stationary conductor with an unchanging strength magnetic field
 - Vary magnetic flux strength from a stationary magnet through a stationary conduct. As the flux strength varies, the lines of force will expand and contract causing the relative motion necessary to induced current

48. (a) def loss of definition on the edges of the image caused by geometrical factors of the radiographic equipment

- (b) Object-to-image detector distance to D to source-to-object distance (SOD)
- 1:1 IOD: SOD
- Target angle and therefore the real length of focus for a given apparent size
 - Focal spot size

SECTION 3 (Zones)

1. I^2R loss - called copper loss
- caused by the inherent resistance to current flow that is found in all conductors
- power lost $\propto$ to square of current. lost power given off as heat
 - minimized by using low-resistance wire such as large diameter copper and by using high voltage and low amperage

4.

Increase in temperature increases drift velocity because as temp increases atomic vibrations will increase which will cause more collisions with the crystal lattice. Hence drift velocity will decrease. Electrical conductivity of a conductor will decrease with an increase in temperature.

As temperature increases the atomic collisions provide enough energy to some electrons to permit them to jump into the atoms conducting band. Heat is a measure of the amount of atomic and molecular energy often seen as vibration. In conductors increased temperature increases free electron collisions thus lessens electrical current flow in insulators. Increase in temperature causes electrons to lose energy, decreases insulating ability. In semiconductors become more conductive as temp increases.

(9) Source-to-image receptor distance (SID)
The greater the SID the smaller the magnification because as SID increases the percentage of total distance that makes up 10D decreases.

(10) Object-to-image receptor distance (OID)
Reducing or minimizing OID decreases magnification. Also affects resolution of the image.

6. Ferromagnetic materials are highly permeable and greatly susceptible to magnetic induction. They have majority of their dipoles lying in same direction thus setting up a natural magnetic field.

Examples - Iron, Cobalt, Nickel

7.

SECTION 2

- 1.
- (i) ~~me~~ ~~mechanical~~ ~~Chemical~~ - result from action of molecules or physical movement. two forms, kinetic, potential
 - (ii) ~~Electrical~~ - result from movement of electron
 - (iii) ~~Heat (Thermal)~~ - result from motion of atoms or molecules
 - (iv) ~~Chemical~~ - form released during chemical reaction of battery
 - (v) ~~Nuclear~~ - stored in the nucleus of each atom and holds the nuclear particles in a tight bond
 - (vi) ~~Electromagnetic~~ - result from electric and magnetic disturbances in space

Any 5 (5 marks)

2. Magnetic induction is the process whereby when a non-magnetized iron bar is brought within the lines of force of a strong magnet, the dipoles will temporarily align themselves with the lines of force passing through the iron bar. If the iron bar is removed from the field after a short while the dipoles will return to their random orientation. Operates like electromagnetic induction.

3.

$$\frac{V_s}{V_p} = \frac{I_s}{I_p}$$

$$\frac{V_s}{415V} = \frac{20,000 \text{ turns}}{200 \text{ turns}}$$

$$V_s = \frac{8,300,000}{200}$$

$$= 41,500 \text{ volts}$$

$$= 41.5 \text{ kV}$$

SECTION A (40 MKS)

1. A ~~31. B Free~~
2. C ~~32. B~~
3. B ~~33. B~~
4. B ~~34. D~~
5. D Free ~~35. C~~
6. D ~~36. D~~
7. A ~~37. A~~
8. A ~~38. D~~
9. B ~~39. E~~
10. C ~~40. B~~
11. D
12. B
13. D
14. B Free
15. A
16. B
17. A
18. C
19. D
20. B
21. C
22. D
23. C
24. D
25. C
26. C
27. B
28. C
29. D
30. A

Continue
from next
page

- a) Electron flow is pulsed but uninterrupted
 b) Electrons flow in one direction but not the other
 c) The result is constant potential DC
 d) Voltage is increased

Section 2: Short Answer Questions (40 marks)

1. State five types of energy (5 marks)
2. Explain magnetic induction (5 marks)
3. If a transformer is supplied with 415V to the primary coil has 200 turns of wire on the primary coil 20,000 turns of wire on the secondary coil, calculate the voltage that will be in the secondary coil (5 marks)
4. Explain how the temperature of a conductor influence the resistance (5 marks)
5. Explain the factors that affect size distortion in a radiographic image (5 marks)
6. Citing examples, explain ferromagnetic materials (5 marks)
7. Outline the three ways that can be used to create motion between lines of force and a conductor in electromagnetic induction (5 marks)
8. a) Define Geometrical unsharpness (Ug) (2 marks)
 b) State the factors that control geometrical unsharpness (3 marks)

Section 3: Long Answer Questions (20 marks)

1. Describe the factors that greatly affect the efficiency of the transformers in the X-ray equipment and how they can be minimized (20 marks)

Answer

④ Metals conduct electricity due to the presence of free electrons. When heated these free electrons gain energy and collide with each other. They hinder the motion of each other and hence overall reduce conductivity.

- ☒ b) A nucleus
c) A permanent magnet
d) An electromagnet
33. Which of the following would likely be classified as ferromagnetic material?
a) Air
☒ b) Iron
c) Glass
d) Lead
34. An electron moving in a conductor
a) Causes the conductor to behave as a bar magnet
b) Causes the conductor to bend
c) Produces a magnetic field in the conductor
☒ d) Produces a magnetic field perpendicular to the conductor
35. An electromagnet
a) Cannot be turned off
b) Has an air core
☒ c) Is a coil of wire wound around an iron core
d) Produces a magnetic field with or without an electric current
36. In an electric motor
a) A coil of wire is mechanically rotated
b) A commutator ring is not necessary
c) AC is changed to DC
☒ d) Electric current is supplied to a coil of wire
37. The electric current produced by an AC generator has
☒ a) Alternating positive and negative intensity
b) Constant negative intensity
c) Constant positive intensity
d) Pulsating positive intensity
38. The principle application of a transformer in an X-ray imaging system is to
a) Change AC to DC
b) Change DC to AC
c) Change frequency
☒ d) Change voltage
39. Which of the following principle of rectification produces the maximum efficiency of X-ray production?
a) Four-diode rectification
b) Half-wave rectification
☒ c) High frequency
d) Self-rectification
40. A circuit that contains a single rectifier

- c) Usually inner-shell electrons move
d) ☒ Usually outer-shell electrons move
25. Which of the following is a method of electrification?
a) Transmission
b) Excitation
c) ☒ Induction
d) Resonance
26. Objects become electrified because of
a) An excess of neutrons
b) An excess of protons
c) ☒ Transfer of electrons
d) Transfer of protons
27. The unit electrostatic charge is the
a) Ampere
b) ☒ Coulomb
c) Electron volt
d) Newton
28. The electrical resistance of a wire increases as the diameter of the
a) Insulator decreases
b) Insulator increases
c) ☒ Wire decreases
d) Wire increases
29. The number of volts required to cause a current of 40A in a circuit having a resistance of 5Ω (ohms) is
a) 5V
b) 40V
c) 45V
d) ☒ 200V
30. Ohms law states that
a) ☒ The electrical potential is a product of current and resistance
b) Electrical current is the product of voltage resistance
c) Electrical power is equal to voltage times resistance
d) Electrical potential to current squared times resistance
31. In a series circuit
a) Ohm's law fails
b) ☒ The total resistance is the sum of the individual currents ^{resistors}
c) The total current is the sum of the individual currents
d) Only three circuit elements are allowed
32. An example of a magnetic domain is
a) A bar magnet

- d) Atomic mass number determines the chemical properties
17. Isomers are atoms that have different
- ☒ a) Energy states
 - b) Filled electron shells
 - c) Numbers of neutrons
 - d) Numbers of protons
18. In an electronic spectrum, photons of a radio broadcast have relatively
- a) High energy and long wavelengths
 - b) High energy and short wavelengths
 - ☒ c) Low energy and long wavelengths
 - d) Low energy and short wavelengths
19. The principle difference between X-rays and gamma rays is their
- a) Energy
 - b) Frequency
 - c) Wavelength
 - ☒ d) Origin
20. Electromagnetic radiation
- a) Exists at zero velocity
 - ☒ b) Exists only if its velocity is 3×10^8 m/s - *speed of light*
 - c) Has energy represented by amplitude
 - d) Has mass that increases with increasing velocity
21. The inverse square law is as a result of
- a) Attenuation
 - b) Absorption
 - ☒ c) Divergence
 - d) Scatter
22. If an instrument position 1m from a point source is moved 50cm closer to the source, the radiation intensity will
- a) Decrease by a factor of 2
 - b) Decrease by a factor of 4
 - c) Increase by a factor of 2
 - ☒ d) Increase by a factor of 4
23. The principal reservoir for excess electric charge is the
- a) Clouds
 - b) Lightning
 - ☒ c) Earth
 - d) Water pipes
24. Regarding the movement of an electric charge from one atom to another atom,
- a) Both positives and negative charges can move
 - b) It must occur in a large atom

- d) Matter and energy are related ✓
9. Which of the following is a unit of work?
- a) Gray
 - b) ✓ Joule
 - c) Hertz
 - d) Newton
10. Which of the following statements about energy is true?
- a) Energy is force
 - b) Energy is a form a power
 - c) ✓ Energy is the ability to do work
 - d) Energy is the rate of doing work
11. Heat is transferred from a glass-enclosed five place primarily by: _
- a) Conduction
 - b) Convection
 - c) Convention
 - d) ✓ Radiation
12. Which of the following element is not placed in any group of the periodic table?
- a) Helium
 - b) ✓ Hydrogen
 - c) Tungsten
 - d) Uranium
13. The Horizontal rows in the period table are called
- a) Articles
 - b) Compounds
 - c) Groups
 - d) ✓ Periods
14. How many atoms are there in one molecule of Sodium bicarbonate (NaHCO_3)_2 Free
- a) 1
 - b) ✓ 6
 - c) 3
 - d) 4
15. The number of protons in the nucleus of an atom is called the
- a) ✓ Atomic number
 - b) Atomic mass
 - c) Valence
 - d) Ionization state
16. Regarding atomic nomenclature
- a) Atomic mass is the number of neutrons
 - b) ✓ Atomic mass is the number of protons and neutrons
 - c) Atomic mass is the number of protons minus neutrons
- 

Section 1: Multiple Choice Questions (40 marks)

