

MUHANGA DISTRICT

DATE:/03/2026

ADVANCED LEVEL EXAMINATIONS OF PHYSICS

ACADEMIC YEAR:2025- 2026

TERM:2

COMBINATIONS:

- ❖ **MATH-PHYSICS-GEOGRAPHY (MPG)**
- ❖ **PHYSICS-CHEMISTRY-MATHEMATICS (PCM)**
- ❖ **PHYSICS-CHEMISTRY-BIOLOGY (PCB)**
- ❖ **MATHEMATICS-PHYSICS-COMPUTER (MPC)**

DURATION: 3 HOURS

INSTRUCTIONS:

This paper has **2** sections **A** and **B**

SECTION A: Attempt **ALL** questions **(70 marks)**

SECTION B: Attempt any **THREE** questions **(30 marks)**

Constants:

- ❖ $K=9 \times 10^9 \text{Nm}^2\text{C}^{-2}$
- ❖ $G = 6.67 \times 10^{-11} \text{Nm}^2\text{kg}^{-2}$
- ❖ $g = 10 \text{ m/s}^2$
- ❖ $e = 1.6 \times 10^{-19}\text{C}$,
- ❖ $m_e = 9.11 \times 10^{-31}\text{kg}$ and $h = 6.63 \times 10^{-34}\text{Js}$

-Silent non-programmable calculators may be used.

SECTION A: ATTEMPT ALL QUESTIONS/70MARKS

Choose the letter that corresponds to the correct answer

1) **A)** A black body is one that **(1Mark)**

ANSWER: **b) Absorbs all incident radiations**

B) If light of frequency $2f_0$ is incident on a metal of threshold frequency f_0 .the maximum kinetic energy of emitted electrons is proportional to: **(1Mark)**

ANSWER: **c) hf_0**

C) The stopping potential for a photoelectric emission process is 10V. The maximum kinetic energy of the electrons ejected in the process is: **(2Marks)**

ANSWER: **c) $1.6 \times 10^{-18} \text{J}$**

D) As the temperature of a blackbody increases, the peak wavelength: **(1Mark)**

ANSWER: **c) Decreases**

E) An electron falls from rest through a potential difference of 100V. Its de Broglie wavelength in Angstrom? (Take $m_e=9.11 \times 10^{-31} \text{kg}$, $e=1.602 \times 10^{-19} \text{C}$) **(2Marks)**

ANSWER: **a) 1.23\AA**

2)A. If the length of a simple pendulum is doubled, its period will: **(1Mark)**

ANSWER: **b) Be greater by factor $\sqrt{2}$**

B. A particle in SHM passes through equilibrium with speed 2 m/s and amplitude 0.5 m. Its angular frequency is: **(1Mark)**

ANSWER: **c) 4 rad/s**

C. The total mechanical energy of a 0.5 kg mass executing SHM with amplitude 0.1 m and $\omega = 10 \text{ rad/s}$ is: **(1Mark)**

ANSWER: **a) 0.25 J**

D. In SHM, if displacement is given by $X = 0.1 \sin 6t$.The maximum acceleration is:

ANSWER: **b) 3.6 m/s^2 **(1Mark)****

E. If one of two parallel springs breaks, the time period of oscillation will: **1mark**

ANSWER: **a) Increase**

F. The motion is underdamped when: **(2Marks)**

ANSWER: **c) $b^2 < 4mk$**

G. If the damping force is very large, the system becomes: **(1Mark)**

ANSWER: **c) Overdamped**

H. For overdamped motion, the solution of the displacement is: **(1Mark)**

ANSWER: **c) Sum of two real exponential terms**

I) In critically damped motion, the system: **(1Mark)**

ANSWER:

