ASSOCIATION CARREFOUR UMUREZI

PHYSICS II & III
12 / 03 /2024
9:00 AM -12:00 AM

ADVANCED LEVEL TEST :2023-2024
COMBINATIONS: (S6 MPG, PCB , PCM & MPC)
DURATION: 3 HOURS

INSTRUCTIONS:
1.Do not open this question paper until you are told to do so.
2.Use only a **blue** or a **black** pen and pencil for drawings
3.Use of calculator is allowed.
4.**Graph paper** is provided for practical question
5.This Paper has four sections : A, B ,C and D **(Section D is mandatory)**

Section A : Multiple choice questions : Answer all questions / **(10 marks**)
Section B : Structured questions : Answer all questions / **(45 marks)**
Section C : Attempt only three questions / **(30 marks)**
Section D : Practical Question : Answer all questions / **(15marks)**

The useful constants:

You will use the following if needed:
Charge of an electron= $1.6x10^{-19}C$
Speed of light in vacuum= $3x10^{8}m/s$
Acceleration due to gravity= $9.81m/s^{2}$
Mass of an electron= $9.11x10^{-31}kg$
Planck's constant= $6.63x10^{-34}J.s$
Avogadro's number NA= $6.022X10^{23}$/mol
Universal gas constant R=8.314J/mol.K
Radius of the earth = 6400km
Density of water = 1000 kg/m^3
Permeability of free space: $\mu_0 = 4\pi \times 10^{-7}\ H/m$
Mass of the Earth = $6 \times 10^{24}kg$
Gravitational constant $G = 6.673 \times 10^{-11}N.m^2.kg^{-2}$
Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$
Adiabatic constant of air γ =1.4
Speed of sound in air v=340m/s
Coulomb's constant $k = \frac{1}{4\pi\varepsilon_o}$ =9x10^9 Nm^2/C^2

SECTION A: Write only the letter which corresponds to the best answer

1. A sound wave is different than a light wave in that a sound wave is:
A. produced by an oscillating object and a light wave is not.
B. not capable of traveling through a vacuum.
C. not capable of diffracting and a light wave is.
D. capable of existing with a variety of frequencies and a light wave has a single frequency
2. The earth's radiative equilibrium temperature is:
A. the temperature at which the earth is absorbing solar radiation and emitting
B. infrared radiation at equal rates the temperature at which the earth is radiating energy at
maximum intensity
C. the average temperature the earth must maintain to prevent the oceans from freezing solid
D. the temperature at which rates of evaporation and condensation on the earth are in balance

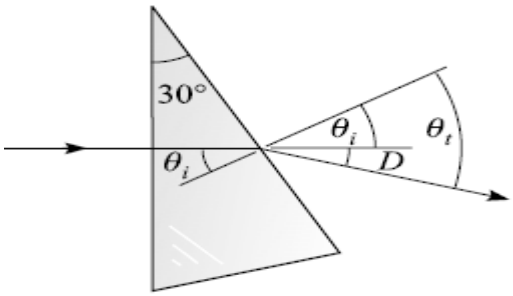
3. In transmission, the range of short waves are between
A. Radio wave and microwave B. X-rays and gamma rays
C. infrared and visible light D. infrared and ultraviolet
4. Amplitude modulated radio waves are received by a tuned radio-frequency (trf) Receiver. The receiver has a suitable detector circuit in order to
A. Amplifier the carrier waves B. Amplifier the audio-frequencies carried
C. Rectifier the carrier waves D. detect the carrier waves
E. Transfer the audio-frequencies to the radio-frequency amplifier
5. In quantum electrodynamics (QED), electromagnetic forces are mediated by
A. the interaction of electrons. B. the weak nuclear interaction. C. hadrons.
D. the exchange of virtual photons. E. action at a distance.
6.For an aluminium the modulus of rigidity is 2.1 $x10^{10}N/m^2$and density of $2.7x10^3kg/m^3$ the speed of transverse waves in this medium is:
A. 340m/s B. $2.79x10^3m/s$ C.$7.8\ x10^6m/s$ C.$1.29x10^{-7}m/s$
7.The condition for destructive interference is the path of difference, should be equal to
A. odd number of half wavelength B. even number of half wavelength
C. whole number of wavelength D. even whole number of wavelength
8. For a particle performing a uniform circular motion, the acceleration is
A. constant in direction B. constant in magnitude but not in direction
C. constant in magnitude and in direction D. constant in neither magnitude nor in direction
9. In a Carnot cycle, the working medium rejects heat at a ..... temperature
A. lower B. higher C. constant D. none of the mentioned