1. X-ray tube voltages are measured in
 - a) Kilovolt ✓
 - b) Megavolt
 - c) Microvolt
 - d) Volt
2. A radiographic exposure that lasts $1/10$ s is equivalent to
 - a) 100ms
 - b) 1ms
 - ~~c) 100ms~~
 - d) 1000ms
3. A radiographic exposure is made at 600mA and 200Sm ^{200ms}. This is equivalent to
 - a) 1.2 mAs
 - ~~b) 1.2×10^2 mAs~~ ✓
 - c) 1.2×10^1 mAs
 - d) 1.2×10^3 mAs
4. Which of the following is not a base quantity in the SI
 - a) Electric current
 - ~~b) Exposure~~
 - c) Mass -
 - d) Time.
- *5. Which of the following is expressed in the proper units
 - a) Absorbed dose; Sr ^(Sv)
 - b) Activity rem
 - c) Dose equivalent rad
 - ~~d) Exposure: mGya~~
6. A kilogram is the
 - a) Energy required to raise 1 (lb) of water 1°C
 - b) Mass of a standard gold bar
 - c) Mass of 1lb of water
 - ~~d) Mass of 1000cm^3 of water~~
7. Which of the following is a unit of radioactivity?
 - ~~a) Ci~~
 - b) Gy
 - c) J
 - d) Rad
8. Which of the following currently states Newton's first law of motion ^{1st}
 - ~~a) An object at rest will remain at rest unless acted on by external force~~ ^{1st}
 - b) An object with mass (M) and acceleration is acted on by a force, given by the equation $F=ma$ ^{2nd}
 - c) For every action, there is an opposite equal reaction ^{3rd}

MARKING SCHEME

KMTC/QP-08/EP5



**KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF MEDICAL IMAGING SCIENCES**

**END OF SEMESTER EXAMINATION
FOR
DIPLOMA IN MEDICAL IMAGING**

PAPER: MEDICAL PHYSICS AND CHEMISTRY I (MPC I)

DATE: 18th February 2020

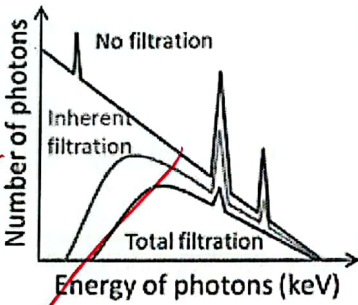
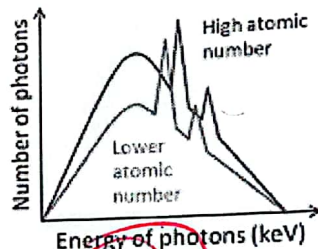
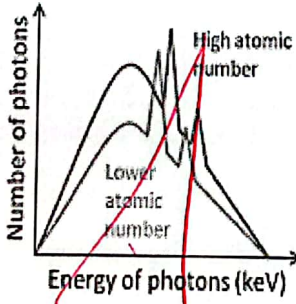
TIME: 3 HOURS (9:00AM – 12:00 PM)

INSTRUCTIONS

1. This paper consists of:
 - Section 1 (40 Multiple Choice Questions)
 - Section 2 (8 Short Answer Questions)
 - Section 3 (1 Long Answer Question)
2. Attempt **ALL** Questions
3. Write the **EXAMINATION NUMBER** given on all the answer sheets provided and on the question paper.
4. Ensure that all examination answer scripts are handed in at the end of the examination
5. Ensure you sign the examination register provided

EXAMINATION NUMBER

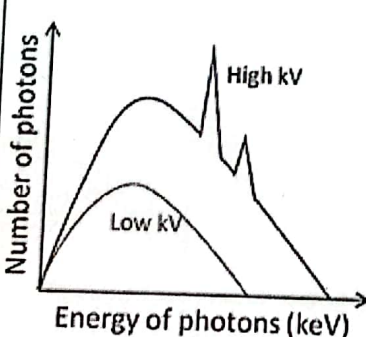
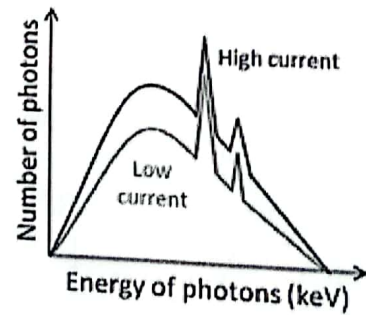
energy
produced

Filtration Fewer lower energy photons Decreased: - Total quantity of photons Increased: - Average energy of photons	Filtration  Number of photons Energy of photons (keV) No filtration Inherent filtration Total filtration - Shift both in intensity and energy	Increasing Atomic Number of Target Increased: - Quantity of x-ray photons - Characteristic energy	Increasing atomic number of target  Number of photons Energy of photons (keV) Lower atomic number High atomic number no energy shift
Waveform of Current Having a more uniform current (rectified) results in - Increased: - Average energy - Quantity of x-ray photons Same maximum keV	Increasing atomic number of target  Number of photons Energy of photons (keV) Lower atomic number High atomic number		

chamber will conduct electricity. When radiation enters the chamber through the window, the photons in the radiation will ionize the inert gas inside the chamber. This will make the gas conductive. The electrons produced due to ionization are accelerated due to the potential that was applied and these electrons cause more ionization. The ionized electrons travel towards the anode. The anode is connected to a counter. The counter counts the electrons reaching the anode and therefore measure radiation.

30 50. Discuss the principal factors influencing the shape of an x-ray spectrum (20 marks)

- (11) mA
- (10) kVp
- (11) added filtration
- (11) generator wave form
- (11) target material
- ~~Voltage phase~~

Increasing the Tube Potential (kV)	Increasing the Tube Current (mA)
Increased : - Quantity of x-ray photons - Average energy - Maximum energy If kV great enough, characteristic	Increased quantity of x-ray photons No change in: - Characteristic energy - Average energy - Minimum energy - Maximum energy
 - shift both in photon intensity and energy 3	 - No shift in energy 4

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This is the measure of the penetrating power of the x-ray beam and is the amount of matter required to attenuate the beam to half its value. It differs for different materials and strengths of beams. To calculate the factor of reduction use: 2^{HVL}

e.g. if the HVL of a beam is 2mm, by what factor is the beam attenuated by if it passes through 8mm of material?

8mm = 4 HVLs

$$2^4 = 16$$

The beam is attenuated by a factor of 16

$$N = N_0 e^{-\mu x}$$

$$\frac{1}{2} N_0 = N_0 e^{-\mu x_2}$$

$$\ln 0.5 = -\mu x_2$$

$$x_2 = \frac{0.693}{\mu}$$

SECTION C – 40MKS

29-49.

a. Explain 5 applications of radioactivity

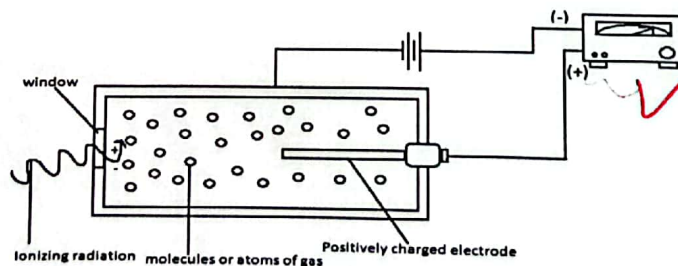
(10mks)

- Tracing
- Medical application
- Dating once living object
- Preservation of food
- Radioimmunoassay
- Simple metabolic examinations

explain five - 10

b. Describe the principles of Geiger Muller tube

(10mks)



A Geiger-Muller counter is a device used for the detection and measurement of ionizing radiation. The Geiger Muller tube has a chamber filled with an inert gas (helium, neon, or argon) at low pressure. When a high voltage is applied to this chamber the metallic

iv. Maximum permissible dose

Maximum dose which a person should receive in a specified period and considered to produce no harmful effect

v. Skin dose

dose received at a point on the skin

(5mks)

26 46. State 5 properties of gamma particles

- Gamma, γ -rays are not deflected by electric and magnetic fields. It shows that they do not have any charge.
- Gamma, γ -rays are electromagnetic waves like X-rays. The wavelength of γ -ray photon is smaller than that of X-rays.
- The rest mass of a Gamma, γ -ray photon is zero. Gamma, γ -rays travel with the speed of light.
- Gamma, γ -rays have very large penetrating power. They can pass through several centimeter of iron and lead.
- Gamma, γ -rays can produce fluorescence in a fluorescent substance.
- Gamma, γ -rays affect a photographic plate more than β -particles.
- Gamma, γ -rays can knock out electrons from the surface of a metal, on which they may fall.

27 47. State 5 characteristics of Tungsten that makes it a material of choice for target of the x-ray tube

(5mks)

- High melting point
- High atomic number
- High density.
- Reasonable absorption of heat.
- Fairly high thermal conductivity
- Good mechanical strength
- Reduced risk of surface crazing as a result of added rhenium

28 48. Define half value layer, and briefly describe how it can be determined

(5mks)

- (9)
- ii. They undergo reflection, refraction and diffraction.
 - iii. All electromagnetic waves travel at the speed of light i.e. $3 \times 10^8 \text{ ms}^{-1}$.
 - iv. They carry no electric charge
 - v. They transfer energy from a source to a receiver in the form of oscillating electric and magnetic fields.
 - vi. They obey the wave equation ($v = \lambda f$).

