REPUBLIC OF RWANDA WESTERN PROVINCE RUBAVU DISTRICT	**DISTRICT COMPREHENSIVE EXAMINATION** **SECOND TERM** **SCHOOL YEAR: 2023/2024** **SUBJECT**: PHYSICS II **LEVEL**: SENIOR SIX **COMBINATIONS**:PCB, PCM, MPG, PCG, PEM	**Date:** **13**/03/2024 **Duration:** 3hrs **Time:** 08:30-11:30 **Max:** **100** Marks

Instructions:

1. **Write your names on your answer sheet.**
2. **This exam has 2 Sections A and B.**
3. **Section A: This section is compulsory.**
4. **Choose only three questions from section B.**
5. **Calculators and mathematical instruments may be used.**
6. **Use a blue or black pen for writing.**

Useful constants:

$V_{\text{sound in water}}$(25°C) =1533m/s

Electric constant K=$9\times10^{9} Nm^{2}.C^{-2}$

The mass of electron $m_e = 9.11x10^{-31}\ kg$
Planck's constant $h = 6.626x10^{-34}\ J.s$
Speed of light in vacuum $C=3x10^{8} m/s$
Electron charge $e=1.6x10^{-19} C$
Acceleration due to gravity $g = 9.81\ m/s^2$

ln2= 0.69

SECTION A: ATTEMPT ALL QUESTIONS (70 marks)

1. When a sound waves passes from air into water, what properties of the wave will change? (**1 mark**)

A. Frequency
B. Wave speed.
C. Both frequency and wavelength.
D. Wavelength.
E. Both wave speed and wavelength.

2. The balance between the amount of energy entering and exiting the Earth system is known as: (**1 mark**)

A. Paleoclimatology
B. Black body Radiation
C. Solar radiation
D. Radiative balance

3. The government of Rwanda is advising the people to conserve the nature. This is intended to limit the incidence of rise in the temperature. This conservation of nature (**1mark**)

A. Reduces the amount of water vapor that leads to increase in temperature
B. Increases the amount of plant species that is required to boost our tourism industry
C. Reduces the amount of Carbon dioxide in the space
D. Provides a green environment for human settlement

4. Agrophysics is defined as: (**1 mark**)

A. The branch of science dealing with study of matter and energy and their mutual relation.
B. The branch of natural sciences dealing with the application of physics in agriculture and environment.
C. The branch of science dealing with communication devices to measure and collect information about physical conditions in agricultural and natural environments.
D. None of these

5. The positron is called the antiparticle of electron, because it: (**1 mark**)

A. Has opposite charge and Annihilates with an electron
B. Has the same mass
C. Collides with an electron
D. Annihilates with an electron

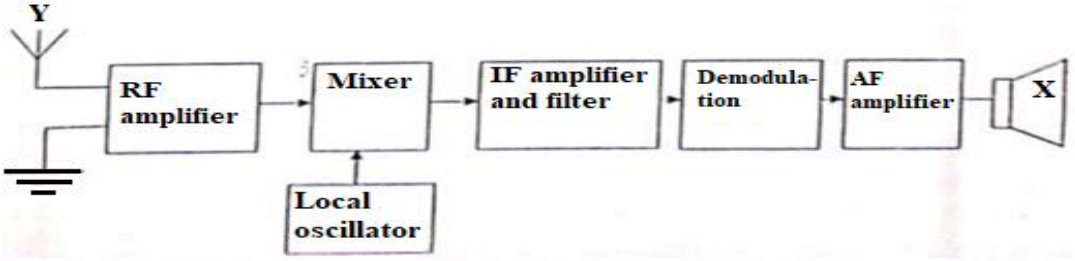
6. John defined black body as anybody that is black. Do you agree with his definition? If YES, why? And if NOT why not? Also sketch curves to show the distribution of energy with wavelength in the radiation from a black body varies with temperature. (**3 marks**)

7. a. Explain what is meant by Doppler's effect (**2 marks**)

b. A police car sound a siren of 1000 Hz as it approaches a stationary observer at a speed of 33.5 m/s. What is the apparent frequency of the siren as heard by the observer if the speed of sound in air is 340 m/s. (**3 marks**)

c. Give 2 applications of the Doppler Effect. (**2 marks**)

8. The basic block diagram of a certain radio receiver is shown in figure below:



Analyze the above diagram and answer the following questions:

a) What do the acronyms RF, IF, and AF mean? (**3 marks**)

