KENYA MEDICAL TRAINING COLLEGE

FACULTY OF DIAGNOSTIC SCIENCES

DEPARTMENT OF RADIOGRAPHY AND IMAGING

DIPLOMA IN RADIOGRAPHY AND IMAGING

MARCH 2021 CLASS

END OF SEMESTER ONE EXAMINATION

PAPER: MEDICAL PHYSICS AND CHEMISTRY (MPC I)

DATE: 4th August 2021	**TIME: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(40 MARKS)

1. A substance which all physical things are composed is known as
   a. Body
   b. Particle
   c. Mass
   d. Matter
2. A quantity which has only magnitude is known as
   a. Vector quantity
   b. Scalar quantity
   c. Measurement quantity
   d. Displacement quantity
3. Which one of the following is not a Vector quantity
   a. Displacement
   b. Velocity
   c. Speed
   d. Acceleration
4. The quantity of heat required to raise the temperature of 1gram of water by 1 degree centigrade is known as:
   a. Calorie
   b. Specific heat
   c. Thermal Capacity
   d. Thermal conductivity
5. The mass of a proton is equivalent to how much kilograms
   a. 1.67×10^{-27}
   b. 1.67×10^{-31}
   c. 1.67×10^{-23}
   d. 1.67×10^{-12}
6. Which one of the following is the fundamental unit of time
   a. Hour
   b. Minute
   c. Second
   d. Day
7. The rate at which a moving body changes its position in a given direction is known as
   a. Speed
   b. Velocity
   c. Acceleration
   d. Momentum
8. A tendency of a body or mass to resist change to their state of rest or of uniform motion in a straight line is known as
   a. Momentum
   b. deceleration
   c. inertia
   d. Acceleration

9. In physics, the degree of distortion produced by stress is known as
    a. Stress
    b. Pressure
    c. Shear
    d. Strain
10. Force per unit area is known as
    a. Momentum
    b. Pressure
    c. Strain
    d. Compression
11. Which of the following statement is False about magnetic poles
    a. The two poles of a magnet are dissimilar
    b. Similar poles attract dissimilar poles repel
    c. The repulsion and attraction between magnetic poles is due to a force acting between them
    d. The force of attraction or repulsion between two poles is determined by magnetic permeability
12. Which one of the following is the CGS unit for force
    a. Newton
    b. Erg
    c. Dyne
    d. Statcoulomb
13. Convert 109^0 F to degrees centigrade
    a. 47
    b. 45
    c. 40
    d. 43
14. Convert 70^0F to degrees Kelvin
    a. 294
    b. 273
    c. 282
    d. 268
15. Which one of the following is not a factor that affects geometrical unsharpness during radiological procedures?
    a. Target angle
    b. Tube focus
    c. Source to image distance
    d. Selected Kilovoltage
16. An arrangement consisting of a wire wound round an iron bar is known as
    a. Solenoid
    b. Inductor
    c. Electromagnet
    d. Relay

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24. The tendency of the collection of negative electron charges in the space near the filament to limit the emission of more electrons from the filament is known as
    a. Space charge effects
    b. Electron emission
    c. Space charge
    d. Field emission
25. The ability of a substance to allow current to flow through it is known as
    a. Capacitance
    b. Impedance
    c. Resistance
    d. Conductance
26. The atom of substances which have their outermost shell completely filled up and their valence electrons strongly bound on their respective nuclei are known as
    a. Conductors
    b. Semiconductor
    c. Insulators
    d. Semi-insulators
27. In electrical conduction, the energy band arrangement in semi –conductors is quite similar to that of insulators, except that
    a. The conduction band in semi – conductors is much closer to the valence band than is the case with insulators.
    b. The conduction band in semi – conductors is similar to the valence band of the insulators
    c. The conduction band in semi – conductors is much further to the valence band than is the case with insulators
    d. The conduction band in semi – conductors is much thicker than the valence band than is the case with insulators
28. 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
29. 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 (1^2 R) are known as
    a. Core losses
    b. Eddy current losses
    c. Hysteresis losses
    d. Copper losses
30. Breaking down of a dissolved compound into its constituents is known as
    a. Dissolution
    b. Thermoelectricity
    c. Electrolysis
    d. Chemistry

31. During the process of electricity generation, the number of complete cycles per second is known as
    a. Wavelength
    b. Amplitude
    c. Phase
    d. Frequency
32. 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
33. 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
34. Which one of the Newton's law of motion states the principle of inertia
    a. First law
    b. Second law
    c. Third law
    d. None of the above
35. Mass per unit volume is the units for
    a. Relative density
    b. Work
    c. Momentum
    d. Density
36. The quantity of work done in a given time is known as
    a. Energy
    b. Power
    c. Force
    d. Pressure
37. The flow of one practical unit of charge past a given point in a circuit per second is known as
    a. Ampere
    b. Coulomb
    c. Voltage
    d. Electric charge
38. 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.

