ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

# Physics Model Paper 3 2025

**Time Allowed: 2 Hours 30 minutes**
**Total Marks: 120**

You must bring a soft pencil (preferably type B or HB), a clean eraser, and a dark blue or black pen.

Before attempting the paper, write your name, candidate number, centre name, and centre number clearly in the designated spaces.

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## Instructions for Candidates

- This paper consists of **seven** essay-type questions. You must attempt any **six** questions, including all their sub-parts.
- Each question carries **20 marks**.
- You may use a scientific calculator.
- You should show all your working and use appropriate units.
- Do not use an erasable pen or correction fluid.
- Avoid writing over any barcodes printed on the paper.

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## Information for Candidates

- This paper has a total of **120 marks**. All questions carry equal marks.
- The number of marks for each question or part question is shown in brackets [ ].
- A formula sheet will be provided with this paper.

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Please read all questions carefully and follow the instructions exactly to ensure your responses are properly evaluated.

**Q1.** **(20 marks)**

(a) Define the following and state their SI units [6]

angular

velocity ……

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……..……

centripetal

force ……

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(b) A car of mass 1000 kg moves around a circular track of radius 50 m at a constant speed of 20 m/s.

(i) Calculate angular velocity.

ω= ……..[2]

(ii) Find centripetal acceleration.

$a_c$= ……..[2]

(iii) Determine centripetal force.

$C_f$= ……..[2]

(c) A spring-mass system oscillates with x(t)=0.05cos (15t).

(i) State:

angular frequency

…….[1]

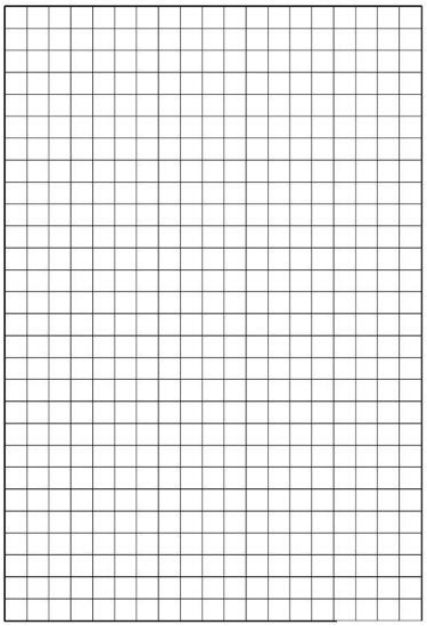
amplitude:

……..[1]

(ii) Calculate maximum acceleration.

a = ……[1]

(iii) Sketch acceleration–time graph for one cycle. [1]



(d) Explain resonance in tuning forks and give one beneficial and one harmful example. [4]

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**Q2.** **(20 marks)**

(a) Define electric field strength and Coulomb's law. State its SI unit. [6]

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(b) Two charges, +5 μC and –2 μC, are separated by 0.20 m

(i) Calculate force between them.

F = ……..[3]

