BUGESERA DISTICT

END OF TERM II 2023/2024

S5 PHYSICS PAPER I (Theory)

COMBINATIONS : MPC, MPG, PCB & PCM.

Marks : /100 marks

DURATION : 3 HOURS

NSTRUCTIONS :

- Attempt all questions in section A and B
- Write all necessary *formulae*, and *S.I units* where necessary to avoid loss of marks.
- Do not open this question paper until you are told to do so.
- Use only a **blue** or **black** pen.

Assume where necessary the following constants.

- Magnitude of charge of an electron : $e = 1.6x10^{-19}C$
- Speed an electromagnetic wave in free space: $c = 3.0x10^{8}ms^{-1}$
- Permittivity of a free space :$\varepsilon_o = 8.85x10^{-12}Fm^{-1}$
- Mass of an electron : $m_e = 9.1x10^{-31}kg$
- Planks constant : $h = 6.625x10^{-34}Js$
- Permeability of a free space : $\mu_o = 4\pi x10^{-7}Hm^{-1}$
- Acceleration due to gravity : $g = 9.81ms^{-2}$
- Constant : $\frac{1}{4\pi\varepsilon_o} = 9.0x10^{9}mF^{-1}$
- Universal Gravitational Constant G $6.67x10^{-11}Nm^2kg^{-2}$

SECTION A (70 Marks) Attempt all questions

PART I: MULTIPLE CHOICE QUESTIONS.

1) Which of the following quantities is conserved during Compton scattering? **/4mrks**

A) Energy B) Momentum C) Mass D) Charge

2) Which of the following statements about the photoelectric effect is false? **/4mrks**

A) The kinetic energy of emitted electrons depends on the frequency of incident light.

B) Increasing the intensity of incident light increases the number of emitted electrons.

C) There is a threshold frequency below which no electrons are emitted.

D) The photoelectric effect can be explained using classical wave theory.

3) In a damped oscillatory system, what happens to the amplitude of oscillation over time? **/4mrks**

A) It remains constant B) It increases exponentially C) It decreases exponentially D) It oscillates chaotically

4) A Planet has two moons of equal mass. Moon one is in circular orbit of radius r. Moon two is in a circular orbit of radius 2r. The magnitude of the gravitational force exerted by the planet on moon two is: **/4mrks**

A) four times as large as that on moon one. B) twice as large as that on moon one
C) Half as large as that on moon one. D) one fourth as large as that on moon one
E) Equal to that on moon one.

PART II: Put your answers on the Answer sheets provided.

5) Find the ratio of the coulomb electric force(F_E) to the gravitational force (F_G)between two electrons in vacuum? **/4mrks**

6) a) State Kepler's laws of planetary motion **/3mrks**

b) what is the absolute potential at each of the following distances from a charge of 2micro-coulomb, r =10cm and r =50cm, then, how much work is required to curry a 0.05micro-coulomb charge from the point at r =50cm to that at r =10cm? **/5mrks**

7) Explain why fossil fuels are all non-renewable but not all non-renewable are fossil fuels? **/4mrks**

8) A small piece of lead of mass 40 g is attached to the end of a light string of length 50 cm and it is allowed to hang freely. The lead is displaced to 0.5 cm above its rest position, and released.
(a) Calculate the period of the resulting motion, assuming it is simple harmonic? **/2mrks**
(b) Calculate the maximum speed of the lead piece. (Take g = 9.81 m s^{-2}). **/2mrks**

9) a) List any two phenomena that illustrate the wave nature of light? **/2mrks**
b) On what factor (ANY TWO) do the black body radiation depend? **/2mrk**
c) define the term blackbody? **/2mrk**

10) The work function for sodium is 4.6×10^{-19}J. a) Calculate the lowest frequency of light that will cause photoelectric emission.
/2mrks
b) What is the maximum energy of electrons emitted when the light of frequency 7.3×10^{14}Hz is used?
/2mrks

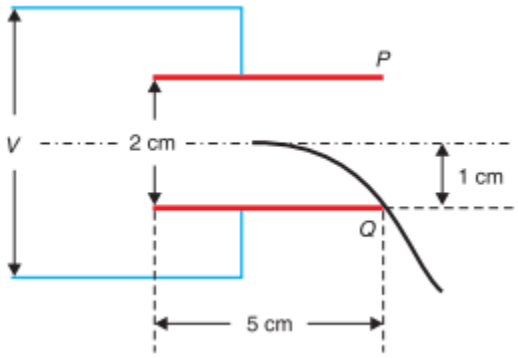
11) a) States the Huygens' principle of the wave theory of light? **/2mrks**
b) Explain any two merit of Huygens 'wave theory of light **/2mrks**

