REPUBLIC OF RWANDA

SOUTHERN PROVINCE

NYANZA DISTRICT

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PHYSICS EXAMINATION
Monday, March, 18/03/2024

Time: 9.00 AM - 12.00 PM

SUBJECT: PHYSICS II
CLASS: SENIOR 5
DURATION: 3 HOURS
COMBINATIONS:

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

INSTRUCTIONS:
This exam contains two section (A&B):
Section A: Attempt all questions **(70Marks)**
Section B: Attempt any three questions. **(30Marks)**

Use the following constant where necessary;

Acceleration due to gravity, $\mathbf{g = 9.81 ms^{-2}}$

Speed of light in vacuum, $\mathbf{c = 3.0x10^{8} m/s}$

Mass of the electron, $\mathbf{m_e = 9.11x10^{-31}\ kg}$

Gravitational constant, $\mathbf{G = 6.67x10^{-11} N\ m^2/\ kg^2}$

Charge of electron, $\mathbf{e = 1.6\times10^{-19} C}$

Planck's constant, $\mathbf{h = 6.63\times10^{-34} Js}$

Mass of the Earth, $\mathbf{M = 5.97\times10^{24} kg}$

Radius of the Earth, $\mathbf{R = 6.37\times10^{3} km}$

Stefan-Boltzmann's constant, $\mathbf{\sigma = 5.67x10^{-8} Wm^{-2}K^{-4}}$

SECTION A. Attempt <u>all</u> questions (70MARKS)

1. In SHM, the ……..is the maximum displacement from the center of oscillation. ***1Mark***

A. Velocity C. Amplitude
B. speed D. acceleration

2. a. Define an electric dipole ***1Mark***

b. Draw a sketch to show electric field lines of an electric dipole and equipotential surfaces ***3 Marks***

3. a. If an electron and a proton travel at the same speed, which has the shorter wavelength? Explain. ***2Marks***

b. Why do we say that light has particle properties? ***2Marks***

4. Examine **figure 1** related to the graph lines A, B, and C of damped oscillations and answer questions that follow

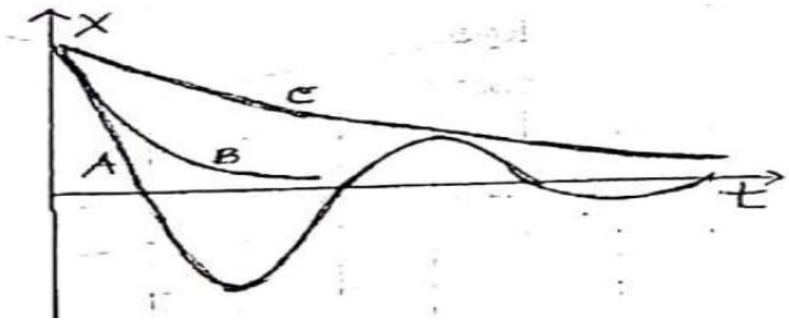


Figure1.

a. Identify the graph line showing the critical damped oscillation. ***1Mark***

b. What is the main cause of damped oscillation ***1Mark***

c. Name any two characteristics of damped oscillation ***2Marks***

5. Two springs A and B of spring constants Ka and Kb respectively are connected to a mass m as shown in figure below. The surface on which the mass slides is frictionless.

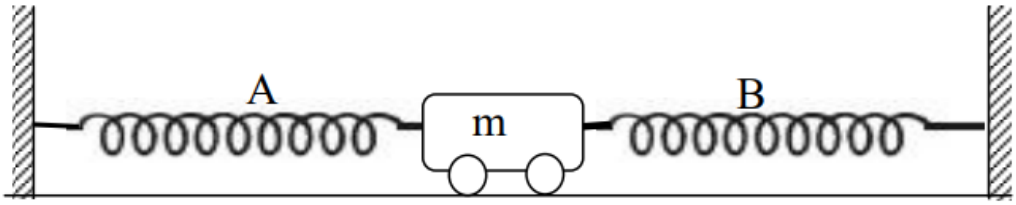


Figure2.

a. Show that if the mass is slightly displaces, it oscillates with SHM of frequency, f given by

$$\mathbf{f} = \frac{1}{2\pi}\sqrt{\frac{K_a+K_b}{m}}$$ ***6Marks***

b. If the two springs are identical such that $K_a = K_b = 5.0 Nm^{-1}$ and mass, m=50g. Calculate the period of the oscillation. ***2Marks***

6. (Fill in the blanks).

The mass of a 300kg object is ……(i). Its weight on earth is ……(ii). An object that weights 20 N on earth has a mass on the moon equal to ……(iii) and its acceleration on the Moon is……(iv). ***4Marks***

7. a. The electric field in a certain neon ions is 5000V/m. What force does this field exert on a neon ion of a mass $3.3x10^{-26}$ kg and charge +e? ***2Marks***

b. The potential difference between a certain thundercloud and the ground is $7x10^6$V. Find the energy dissipated when a charge of 50C is transferred from the cloud to the cloud in a lightning stroke. ***2Marks***

8. a. State 3 types of fossil fuels ***3Marks***

b. i. Distinguish nuclear fusion from nuclear fission. ***2Marks***

ii. Explain how nuclear fission can be used in our world life. ***2Marks***

9. a. How are stationary waves formed? ***2Marks***

b. A stretched string of a guitar has a length of 791 mm. The string emits a note of 256 Hz when it vibrates at its fundamental frequency.