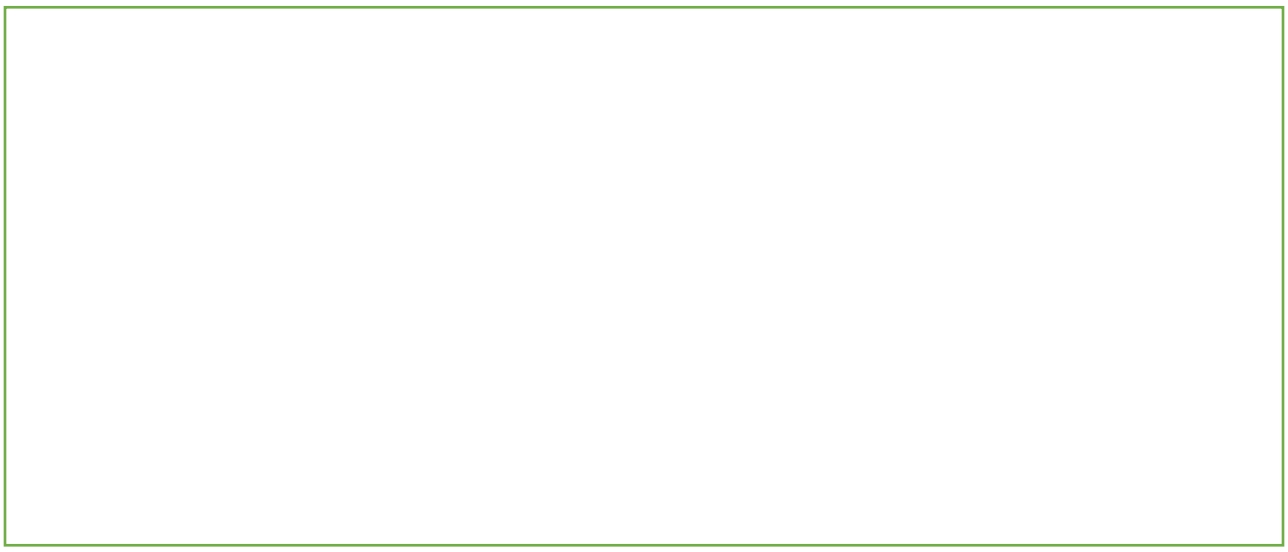
(ii) Find field strength at midpoint.

……..[2]

(iii) State direction of field.

…… [1]

(c) Sketch electric field lines between the charges. [4]



(d) Explain how uniform electric fields in particle accelerators. [4]

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**Q3.** **(20 marks)**

(a) Define photon and explain quantization of energy. State Planck's relation. [6]

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(b) Ultraviolet light of wavelength 250 nm falls on a metal of work function 3.5 eV.

(i) Calculate photon energy.

E = ……..[2]

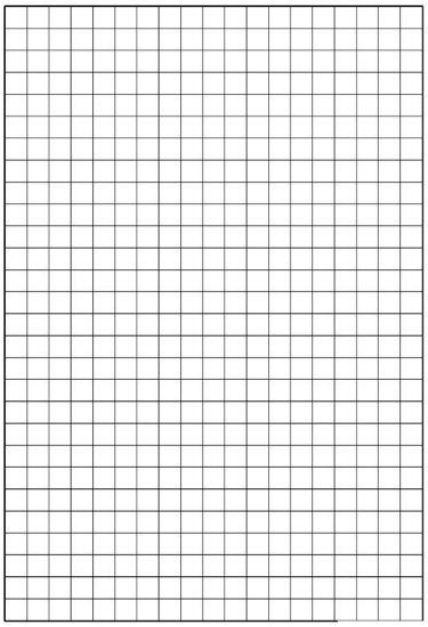
(ii) Determine if photoelectrons are emitted.

……..[2]

(iii) Calculate maximum K.E.

K.E = ……..[2]

(c) Sketch graph of stopping potential vs frequency. Label threshold frequency. [4]



(d) Explain how line spectra provide evidence for quantized energy levels. [4]

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**Q4.** **(20 marks)**

(a) Define refraction and diffraction. Give one everyday example of each. [6]

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(b) Light of wavelength 600 nm passes through a slit of width $2.0 \times 10^{4}$ m.

(i) Calculate angular position of first minimum.

……..[2]

(ii) Find width of central maximum on screen 2.0 m away.

……..[2]

(iii) Explain effect of reducing slit width

……..[2]

(c) Two coherent sources of wavelength 500 nm separated by 0.20 mm observed on screen 1.0 m away.

(i) Calculate fringe spacing.

……..[2]

(ii) Sketch interference pattern. [2]

(d) Explain how photoelectric effect and electron diffraction support wave- particle duality.
[4]

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**Q5.** **(20 marks)**

(a) Define binding energy and mass defect. State their significance. [6]

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(b) Mass of He-4 nucleus = 4.0015 u; combined nucleon mass = 4.0320 u.

(i) Calculate mass defect.

……..[2]

(ii) Determine binding energy in MeV.