b) Returns to equilibrium in the shortest time without oscillation

3)A. What type of fossil fuel is mined from the ground? **(1Mark)**

ANSWER: **c) Coal**

B. Which of the following produces greenhouse gases? **(1Mark)**

ANSWER: **a) Burning fossil fuel**

C. Which energy source uses photovoltaic cells? **(1Mark)**

ANSWER: **b) Solar energy**

D. Which non-fossil fuel produces energy through nuclear fission? **(1Mark)**

ANSWER: **a) Uranium**

E. A material that absorbs neutrons and controls the reaction is called: **(1Mark)**

ANSWER: **c) Control rod**

4)A. A uniform electric field means: **(1Mark)**

ANSWER **b) Field strength is constant in magnitude and direction**

B. The electric potential due to a point charge decreases with: **(1Mark)**

ANSWER: **a) Distance**

C. Two objects, one with a mass m and other with a mass $4m$ are attracted to each other by gravitational force. If the gravitational force on $4m$ is F , what is the force on mass m in terms of F ? **(2Marks)**

ANSWER: **c) F**

D. The escape velocity of a projectile from the Earth can be calculated using the formula (Where G : gravitational constant, R_E : Radius of earth and M : Mass of Earth) **(1Mark)**

ANSWER: **b) $v_e = \sqrt{\frac{2GM}{R_E}}$**

5)A. If at a node, currents $4A$ and $6A$ enter, and current $3A$ leaves, the remaining current leaving the node is: **(2Marks)**

ANSWER: **b) 7A**

B. Kirchhoff's Voltage Law (**KVL**) is based on the principle of conservation of: **(1Mark)**

ANSWER: **b) Energy**

C. If the radius of a satellite's circular orbit is doubled, its total mechanical energy becomes: **(2Marks)**

ANSWER: **b) Halved**

D. For a satellite orbiting a planet in a circular orbit, Kepler's Third Law predicts that its period depends on: **(2Marks)**

ANSWER:

c) Radius of orbit and mass of central planet

E. Kepler's Second Law implies that a planet moves fastest when it is: **(2Marks)**

ANSWER: **b) At perihelion**

6) State whether the following by true or false: (10marks)

- A) True
- B) False
- C) False

- D) False
- E) True
- F) False
- G) False
- H) False
- I) False
- J) False

7)

(a) The field lines around a point mass and negative point charge are identical since are both directed inward **(1mark)**.

Around a point mass:

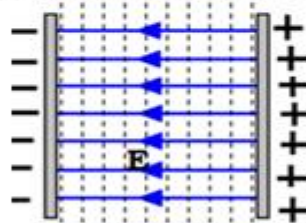


Around a point charge:

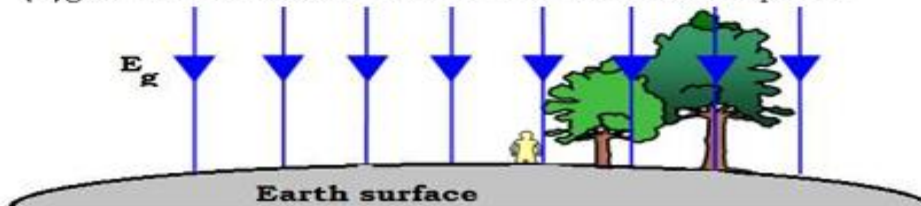


(b)

(i) electric field are uniform between two parallel charged plates



(ii) gravitational field are uniform near the surface of planet

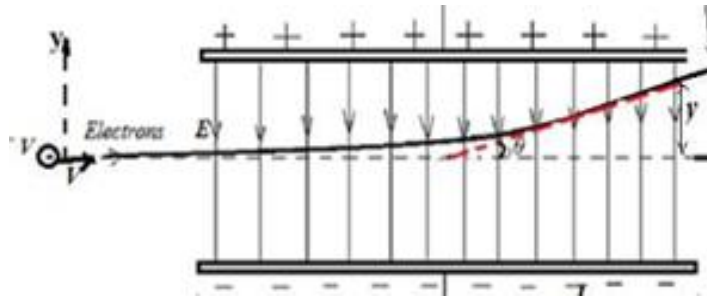


H

SECTION B (ATTEMPT ANY THREE QUESTIONS)