23/43. The half life of a sample of a radioactive substance is 98 minutes. How long does it take for the activity of the sample to reduce to $1/32$ of its original value (5mks)

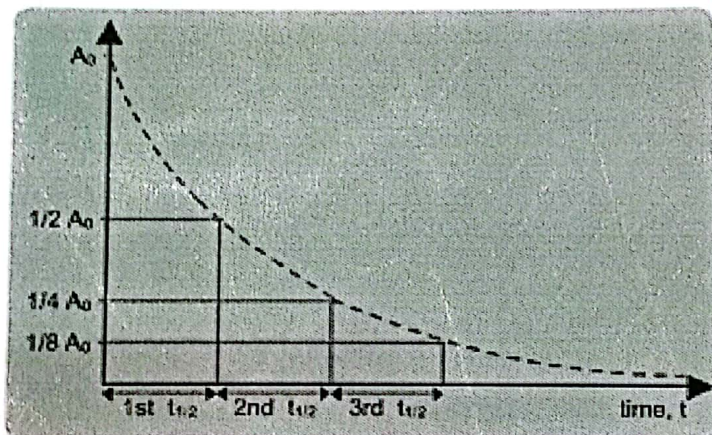
= 490 minutes

$N = N_0 e^{-\lambda t}$

$\frac{1}{32} = e^{-\lambda t}$

$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{98}$

24/44. With an aid of a graph explain half life (5 Marks)



(9)

$\frac{1}{32} = e^{(-7.07 \times 10^{-3} t)}$

$-3.466 = -7.07 \times 10^{-3} \times t$

$t = 490.2 \text{ minutes}$

$= 7.07 \times 10^{-3}$

25/45. Define the following terminologies as used in radiation dosimetry (5mks)

- i. Absorbed dose: the radiation energy absorbed per unit mass of an organ or tissue.
- ii. Threshold dose
is a dose level below which there is no effect of radiation on the biological response
- iii. Exposure dose
The dose at a specified point expressed as the ionization it produces per unit mass of air

Energy / mass

Ionization / Air mass

19. Ultrasound is sound with frequency greater than

- a. 2 Hz
- b. 15 Hz
- c. 20,000 Hz
- d. 1540 Hz

C

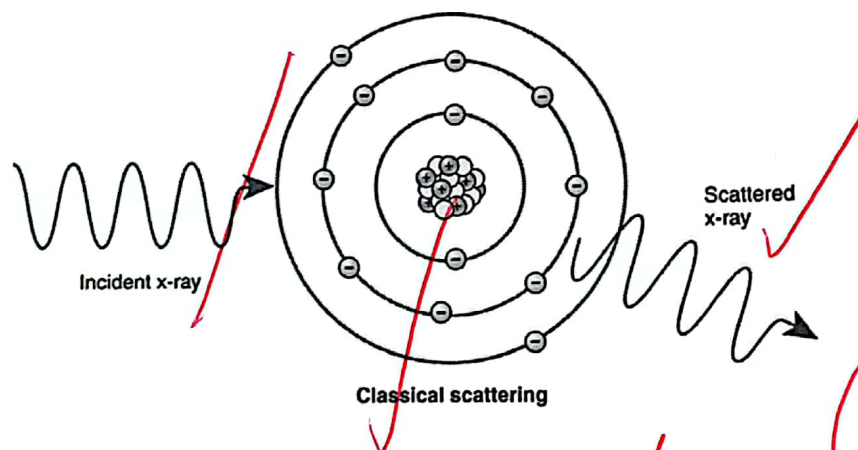
20. Which of the following statement is NOT true about beam of x-rays

- a. Beam of x-ray pass through body tissue unaffected
- b. Beam of x-ray may transfer all energy to matter and do not pass through the patient to the film
- c. Beam of x-ray may diverted with or without energy loss
- d. Beam of x-ray is monoenergetic

D

Section B – 40mks

41. With an aid of well labeled diagram, describe the process of coherent scattering (5mks)



- a. In this scattering event the X-ray the incident Photon interacts with an orbital electron of a tissue atom and changes direction. In this particular interaction the incident x-ray photon is of a rather low energy (generally less than 10 KeV) and when it interact with tissue atom they are not likely to cause ionization. Instead the atom absorbs the energy of this x-ray photon, causing excitation of the atom and then immediately releases the energy in a new direction.

42. State 5 common properties of electromagnetic waves (5mks)

- i. They do not require a material medium and can travel through a vacuum.

- a. K characteristic
 - b. L characteristic
 - c. No Interaction
 - d. No X-ray produced
14. During x-ray production, in which interaction does the filament electron misses all the orbital electrons and interacts with the nucleus of the target atom.
- a. Characteristic interactions
 - b. Bremsstrahlung interactions
 - c. Compton interactions
 - d. Classical interactions
15. Which one of the following is a major source of occupational exposure
- a. Photodisintegration
 - b. Pair production
 - c. Photoelectric interactions
 - d. Compton interaction
16. The filtration of an atomic beam has the effect of
- a. Improving the quality of the transmitted X-ray beam
 - b. Increasing the quantity of the transmitted X-ray beam
 - c. Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - d. Improving the quality and increasing quantity of the transmitted X-ray beam
17. A specific combination of protons and neutrons in a nucleus is called
- a. Nucleus
 - b. Nuclide
 - c. Neutrino
 - d. Nucleolus (FREE)
18. A photon of 10Mev colliding with a nuclear will likely result in which type of interaction
- a. Photoelectric
 - b. Photodisintegration
 - c. Thompson
 - d. Compton

- a. Tube current
 - b. Exposure time
 - c. Tube voltage
 - d. Filament voltage
9. Which of the following statements is true about non ionizing radiation
- a. Deposits energy in the materials through which it passes.
 - b. They have sufficient energy to break molecular bonds or remove electrons from atoms.
 - c. Example include of non ionizing radiation include; visible light, heat, beta, microwaves, and radio waves
 - d. They are able to cause ionization
10. For X-ray to be produced, the following conditions have to be met except
- a. Exposure factors have to be selected.
 - b. Electricity has to travel to the anode, cathode and filament.
 - c. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
 - d. The X-ray tube window has to be opened
11. During the process of X-ray production, the filament electrons penetrate the face of the target to a depth of approximately how many millimeters?
- a. 0.5 millimeters
 - b. 0.2 millimeters
 - c. 0.1 millimeters
 - d. 0.3 millimeters
12. During x-ray production, what is the shortest binding energy of K-shell electrons in tungsten
- a. 40 Kev
 - b. 20 Kev
 - c. 70 Kev
 - d. 10 Kev
13. A filament electron has 50 KeV of kinetic energy and strikes a Tungsten K-shell electron. What would be the result of this type of interaction

4. The following are conditions necessary for X-ray to be produced except?
- a. Exposure factors have to be selected.
 - b. The anode has to rotate to full speed
 - c. Electricity has to travel to the anode and cathode filament.
 - d. Electrons have to be boiled off in the filament and are streaming across the anode at tremendous speed.
5. Which of the following statements is true about x-ray beam quantity
- a. Beam quantity varies inversely as the square of the ratio of change in kVp.
 - b. Beam quantity varies directly as the square of distance.
 - c. The use of filtration decreases x-ray beam quantity to an extent that it depends on other factors
 - d. Beam quantity is inversely directly proportional to mAs.
6. An interaction with matter that occur throughout the diagnostic range involving moderate energy X-ray photons is known as:
- a. Classical Interactions
 - b. Pair production
 - c. Photodisintegration interactions
 - d. Compton Interactions
7. The statements below describe the application of an electromagnetic waves.
- i. Used to produce images of hot objects through the colours
 - ii. Produced by the amount of heat dissipated by an object.
 - iii. They are used in hospitals to detect illnesses (diagnosis)
 - iv. Used in warfare missiles and burglar alarm systems

Identify the type of wave whose application is described above.

- a. Infra-red radiation
 - b. Visible spectrum
 - c. X-Rays
 - d. Gamma rays
8. In order to obtain a higher-energy x-rays, one needs to change?

KMTC/QP-08/EPS

KENYA MEDICAL TRAINING COLLEGE

Department of Radiography and Imaging

COLLEGE EXAMINATIONS FOR ACADEMIC YEAR 2022/2023

**END OF SEMESTER EXAMINATIONS FOR DIPLOMA IN MEDICAL IMAGING
SCIENCE**

MPC 1209: Medical Physics and Chemistry II

DATE:

TIME: 3 hours

Instructions

Answer all questions in sections A, B and C

SECTION A: 40 MARKS

1. Up to what intensity of radiation is used for mammography?
a) $< 10\text{keV}$
b) $< 70\text{keV}$
c) $< 30\text{keV}$ **C**
d) $< 40\text{keV}$
2. Radioactive emissions have different ability to penetrate materials. Alpha particles are,
a. Relatively big and heavy in atomic terms and a highly ionizing form of radiation able to penetrate the skin
b. Relatively big and heavy in atomic terms and a highly ionising form of radiation but not able to penetrate the skin
c. Relatively small and light but able to penetrate the skin **B**
d. Relatively small and light but unable to penetrate skin.
3. Which of the following statement is false about X-rays
a. Most X-rays have a wavelength ranging from 10^{-8}m to 10^{-4}m ,
b. Most X-rays have frequencies in the range of $3 \times 10^{16}\text{ Hz}$ to $3 \times 10^{19}\text{ Hz}$
c. Most X-rays have energies in the range of 124 eV to 124 keV . **A**
d. Most X-rays have frequencies in the range of 30 petahertz to 30 exahertz

①



Explanation - 5 marks

20 mks

- 8 (u) - The property of an electric conductor or circuit that causes an electromotive force to be generated by change in the current flowing.
- A property of an electric circuit by which an electromotive force is induced in it by a variation of current either in the circuit itself or in neighbouring circuit.

- (b) - Inductors are used in electrical power and electronic circuits for
- (i) Choking
 - (ii) Blocking
 - (iii) Attenuating
 - (iv) filtering / smoothing high frequency noise in electrical circuits
 - (v) storing & transferring energy in power converters (dc-dc or ac-dc)
 - (vi) used to store electric energy.

-
- tuning circuits
- sensors
 - store energy in devices
 - induction motors
 - transformers
 - filters
 - chokes
 - ferrite beads
 - inductors used as relays

6 (4) — Magnetic brakes / electric brakes work on the principle of eddy currents. When a magnetic field is applied on the rotating drum, eddy currents are induced in the drum. The eddy currents decrease steadily in magnitude as the drum slows down. Thus the braking effect is quite smooth.

— Energy meters are instruments (galvanometers) used to measure the electrical energy consumed by the electrical appliances. A metal disc in the meter rotates due to eddy currents.

— Induction (a.c.) motor (rotor) is a low resistance coil placed in a rotating magnetic field. Eddy currents in a rotor, rotate in the direction of the magnetic field.

— Eddy currents of high frequencies are used in the induction furnace which is used to prepare alloy by the melting the constituent metals.

2

4.

$$p = \frac{W}{t} = 0.8$$

$$W = F \times S$$

$$F = ma = 0.8 \times 3 = 2.4 \text{ N}$$

$$p = \frac{2.4 \times 1.5}{0.1 \text{ s}} = 36 \text{ W}$$

5.

