REPUBLIC OF RWANDA

GATSIBO DISTRIC

END OF THE SECOND TERM EXAMINATION

MARCH 2024

SUBJECT: PHYSICS
DATE:...../03/2024

CLASS: SENIOR FIVE(s5)

DURATION: **3 HOURS**

MAX: 100 MARKS

COMBINATIONS

- **MATHEMATIC-PHYSICS-GEOGRAPHY. (MPG)**
- **MATHEMATICS-PHYSICS-COMPUTER SCIENCE. (MPC)**
- **PHYSICS-CHEMISTRY-BIOLOGY. (PCB)**
- **PHYSICS-CHEMISTRY-MATHEMATICS. (PCM)**
- **PHYSICS-ECONOMICS-MATHEMATICS. (PEM)**

INSTRUCTIONS:

This paper consists of two sections: **A** and **B.**

Section A: attempt all questions. **(70 marks)**

Section B: attempt only **three** questions. **(30 marks)**

USEFUL CONSTANTS

- Charge of an electron $e=1.6\times10^{-19}\ C$
- Speed of light $c=3\times10^{8}\ m/s$
- Mass of proton $m_p=1.67\times10^{-27}\ kg$
- Planck's constant $h=6.62\times10^{-34}$J.s

SECTION A (70 marks)

1. The following phenomena prove that light can behave like either a particle or a wave: Reflection of light, refraction of light, interference of light, photoelectric effect, Compton effect
   a)What phenomena best prove that light is a particle instead of wave? **(2marks)**

   b)What phenomena best prove that light is a wave instead of particle? **(3 marks)**

2. a)In a photoelectric effect experiment the stopping potential is: ***(2marks)***
   i)the energy required to remove an electron from the sample
   ii)the kinetic energy of the most energetic electron ejected
   iii)the potential energy of the most energetic electron ejected
   iv)the photon energy
   v)the electric potential that causes the electron current to vanish

   b) A pulse of light of duration 100ns is absorbed completely by a small object initially at rest.
   Power of the pulse is 30mW and speed of light is 3×10^8m/s.
   Find the final momentum of the object. (**3marks)**

3. a) Define photoelectric effect.**(1mark**)
   b) photoelectric effect is similar to thermionic emission? If not Explain. **(2marks)**
   c) The laser in a compact disc player. It uses light with a wavelength of 7.8×10^2 nm. Calculate the energy of a single photon of this light. **(2marks)**

4. Fill in the passage using the words in box: (**5 marks)**

Time period, restoring, not true, oscillatory motion, periodic, displacement, periodic, towards, amplitude.

Any motion that repeats itself again and again at regular intervals of time is called ---***a***----------motion. The smallest interval of time after which the motion is repeated is called its -------***b***------.
If a body moves back and forth repeatedly about its mean position, its motion is ------***c***----------.
Every oscillatory motion is ----------***d***----------but reverse is----------***e***----------.

Simple harmonic motion is a special case of ----------***f***----------in which the particle moves to and fro about mean position under the action of a ----------***g***----

--------force which is directly proportional to its ----------***h***-------from mean position is always directed --------***i***---------- mean position.

----------***j***----------is the maximum displacement from mean position

5. a) An equation of a damped oscillation is $m\frac{dx^2}{dt^2} + b\frac{dx}{dt} + kx = 0$

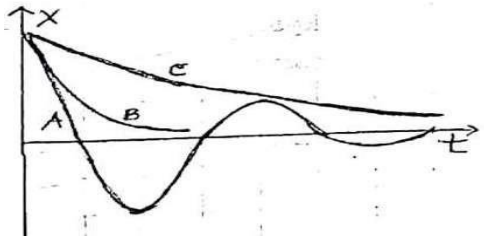
State the type of damped oscillation for each of the following cases

i. The damping constant $b = \sqrt{4mk}$ **(1mrk)**

ii. $b \succ \sqrt{4mk}$ **(1mrk)**

iii. $b \prec \sqrt{4mk}$ **(1mrk)**

b) Examine figure below related to the graph lines A, B and C of damped oscillations and answer the questions that follow:



i. Identify the graph line showing the critical damped oscillation.(**1mark)**

ii. What is the main cause of damped oscillations? (**1mark**)