……..[2]

(iii) Find binding energy per nucleon

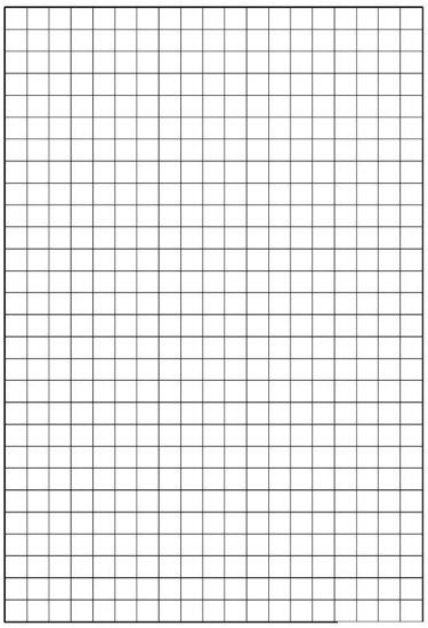
| | |
|---|---|
| | |

……..[2]

(c) Explain difference between fission and fusion. [3]

(i) Give one example of each

(ii) Sketch binding energy per nucleon vs mass number graph. [1]



(d) Discuss advantages and challenges of fusion as energy source. [4]

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**Q6.** **(20 marks)**

(a) Define gravitational field and electric field. State their sources and units. [6]

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(b) A point mass of 5.0 kg produces a gravitational field at 2.0 m.

(i) Calculate field strength.

……..[2]

(ii) Find force on 2.0 kg mass.

……..[2]

(iii) Compare gravitational and electric fields

……..[2]

(c) A charge of +3.0 μC is placed at origin.

(i) Calculate field strength at 0.50 m.

……..[2]

(ii) Sketch field lines. [2]

(d) Explain how fields describe forces at a distance with examples. [4]

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**Q7.** **(20 marks)**

(a) Define gravitational force and electrostatic force. State their laws. [6]

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(b) Proton and electron separated by $5.0 \times 10^{-11}$ m.

(i) Calculate electrostatic force.

……..[2]

(ii) Calculate gravitational force.

……..[2]

(iii) Compare relative strengths.

……..[2]

(c) A satellite of mass 500 kg orbits Earth at 300 km altitude.

(i) Calculate gravitational field strength at this height.

……..[2]

(ii) Determine centripetal force.

……..[1]

(iii) Sketch Earth, satellite, and force vectors. [1]

(d) Discuss how fields unify interactions of charges and masses. Give one application. [4]

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# Table of Specification HSSC-A P3

| Chapter | AO1 (Knowledge – 30%) | AO2 (Application – 50%) | AO3 (Analysis – 20%) | Total Marks |
|---|---|---|---|---|
| 6: Circular motion and Simple harmonic motion (SHM) | 6 marks | 10 marks | 4 marks | 20 marks |
| 8: Capacitance | 6 marks | 10 marks | 4 marks | 20 marks |
| 9: Photons, photoelectric effect and spectra | 6 marks | 10 marks | 4 marks | 20 marks |
| 11: Refraction, Diffraction, Interference and wave-particle duality | 6 marks | 10 marks | 4 marks | 20 marks |
| 14: Binding Energy, Nuclear Fission, and Nuclear Fusion | 6 marks | 10 marks | 4 marks | 20 marks |
| 15: Fields and their sources | 6 marks | 10 marks | 4 marks | 20 marks |
| 16: Interactions Of charges Masses and Fields | 6 marks | 10 marks | 4 marks | 20 marks |

**Marking Scheme (Q1)**

**(a)** Angular velocity = rate of change of angular displacement (rad/s). Centripetal force = inward force keeping body in circular motion (N). **[6 AO1]**
**(b)** $\omega = v/r = 20/50 = 0.40\,rad/s$. $a_c = v^2/r = 400/50 = 8.0\,m/s^2$.
$F = ma = 1000 \times 8.0 = 8000\,N$. **[6 AO2]**
**(c)** Amplitude = 0.05 m, $\omega = 15\,rad/s$. Max acceleration = $\omega^2 A = 225 \times 0.05 = 11.25\,m/s^2$. Graph sinusoidal. **[4 AO2]**
**(d)** Resonance when driving frequency = natural frequency. Beneficial: musical instruments. Harmful: bridge collapse. **[4 AO3]**