- Consist mostly of empty space
- most mass is at the centre

6

(a)

- use of laminations
- selecting magnetic core materials that have low electrical conductivity

(b)

- crack detection

→ magnetic/electric breaker

Tube and wire testing

- Energy meter
Galvanometer

Condenser tube inspection

- Induction a.c. motor (winding)

Material sorting

- Induction furnace

weld testing

Coating thickness measurement

7.

$$C \propto A$$

$$C \propto \frac{1}{d}$$

$$C \propto \frac{A}{d}$$

$$C = \epsilon_0 \frac{A}{d}$$

d - distance of separation

A - area of plates

SECTION 2

①

1

(a)

Electron emission

- Is the emission of electrons from the metal surface.

(b) - It should have a low work function

- It should have a high melting point

- vacuum environment

- High mechanical strength

- High emission frequency efficiency

2.

$$\frac{100 \text{ cm}}{77 \text{ cm}} = 1.3 \text{ times the size of the coil.}$$

$$M = \frac{SID}{SOD} = \frac{\text{Source to image receptor distance}}{\text{Source to object distance}}$$

3.

$$M = \frac{SID}{SOD} = \frac{100 \text{ cm}}{100 - 9 \text{ inch}} = \frac{100 \text{ cm}}{100 - 9 \times 2.54 \text{ cm/inch}}$$

$$M = \frac{SID}{SOD} = \frac{100}{77} = 1.3 \text{ Image of the coil will be 1.3 times the size of the coil.}$$

3. (i) quantities increase or decrease together

(ii) Inverse - inversely proportional

(iii) Inverse square law - The intensity decreases as the square of distance of separation

(iv) Exponential law - quantities vary exponentially.

SECTION I

1. ~~D~~ B
2. ~~A~~ C
3. C
4. C
5. ~~B~~ C
6. A
7. C
- * 8. ~~A~~ D
9. B
10. A
11. ~~A~~ A
12. ~~B~~ ~~C~~
13. ~~B~~ ~~A~~ ~~B~~ A
14. A B
15. B
16. A
17. A
18. A
19. C
20. ~~A~~ B
21. C
22. ~~A~~ B
23. ~~A~~ C
24. C
25. B
26. ~~A~~ B
- * 27. ~~B~~ C
28. A
29. Free C
30. D
31. A
32. C
33. C
34. B
35. C
36. C
37. B
38. C
39. A
40. ~~A~~ B

SECTION 3: LONG ANSWER QUESTION (20 MARKS)

- ✓ 1. (a) With an aid of a well labeled diagram, discuss hysteresis with respect to electromagnetism (10mks)
- ↗ 50. Starting from the definition of the radioactive decay law derive the exponential decay law formula. (10marks)

section I

1.

2.

3.

4.

40. The main advantage of full wave rectification over half-wave rectification is

- (a) A greater number of x-rays per cycle
- (b) Higher energy x-rays
- (c) Higher mA
- (d) Less voltage ripple

SECTION 2: SHORT ANSWER QUESTIONS. (40 MARKS)

1. (a) What is electron emission?

(b) State four properties that a thermionic emitter should possess. (5marks)

* 2. A 9-inch thick patient has a coin placed on the skin. The SID is 100 cm. What will be the magnification of the coin? (5marks)

3. Explain the following terms (5 marks)

- i) Direct proportionality
- ii) Indirect proportionality
- iii) Inverse square law
- iv) Exponential Law

4. A radiographer lifts 0.8Kg cassette from the floor to the top of 1.5m table with an acceleration of $3/\text{ms}^2$. What is the power exerted if it takes 1.0 s (5marks)

5. Describe what an atom is composed of and where most of the mass of the atom is. (5 Marks)

6. (a) Name one way of reducing Eddy Currents.

(b) State the applications of Eddy Currents. (5mks)

7. Prove that the capacitance of a capacitor of two parallel plates having an area A and separated by a distance d is given by $C = \frac{A\epsilon_0}{d}$ (5 marks)

8. (a) Define Inductance.

(b) State the applications of inductance (5marks)

34. Find the wrong statement.

- (a) An electron gun is to create electrons and then accelerate them to a very high speed
- ☒ (b) Thermionic emissions and photoelectric emissions are the same
- (c) The kinetic energy of photoelectrons vary
- (d) Vacuum tubes are thermionic devices

35. The process by which free electrons are emitted from the surface of a metal when external heat energy is applied is called.....

- (a) Schottky emission
- (b) Photo-excited emission
- ☒ (c) Thermionic emission
- (d) Photo-electric emission

36. In X-ray emission tubes, X-ray is emitted by the acceleration of _____

- (a) Atoms (b) Protons ☒ (c) Electrons (d) Neutrons

37. The part of the x-ray generator that supplies the high voltage necessary between the cathode and the anode is called the:

- (a) Filament circuit
- ☒ (b) Main x-ray circuit
- (c) Low voltage circuit
- (d) Thermionic emission circuit

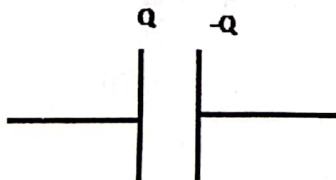
38. In modern x-ray equipment, the device most often used for current rectifications is a (an):

- (a) Modified x-ray tube
- (b) Thermionic valve tube
- ☒ (c) Solid state diode
- (d) Ionization chamber

39. The process by which Alternating Current is converted into pulsating Direct Current is termed:

- ☒ (a) Rectification
- (b) Polarization
- (c) Electrification
- (d) Depolarization

- (d) They have both primary and secondary windings
28. The principle purpose of the autotransformer is to:
- (a) Adjust voltage
 - (b) Decrease voltage
 - (c) Rectify voltage
 - (d) Stabilize voltage
29. When the right-hand rule is applied to a straight wire, the thumb indicates the direction of the:
- (a) Circuit resistance
 - (b) Electric field
 - (c) Electric current
 - (d) Magnetic field
30. The transformer changes:
- (a) Electric current to voltage
 - (b) Electric energy to electromagnetic energy
 - (c) Electric energy to mechanical energy
 - (d) The amplitude of the voltage
31. What is the value of capacitance of a capacitor if it has a charge of 9C and voltage of 5V?
- (a) 1.8F (b) 45F (c) 4.5F (d) 8.1F
32. What happens to the capacitance when a dielectric material is inserted between the plates of a parallel plate capacitor?
- (a) Capacitance decreases
 - (b) Capacitance remains same
 - (c) Capacitance increases
 - (d) Depends upon the material of the dielectric
33. What is the total charge on the parallel plate capacitor shown?



- (a) 2Q (b) Q/2 (c) 0 (d) -Q/2

(d) Magnetic force

20. If a coil is wound around a steel core and electric current is passed through the coil, the steel core acts as a?

(a) Electromagnet

(b) Permanent magnet

(c) Neither electromagnet nor permanent magnet

(d) Either electromagnet or permanent magnet

21. The magnetic field strength of a solenoid can be increased by inserting which of the following materials as the core?

(a) Copper (b) Silver (c) Iron (d) Aluminum

22. What happens to the magnetic field in the solenoid when the length of the solenoid increases?

(a) Increases (b) Decreases (c) Remains constant (d) Becomes zero

23. A relay is used to

(a) Break the fault current

(b) Sense the fault

(c) Sense the fault and direct to trip the circuit breaker

(d) All of these

24. Which relay is also called angle impedance relay?

(a) Impedance Relay (b) Reactance Relay (c) Mho Relay (d) Frequency Relay

25. Hysteresis is the occurrence of in a magnetic circuit.

(a) Lagging of H behind B

(b) Lagging of B behind H

(c) setting up constant flux

(d) None of the above

26. At low frequencies, materials use for transformer cores is

(a) Copper (b) Silicon iron (c) Soft iron (d) None of the above

silicon iron

27. Which one of the following is always true about generators and motors?

(a) They are electromagnets

(b) They both require commutators

(c) They convert energy from one form into another

14. The number of the outermost electron shell of an atom is equal to it _____ in the periodic table

- (a) Group
- ☒ (b) Valence
- (c) Element
- (d) Period

15. The properties of elements in a horizontal row of the periodic table follow

- (a) A nonrepeating pattern
- ☒ (b) A periodic pattern
- (c) No pattern
- (d) Unpredictable pattern

16. As we go from left to right a cross period, electron affinity

- ☒ (a) Increases
- (b) Decreases
- (c) Remains same
- (d) None of above

17. Coulombs law states that electrostatic force is

- ☒ (a) Inversely proportional to the square of the distance between the charges
- (b) Directly proportional to the square of the product of the charges
- (c) Directly proportional to the square of the distance between the charges
- (d) Inversely proportional to the product of the charges

18. Most magnets:

- ☒ (a) Are affected by another magnetic field
- (b) Are diamagnetic
- (c) Are naturally occurring if used in science and technology
- (d) Have north, south and neutral poles

19. All magnetic lines of force crossing a given area are referred to

- (a) Magnetic field
- ☒ (b) Magnetic field strength
- ☒ (c) Magnetic flux ✓

9. The following factors control the geometrical un-sharpness except

- (a) Source to object distance ✓
- (b) Source to detector distance
- (c) Source size/focal spot size ✓
- (d) Object to detector distance ✓

10. Which of the following is true regarding our understanding of atomic structure?

- (a) Rutherford describes the nuclear atom
- (b) Rutherford is known as the "Father of Radioactivity"
- (c) Rutherford identified cathode rays as particles and constituents
- (d) Rutherford is responsible for the periodic table

11. Who proposed the atomic theory?

- (a) John Dalton
- (b) Robert Millikan
- (c) J. J. Thomson
- (d) Neils Bohr

12. Which of the following conclusions could not be derived from Rutherford's α -particle scattering experiment?

- a) Most of the space in the atom is empty.
- (b) The radius of the atom is about 10^{-10} m while that of nucleus is 10^{-15} m.
- ✓ (c) Electrons move in a circular path of fixed energy called orbits.
- (d) Electrons and the nucleus are held together by electrostatic forces of attraction.