6. Match the letters in column A with their corresponding number in column B. (**5 marks)**

COLUMN(A)	COLUMN (B)
a. electric potential	1.a force field that surrounds an electric charge or group of charges
b.voltage	2.overtone
c.the higher order frequencies	3. electrical potential energy per charge

d.electric field	4.damping
e.dercease in amplitude	5.a measure of electric potential

7. Equation of travelling wave on a stretched string of linear density 5g/m is $y=0.03\sin(450t-9x)$ where distance and time are measured in SI units. Determine the tension in the string. (**4marks**)

8. a) state the newton's low of universal gravitation. (**2marks)**

b) The planet Mercury travels around the Sun with a mean orbital radius of 5.8×10^{10}m. The mass of the Sun is 1.99×10^{30} kg. Use Newton's version of Kepler's third law to determine how long it takes Mercury to orbit the Sun. Give your answer in Earth days.(**3 marks)**

9. For the damped oscillator system, the block has a mass of 1.50 kg and the spring constant is 8N/m.

The damping force is given by $b(dx/dt)$, where b = 230g/s. The block is pulled down 12.0 cm and released.

(a) Calculate the time required for the amplitude of the resulting oscillations to fall to one-third of its initial value. **(2 marks)**

(b) How many oscillations are made by the block in this time? **(2 marks**

10. a) State the Kepler's laws of planetary motion. **(3marks)**

b)Find the ratio of the Coulomb electric force F_E and gravitational force F_G between two electrons in vacuum. $K=9\times10^9 Nm^2C^{-2}$,$G=6.67\times10\text{-}11Nm^2kg^{-2}$ **(2marks)**

11. A cell of unknown emf E and internal resistance r was connected in series with an ammeter, a switch and a 10Ω resistor P, as indicated. When the switch was closed, the ammeter reading was 0.40A. When P was replaced by a 5 Ω resistor Q, the ammeter reading became 0.65A.

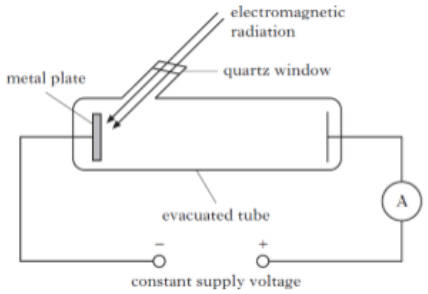
From these observation. Determine the internal resistance of the cell. (**4marks)**

12. a) what do you understand by the term equipotential lines? **(2marks)**

b) equipotential lines must be parallel to electric field line?

Explain your answer **(2marks)**

13. A metal plate emits electrons when certain wavelengths of electromagnetic radiation are incident on it.



The work function of the metal is $2{\cdot}24 \times 10^{-19}$ J.

Electrons are released when electromagnetic radiation of wavelength 525 nm is incident on the surface of the metal plate.

a)Show that the energy of each photon of the incident radiation is $3{\cdot}79 \times 10^{-19}$ J. **(2 marks)**

b)Calculate the maximum kinetic energy of an electron released from the surface of the metal plate. **(2 marks)**

14. Read the passage below and answer the questions that follow "satellites which orbit 22,238 miles (35,788 km) above the Earth's equator are said to be in geostationary orbit. Most telecommunication satellites are in this type of orbit. Other satellites are in solar orbit only a few hundreds of miles above the earth. These are said to be in low earth orbit. These are mainly military satellites which because of their low orbit can "see" things in great detail".

a) What is difference between an artificial and a natural satellite of the Earth? **(2marks**)

b) Briefly explain three benefits of artificial satellites. **(3 marks)**

15. Enumerate at least five problems associated with the production of nuclear power**.**

(5marks)

