ADVANCED PHYSICS
SENIOR FIVE
DURATION: 3hours

MUSANZE DISTRICT
ACADEMIC YEAR: 2023-2024
SECOND TERM

DISTRICT COMPREHENSIVE ASSESSMENT, 2023-2024

SUBJECT: PHYSICS THEORY EXAM/100marks

COMBINATIONS:
PHYSICS-CHEMISTRY MATHEMATICS (PCM), MATH-PHYSICS-COMPUTER SCIENCE (MPC)
PHYSICS-CHEMISTRY-BIOLOGY (PCB), MATH- PHYSICS- GEOGRAPHY (MPG)
PHYSICS- ECONOMICS- MATH (PEM)

INSTRUCTIONS

- ✓ This paper consists of two sections:

SECTION A: Attempt all questions **(70marks)**
SECTION B: Attempt only three (3) questions of your choice **(30marks)**

- ✓ Non programmable scientific calculators and mathematical sets may be used where appropriate
- ✓ Use only a blue or black pen

ADVICE

- ✓ Read every question carefully before you start to answer it.
- ✓ Try to answer every question.
- ✓ Check your answers if you have time at the end.
- ✓ Look at the marks as a guide to how much time to spend on each question.

USEFUL CONSTANTS:
Magnitude of the electronic charge = 1.6 10-19C
Mass of electron = 9.1×10^{-31} kg
Speed of light in vacuum/air, C=3×10^{8} m/s
Permittivity of free space/air, is 8.85×10^{-12} C2/Nm2
Planck's constant, h=6.63 10^{-34} J.s
Acceleration due to gravity, 9=9.81m.s-2

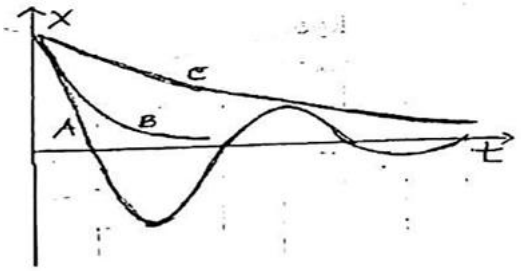
SECTION A

1. In the Rutherford's planetary model of the atom, what keeps the electrons from flying off into space? **/2marks**
2. Indicate **T (TRUE)** if the statement is correct or **F (FALSE)** if the statement is wrong.
   a) A wave is a theoretical object that absorbs 100% of the radiation that hits it. **/1mark**
   b) A wave is any disturbance that results into the transfer of energy from one point to another point. **/1mark**
3. In a photoelectric-effect experiment, The following will increase the maximum kinetic energy of the photoelectrons Respond with yes or No In each case and justify your answer
   a) Use light of greater intensity; **/1.5marks**
   b) use light of higher frequency; **/1.5marks**
   c) use light of longer wavelength; **/1.5marks**
   d) use a metal surface with a larger work function **/1.5marks**
4. By using words like trough, diffraction, progressive wave and node, complete the following sentences:
   a) For stationary waves, the position at which the two waves cancel is called ..... /**1mark**
   b) .....is one of the properties of waves **/1mark**
   c) The disturbance moving from one point to another is called the .....**/1mark**
5. The laser in a CD player uses light with a wavelength of $7.8x10^{-34}$nm. Choose the right answer for the energy of a single photon of this light in the list below and explain your choice. (show your working)
   (a)$E=2.55x10^{-19}W$ **(b)** $E=2.55x10^{-19}J$ **(c)** $E=2.48x\ 10^{-19}J$ **(d)** No right answer. **/4marks.**
6. An incident x-ray photon of wavelength 0.090nm is scattered in the backward direction from a free electron that is initially at rest.
   a) What is the magnitude of the momentum of the scattered photon? (**2.5marks)**
   b) What is the kinetic energy of the electron after the photon is scattered**(1.5marks)**
7.
   a) What do you understand by a Non-fossil fuel. /**2mks**
   b) Give at least two examples of non-fossil fuels and explain briefly how they work to produce energy. /**4mks**
8. Can two pulses traveling in opposite directions on the same string reflect from each other? Explain. **/4marks.**