13. Assertion (A): All isotopes of a given element show the same type of chemical behavior.

Reason (R): The chemical properties of an atom are controlled by the number of electrons in the atom.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true but R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) Both A and R is false

KMTU/QR-08/1111

SECTION 1: MULTIPLE CHOICE QUESTIONS (40 MARKS)

1. Which of the following is in direct proportion?
 - (a) One side of a cuboid and its volume.
 - (b) Speed of a vehicle and the distance travelled in a fixed time interval.
 - (c) Change in weight and height among individuals.
 - (d) Number of pipes to fill a tank and the time required to fill the same tank.
2. Both x and y vary inversely with each other. When x is 10, y is 6, which of the following is not a possible pair of corresponding values of x and y ?
 - (a) 12 and 5
 - (b) 15 and 4
 - (c) 25 and 2.4
 - (d) 45 and 1.3
3. A radiographic exposure of the chest was taken at 72 inches using 10 mAs and had an exposure of 50 mR. what would the exposure be at 80 inches?
 - (a) 5.71mR
 - (b) 57.1mR
 - (c) 40.5mR
 - (d) 4.05mR
4. Which of the following is an SI base unit?
 - (a) Becquerel
 - (b) Gray
 - (c) Kilogram
 - (d) Coulomb
5. Which of the following is a unit of work
 - (a) Joule/Second
 - (b) Joule
 - (c) Hertz
 - (d) Newton
6. Find the work done in lifting an infant patient weighing 90 N (20 lb) to a height of 1.5 m.
 - (a) 135W
 - (b) 60N
 - (c) 135J
 - (d) 30J/S
7. Which of the following statements about energy is true
 - (a) Energy is force
 - (b) Energy is a form of power
 - (c) Energy is the ability to do work
 - (d) Energy is the rate of doing work
8. Heat is transferred from a glass enclosed fire place primarily by
 - (a) Conduction
 - (b) Convection
 - (c) Convention
 - (d) Radiation



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KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING
SEPTEMBER 2021 CLASS
YEAR ONE END OF SEMESTER ONE EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY I (MPC)

DATE: 7th February 2022

TIME: 3Hrs (9am-12pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
5. Any examination malpractices will be handled as per the college examination policy

REGISTRATION NUMBER:.....

(a) Diamagnetic

A diamagnetic substance is one whose atoms have no permanent magnetic dipole moment.

When an external magnetic field is applied to a diamagnetic substance such as bismuth or silver, a weak magnetic dipole moment is induced in the direction opposite the applied field.

All materials are actually diamagnetic, i.e. that a weak repulsive force is generated by in a magnetic field by the current of the orbiting electron.

(Bismuth, Mercury, Silver, Carbon, Lead, Copper)

(b) Paramagnetic

These are metals that are weakly attracted to magnets. They include aluminium, gold and copper.

The atoms of these substances contain electrons most of which spin in the same direction but not all.

This gives the atoms some polarity. They are only weakly influenced by a magnetic field and since some of the atoms can be turned to point their poles in the same direction, these metals can become very weak magnets.

(c) ferromagnetic substances

ferromagnetic materials are those substances which exhibit strong magnetism in the same direction of the field when a magnetic field is applied to it.

It can be defined as some materials (Cobalt, gadolinium, iron etc) will become permanent magnet with the use of magnetic field.

When a rod of this material is placed in a magnetic field, it rapidly aligns itself in the direction of the field.

(d) The law of logarithm ✓ (2)

- the level of noise/sound is measured in dB (decibels) on logarithm scale.

4. Conduction, Convection, Radiation ✓ (5)

5. To provide the tube current flowing in one direction and to maintain steady supply of voltage (almost constant) (5)

6. In n-type doping, arsenic or phosphorus is added in small quantities to the silicon. Both of these elements have five electrons in their outer orbitals and so they are not out of place when they get into the silicon crystalline structure. Since the fifth electron has nothing to bond to, it is free to move ~~and~~ around allowing an electric current to flow through the silicon.

(5) In p-type doping, boron or gallium is used as the dopant. These elements each have three electrons in their outer orbitals. When they are mixed into the silicon lattice, they form holes in the valence band of silicon atoms. This means that the electrons in the valence band become mobile and the holes move in the opposite direction to the movement of the electrons. Only positive charges can move due to the positive holes. These conductors are known as 'p-type'.

SECTION 2 (40 Mks)

1.

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} \checkmark$$

$$N_s = 20,000$$

$$N_p = 200$$

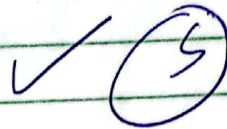
$$V_p = 415$$

$$V_s = ?$$

$$V_s = \frac{V_p \times N_s}{N_p} \checkmark$$

$$= \frac{415 \times 20,000}{200} \checkmark$$

$$= 41500 \checkmark$$



2. As temperature rises, the number of phonons increases and with it the likelihood that the electrons and phonons will collide. Thus when temperature goes up, resistance goes up.
 phonon is a definite unit or quantum of vibrational mechanical energy

(5 mks)

3.

(a) Direct proportionality

- one quantity varies directly as the other and vice versa. When one increases, the other also increases.

(2)

(b) Indirect proportionality

- When one quantity increases, the other reduces.

(2)

(c) Inverse square law

- The intensity of X-ray beam is inversely proportional to the square of distance.

(2)

Marking scheme

MPC I

MARCH / SEPT 2020 CLASS

SECTION I (40 marks)

- | | |
|--------------------|--------------------|
| 1. A | 21. A |
| 2. E | 22. B |
| 3. A | 23. A |
| 4. A | 24. A |
| 5. C | 25. D |
| 6. E | 26. A |
| 7. C | 27. A |
| 8. E | 28. A C |
| 9. B | 29. A |
| 10. D | 30. C |
| 11. A C | 31. B D |
| 12. D | 32. B C |
| 13. A | 33. B |
| 14. B | 34. A |
| * 15. A | 35. B |
| 16. C | free 36. B |
| 17. A | 37. D |
| 18. C | 38. C |
| 19. D | 39. C |
| 20. A | 40. C |
| 21 | |

- b) An excess of protons
- c) Transfer of electrons
- d) Transfer of protons

SECTION 2: SHORT ANSWER QUESTIONS (40 MARKS)

1. If a transformer is supplied with 415V from the mains and the primary coil has 200 turns of wire while the secondary coil has 20,000 turns of wire, calculate the voltage that will be in the secondary coil (5mks)
2. Explain how the temperature of a conductor influence the resistance 5mks
3. Explain the following terms stating their significance in radiography (10mks)
 - a. Direct proportionality
 - b. Indirect proportionality
 - c. Inverse square law
 - d. The law of logarithm
4. Explain any two methods of heat transfer (5mks) — *convection, conduction*
5. Explain why the voltage on the secondary side of the transformers in x-ray tubes needs to be rectified (5 marks)
6. Differentiate between p-type doping and n-type doping (10mks)

SECTION 3: LONG ANSWER QUESTIONS (20 MARKS)

1. Discuss the following classifications of magnetic materials based on their magnetic susceptibility property when placed in a magnetic field

- a) Diamagnetic —
- b) Paramagnetic — *u*
- c) Ferromagnetic substances. *sl.*

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$V_p = 415$
 $V_s = ?$
 $N_p = 200$
 $N_s = 20000$

$$\frac{415}{V_s} = \frac{200}{20000}$$

$$V_s = \frac{415 \times 20000}{200} = 41,500 \text{ V}$$

- c) Increase by a factor of 2
~~d)~~ Increase by a factor of 4
32. The principal reservoir for excess electric charge is the
 a) Clouds
 b) Lightning
~~c)~~ Earth
 d) Water pipes
33. Compounds that have same molecular formula but different arrangement of atoms in their molecules are called
 a. Isotopes *Plants of 601*
~~b.~~ Isomers
 c. Hydrocarbons
 d. Organic compounds
34. Which of the following principle of rectification produces the maximum efficiency of X-ray production?
~~a)~~ Four-diode rectification *7V*
~~b)~~ Half-wave rectification
 c) High frequency
 d) Self-rectification
35. A circuit that contains a single rectifier
 a. Electron flow is pulsed but uninterrupted
~~b.~~ Electrons flow in one direction but not the other
 c. The result is constant potential DC
 d. Voltage is increased
36. In a series circuit *RSA*
 a) Ohm's law fails
~~b)~~ The total resistance is the sum of the individual currents
 c) The total current is the sum of the individual currents
 d) Only three circuit elements are allowed
37. The number of volts required to cause a current of 40A in a circuit having a resistance of 5Ω(ohms) is
 a) 5V
 b) 40V
 c) 45V
~~d)~~ 200V
 *$V = IR$
 $40 \times 5 = 200$*
 *$V = IR$
 $40 \times 5 = 200$*
38. In medical imaging, the phenomenon called focal-spot blur, (penumbra) greatly affects
 a. Image contrast
 b. Image magnification
~~c.~~ Image sharpness
 d. Image quality
39. Which of the following is a method of electrification?
 a) Transmission
 b) Excitation
~~c)~~ Induction
 d) Resonance
40. Objects become electrified because of
 a) An excess of neutrons

- KMTC/UP-007
- b. Total number of electrons in the atom
 - c. Valence state of the atom
 - ☒ d. Number of electrons in the outer shell
26. Coulombs law states that electrostatic force is
- ☒ a. Inversely proportional to the square of the distance between the charges
 - b. Directly proportional to the square of the product of the charges
 - c. Directly proportional to the square of the distance between the charges
 - d. Inversely proportional to the product of the charges
27. Most magnets:
- ☒ a. Are affected by another magnetic field
 - b. Are diamagnetic
 - c. Are naturally occurring if used in science and technology
 - d. Have north, south and neutral poles
28. Which one of the following is always true about generators and motors?
- a. They are electromagnets
 - ☒ b. They both require commutators
 - ☒ c. They convert energy from one form into another
 - d. They have both primary and secondary windings
29. The main advantage of full waves rectification over half-wave rectification is?
- ☒ a. A greater number of X-rays per cycle
 - b. Higher energy X-Rays
 - c. Higher mA
 - d. Less voltage ripple
30. The inverse square law is as a result of
- a) Attenuation
 - b) Absorption
 - ☒ c) Divergence
 - d) Scatter
31. If an instrument position 1m from a point source is moved 50cm closer to the source, the radiation intensity will
- a) Decrease by a factor of 2
 - b) Decrease by a factor of 4