12)A SHM has a mass of 3.61 kg, a period of 4.17 s, and a total energy of 15.7 J. What is its amplitude? **/4mrks**

13) Find initial phase and amplitude for simple harmonic motion represented by an equation: $y = 3\cos\omega t + 4\sin\omega t$ **/6mrks**

14) Explain the types of damped oscillation with clear examples? **/6mrks**

15) A beam of electrons moving with velocity **1×10^7 m/s** enters mid-way between two horizontal parallel plates P and Q in a direction parallel to the plates as shown on Figure below P and Q are 5 cm long and 2 cm apart, and have a p.d applied between them. **/4mrks**

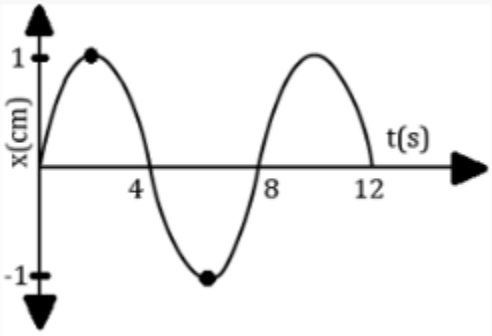


SECTION B: Attempt only three (3) questions/ 30marks

16) a) Define simple harmonic motion. **/1marks**

b) Discuss at least two characteristics of a body performing Simple Harmonic Motion (S.H.M)? **/2marks**

c) The displacement-time(x-t) graph of a particle undergoing simple harmonic motion is shown below. Find the acceleration of the particle at $t = \frac{4}{3}$ second **/4marks**



d) A particle is executing SHM along a straight line. Its velocities at distances $\mathbf{x_1}$ and $\mathbf{x_2}$ from the mean position are $\mathbf{v_1}$ and $\mathbf{v_2}$ respectively. Find the expression of time period of oscillation? **/3marks**

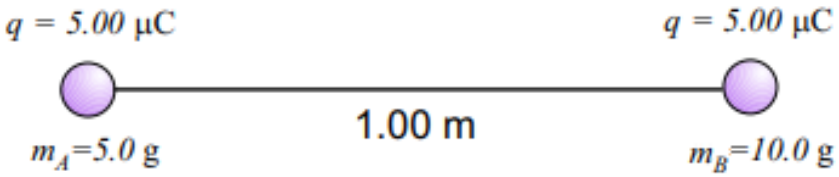
17) a) Air pollution may kill people now, but radiation induces genetic effects that will damage future generations. How can we justify our enjoying the benefits of nuclear energy (any five arguments) while future generations bear the suffering from it? **/5marks**

b) Discuss in five arguments, how do we confirm that the **'greenhouse effect'** is real? **/5marks**

18)a) Define **electric potential** and **electric potential energy**? **/2marks**

b) Explain equipotential lines from equipotential surface? **/1marks**

c) Two tiny metal spheres A and B of mass Ma = 5.00 g and Mb = 10.0 g have equal positive charges q = 5.00 μC. The spheres are connected by a massless non-conducting string of length d = 1.00 m, which is much greater than the radii of the spheres.



(i) What is the electric potential energy of the system? **/2marks**

(ii) Suppose you cut the string. At that instant, what is the acceleration of each sphere? **/2marks**

(iii) A long time after you cut the string, what is the speed of each sphere? **/3marks**

19) a) Define **Forced oscillation** and **write down** its equation by explaining each term? **/4mrks**

b) Consider a mass-spring system described by the equation $2\frac{d^2y}{dt^2}+3\frac{dy}{dt}+wy=0$, y(0)= -5 and $\frac{dy}{dt}=6$, Give the value(s) of **w** for which the system is under, over, and critically damped. **/6mrks**

20) a) Estimates the effective value of g on the top of Mt. Everest, 8850 m above sea level. That is, what is the acceleration due to gravity of objects allowed to fall freely at this altitude? **/4mrks**

b) A satellite travels at a height from the centre of Earth twice the radius of the Earth. Determine the period of revolution of the satellite. (The radius of Earth = 6.4 x 10^6m, mass of Earth = 6.0 x 10^{24} kg). **/6marks.**

GOOD LUCK!