9. Why do we say that light has wave properties and why do we say that it has particle properties? **/4marks.**
10. In both photo electric effect and in Compton effect, a photon collides with an electron causing an electron to fly off, what then is the difference between the two processes? **/6marks.**
11.

a) Explain the wave nature of matter. **/3mks**
b) Determine the de Broglie wavelength for a baseball of mass 0.15kg moving at speed of 13m/s. **/3mks**

12. Define the following terms:
    a) Resonance **(1mark)**
    b) Stationary wave **(1mark)**
    c) Force oscillation **(1mark)**
    d) Quantum mechanics **(1mark)**
    e) blackbody **(1mark)**
13. Examine the Fig.2 below related to the graph lines A, B and C of damped oscillations and answer the questions that follow.



a) Identify the graph line showing the critical damped oscillation. **/1mk**
b) What is the main cause of damped oscillations? **/2mk**
c) A 2kg object attached to a spring moves without friction and is driven by an external force given by $F=3\sin 2\pi t$. If the force constant of the spring is k=20N/m, determine: **(i)**the period **/1.5mks (ii)** the amplitude of the motion **/1.5mks**

14.

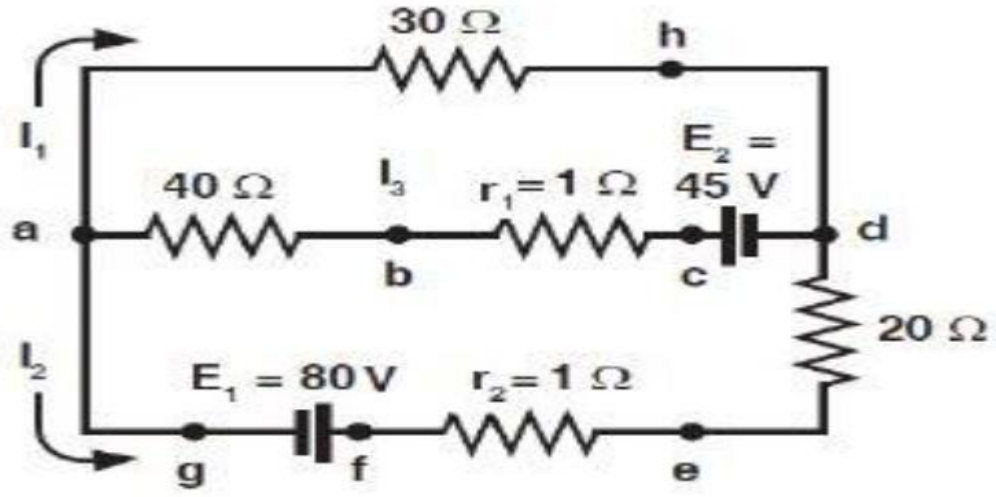
a) State Kepler' s laws of Planetary motion. **/3marks**
b) An Earth satellite moves in a circular orbit 640 km (uniform circular motion) above Earth's surface with a period of 98.0 min. What are
    i. the speed and
    ii. the magnitude of the centripetal acceleration of the satellite? **/3marks**

15.

a) State Kirchoff' s rules (KCL and KVL) for complex circuits. /**2mks**

b) Which of these laws is a consequence of the principle of conservation of energy? /**1mk**

c) Using Kirchoff's rules, calculate the currents I1, I2 and I3 in the three branches of the circuit /**3mks**

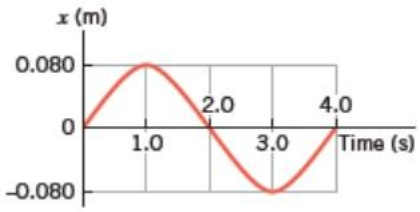


SECTION B

16.

a) Compare and contrast between simple harmonic motion and damped oscillatory motion. (**5marks)**