$$I = \frac{1}{2}$$

$$= (C_1 \times C_2) \times \frac{1}{d^2}$$

18. Chemical reaction in which the oxidation number of a molecule, atom or ion changes by gaining or losing an electron is referred to;
- Oxidation
 - Reduction
 - Oxidation-reduction
 - None of the above
19. With reference to the interaction of electrons from the cathode with atoms of the anode, what percentage of heat typically occurs?
- 1 per cent
 - 10 per cent
 - 2 per cent
 - 99 per cent.
20. The filtration of an X-ray beam has the effect of:
- Improving the quality of the transmitted X-ray beam
 - Increasing the quantity of the transmitted X-ray beam
 - Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - Improving the quality and increasing quantity of the transmitted X-ray beam.
21. A specific combination of protons and neutrons in a nucleus is called
- nucleons
 - nuclide
 - neutrino
 - nucleolus
22. Which of following decreases when pH is less than 7?
- [H⁺]
 - [OH⁻]
 - Both A and B
 - None of these
23. Which of the following currently states Newton's first law of motion
- An object at rest will remain at rest unless acted on by external force 1st
 - An object with mass (M) and acceleration is acted on by a force, given by the equation $F=ma$ 2nd
 - For every action, there is an opposite equal reaction 3rd
24. Which of the following is true regarding our understanding of atomic structure?
- Rutherford describes the nuclear atom
 - Rutherford is known as the "Father of Radioactivity"
 - Rutherford identified cathode rays as particles and constituents
 - Rutherford is responsible for the periodic table
25. In the periodic table of elements, the group number identifies the;
- Electron spin state

ncl

- a. 27.5V
- ☒ b. 55 V
- c. 880 V
- d. 1760 V
- e. 3520 V

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$V_s = \frac{V_p \times N_s}{N_p}$$

$$= \frac{55 \times 550}{220} = 137.5$$

10. Electromagnetic radiation is:
- a. Radiation that has relatively long wavelengths much larger than an atom.
 - b. Radiation that has relatively short wavelengths, much smaller than an atom.
 - c. Radiation that has a wavelength that is of a similar size to that of the atom.
 - ☒ d. Radiation that the wavelength varies according to the frequency.
11. Electromagnetic radiation is:
- a. Classified only by its wave length
 - b. Classified only by its frequency
 - ☒ c. Classified by both its frequency and wavelength
 - d. Always visible.
12. With reference to the interaction of electrons from the cathode with atoms of the anode, what percentage of heat typically occurs?
- a. 1 per cent
 - b. 10 per cent
 - c. 2 per cent
 - ☒ d. 99 per cent.
13. The filtration of an X-ray beam has the effect of:
- ☒ a. Improving the quality of the transmitted X-ray beam
 - b. Increasing the quantity of the transmitted X-ray beam
 - c. Reducing the quantity and decreasing quality of the transmitted X-ray beam
 - d. Improving the quality and increasing quantity of the transmitted X-ray beam.
14. Typical anode angles in general diagnostic X-ray tubes (excluding mammography) tend to be between:
- a. 4 and 6°
 - ☒ b. 16 and 20°
 - c. 25 and 30°
 - d. 30 and 45°.
15. The X-ray tube incorporates an angled target in order to:
- ☒ a. Decrease the size of real focal spot
 - b. Decrease the size of apparent focal spot
 - c. Increase the size of apparent focal spot
 - d. Increase length of target track.
16. The following material is added to the anode disc of a rotating X-ray tube to prevent the crazing effect:
- a. Molybdenum
 - b. Carbon
 - ☒ c. Rhenium
 - d. Copper.
17. The added filtration of a diagnostic X-ray tube typically consists of:
- ☒ a. Aluminium or copper
 - b. Aluminium and beryllium
 - c. Copper or tin
 - d. Tin or lead.

SECTION1: MULTIPLE CHOICE QUESTIONS 20 MARKS

1. X-ray tube voltages are measured in
 - a) Kilovolt
 - b) Megavolt
 - c) Microvolt
 - d) Volt
2. The transformer changes
 - a. electric current to voltage
 - b. electric energy to electromagnetic energy
 - c. electric energy to mechanical energy
 - d. mechanical energy to electric energy
 - e. the amplitude of the voltage
3. A transformer will operate
 - a. on ac but not dc
 - b. on both dc and ac
 - c. on dc but not on ac
 - d. only above its critical current
 - e. only on a constant voltage
4. An autotransformer
 - a. contains a single coil that serves as both primary and secondary coils
 - b. controls x-ray tube current
 - c. is a shell type of transformer
 - d. is an electromechanical device
 - e. is used to control frequency
5. a semiconductor rectifier
 - a. has a heated anode
 - b. has a heated cathode
 - c. is a solid state device
 - d. is an electromechanical device
 - e. is a triode valve
6. which of the following is a component of a thermionic diode
 - a. grid
 - b. filament
 - c. silicon
 - d. cathode and grid
 - e. anode and grid
7. In a thermionic diode rectifier, the electron flow is from
 - a. anode to cathode only when the anode is negative with respect to the cathode
 - b. anode to cathode only when the anode is positive with respect to the cathode
 - c. cathode to the anode only when the anode is positive with respect to the cathode
 - d. either anode or cathode, depending on voltage wave form
8. Voltage supply to the primary side of the high tension transformer comes from
 - a. filament transformer
 - b. line voltage compensator
 - c. primary side of the autotransformer
 - d. rectifier
 - e. secondary side of the autotransformer
9. Two hundred and twenty volts (220 V) are supplied to 800 primary turns of an autotransformer, calculate the output voltage across 200 secondary turns

$$\frac{V_p}{N_p} = \frac{V_s}{N_s}$$

$$\frac{220}{800} = \frac{V_s}{200}$$

$$V_s = \frac{220 \times 200}{800} = 55 \text{ V}$$



**KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING**

**END OF YEAR ONE SUPPLEMENTARY EXAMINATIONS
DIPLOMA IN RADIOGRAPHY AND IMAGING (MARCH/SEPT 2020 CLASS)**

PAPER: MEDICAL PHYSICS AND CHEMISTRY I (MPC1112)

DATE: 28/9/2021

TIME: 3 HOURS (9AM-12PM)

INSTRUCTIONS

1. This paper consists of:

- Section 1 (Multiple Choice Questions 40Marks)
- Section 2 (Short Answer Questions 40 Marks)
- Section 3 (Long Answer Question 20 Marks)

2. Attempt **ALL** Questions

3. Write the **EXAMINATION NUMBER** given on all the answer sheets provided and on the question paper.

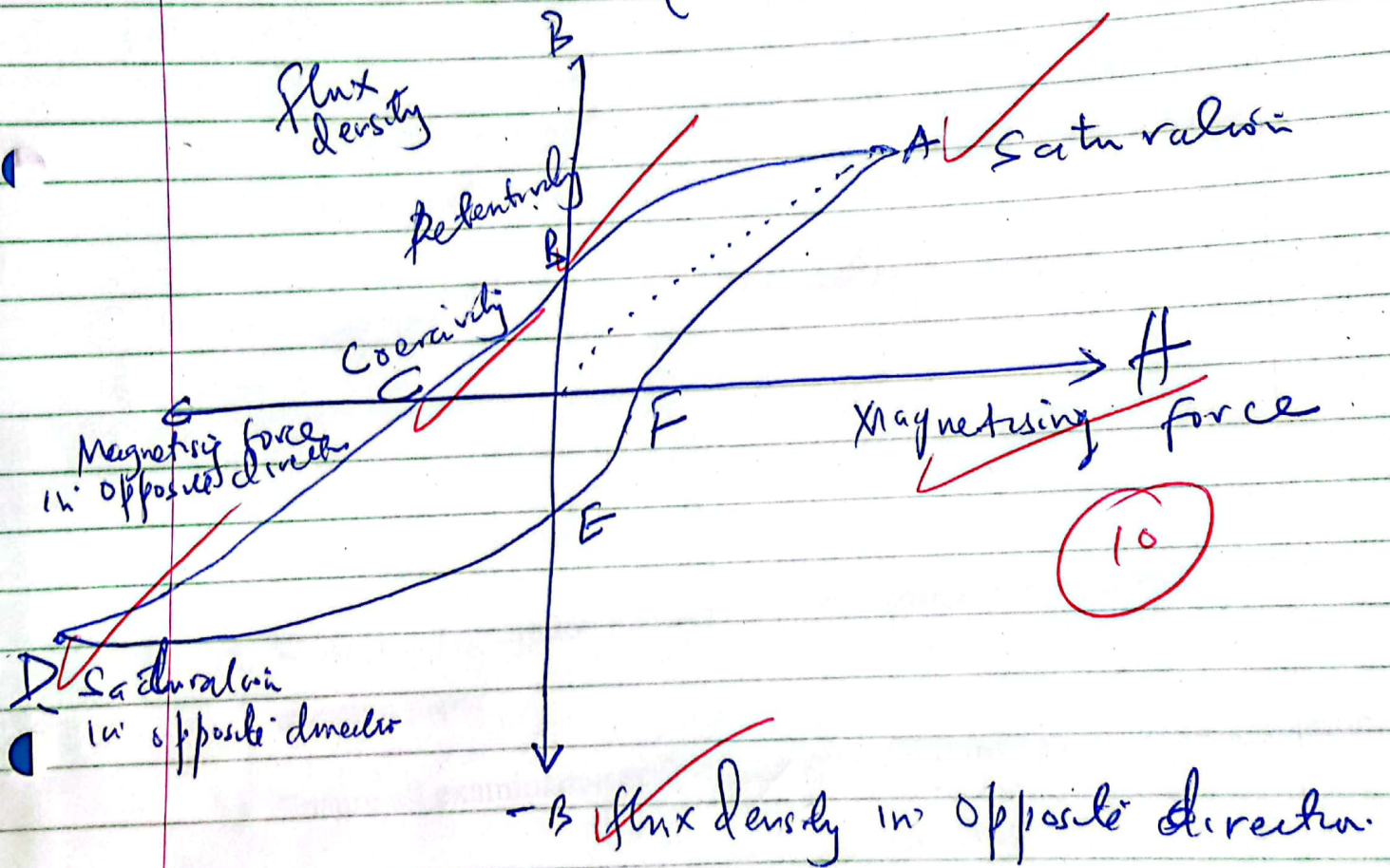
4. Ensure that all examination answer scripts are handed in at the end of the examination

5. Ensure that you sign the examination register provided

EXAMINATION NUMBER: _____

⑤ - Creation of charges of opposite sign.