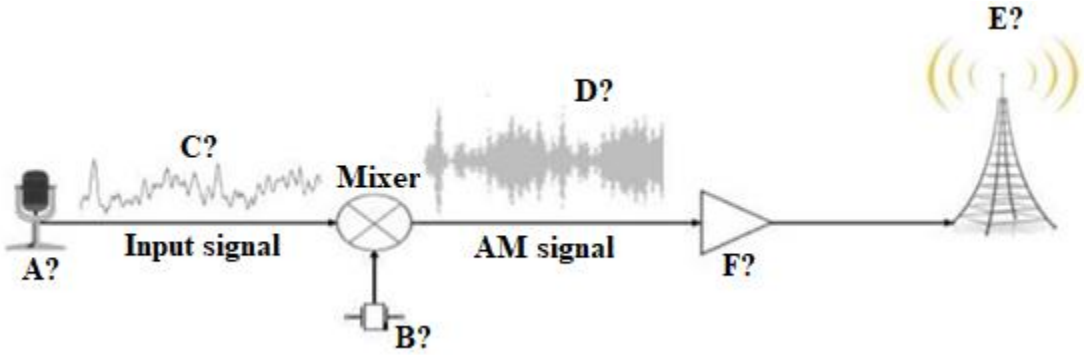
b) Name the components X and Y. (**2 marks**)

c) What is the role of the demodulator or the detector? (**2 marks**)

9. Dolphins use sound waves to locate food. Experiments have shown that a dolphin can detect a 7.5 cm target 110 m away, even in murky water. For a bit of "dinner" at that distance, how much time passes between the moment the dolphin emits a sound pulse and the moment the dolphin hears its reflection and thereby detects the distant target? (**3 marks**)

10. The figure below is about transmission of signals in telecommunication. Study it carefully and

Answer the related questions:



a. What do A,B,C,D and E stand for? (**3 marks**)
b. What is the main function of element A (**2 marks**)
c. What is the main function of element E (**2 marks**)

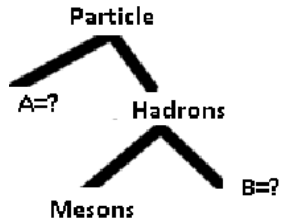
11. The idea of uncertainty is used in many contexts; social, economic and scientific. People often talk about uncertain times, and when you perform a measurement you should always estimate the uncertainty (sometimes called the error). In physics, the Heisenberg Uncertainty relation has a very specific meaning.

a. Write down the Heisenberg uncertainty equation for position and momentum. (**1 mark**)
b. Explain its physical significance (**2 marks**)
c. Does the Heisenberg uncertainty principle need to be considered when calculating the uncertainties in a typical first year physics experiment? Why or why not? (**2 marks**)
d. Discuss the following statement: the uncertainty principle places a limit on the accuracy with which a measurement can be made. Do you agree or disagree, and why? (**2 marks**)

12. Children sometimes play with a homemade telephone by attaching a string to the bottoms of two paper cups. When the string is stretched and a child speaks into one cup, the sound can be heard at the other cup. Explain clearly how the sound wave travels from one cup to the other**.** **(3 marks)**



13. a. According to the classification of elementary particles by mass. Complete the following figure: (**2 marks**)



b. Using diagrams, differentiate pair production from annihilation. (**3 marks**)

c. The 2 up quarks (u) in a proton are separated by a distance $1 \times 10^{-15}\ m$. These quarks each have an electric charge of $+\frac{2e}{3}$ and mass of $m_u = 7 \times 10^{-30}\ kg$, so they repel each other through an electric force obeying Coulomb's law. They also attract each other through a gravitational force. What is the ratio of the magnitude of the electric and gravitational forces between these 2 quarks? (**4 marks**)

14. a. Define the term mechanical weathering. (**2 marks**)

b. State four factors that can speed up the process of mechanical weathering. (**4 marks**)

c. Human activities are responsible for enormous amounts of mechanical weathering, by digging or blasting into rock to build homes, roads, and subways or to quarry stone. Suggest 3 measures that can be taken to minimize mechanical weathering caused by human activities? (**3 marks**)

d. Explain briefly the role of machines in agriculture. (**2 marks**)

15. a. Define the term earth's albedo. (**2 marks**)

b. State the 3 factors affecting the earth's albedo. (**3 marks**)

c. Calculate the albedo of a surface that receives 15000 $W.m^{-2}$ and reflects 15 $KW.m^{-2}$. Comment on the surface of that body (**3 marks**)