39. Substances which allow electricity to flow through them easily are known as
a. Conductors
b. Semiconductor
c. Insulators
d. Semi-insulators

40. The line voltage obtained from a three phase supplies total to?
a. 480 volts
b. 240 volts
c. 720 volts
d. 415 volts

SECTION 2: SHORT ANSWER QUESTIONS (40MKS)

1. State the factors that govern the rate at which x-ray tube target cools (5mks)
2. An exposure of 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)
3. 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)
4. Describe heat transfer in liquids (5mks)
5. With aid of diagrams, define the following terms with respect to circles (5mks)
   a. Radius
   b. Diameter
   c. Tangent
   d. An arc
   e. A secant
6. State five (5) information that are included in the rating of x-ray transformer. (5mks)
7. List five (5) types of Transformers that are found in X-ray equipment (5mks)
8. State five (5) factors that determine the size and the shape of the core of the transformer (5mks)

SECTION 3: LONG ANSWER QUESTION 20MKS

9. With an aid of a well labelled diagram, discuss hysteresis with respect to electromagnetism

KENYA MEDICAL TRAINING COLLEGE
NYERI CAMPUS
DEPARTMENT OF MEDICAL IMAGING SCIENCES

2016/2017 ACADEMIC YEAR
SEMESTER 1 MID-SEMESTER EXAM

CLASS: 2016
MODULE: MEDICAL PHYSICS AND CHEMISTRY(211)
DATE: 13th DECEMBER, 2016
TIME: 14:00-16:00 HRS

INSTRUCTIONS

1. You are allowed **TWO HOURS** for answering **ALL** the **FOUR** questions of this paper.
2. You should write legibly and avoid irrelevant matters.
3. Questions not numbered or wrongly numbered will not be marked.
4. You are advised to read the questions carefully and illustrate your answers by diagrams where necessary.
5. Marks indicated alongside the questions are for your guidance in planning your answers.
6. **DO NOT** write your name on any question paper/answer sheet. Instead write your College Number.

QUESTION ONE

a) What is an inductor *(2marks)*

b) State three factors affecting inductance of an inductor *(3marks)*

c) Imagine that an inductor of 200mH connected across a supply of 9V is passing a current of 2A. When the current is switched off, it collapses to zero in 10 ms, what would be the emf generated across the coil *(4marks)*

d) A source is producing an intensity of 456R/h at one foot from the source. What would be the distance in feet to the 100, 5 and 2mR/h boundaries *(6marks)*

e) Define the following terms as used in electromagnetic induction

(i) Retentivity *(2marks)*

(ii) Residual magnetic flux density *(2marks)*

(iii) Coercive field *(2marks)*

(iv) Permeability *(2marks)*

f) Simplify $\ln (3 + x) - \ln (x^2 - 9)$ *(2marks)*

QUESTION TWO

a). The following data are obtained for a nickel-iron alloy during the generation of a steady-state ferromagnetic hysteresis loop.

H (amperes/m)	B (weber/m^2)
50	0.95
25	0.94
0	0.92
-10	0.90
-15	0.75
-20	-0.55
-25	-0.87
-50	-0.95

(i) Plot the data *(5mark)*

(ii) What is the residual magnetic flux density? **(2marks)**

(iii) What is the coercive field? *(2marks)*

(iv) Determine the saturation magnetic flux density. *(2marks)*

b) (i) State two laws of electromagnetic induction *(4marks)*

(ii) State and explain three factors determining the magnitude of induced emf in a closed circuit *(6marks)*

(iii) State four properties of magnetic lines of force *(4marks)*

QUESTION THREE

(a) Discuss the Bohr theory of atomic structure *(4marks)*

(b) Explain the limitation of the Bohr theory of atomic structure and discuss how the limitation was resolved *(3marks)*

(c) State and explain three basic nuclear radiation emissions *(6marks)*

(d) State the Heisenberg uncertainty principle *(2marks)*

(e) In demonstrating the understanding of nuclear reaction, explain the difference between nuclear fission and nuclear fusion *(4marks)*

(f) Define work, energy and power *(6 marks)*

(g) Explain the difference between saturated hydrocarbon and saturated hydrocarbon *(4marks)*

(h) Define functional group and state its importance in organic chemistry *(4marks)*

QUESTION FOUR

a) With the aid of a well labelled diagram differentiate between direct current (DC) and alternating current (AC) *(6marks)*

b) State the first law of thermodynamics *(2marks)*

c) State and explain **two** methods of heat transfer *(4marks)*

d)) An X-ray generator is supplied with 240V and draws 50A of current. What is the consumed power? *(5marks)*

e) The position of an electron in an atom is to be determined to the precision of *0.02nm*.Estimate the uncertainty involved in the velocity of an electron. Take $h = 6.626 \times 10^{-34}$ *Js*, mass of $\bar{e} = 9.11 \times 10^{-31}$ kg *(4marks)*

f) State the four quantum numbers that can be used to describe the state of an electron in an atom *(4marks).*

