BUGESERA DISTRICT.

END OF TERM II EXAMINATIONS, 2023/2024

SUBJECT: PHYSICS THEORY

SENIOR SIX

COMBINATIONS:

PHYSICS-CHEMISTRY-MATHEMATICS (PCM)
MATHEMATICS- PHYSICS- COMPUTER SCIENCE (MPC)
PHYSICS –CHEMISTRY- BIOLOGY (PCB)
MATHEMATICS –PHYSICS- GEOGRAPHY (MPG)

DURATION: 3 HOURS

INSTRUCTIONS:

1) Do not open this question paper until you are told to do so.
2) Answer all questions: **100 marks.**
3) Use only a **blue** or **black** pen.

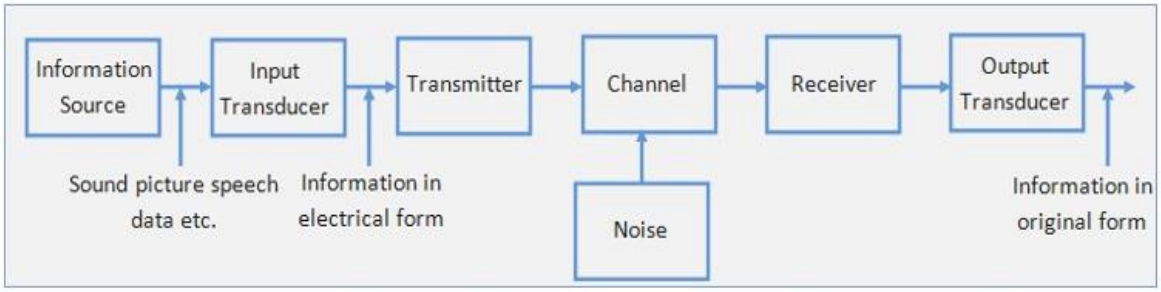
Assume where necessary the following constants.

- Magnitude of charge of an electron : $e = 1.6x10^{-19}C$
- Speed an electromagnetic wave in free space :$c = 3.0x10^{8}ms^{-1}$
- Mass of an electron : $m_e = 9.11x10^{-31}kg$
- Speed of sound in air at $0^{0}C$: v=331 m/s

SECTION A. Attempt all questions in this section (70 marks)

1. (a) Arrange gases, solids and liquids in the order from the slowest to fastest medium in which sound travels. **(2 marks)**
   (b)A sound wave has a frequency of 677 Hz in air and a wavelength of 0.54 m. What is the temperature of the air? Assume the velocity of sound at 0 °C to be 331 m/s **(3 marks)**
2. (a) (i) State the name of the antiparticle of an electron. **(1 mark)**
   (ii) Name and describe what happens when an electron and its antiparticle meet. **(2 marks)**
   (b) Calculate the minimum amount of energy, in **J**, released as radiation energy when a particle of rest energy 0.51MeV meets its corresponding antiparticle **(2mks)**

3. The diagram below indicates how information is generated from the source up to the point when the receiver interprets the broadcasted message. Study it carefully and understand the questions that follow.



a) In accordance to the image, what do you understand by the following terms

i) In Put transducer **(2 mks)**

ii) Channel. **(2 mks)**

b) Explain the major use of the receiver in the system. **(2mks)**

4. (a) What do you understand by the term earthquake? **(2mk)**
   (b) How has earthquake affected some parts of Goma and Rubavu? Give 2 points **(2mks)**

5. Explain the physical properties of Soil and explain clearly how each impact agricultural activities? **(4mks)**

6. Match each of particles **(column A)** with its description **(column B). (4marks)**

Column A	**Column B**
a) Fermions	i) carry strong nuclear force between matter particles
b) Quarks	ii) make up hadrons such as protons
c) Gluons	iii) feel weak force and not strong nuclear force.
d) muons	iv) have half integer spin