SECTION B/30marks

16. An object oscillates with simple harmonic motion along the x axis. Its position varies with time according to the equation

$x = 4.0\cos\left(\pi t + \frac{\pi}{4}\right)$ where x *is in metre,* t is in seconds and the angles in the parentheses are in radians.

a. Determine the amplitude, period and the frequency of the motion. **(3marks).**

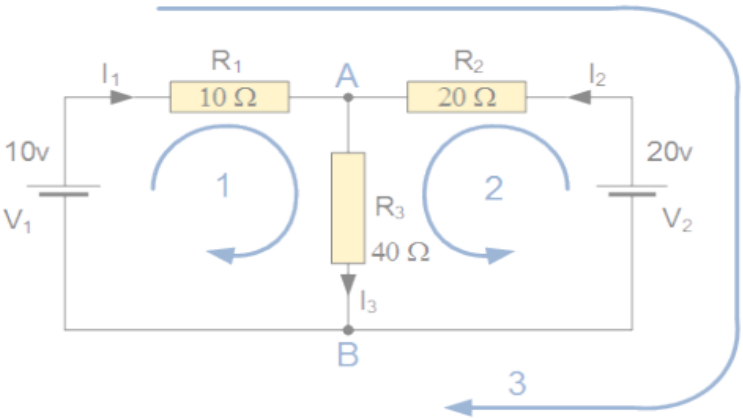
b. Calculate the velocity and acceleration of the object at any time *t*. **(2marks)**

c. Using the results of part (*b*), determine the position, velocity, and acceleration of the object at $t = 1.0$ *s*. **(2marks)**

d. Determine the maximum speed and maximum acceleration of the object. **(1mark)**

e. Find the displacement of the object between $t = 0$ *s* and $t = 1.0$ s and direction of wave. **(2marks)**

17. The diagram below shows electric circuit where I1, I2 and I3 are electrical currents passing through a branches of a circuit.



a) State Kirchhoff's rules **(2 marks)**

b) If R1, R2, and R3, V1and V2 are respective resistors and voltages in the circuit. Find values I1, I2 and I3. **(6 marks)**

c) Calculate the potential difference between A and B **(2marks)**

18. a) what do you understand by the term wave? ***(1mark)***

b) what the principle of superposition of waves?(***2mark***s)

c) state the property of wave which describe the result of superposition and its types.***(3marks***)

d) In an effort to get your name in the Guinnesss Book of world records you set out to build a bass viol with strings that have a length of 5m between fixed points . one string has a linear mass density of 40g/m and fundamental frequency of 20Hz.

i) Calculate the tension of this string ***(2marks)***

ii) Calculate the frequency and wavelength of the second harmonic ***(2marks)***

19. a) Clearly distinguish between fossil and non-fossil fuels **(3marks)**

b)The following are the main energy resources produced and consumed all over the world: Biomass, Bio-fuel, Coal, Geothermal, Hydroelectric, Natural Gas, Nuclear, Ocean Thermal Energy Conversion (OTEC), Oil (Petroleum), Solar, Tides and Waves, Wind. Considering all of the energy resources provided above, separate the Fossil Fuels from the Non-Fossil Fuels. **(5 marks)**

c) State any two disadvantages of fossil fuels (**2 marks)**

20. **)** An electron is placed between the two horizontal electrically charged plates. The electron accelerates toward the upper plate. The electric field strength between the plates is 4.8×10^{11} newtons per coulomb.

a) Draw and Label the plates with the correct charge. (**2 marks)**

b)(i) Sketch at least four electric field lines to represent the field between the plates. Ensure that the direction of the field lines is correct. (**1 mark)**

(ii) Field lines always represent what a ……charge will do. (**1mar**k)

c) Use the electric field strength given above and the charge on the electron to determine the net force acting on the electron while it is between the plates. (**2 marks)**

d) calculate the acceleration of the electron while between the plates.(**2 marks)**

e) what would be the acceleration if a proton were accelerated in the same field. (**2 marks)**

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