Each counts out of 10 marks

8)a) Draw a sketch of this arrangement. (2 marks)



b) Given:

Potential difference across plates = 4000 V

Plate separation = 3.4 cm = 0.034 m

Accelerating p.d = 5000 V

Plate length = 6.0 cm = 0.06 m

Kinetic energy gained

Electrons accelerated through 5000 V:

(i) In electron volts: $K_e = eV$

$K_e = 5000 e$

(ii) In joules:

$KE = (1.6 \times 10^{-19}) (5000)$

$KE = 8.0 \times 10^{-16} J$

(2 marks)

(c) Maximum speed of electrons (1 mark)

Using:

$$KE = \frac{1}{2}mv^2$$

(d) Time to pass between plates (1 mark)

$$t = \frac{L}{v}$$

$$t = \frac{0.06}{4.2 \times 10^7}$$

$$t = 1.43 \times 10^{-9} \text{ s}$$

(e) Electric field between plates (1 mark)

$$E = \frac{V}{d}$$

$$E = \frac{4000}{0.034}$$

$$E = 1.18 \times 10^5 \text{ N/C}$$

(f) Force on each electron (1 mark)

$$F = eE$$

$$F = (1.6 \times 10^{-19})(1.18 \times 10^5)$$

$$F = 1.89 \times 10^{-14} \text{ N}$$

(g) Acceleration of electrons (1 mark)

$$a = \frac{F}{m}$$

$$a = \frac{1.89 \times 10^{-14}}{9.11 \times 10^{-31}}$$

$$a = 2.07 \times 10^{16} \text{ m/s}^2$$

(h) Deflection of the beam (1 mark)

Using:

$$y = \frac{1}{2}at^2$$

$$y = \frac{1}{2}(2.07 \times 10^{16})(1.43 \times 10^{-9})^2$$

$$y = \frac{1}{2}(2.07 \times 10^{16})(2.04 \times 10^{-18})$$

$$y = 0.021 \text{ m}$$

$$y = 2.1 \text{ cm}$$

9) a) a. Phase Constant: $y = \sin(\omega t + \phi)$ at $t = 0, y(0) = 0$

$$\varphi = 0 \text{ rad}$$

b. Equation of Displacement: Amplitude = 0.6 mm

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.15} \approx 41.89 \text{ rad/s.}$$

$$y(t) = 0.6 \sin(41.89t)$$

c. Spring Constant (k):

$$k = m\omega^2 = 4 \text{ kg} \times (41.89 \text{ rad/s})^2 \approx 7019.5 \text{ N/m.}$$

d. Total Energy (E):

The total mechanical energy is $E = \frac{1}{2}kA^2$:

- $E = \frac{1}{2} \times 7019.5 \times (6 \times 10^{-4})^2 \approx 1.26 \times 10^{-3} \text{ J.}$

e. Maximum Speed (v_{max})


- $v_{max} = A\omega = 0.0006 \text{ m} \times 41.89 \text{ rad/s} \approx 0.025 \text{ m/s}$ (or 25 mm/s).

f. Maximum Acceleration (a_{max})

- $a_{max} = A\omega^2 = 0.0006 \text{ m} \times (41.89 \text{ rad/s})^2 \approx 1.05 \text{ m/s}^2.$

g. Velocity-Time Graph Sketch

The velocity graph is the derivative of the displacement graph ($v = v_{max} \cos(\omega t)$).

- It starts at its maximum value (25 mm/s) when $t = 0$.
- It reaches zero when displacement is at its peak ($t \approx 0.0375 \text{ s}$).
- The period remains **0.15 s**. 

10)A.