QUESTION ONE

(a) An inductor is a circuit element that stores magnetic field. (1) 2

(b) (i) The number of turns of a wire in an inductor

(ii) The Material of the core

(iii) The shape, size and arrangement of the wire making up the coils. (3)

(c) $\mathcal{E} = L\frac{di}{dt} = 200mH \times \frac{2}{10ms}$

$= 200\times10^{-3} \times \frac{2}{10\times10^{-3}}$

$= 40 Volts$ (4)

(d) 100 mΩ/h $\quad I_1\Delta_1^2 = I_2\Delta_2^2$

$\Delta_2^2 = \frac{I_1\Delta_1^2}{I_2} = \frac{456000\times1^2}{100}$

$\Delta^2 = 4560$

$\Delta_2 = \sqrt{4560} = 67.5$ feet.

(2)

5mR/h $D_2^2 = \frac{456000 \times 1}{5}$

$= 91200$

$D_2 = \sqrt{91200} = 301.99$ feet

2mR/h $D_2^2 = \frac{456000 \times 1}{2}$

$= \sqrt{\frac{456000}{2}} = 477.5$ feet

(6 mks)

(i) It is a material's ability to retain a certain amount of residual magnetic field when the magnetizing force is removed after achieving saturation. (2)

(ii) The magnetic flux density that remains in a material when the magnetizing force is zero. (2)

(iii) The amount of reverse magnetic field which must be applied to a magnetic material to make the magnetic flux return to zero (2)

(iv) A property of a material that describes the ease with which a magnetic flux is established in the component. (3)

(1) $\ln\left(\frac{3+x}{x^2-9}\right) = \ln\frac{(3+x)}{(x-3)(x+3)}$

$= \ln\left[\frac{(x+3)}{(x-3)(x+3)}\right]$

$= \ln\frac{1}{x-3}$ (2 mks)

$= \ln(x-3)^{-1}$

$= -\ln(x-3)$

2

QUESTION TWO

(a) (i) plot graph (5mks)

— axes ✓ 1
— Curve ✓ 2
— Tittle ✓ 1
— points ✓ 1

Magnetic flux density Vs applied field

(ii) The remnant / residual magnetic flux density is the value of B, when the field H, is zero (0.92 weber/m²) ✓ (2)

(iii) The coercive field is the value of field strength, H, when the magnetic flux density B is 0. ✓ (2)

(iv) The saturation magnetic flux density is the maximum value of the magnetic flux density (0.95 weber/m²) ✓ (2)

(b) (i) Faradays law of induction

— That a voltage is induced in a circuit wherever relative motion exists between a conductor and a magnetic field and that the magnitude of this voltage is proportional to the rate of change of the flux ✓ (2)

Lenz's law

The direction of an induced emf is such that it will always oppose the change that is causing it.

(20) ① Increasing the amount of individual conductors cutting

① Increasing the number of turns of wire in the coil

— By increasing the amount of individual conductors cutting through the magnetic field the amount of induced emf produced will be the sum of all the individual loops of the coil

② Increasing the speed of the relative motion between the coil and the magnet

— If the same coil of wire passed through the same magnetic field but its speed or velocity is increased, the wire will cut the lines of flux at a faster rate so more induced emf will be produced

(c) Increasing the strength of the Magnetic field

- If the same coil of wire is moved at the same speed through a stronger magnetic field there will be more emf produced because there are more lines of force to cut. (2)

(iii)
- Lines of force never cross
- Lines of force are continous
- Lines of force always form individual closed loops around the magnet
- Lines of force that are close together indicate a strong magnetic field
- Lines of force that are further apart indicate a weak magnetic field.

any Four (4 mks)

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any four (4 mks)

(i) α particle
- simply helium atom
- heavier than electron
- +ve charged

(ii) β - particle
- simply an electron
- negatively charged
- Has more penetrating power than α - particle

(iii) γ - rays
- simply energy
- Move faster than electrons
- Has more penetrating power than β - particle

(d) It is difficult to estimate the position and velocity of a particle with accuracy. If one is known then the other will not be determined precisely.

(e) nuclear fission - splitting of heavy nuclei to form small nuclei (lighter)

nuclear fusion - Combination of lighter nuclei to form a heavy nuclide

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Work can be defined as something that expends some of your energy

Work is done by a force only if that force causes a net displacement of the object

Energy and work are the same thing when work is done - energy is changed from one type to another type

Power is the measure of the rate of doing work or energy is changed

$$\text{Power} = \frac{\text{Work done}}{\text{time taken.}}$$

(mks)