10.which of the following Bohr's postulates was incorrect?
A. energy of electrons is quantized B. momentum of electrons is quantized
C. electrons release energy when shifting from excited state to the ground state
D. electrons revolve around the nucleus in fixed circular orbits.

SECTION B: Structured questions: Attempt all questions /45marks

1.(a) (i) Define principal focus of a concave lens. **/0.5marks**
(ii) Draw a ray diagram to show formation of an image of finite object in concave lens **/1mark**
(iii) Describe the image formed in (a)(ii) **/0.5marks**
b). Show that the effective focal length, f, of two thin lenses in contact is given by $\frac{1}{f} = \frac{1}{f1} + \frac{1}{f2}$ where f_1 and f_2 are the foal lengths of the individual lenses. **/2marks**

2.The glass prism shown in figure below has an index of refraction of 1.55. Find the angle of deviation ***D*** for the case shown **/2marks**

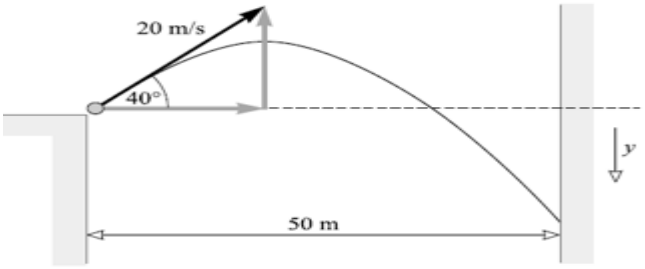


3. a) What do you understand by specific latent heat of evaporation of a liquid? **/1mark**

b) Twenty cubic centimeters of monatomic gas at 12^0C and 100kPa is suddenly and adiabatically compressed to 0.50cm^3. What are its new pressure and temperature. **/2marks**

4. a. Explain the terms "time of flight" and "range" as applied to projectile motion. **/1mark**
b. A stone is projected at an angle of 20^0 with the horizontal and just clears a wall which is 10m high and 30m from the point of projection.
Find the:
(i) Speed of projection. **/1mark**
(ii) Angle which the stone makes with the horizontal as it clears the wall. **/1mark**
c) As shown in figure below, a ball is thrown from the top of one building toward a tall building 50m away. The initial velocity of the ball is 20m/s and at an angle of 40^0 above the horizontal.

How far below its original level will the ball strike the opposite wall? **/2marks**