7. Consider the following nuclear reaction $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + ?$,
   a) Explain why neutrons are used to split Uranium -235. **(2mks)**
   b) what is the number of neutrons released during this nuclear reaction? **(1mk)**
   c) Calculate the energy released in the reaction above given that $^{235}_{92}U = 235.043923u$, $^{1}_{0}n = 1.008665u$, $^{141}_{56}Ba = 140.914411u$, $^{92}_{36}Kr = 91.926156u$, 1u = 931.5 MeV/$C^2$. **(3mks)**

8. Choose the correct answer.
   A) Which of the following is not a solution for global warming
   i) Using compact fluorescent light bulbs
   ii) Planting more trees

iii) Reducing fossil fuel consumption
iv) Deforestation **(1mk)**

B) During the nighttime, Earth's surface mainly gives off which form of energy?
i) ultraviolet
ii) infrared
iii) visible light
iv) Earth's surface does not give off energy during the nighttime. **(1mk)**

C) If human civilization had never developed on Earth, would there be a greenhouse effect?
i) Yes, greenhouse effect is caused by naturally occurring gases.
ii) No, the greenhouse effect is caused by humans burning fossil fuels
iii) No, the greenhouse effect is caused by humans depleting ozone.
iv) No, there is no conclusive evidence that a greenhouse effect exist. **(1mk)**

D) What is albedo?
i) A measure of how much light hits and reflect off a surface.
ii) The absorption of radiation by an object.
iii) The percentage of emitted heat from the ocean
iv) The percentage of sun's radiation transmitted through the atmosphere. **(1mk)**

9. Loudness and pitch are some characteristics of musical note.
a)Specify the physical property of sound wave on which each characteristics provided depends. **(2mks)**

b) A rock band gives rise to an average sound level of 105 dB at a distance of 20 m from the center of a band. As an approximation, assume that the band radiates sound equally into a hemisphere. What is the sound power output of the band? **(3mks)**

10. (a) Explain the concept of landslide. **(2mk)**
(b) State two causes of landslides. **(2mks)**

11. (a) Radioactive substances can be beneficial or harmful. Describe one beneficial use of radioactive substances. **(2mks)**
(b) Complete the following nuclear equation:

(i) $^{241}_{95}Am \rightarrow {}^{\cdots}_{\cdots}Np + {}^{\cdots}_{\cdots}He$ **(2mks)**

(ii) $^{239}_{93}Np \rightarrow {}^{239}_{94}Pu + ? + ?$ **(2mks)**

12. Fill in the blanks with appropriate word: (Just write the answers corresponding to the spaces in order)

(a) The region of sound wave with high pressure and density is called……(1)…..and that with low pressure and density is called……(2)…….

(b) ……(1)…….. is a logarithmic quantity of the intensity of a sound relative to a reference value and ……(2)…… the minimum sound pressure level at which a sound of a given frequency can be perceived by the human ear. **(4mks)**

13. (a) Differentiate monomode optical fiber from multimode optical fiber. **(3mks)**
(b) List two advantages of using optical fiber**.** **(2mks)**

14. Write whether the statements are **true** or **false**. **(4mks)**
a) The amount of sunlight striking a given location on Earth primarily depends on the location's latitude.
b) The layer of the Atmosphere where most world's weather occurs is stratosphere.
c) As the temperature increases in the atmosphere, the minimum radiation occurs at short wavelengths.
d) The gas with maximum percentage in the atmosphere is nitrogen.

15. (a) State **two** differences between analog and digital signals. **(2mks)**
(b) What is the application of a carrier wave in a telecommunication system? **(2mks**)

SECTION B (30 MARKS). Attempt any 3 questions Only.