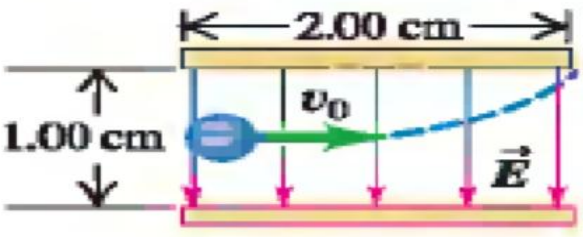
b) An 0.80-kg object is attached to one end of a spring, as in Figure below, and the system is set into simple harmonic motion. The displacement *x* of the object as a function of time is shown in the drawing. With the aid of these data, determine **(i)** the amplitude A of the motion, **(ii)** the angular frequency ω, **(iii)** the spring constant k, **(iv)** the speed of the object at t=1.0 s, and **(v)** the magnitude of the object's acceleration at t= 1.0 s. (**5marks)**



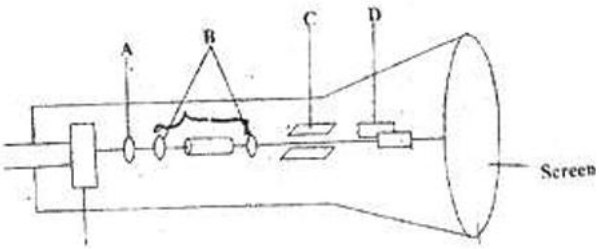
17. An electron is projected with an initial speed $v_o=1.6x10^6$m/s into a uniform field between the parallel plates in figure below. Assume that the electric field between the plates is uniform and directed vertically

downward and that the field outside the plates is zero. The electron enters the at a point midway between the plates.

a) If the electron just misses the upper plate and it emerges from the field, find the magnitude of the electric field.
b) Suppose that in figure below the electron is replaced by a proton with the same initial speed v_o.Would the proton hit one of the plate? If the proton would not hit one of the plates, what would be the magnitude and direction of its vertical displacement as it exits the region between the plates?
c) Compare the paths travelled by the electron and the proton and explain the differences.
d) Discuss whether it is reasonable ignore the effects of gravity for each particle.

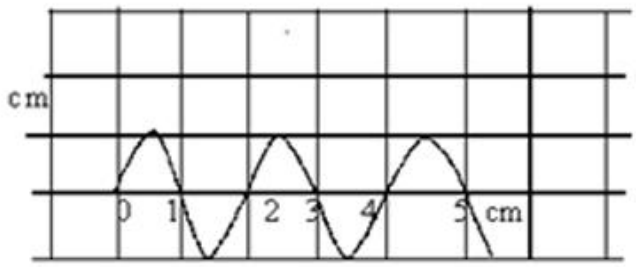


18. Figure below shows a cathode ray tube in which a beam of electrons is cast on the screen



a)
i) State how the electrons are produced in the tube. **(1mks)**
ii) Give the difference between cathode rays with x-rays **(4mks)**
iii) What are the functions of parts labelled C and D? **(2mks)**

b) the graph shows the waveform of a signal applied at the Y-plates of an oscilloscope whose time-base is switched to the scale of 2 milliseconds per centimeter.



Determine

i. the period of the signal **(1.5marks)**
ii. the frequency of the signal. **(1.5marks)**

19. A travelling wave is described by the equation $y(x,t)=0.003\cos(20x+200t)$ where y ant t are measured in metres and t in seconds.
    a) What is the direction in which the wave is travelling? **/1.5mks**
    b) Calculate the following quantities:
        i. Angular wave number **/1.5mks**
        ii. Angular frequency **/1.5mks**
        iii. Wave speed **/1.5mks**
    c) Calculate the particle velocity when x=0.3m and t=0.02s.**/2mks**
    d) Calculate the particle acceleration when x=0.3m and t=0.02s.**/2mks**

20. Fossil fuels are hydrocarbons, primarily coal, fuel oil or natural gas, formed from the remains of dead plants and animals.
    a) Write short notes on the advantages and disadvantages of fossil fuels (Coal, Oil and Natural gas) mentioned in the above paragraph. /**5mks**
    b) Explain the environmental problems of fossil fuels and suggest solutions clearly. /**5mks**