5.a) Define the term: **/1.5marks**

i) work function of a metal

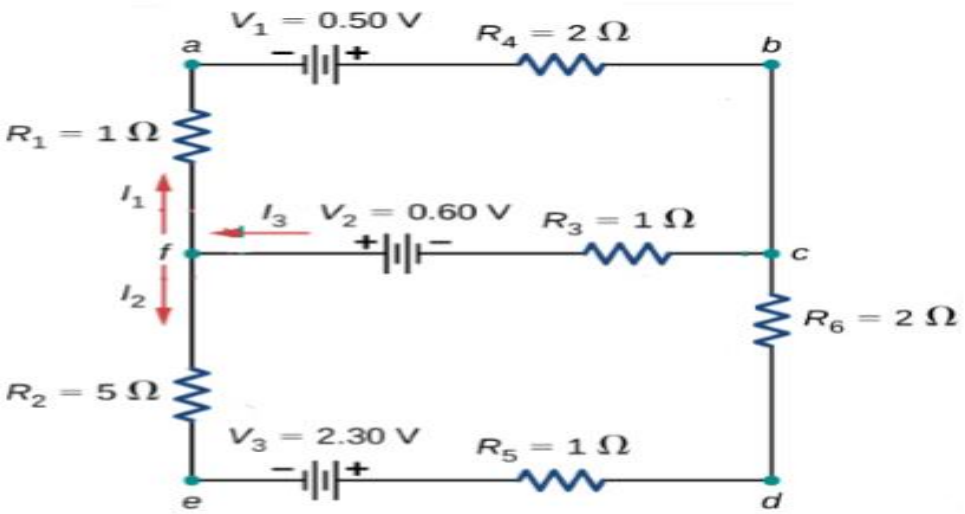
ii) Photoelectrons

iii) Stopping potential

b) What potential difference must be applied to stop the fastest photoelectrons emitted by a nickel surface under the action of ultraviolet light of wavelength 200nm? The work function of nickel is 5.01eV. **/2marks**

6. a) State the Kirchhoff's voltage law. **/1mark**

b) Analyse carefully the following electrical circuit



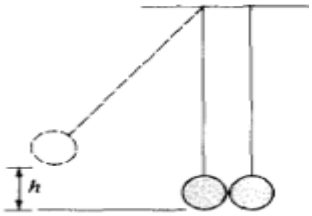
Use Kirchhoff's laws to find the electric currents (I_1,I_2 & I_3) flowing in the above electric circuit. **/3marks**

7. Refer to the figure below,the pendulum on the left is pulled aside to the position shown.It is then released and allowed to collide with the other pendulum,which is at rest.

a) What is the speed of the ball on the left just before collision?

After collision ,the two stick together . **/1mark**

b)How high ,in terms of ***h*,**does the combination swing ?Assume that the two balls have equal masses(m). **/3marks**



8.The mass of the earth is 81times that of the moon and the distance from the centre of the earth to that of the moon is about $4.0x10^5km$. Calculate the distance from the centre of the earth to where the resultant gravitational force becomes zero when a spacecraft is launched from the earth to the moon. **/3marks**

9. A turning fork of frequency of 400Hz is moved away from an observer and toward a flat wall with a speed of 2.0m/s. What is the apparent frequency:
a) of the unreflected sound waves coming directly to the observer? **/2marks**
b) of the sound waves coming to the observer after reflection? **/2marks**
c) How many beats per second are heard? **/1mark**

10. A particle of mass ***m*** lies on a smooth horizontal table and is connected to a freely hanging particle of mass ***M*** by a light inextensible string passing over a smooth fixed pulley at the edge of the table.Initially the system is at rest with ***m*** at a distance ***d*** from the edge of the table.Show that the time taken for the mass ***m*** to reach the edge of the table is $\sqrt{\frac{2d(m+M)}{Mg}}$ Where g is acceleration due to gravity. **/3marks**

11.a) Distinguish between nuclear fission and nuclear fusion.Give any one equation for each case to support your answer **/2marks**

b)Given that :Mass of $^{235}_{92}U = 235.04u$

Mass of $^{141}_{56}Ba = 140.91u$ Mass of $^{1}_{0}n = 1.01u$

Mass of $^{92}_{36}Kr = 91.91u$

Avogadro's number $(N_a) = 6.02x10^{23}mol^{-1}$. And then $1u = 932MeV$

Calculate the energy released when 40kg of $^{235}_{92}U$ undergoes fission according to

$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n$ **/3marks**

12.a) Define half-life **/1mark**

b) The radium isotope $^{224}_{88}Ra$ decays by α-emission and has a half-life of 3.6days. What is the initial number of atoms of this isotope in a sample of $1.0x10^{-3}g$ and number of atoms of the isotope after 14.4 days? **/2.5marks**

