S6 Physics Practice Paper: Circular Motion and Gravitation, Simple Harmonic Motion, Double-Slit Interference, Photoelectric Effect and Atomic Model, Electric Field and Capacitance, Transformers and Power Transmission

S6 Physics | 100 marks | 75 minutes

Question 1 Circular Motion and Gravitation

Take $g = 9.8\ m/s^2$ and the radius of the Earth as 6.4×10^6 m. Show the formula used.

A ball of mass 0.20 kg moves in a horizontal circle of radius 0.50 m with a period of 0.40 s. Find its angular velocity and linear speed. *(4 marks)*

Find the centripetal acceleration of the ball and the tension in the string. *(4 marks)*

If the string suddenly breaks, in what direction does the ball move afterwards? Explain. *(3 marks)*

A satellite orbits in a circle at twice the Earth radius from the Earth centre. Find the gravitational field strength there, its speed and its period. *(5 marks)*

Question 2 Simple Harmonic Motion

A spring-mass oscillator has mass 0.50 kg, spring constant 50 N/m and amplitude 0.10 m.

Find the angular frequency, period and frequency of the oscillation. *(4 marks)*

Find the maximum speed and the maximum acceleration. *(4 marks)*

At a displacement of 0.06 m, find the magnitude of the velocity and of the acceleration. *(4 marks)*

Find the total mechanical energy, and the potential and kinetic energy at a displacement of 0.06 m. *(4 marks)*

Question 3 Double-Slit Interference

Slit separation 0.50 mm, screen distance 2.0 m, monochromatic light of wavelength 600 nm.

Find the spacing between adjacent bright fringes on the screen. *(4 marks)*

Find the distance between the third-order bright fringe and the central bright fringe. *(4 marks)*

What is the path difference at the third-order bright fringe? How would the fringe spacing change if light of longer wavelength were used? *(4 marks)*

If light of wavelength 500 nm is used instead, find the new fringe spacing and the percentage change in spacing. *(4 marks)*

Question 4 Photoelectric Effect and Atomic Model

Take $hc = 1240\ eV\cdot nm$, the work function of the metal as 2.30 eV and the incident wavelength as 400 nm.

Find the energy of an incident photon. *(5 marks)*

Find the maximum kinetic energy of the photoelectrons and the stopping potential. *(5 marks)*

Find the threshold wavelength of the metal and the maximum speed of the photoelectrons. *(4 marks)*

For hydrogen, find the photon energy and wavelength for the n = 3 to n = 2 and the n = 4 to n = 2 transitions ($E_n = -13.6/n^2$ eV). *(4 marks)*

Question 5 Uniform Electric Field and Capacitance

Two parallel metal plates are 0.050 m apart with a potential difference of 250 V.

Find the electric field strength between the plates. Find the magnitude of the force on a charge of −4.0 μC placed between them. *(5 marks)*

The charge moves 0.020 m along the field from the positive to the negative plate. Find the work done by the field and the potential difference between the two points. *(5 marks)*

A 20 μF capacitor is connected to a 250 V supply. Find the charge and the energy stored. *(4 marks)*

What is the potential at a distance of 0.30 m from a point charge of +2.0 μC? (Take $k = 9.0 \times 10^9$ N m² C^{-2}) *(4 marks)*

Question 6 Transformers and Power Transmission

Assume ideal transformers throughout.

A transformer has 1 000 turns in the primary and 50 turns in the secondary, with 220 V across the primary. Find the secondary voltage. *(4 marks)*

If the secondary delivers 44 W, find the secondary current and the primary current. *(4 marks)*

A power station delivers 100 kW at 10 kV. The total resistance of the transmission cables is 5.0 Ω. Find the current, the power loss and the percentage loss. *(5 marks)*

If the same power were delivered at 1 kV, find the percentage loss and explain why high-voltage transmission is used. *(3 marks)*