i. Draw a diagram to represent the fundamental frequency of a stationary wave in a string. ***1Mark***

ii. Calculate the speed of waves in this stretched string of a guitar ***2Marks***

10. The displacement x (in SI unit) of a body moving with SHM is given by $\boldsymbol{x = 3.5\sin(4t + 0.2)}$ in meters. Find the amplitude, angular velocity, $\boldsymbol{w}$ period, T and linear velocity at time t =1.5s. ***6Marks***

11. Light of frequency, $\mathbf{f = 6x10^{14}Hz}$ is incident on a metal surface and the emitted electrons have kinetic energy of $\mathbf{2x10^{-29}J}$. Calculate:

a. Work function of the metal ***2Marks***

b. Threshold frequency of the metal ***2Marks***

12. a. Differentiate ammeter from galvanometer ***2Marks***

b. In the following circuit, using the Kirchhoff rules find the currents I_1, I_2 and I_3 ***5Marks***

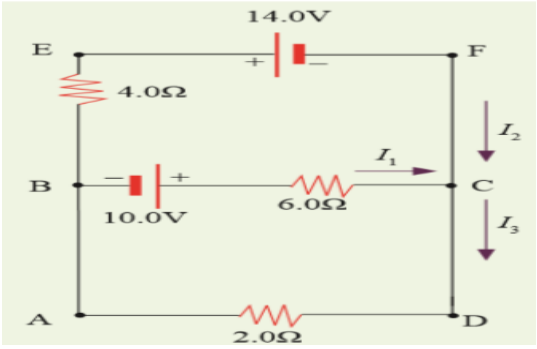


Figure 3

13. a. What happens to the period of a simple pendulum if the pendulum's length is doubled? ***1Mark***

b. What happens to the period if the mass of the suspended bob is doubled? ***1Mark***

14. a. Give mathematical statement of black body radiation laws. ***2Marks***

b. Mercury has a radius of $2.50x10^6$m. Its sunny side has a temperature of 400^oC and its shady side -200^oC. Treating it like a black body, find its power. ***4Marks***

15. The displacement y given of a wave travelling in the x-direction at time t is $\mathbf{y = a\sin\left[2\pi\left(\frac{t}{0.1} - \frac{x}{0.2}\right)\right]}$meters.

Find: **a.** The period of the wave ***1Mark***

b. The velocity of the wave ***2Marks***

c. The direction in which the wave is travelling ***1Mark***

SECTION B. Attempt <u>only three</u> questions 30Marks

16. a. What is meant by: **i.** Thermionic emission? ***1Mark***

ii. Cathode rays**.** ***1Mark***

b. i. Give four properties of cathode rays. ***2Marks***

ii. Describe briefly, the functioning of principal parts of a cathode ray oscilloscope. ***2Marks***

c. An electron gun operating at 3000V is used to shoot electrons into the space between two oppositely charged parallel plates. The plate spacing is 50mm and length 100mm. Calculate the deflection of the electrons at the point where they emerge from the field when the plate potential difference, is 1000V. ***4Marks***

17. a.i. State Newton's universal gravitation law and explain why is called universal law? ***1Mark***

ii. Define the term gravitational field. ***1Mark***

iii. Use your answers in i. and ii. to show that earth's gravitational field strength is $\frac{GM}{R^2}$ where M is the mass of earth, R is the radius of earth and G is the gravitational constant. ***2Marks***

b. What meant by gravitational potential? Use data provided to show that the gravitational potential of earth surface is **-6.255×10^7 J/Kg** ***2Marks***

c. A communication satellite at geostationary orbit is such that its period of revolution about the earth is 24h. Explain the significance of this period and show that the radius R_0 of the orbit is given by:

$$Ro = \sqrt[3]{\frac{GM}{4\pi^2}T^2}$$ ***4Marks***

18 a. Give Einstein's photoelectric equation and explain each symbol you use. ***1Mark***

b. i. In photoelectric effect, what does it mean this symbol (figure4)? ***1Mark***

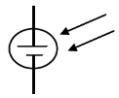


Figure4

ii. State whether this symbol can be used (2 areas of applications) ***1Mark***

c. i. Explain the term ''Stopping potential" ***1Mark***

ii. By using equation given in a. above, deduce mathematical expression of stopping potential. ***2Marks***

d. i. State two laws of photoelectric emission and two factors affecting photoelectric emission. ***2Marks***

ii. A copper surface is irradiated by light of wavelength 2.5×10^{-7}m and has a stopping potential of 0.25V. Calculate the work function. ***2Marks***

19. In the Bohr model, the speed of the electrons in a hydrogen atom in the n level is given by $v_n = \frac{e}{2\varepsilon_o nh}$ where e is the electron charge, h is the Planck constant and ε_o is the permittivity of free space.

a. Sketch the diagram of the electron motion and show the direction of its position vector and velocity. Show also the direction of the electric force acting on the electron. ***2Marks***

b. Show that the radius of the electron orbit is given by $r_n = \frac{\varepsilon_0 n^2 h^2}{\pi m e^2}$ where m is the mass of the electron. ***3Marks***

c. Calculate the orbital period in each of the n =1, 2 and 3 levels. ***3Marks***

d. The energy of the ground state of the mercury atom is on a scale in which an electron completely free of the atom is at zero energy.

i. Determine the energy corresponding to the second excited state. ***1Mark***

ii. Calculate the ionization potential of the mercury atom. ***1Mark***

20. Discuss, as fully as you can, the problems associated with the production of nuclear Power ***10Marks***

END