<u>SECTION C</u>: (attempt any three questions) / 30marks

13. Climate change may refer to a change in the average weather conditions of a large area within the context of long period of time say 30 years plus. It refers to any significant change in the climate parameters such as temperature, precipitation, wind patterns etc. that occur over a long period of time. The earth's climate is dynamic and always changing through a natural cycle. What the world is more worried about is that the changes that are occurring today have been speeded up. Discuss as full as you can the causes of nowadays speeded up climate change and suggests the measures to be applied to reduce this accelerated climate change. **/10marks**

14. a) A nucleus has a nucleon number A and a proton number Z and a binding energy E_{be}.The rest masses of the proton, neutron and mass of nucleus are M_P, $M_n and$ $M_{nucleus}$ respectively and c is the speed of light.

i)Show that the mass of nucleus $M_{nucleus}$ is given by

$M_{nucleus} = (A - Z)M_n + ZM_P - \frac{E_{be}}{C^2}$ **/2marks**

ii)If the nucleus is deuterium represented by the symbol $^{2}_{1}H$,show that the mass of deuterium atom ($M_{deuterium}$ atom) is given by

$M_{deuterium} = M_n + M_{hydrogen\ atom} - \frac{E_{be}}{C^2}$ Where $M_{hydrogen\ atom}$ is the mass of hydrogen atom. **/5marks**

b) Calculate in MeV,the binding energy per nucleon of deuterium from information given below

Atomic mass of deuterium $M_{deuterium} = 2.01410u$

Atomic mass of hydrogen $M_{hydrogen\ atom} = 1.00783u$

Rest mass of neutron $M_n = 1.00867u$ **/3marks**

15. a) An electron beam with a charge to mass ratio of $1.8x10^{11}Ckg^{-1}$is rotated in a circular orbit of radius r when they enter in a uniform magnetic field of 0.6T with a velocity of $2.0x10^{7}ms^{-1}$.

i)Show that the number of revolutions per second,f,is independent of the radius of the orbit. **/2marks**

ii)Calculate f. **/2marks**

iii)Calculate the radius of the orbit **/2marks**

b) An electron beam with a charge to mass ratio of $1.8x10^{11}Ckg^{-1}$passes undeflected with a uniform velocity of $2.5x10^{6}ms^{-1}$through two parallel plates, when a magnetic field of flux density B is applied perpendicular to an electric field between the plates produced by a potential difference of 120V. If the distance between the two plates is 6cm, calculate the value of electric field strength. **/4marks**

16. a) If an object subtend angle of 2° at eye when seen through telescope having objective and eyepiece of focal length fo = 60 cm and fe = 5 cm respectively than angle subtend by image at eye piece will be