Phenomena	Can be explained in terms of waves	Can be explained in terms of particles
Reflection of light	yes	yes
Refraction of light	yes	yes
Diffraction of light	yes	No
Interference of light	yes	No
Photoelectric effect	No	yes
Compton effect	No	yes

B. a) Planck's constant): According to the graph of K_e vs f , Planck's constant is represented by the **gradient (slope)** of the straight line

$$K_e = hf - hf_0 \quad h = \frac{(0+3.6)1.6 \times 10^{-19}}{(1.05-0.2)10^{14}} = 6.6 \times 10^{-34} \text{ JS}$$

b) **Work function (ϕ):** The work function is the magnitude of the **y-intercept** of the graph

$$\phi = 4.4 \text{ eV}$$

c) **Threshold frequency (f_0):** This is the **x-intercept** of the graph (the frequency where $K_e=0$)

$$f_0 = 1.05 \times 10^{15} \text{ Hz}$$

d) If Incident frequency $f < f_0$: No electrons will be emitted.

This is because the energy of the incident photons is less than the work function required to liberate an electron from the metal surface

11) a.

\sqrt{m}	Period
4.47	0.61
7.07	0.75
10	0.94
12.25	1.09
13.78	1.20
14.14	1.23

b. Graph

plot a graph of **T (y-axis)** against \sqrt{m} (**x-axis**).

Draw a straight line that passes as close as possible to all data points

c.

$$k = \frac{\Delta T}{\Delta \sqrt{m}} = \frac{1.23 - 0.61}{14.14 - 4.47} = \frac{0.62}{9.67} \approx \mathbf{0.064 \text{ s/g}^{1/2}}$$

y-intercept (C):

$$0.61 = (0.064 \times 4.47) + C \rightarrow 0.61 = 0.286 + C \rightarrow C \approx \mathbf{0.324 \text{ s}}$$

d. Constants and Units

-Constant C: Represents the period when no mass is added

Unit of C is Seconds (s)

- Constant k: Represents the proportionality constant related to the spring's stiffness

$$\mathbf{Unit: s/g^{1/2} \text{ (or } s \cdot g^{-1/2}\text{)}}$$

12) A. In the equation $x(t)=A \cos(\omega t+\varphi)$ = what does the phase constant (φ) determine? **/1mark**

b. The initial position of the oscillator

B. $Y_R = Y_1 + Y_2$ $R_1 = 2$ and $R_2 = 2$

$$\Delta\theta = \frac{\pi}{3}$$

$$R = \sqrt{a^2 + b^2 + 2ab\cos(\Delta\theta)}$$

$$R = 2\sqrt{3}$$

$$\tan\theta = \frac{r_1\sin\theta_1 + r_2\sin\theta_2}{r_1\cos\theta_1 + r_2\cos\theta_2}$$

$$\theta = \frac{\pi}{6}$$

(ii) Expression of Y ($y_1 + y_2$)

- $Y = 2\sqrt{3} \sin(\omega t + \frac{\pi}{6}) \text{ m}$

(iii) Amplitude A' and initial phase ϕ' of $Y' = Y + y_3$

Now combine Y ($A = 2\sqrt{3}$, $\phi = \frac{\pi}{6}$) and y_3 ($a = 2$, $\phi = \frac{2\pi}{3}$). The phase difference is $\frac{2\pi}{3} - \frac{\pi}{6} = \frac{4\pi - \pi}{6} = \frac{3\pi}{6} = \frac{\pi}{2}$ (a right angle).

- **Resultant Amplitude (A'):**

Using Pythagoras since they are 90° apart:

$$A' = \sqrt{(2\sqrt{3})^2 + 2^2} = \sqrt{12 + 4} = \sqrt{16} = 4 \text{ m}$$

$$\tan\theta = \frac{r_1\sin\theta_1 + r_2\sin\theta_2}{r_1\cos\theta_1 + r_2\cos\theta_2}$$

$$\theta = \frac{\pi}{3}$$

$$y(t) = 4\sin(\omega t + \frac{\pi}{3})$$

ENJOY THE BEAUTY OF PHYSICS!!!