16. (a) What is **binding energy** of the nucleus? **(1mk)**
(b) Calculate
i) The mass defect, **(2mks)**
ii) the binding energy and **(1mk)**
iii) The binding energy per nucleon of $^{56}_{26}Fe$, **(1mk)**

the most stable isotope of iron, given that,
Mass of a neutron is 1.008665u
Mass of one hydrogen atom $^{1}_{1}H$ is 1.007825u
Atomic mass of $^{56}_{26}Fe$ is 55.93494u and 1 a.m.u=**931.5** MeV

(c) State the decay law. **(1mk)**

(d) A sample consists of 1000 undecayed nuclei of a nuclide whose decay constant is $0.20s^{-1}$. Determine the initial activity of the sample. **(2mks)**

(e) State two dangers of radioisotopes on human cells and Suggest two

precautions you must take for safety against radioactive materials. **(2mks)**

17. You are provided **with a table 1** below containing quarks with their charges(C), Baryon numbers($\tilde{B}$), strangeness(S) and Charm (C).

Quark	**Symbol**	**Charge(C)**	**Baryon number($\tilde{B}$)**	**Strangeness(S)**	**Charm(C)**
Up	u	$+2e/3$	$1/3$	0	0
Down	d	$-1e/3$	$1/3$	0	0
Strange	s	$-1e/3$	$1/3$	-1	0
Charm	c	$+2e/3$	$1/3$	0	+1
Bottom	b	$-1e/3$	$1/3$	0	0
Top	t	$+2e/3$	$1/3$	0	0

Table 1

[$e\ is\ \ the\ elementarycharge$]

(a) Using the information provided in table 1, complete **table 2** **(6 marks)**

Partcle	**Quark composition**	**Q**	**S**	**C**	$\tilde{B}$
p	uud				
Λ	uds				
D^+	$c\bar{s}$				

Table 2

(b) Give two examples of particles that are called force particles? **(2mks)**

(c) Prove if the nuclear reaction below can occur or not. Write a statement that shows how the equation can be rectified *if* you find that it is not possible. **(2mks)**
A pi-plus decays into a positron and an antineutrino as shown below.

$$\pi^+ \rightarrow e^+ + \bar{\nu}$$

Cue: Prove by balancing the Charge, lepton number and baryon number.

18. (a) (i) Is there Doppler shift if the sound source and observer move in the same direction, with the same velocity **(2marks)**

(ii) An ambulance siren emits a sound of frequency 750 Hz. When the ambulance is travelling towards a stationary observer, the frequency detected by observer is 850 Hz. What is the speed of ambulance?
(The speed of sound in air is 340 m/s) **(2marks)**

(b) State any two factors which affect the speed of sound in air. **(2marks)**

(c) (i)Why are there no even harmonics in a pipe that is closed at one end.**(2marks)**

(ii) A tuning fork of frequency 341 Hz is placed on the mouth of a closed pipe. If

the speed of sound in air in the pipe is 340m/s,

1) Calculate the length of the pipe. **(1mark)**

2) Draw a diagram to represent the fundamental frequency of a standing wave in this closed pipe. **(1mark)**

19. Climate change is one of the greatest threats that we face, and it is already having a significant impact on species around the globe. Many scientists have declared this to be the cause to the "sixth extinction of the Earth" Assess the validity of this statement.

20. (a) Explain one way in which energy is lost along the length of an optical fiber**. (2mks)**

(b) When the mean optical power launched into an 8 km length of fiber is 120 μW, the mean optical power at the fiber output is 3 μW. Determine:

i. The signal attenuation per kilometer for the fiber. **(2mks)**

ii. The overall signal attenuation for a 10 km optical link using the same fiber with splices at 1 km intervals, each giving an attenuation of 1 dB. **(2mks)**

(c) A ray of light is travelling through an individual fiber consisting of a cladding and a core. One part has a refractive index of 1.485 and the other has a refractive index of 1.511.

1. Which part of the fiber has the higher refractive index? Explain why. **(2mks)**

2. Calculate

i. The critical angle at the core–cladding interface **(1mk)**

ii. The acceptance angle in air for the fiber. **(1mk)**

GOOD LUCK!