i) (a) 16° , (b) 50° , (c) 24° , (d) 10° **/2marks**

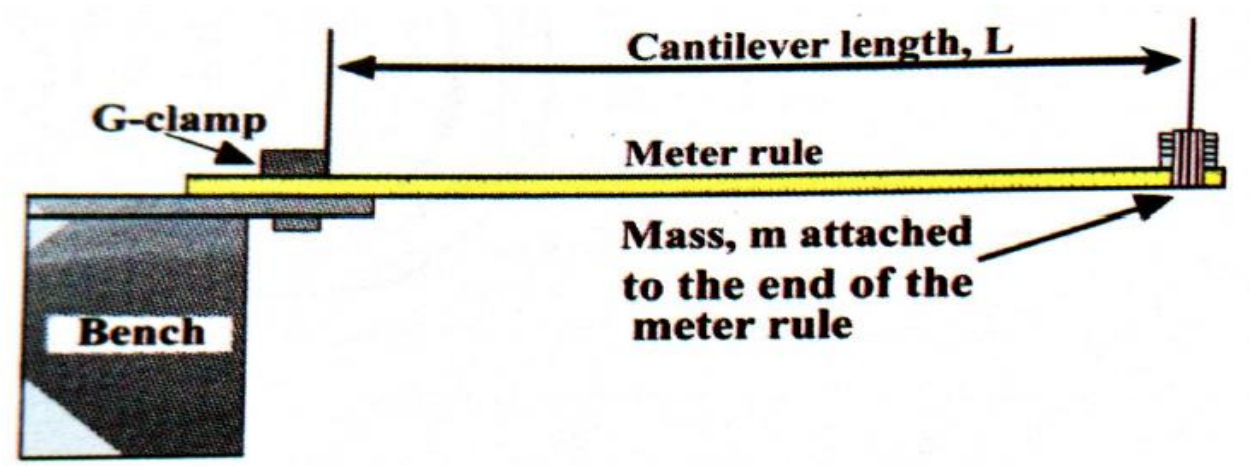
ii) The focal lengths of the lenses of an astronomical telescope are 50 cm and 5 cm. he length of the telescope when the image is formed at the least distance of distinct vision is: (a) 45 cm , (b) 55 cm , (c) $\frac{275}{6}$ cm , d) $\frac{325}{6}$ cm **/2marks**

b) A compound microscope has an eye piece of focal length 2.5cm and an objective of focal length 1.6cm. If the distance between the objective and eyepiece is 22.1cm, calculate the magnifying power produced when the final image is at infinity **/2marks**

c) using the ray diagram differentiate between compound microscope and astronomical telescope when are placed in normal adjustment. **/4marks**

<u>SECTION D</u> : Answer all questions(This section mandatory) /(15marks)

A cantilever is a rigid structural element that extends horizontally and is supported at only one end. Typically, it extends from a flat vertical surface such as a wall, to which it must be firmly attached. Like other structural elements, a cantilever can be formed as a beam, plate, truss or slab. When subjected to a structural load at its far, unsupported end, the cantilever carries the load to the support where it applies a shear stress and a bending moment. Cantilever construction allows overhanging structures without additional support.



In the experiment to determine the periodic time of a cantilever beam, the student have been given the following materials:

- ✓ Meter rule, G-clamp (or a wooden block)
- ✓ Stop watch
- ✓ Set of masses(4x100g)
- ✓ Cellotape and pair of scissors

The student set up the apparatus as shown in the figure above. Start with a length $\boldsymbol{L}$ of 80.0cm, he/she place a 200g mass at 5cm from the free end, displace the mass slightly and release it.
The student uses a stop-watch to measure the time **(**$\boldsymbol{t}$**)**taken for 10 complete oscillations and calculates the time T for one oscillation.
The student repeats the procedures for the values of $\boldsymbol{L}$=70cm,60cm,50cm and 40cm, then records the obtained results in the following table:

$Length$(L)	80	70	60	50	40
$Time\ (t)$	9.50	7.85	6.06	4.60	3.41

Questions

1.Make a suitable table of results including the values of **T** (time of one oscillation), $\boldsymbol{logT}$ and $\boldsymbol{logL}$ with three decimal places (3dp). Where $\boldsymbol{T = \frac{t}{10}}$ **/5marks**

2. Plot a graph of $\boldsymbol{logT}$ against $\boldsymbol{logL}$ **/5marks**

3. Find the gradient, $\boldsymbol{m}$ of your graph **/1mark**

4. Calculate the intercept, $\boldsymbol{C}$, on the vertical axis **/1mark**

5. Calculate the constant $\boldsymbol{a}$ of the meter rule from $\boldsymbol{C = loga}$ **/1mark**

6. Calculate the period of a cantilever from $\boldsymbol{T = aLm}$ **/1mark**

7.Calculate the value of $\boldsymbol{T}$ from $\boldsymbol{logT = m\,logL + loga}$ for the value of $\boldsymbol{L = 70cm}$ **/1mark**

ALL THE BEST WISHES!!!