**Marking Scheme (Q2)**

**(a)** Electric field strength = force per unit charge (N/C). Coulomb's law: $F = k\frac{q_1 q_2}{r^2}$. **[6 AO1]**
**(b)** Force = $2.25\,N$. Field at midpoint ≈ $1.1 \times 10^5\,N/C$. Direction: towards negative charge. **[6 AO2]**
**(c)** Sketch: lines from + to −, denser near charges. **[4 AO2]**
**(d)** Uniform fields accelerate particles in straight lines (accelerators, CRTs). **[4 AO3]**

**Marking Scheme (Q3)**

**(a)** Photon = quantum of EM radiation. Quantization: discrete energy levels. Planck's relation $E = hf$. **[6 AO1]**
**(b)** Photon energy = 4.96 eV. Work function = 3.5 eV → emission occurs. Max KE = 1.46 eV. **[6 AO2]**
**(c)** Graph linear, slope = $h/e$, threshold frequency marked. **[4 AO2]**
**(d)** Line spectra show discrete transitions → evidence of quantized energy levels. **[4 AO3]**

**Marking Scheme (Q4)**

**(a)** Refraction = bending of light between media (e.g., straw in water). Diffraction = spreading of waves at slit/obstacle (e.g., sound around corners). **[6 AO1]**
**(b)** First minimum: $\theta = \lambda/a = 3.0 \times 10^{-3}\, rad$. Width = $2L\theta = 0.012\, m$. Narrower slit → wider pattern. **[6 AO2]**
**(c)** Fringe spacing = 2.5 mm. Sketch: alternating bright/dark fringes. **[4 AO2]**
**(d)** Photoelectric effect → particle nature. Electron diffraction → wave nature. Together = duality. **[4 AO3]**

**Marking Scheme (Q5)**

**(a)** Binding energy = energy to separate nucleons. Mass defect = difference between nucleon sum and actual mass. **[6 AO1]**
**(b)** Mass defect = 0.0305 u. Binding energy = 28.4 MeV. Per nucleon = 7.1 MeV. **[6 AO2]**
**(c)** Fission: U-235 splitting. Fusion: H isotopes → He. Graph: peak at Fe, fusion region (light nuclei), fission region (heavy nuclei). **[4 AO2]**
**(d)** Fusion advantages: abundant fuel, less waste. Challenges: high temp/pressure, containment. **[4 AO3]**

**Marking Scheme (Q6)**

**(a)** Gravitational field = region where mass experiences force (N/kg). Electric field = region where charge experiences force (N/C). **[6 AO1]**
**(b)** $g = 8.34 \times 10^{-11}\, N/kg$. Force = $1.67 \times 10^{-10}\, N$. Gravitational always attractive; electric can be repulsive. **[6 AO2]**
**(c)** $E = 1.08 \times 10^{5}\, N/C$. Sketch: radial lines outward from + charge. **[4 AO2]**
**(d)** Fields explain action at a distance. Examples: Earth's gravity on satellites, electric fields in CRTs. **[4 AO3]**

**Marking Scheme (Q7)**

**(a)** Gravitational force = $F = G\frac{m_1 m_2}{r^2}$. Electrostatic force = $F = k\frac{q_1 q_2}{r^2}$. **[6 AO1]**
**(b)** Electrostatic force ≈ $9.2 \times 10^{-8}\, N$. Gravitational force ≈ $3.6 \times 10^{-47}\, N$. Ratio ≈ $10^{39}$. **[6 AO2]**
**(c)** $g \approx 9.0\, N/kg$. Centripetal force = 4500 N. Diagram: Earth, satellite, inward force, tangential velocity. **[4 AO2]**
**(d)** Fields unify interactions: both gravitational and electric forces described as fields. Applications: satellite communication, particle accelerators. **[4 AO3]**