Hysteresis loop (2014)



Explanation - (D)

4 power = $\frac{\text{work done}}{\text{Time taken}}$

= $\frac{\text{Force} \times \text{distance}}{\text{Time}}$

= $\frac{0.8 \times 3 \times 1.5}{1}$ = 3.6 W

(5 m/s)

- 5 - main found inside the nucleus
- ~~atoms~~ protons, neutrons and electrons

(5)

(6) Electron emission - removal of an electron from the metal surface

Field emission

Photoelectric effect

Thermionic emission

Secondary emission

(5)

(7) $C \propto \text{Area}$

$C \propto \frac{1}{d}$

$C \propto \frac{\epsilon_0 A}{d}$

- Directly proportional to area
- distance of separation inverse

(5)

SECTION 2

1. ~~cancelled~~

2. $M = \frac{SID}{SOD} = \frac{\text{source to image receptor distance}}{\text{source to object distance}}$

$$M = \frac{SID}{SOD} = \frac{100}{100 - 9 \text{ inch}}$$

$$= \frac{100 \text{ cm}}{100 \text{ cm} - (9 \text{ in} \times 2.54 \text{ cm/in})} \quad \text{Convert to cm in}$$

$$= \frac{100 \text{ cm}}{7.7 \text{ cm}}$$

$$= 1.2987 \quad \text{The image of the coin will be 1.3 times the size of the coin.}$$

~~Spina~~

③ Direct proportionality	—	~	✓
Indirect proportionality	—	~	✓
Inverse square law	—	~	✓
Exponential law	—	~	✓
Magnification	—	~	✓

Sept 2021 class

SUPPLEMENTARY MPC I (MPC III 2)

①

1. A

2. D

3. C

4. C

5. A

6. A

7. B

8. A

9. D

10. C

11. D

~~12.~~ D

free 13.

free 14. A

free 15. D

16. C

17. C

18. B

19. C

20. B

SECTION 3: LONG ANSWER QUESTIONS(40 MARKS)

1. With an aid of a well labeled diagram, discuss hysteresis with respect to electromagnetism (10mks) *20mks*
2. Starting from the definition of the attenuation coefficient derive the attenuation law formula. (10marks)
31. Describe the charging and the discharging of a capacitor (10marks) ✓
32. Describe the application of transformers in radiology (10marks) ✓

18. Hysteresis is the occurrence of in a magnetic circuit.

- (a) Lagging of H behind B
- (b) Lagging of B behind H
- (c) Setting up constant flux
- (d) None of the above

19. What happens to the capacitance when a dielectric material is inserted between the plates of a parallel plate capacitor?

- (a) Capacitance decreases
- (b) Capacitance remains same
- (c) Capacitance increases
- (d) Depends upon the material of the dielectric

20. Find the wrong statement.

- (a) An electron gun is to create electrons and then accelerate them to a very high speed
- (b) Thermionic emissions and photoelectric emissions are the same
- (c) The kinetic energy of photoelectrons vary
- (d) Vacuum tubes are thermionic devices

SECTION 2: SHORT ANSWER QUESTIONS. (40 MARKS)

1. What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass = 64.23 amu (26.0%), and one with mass = 65.32 amu? (5Marks)

2. A 9-inch thick patient has a coin placed on the skin. The SID is 100 cm. What will be the magnification of the coin (5marks)

3. Explain the following terms (5 marks)

- i) Direct proportionality 2
- ii) Indirect proportionality 2
- iii) Inverse square law 2
- iv) Exponential Law 2
- v) Magnification - Elongation

10 mkg

4. A radiographer lifts 0.8Kg cassette from the floor to the top of 1.5m table with an acceleration of $3/\text{ms}^2$. What is the power exerted if it takes 1.0 s (5marks)

5. Describe what an atom is composed of and where most of the mass of the atom is. - Proton, Neutron, (5 Marks)

6. (a) Define electron emission. (b) Briefly describe four different types of electron emission. (5mks)

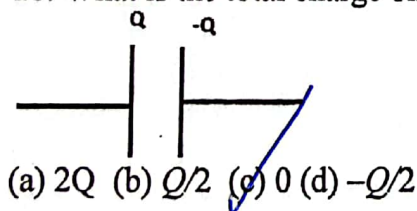
7. Prove that the capacitance of a capacitor of two parallel plates having an area A and separated by a distance d is given by $C = \frac{A\epsilon_0}{d}$ (5 marks)

$$C = \frac{A\epsilon_0}{d}$$

$$C = \frac{A\epsilon_0}{d}$$

8. A positively charged rod is brought near a piece of paper. Explain why the paper is attracted to the rod and sticks to it. (5mks)

10. Concerning the relationship between electricity and magnetism, which of the following statements is false?
- a) A constant current in a wire induces a constant magnetic field around the wire
 - b) A changing current in a wire induces a changing magnetic field around the wire
 - ☒ c) A constant magnetic field induces voltage in a nearby stationary wire
 - d) A changing magnetic field induces voltage in a nearby wire.
11. A material that is weakly repulsed by a magnetic field is known as
- (a) Paramagnetic
 - (b) Diamagnetic
 - (c) Superparamagnetic
 - ☒ (d) Ferromagnetic
12. Poor magnetic field homogeneity may affect image quality in the following ways
- (a) Shading artifacts
 - (b) Spatial distortion ✓
 - (c) Poor fat suppression
 - ☒ (d) Only a) and b)
 - (e) All of the above
13. The most common design configuration for clinical MR scanners is
- a) Open bore superconducting
 - b) Closed bore superconducting / *Any*
 - c) Open bore permanent
 - d) Dipolar electromagnet
14. The most common device used to create the high potential difference (kilovoltage) across the x-ray tube is the high tension:
- ☒ a) Autotransformer
 - b) Variable resistor
 - c) Saturable reactor
 - d) Saturable reactor
15. The selection of voltage to the high tension transformer is most commonly made by adjusting the: (a) Exposure timer (b) Line voltage compensator (c) Filament transformer ☒ (d) Autotransformer
16. What is the total charge on the parallel plate capacitor shown?



17. A relay is used to?
- (a) Break the fault current
 - (b) Sense the fault
 - ☒ (c) Sense the fault and direct to trip the circuit breaker
 - (d) All of these

SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)

1. The inverse square law states the intensity of a source, such as radiation, changes _____ to the square of the distance from the source?
 (a) in inverse proportion ✓
 (b) in direct proportion
 (c) linearly
 (d) logarithmically
2. The intensity of the X-ray tube operated at 60kVp, 200mAs, is 300mR at 90cm. what will be the intensity at 100cm
 (a) 333.3mR (b) 0.0037mR (c) 2.44mR (d) 244mR ✓

$$d_1^2 I_1 = I_2 d_2^2$$

$$300 \text{ mR} \times 90^2 = I_2 \times 100^2$$

$$I_2 = \frac{300 \times 90^2}{100^2}$$
3. Which of the following is the correct formula to use for calculating geometric-unsharpness if F=source size, T=specimen thickness, D=source to object distance and Ug=geometric unsharpness
 (a) $U_g = FD/T$ (b) $U_g = DT/F$ (c) $U_g = FT/D$ ✓ (d) $U_g = FTD$
4. Which of the following is an not a base quantity?
 (a) Time (b) Mass (c) momentum ✓ (d) Length
5. Which of the following is a unit of Power
 (a) Joule/Second ✓ (b) Joule (c) Hertz (d) Newton
6. Find the work done in lifting an infant patient weighing 90 N (20 lb) to a height of 1.5 m.
 (a) 135W ✓ (b) 60N (c) 135J (d) 30J/S
7. Rutherford carried out experiments in which a beam of alpha particles was directed at a thin piece of metal foil. From these experiments he concluded that:
 (a) Electrons are massive particles.
 (b) The positively charged parts of atoms are moving about with a velocity approaching the speed of light.
 (c) The positively charged parts of atoms are extremely small and extremely heavy particles. ✓
 (d) The diameter of an electron is approximately equal to that of the nucleus.
 (e) Electrons travel in circular orbits around the nucleus.
8. Which of the following has a positive charge?
 (a) Proton ✓ (b) Neutron (c) Anion (d) Electron (e) Atom
9. Consider the species ^{72}Zn , ^{75}As and ^{74}Ge . These species have:
 (a) The same number of electrons.
 (b) The same number of protons. ✓
 (c) The same number of neutrons. ✓
 (d) The same number of protons and neutrons.
 (e) The same mass number.

MARKING SCHEME



KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING
SEPTEMBER 2021 CLASS

END OF YEAR ONE SUPPLEMENTARY/SPECIAL EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY I (MPC 1112)

DATE: 8/9/2022

TIME: 3HRS(9am-12pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
5. Any examination malpractices will be handled as per the college examination policy

REGISTRATION NUMBER:.....

Principle of the alternator

A simple alternator is also called dynamo or synchronous generator

From the above diagram, the conductor in the form of a rectangular winding coil or loop, is mounted on (but insulated from) a shaft and arranged concentrically in the magnetic field between the poles of a magnet. The ends of the conductor loop are connected to metal collars S_1 and S_2 which are called slip rings or collector rings. The slip rings are insulated from the shaft and from each other and rotate with the conductor.

Stationary conductors B_1 and B_2 called brushes are in contact with the rotating slip rings. It is through these brushes and slip rings that conductors are connected to an external circuit which is to be supplied with alternating emf. External circuit is represented in the figure above as load resistance R .

When an alternating emf is being induced in the rotating conductors it will drive an alternating current in the complete circuit, that is, from the conductor via a slip ring to a brush then through the external circuit and back to the other brush and slip ring and to the conductor again.

Omish

Principal effects of direct current

- (i) Production of heat eg heating of filament in the thermionic valves and X-ray tubes
- production of light in lamps

(ii) Establishment of a magnetic field in the vicinity of the current-carrying conductor

(iii) Electrolysis - breaking down a dissolved compound into its constituent elements.

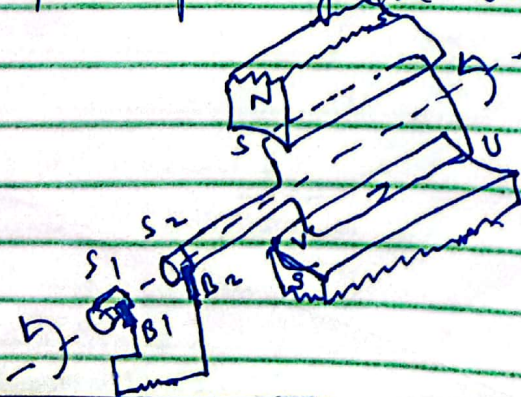
Chemical effects of passing an electric current through certain solutions eg dilute solutions of sulphuric acid. Bubbles of gas appear on the immersed ends of the wire i.e. oxygen is produced on one end and hydrogen is produced on the other end.

(iv) Mechanical effects

When an induction coil is energised a series of electrical discharge can be produced between its terminals. If a sheet of paper is placed in the path of the discharge and then held up to light it will be seen that the sparks have punctured a number of fine pin holes through the sheet.