SECTION B: **ATTEMPT ONLY 3 QUESTIONS** (**30 marks**)

16. Discuss as fully as you can the impact of earthquakes on the environment. (N.B: Use essay format) (**10 marks**)

17. Read carefully the extract below and answer related questions:

Climate change is the defining global challenge of our time. Rapid changes to the global climate over the past several decades have already resulted in widespread impacts across human societies and natural systems. Continued changes of this magnitude will have severe and irreversible planetary impacts lasting hundreds of thousands of years, further threatening people and communities everywhere. Lessening the worst of climate impacts requires a substantial push to limit global temperature changes over the course of this century. This in turn depends on humankind's ability to achieve rapid and sustained reduction in greenhouse gas emissions over the next several decades. Doing so, demands a transformation of our economy and our systems of production and consumption, from changing how we generate energy and produce food to how government and industry, changes at the level of individuals, households and communities are profoundly of greater importance than most people appreciate.

References: Williamson, K., Satre-Meloy, A.,Velasco,K.& Green, K.(2018), Climate change needs behavior change, pp.5

Questions

a. What do you understand by the term climate change? (**2 marks**)
b. i) Imagine 2 greenhouse gases that the authors could mention. **(1 mark**)
ii) Explain how greenhouse gases contribute to the climate change according to the authors. (**2 marks**)
c. The authors mentioned the fact related to climate change in their research topic "climate change needs behavior change". Formulate what the authors wrote to confirm the negative effects of climate change are real. (**2 marks**)
d. How does the government of Rwandan support practically the strategies to reduce climate change proposed by the authors? Identify any three strategies. (**3 marks**)

18. a. State at least 2 types of quarks and 2 types of leptons. (**2 marks**)
b. Explain why the quarks feel the strongest nuclear force while the leptons feel the weakest one. (**2 marks**)
c. State whether the following nuclear reactions/decay occur via strong or weak interaction:
i. $\pi^- + p \rightarrow \Lambda^0 + K^0 + \pi^0$ (**3 marks**)
ii. $K^+ + n \rightarrow \sum^+ + \pi^0$ (**3 marks**)

19. $^{133}_{54}Xe$ is a radioactive gas which is used in studies of lung function. It has a decay constant , λ = 1.51× 10^{-6} s^{-1}. You have just taken delivery of a 4.0 MBq sample for an experiment you wish to conduct.

a. What is the half-life of $^{133}_{54}Xe$ in seconds and in days? (**3 marks**)

b. What will be the activity of your sample in 15.93 days? In 18 days?(**4 marks**)

(The experiment you wish to conduct requires an activity of at least 3.0 MBq.)

c. How long do you have before finding a volunteer subject? (**3 marks**)

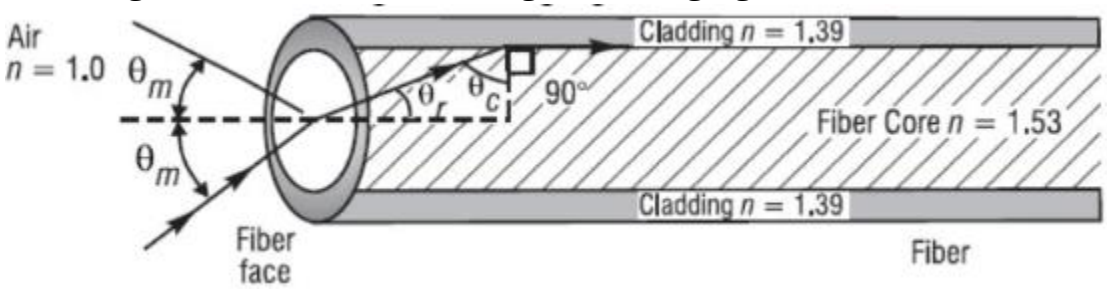
20. a. Distinguish between multimode and monomode optical fiber. (**2 marks**)

b. Explain what is meant by attenuation mechanism in optic fiber. (**2 marks**)

c. State two ways in which energy is lost in optical fibers. (**2 marks**)

d. A step-index fiber 0.01 cm in diameter has a core index of 1.53 and a cladding index of

1.39 (See figure below). such clad fibers are used frequently in applications involving communication, sensing, and imaging.



What is the maximum acceptance angle θ_m for a cone of light rays incident on the fiber face such that the refracted ray in the core of the fiber is incident on the cladding at the critical angle? (**4 marks**)

BEST WISHES!!!