(v) Luminous effects are produced by the discharge of electricity through a gas at low pressure. The production of luminosity by electric discharge in low pressure gas is widely applied in various forms of lighting eg fluorescent tubes

Principle of the alternator



positive field. The stronger the electric field, the greater is the electron emission.

(14) Photo-electric emission - The energy of light falling upon the metal surface is transferred to the free electrons within the metal to enable them to leave the surface. The greater the intensity (i.e. brightness) of light beam falling on the metal surface, the greater is the photo-electric emission.

(15) Secondary emission - A high velocity beam of electrons strikes the metal surface and causes the free electrons of the metal to be knocked out from the surface.

(20 marks)

- Q. (a) (i) magnetic effect - describe
chemical effect -
Heating effect
Electric shocks

(17) Alternator - an electrical generator that converts mechanical energy to electrical energy in the form of alternating current.

The area of the window and cross sectional area of the limb are the main dimensions of a transformer, the product of which is directly proportional to the size and weight of the transformer. ~~more the product (area), the bigger and heavier is the transformer~~

- The auto transformer
- The variac transformer
- Compensating transformer (SMKS)

27. - Frequency and area of the core
 As the frequency increases, the product of window area and cross sectional area of the limb decreases. (this means the size of the transformer core and the amount of iron required for the core decreases). Therefore as the frequency increases, the transformer becomes lighter (SMKS) and smaller in size.

28. I, II, transition elements & III, IV, V, VI, VII and Lanthanides and Actinides (SMKS)

Section 3

29. Field emission
 photoelectric effect
 secondary emission
 Thermionic emission

(i) Thermionic emission - the metal is heated to sufficient temperature (about 2500°C) to enable the free electrons to leave the metal surface. The number of emitted depends on temperature, $\rightarrow$ The higher the temperature, the greater is the emission of electrons. Employed in vacuum tubes.

(ii) field emission - A strong electric field (i.e. a high positive voltage) is applied at the metal surface which pulls the free electrons out of the metal because of the attraction of

23. Difference = $105,000 \text{ m} - 120,000$
 $= 120,000 - 105,000$
 $= 15,000$

Ratio = $\frac{105,000}{120,000} \times 100\%$ = 87.5%

- 24.
- Conduction
 - vibration of molecules in fixed position
 - vibration transfers energy to the next and the process continues

- 25.
- The maximum peak secondary voltage under no load
 - The maximum permissible current which may flow for no longer than one second (momentarily or intermittent loading condition)
 - The maximum permissible current which can be allowed to flow continuously (continuously loading)
 - The percentage permissible overload
 - other information relating to insulation permitted temperature rise under certain conditions during operation

- 26.
- High tension transformer
 - The tube filament heating
 - The valve filament heating transformer

SECTION 2

21

- The temperature of the target
- Temperature difference between the target and the surrounding
- The area of the target
- The condition of the target surface
- The thermal conductivity of the metal with which it is in contact with

(5 m/s)

22

$$\frac{m A s_1}{m A s_2} = \frac{d_1^2}{d_2^2}$$

$$20 \text{ mAs} \times \frac{20 \text{ mAs}}{d_1} = m A s_1$$

$$d_1 = 90 \text{ cm}$$

$$d_2 = 75 \text{ cm}$$

$$m A s_2 = ?$$

$$m A s_2 = m A s_1 \frac{d_2^2}{d_1^2}$$

$$= \frac{20 \text{ mAs} \times 75^2}{90^2}$$

$$= 13.88 \text{ mAs}$$

(5 m/s)

Section 7. - (20 mks)

1. C
2. D
3. C
4. A
5. D
6. B
7. D
8. A
9. D
10. D
11. B
12. C
13. C
14. B
15. A
16. B
17. ~~A~~ D
18. C
19. A
20. D

SECTION 2: SHORT ANSWER QUESTIONS (40MKS)

21. State the factors that govern the rate at which x-ray tube target cools (5mks)
22. An exposure of ~~20ms~~ ^{20mAs} is required to x-ray the skull of a young lady at a source to Image Receptor Distance (SID) of 90cm. If the SID was reduced to 75cm, what would the exposure be if the same density on the film is to be attained (5mks)
23. The voltage from a transformer is expected to be 120,000volts, but only 105,000volts are obtained. Express the difference and the obtained values as percentage of the expected value (5mks)
24. Describe heat transfer in solids (5mks)
25. State five (5) types information that are included in the rating of x-ray transformer. (5mks)
26. List five (5) types of Transformers that are found in X-ray equipment (5mks)
27. The size and the shape of the core of the transformer are determined by which factors? (5mks)
28. Briefly describe the periodic table of elements (5mks)

SECTION 3: LONG ANSWER QUESTIONS (40MKS)

29. Discuss various types of electron emission processes (20mks)
- 30.
- An electric current cannot be directly observed but can be detected by effects it produces. Describe the principal effects of direct current. (10mks)
 - Describe the principle of a simple alternator (10mks)

16. Which of the following statements is false about Transformers?
- a. The power dissipated in primary winding should be equal to the power dissipated in the secondary winding from an ideal point of view.
 - ☒ b. The power dissipated in the secondary winding will always be more than power dissipated in the primary windings because of transformer losses.
 - c. The losses originate from inductive and resistive effects within the transformer.
 - d. Two main type of transformer losses are Core losses and Copper losses
17. The principle transformer losses in the windings that are due to ohmic resistance that are dissipated in form of heat and are proportional to the product of current squared and resistance ($I^2 R$) are known as?
- a. Core losses
 - b. Eddy current losses
 - c. Hysteresis losses
 - ☒ d. Copper losses
18. Which one of the following statements is false about the peak factor?
- a. It is the ratio of peak value to the root mean square (RMS) value of current, EMF or potential difference.
 - b. It is the factor in which RMS values must be multiplied to give peak value
 - ☒ c. Peak factor is equal to 0.707
 - d. If the wave is not sinusoidal the peak factor is determined by the particular shape of the curve
19. The thickness of a sheet of a particular absorbing material which if placed in a beam of X radiation will reduce the intensity of the beam to one half its value is known as?
- ☒ a. Half value thickness
 - b. 2mm aluminium equivalent
 - c. Absorption coefficient
 - d. Linear absorption coefficient
20. The statements below are all true about semiconductors except one. Identify the incorrect statement
- a. When certain elements are added to intrinsic semiconductors, the conductivity of the semiconductor increases.
 - b. Elements added to semiconductor for the purpose of increasing their conductivity are called impurities
 - ☒ c. Impurity elements improve conductivity by providing free electrons or holes which makes conduction possible.
 - d. When the added impurity causes the availability of free electrons the semiconductor becomes known as a P type of semiconductor.

9. Which of the following is not a factor that affects geometrical unsharpness during radiological procedures?
- Target angle
 - Tube focus
 - Source to image distance
 - Selected Kilovoltage
10. Which of the following is not a factor that causes alternating voltage and current to be out of phase?
- Inductance in AC circuit
 - Capacitance in AC circuit
 - Impedance
 - Induced EMF in AC circuit
11. The study of the effects which occur when electricity is not in motion is known as?
- Electricity
 - Electrostatics
 - Electromagnetic
 - Electrification
12. Which of the following statements is false about magnets?
- The number of lines of flux can be determined by the strength of the magnetic pole producing them
 - Good permanent magnet will always retain their magnetic properties in spite of harsh treatment
 - Diamagnetic substances show a strong magnetic effect when placed in a strong magnetic field
 - Magnetisation of a magnetic substance increases as the magnetising force is increased
13. All magnetic lines of force crossing a given area are referred to _____.
- Magnetic field
 - Magnetic field strength
 - Magnetic flux
 - Magnetic force
14. Which of the following statements is true about properties of a magnet?
- If a magnet is freely suspended it sets in any direction
 - A magnet attracts small magnetic substances
 - Magnetic effects are equally concentrated through the magnet
 - Like poles attract unlike poles repel
15. In electrical conduction, the energy band arrangement in semi-conductors is quite similar to that of insulators, except that the conduction band in semi-conductors is _____.
- much closer to the valence band than is the case with insulators.
 - similar to the valence band of the insulators
 - much further to the valence band than is the case with insulators
 - much thicker than the valence band than is the case with insulators

SECTION 1: MULTIPLE CHOICE QUESTIONS (20 MARKS)

1. Which one of the following is not considered as a force?

- a. Gravity
- b. Electrostatic
- ☒ c. Electricity
- d. Electromagnetic

2. The following are units of energy except?

- a. Joule
- b. Erg
- c. Calorie
- ☒ d. Watt

3. Which one of the following is not a Vector quantity?

- a. Displacement
- b. Velocity
- ☒ c. Speed
- d. Acceleration

4. If the distance from a radiation source is halved, the radiation intensity increases by a factor of?

- ☒ a. 2^2
- b. 2^1
- c. 2^{-1}
- d. 2^{-2}

$$I_1 d_1^2 = I_2 d_2^2$$

$$I_2 = \frac{I_1 d_1^2}{d_2^2} = I_1 \left(\frac{d_1}{d_2}\right)^2$$

5. In physics, the degree of distortion produced by stress is known as?

- a. Stress
- b. Pressure
- c. Shear
- ☒ d. Strain

6. The purpose of X-ray transformer is most likely to change the _____.

- a. Magnetic field
- ☒ b. Electrical voltage
- c. Power level
- d. Current intensity

7. Convert 109°F to degrees centigrade.

- a. 47
- b. 45
- c. 40
- ☒ d. 43

8. Convert 70°F to degrees Kelvin.

- ☒ a. 294
- b. 273
- c. 282
- d. 268



KENYA MEDICAL TRAINING COLLEGE
FACULTY OF DIAGNOSTIC SCIENCES
DEPARTMENT OF RADIOGRAPHY AND IMAGING
DIPLOMA IN RADIOGRAPHY AND IMAGING
MARCH 2022 CLASS
YEAR ONE END OF SEMESTER ONE EXAMINATION
PAPER: MEDICAL PHYSICS AND CHEMISTRY I (MPC 1112)

DATE: 5th July 2022

TIME: 3hrs(9am-12pm)

INSTRUCTIONS

1. Attempt all questions.
2. Write your registration number on all the answer sheets provided and on the question paper
3. Ensure all examination scripts are handed in at the end of the examination.
4. Ensure you sign the examination register provided.
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REGISTRATION NUMBER:.....