S6 Physics Practice Paper (Set 1): Circular Motion and Centripetal Force, Gravitation and Satellite Orbits, Momentum and Collisions, Electric Field and Potential, Capacitor Charging and Discharging, Radioactive Decay and Half-life

S6 Physics | Time: 75 minutes | Total: 100 marks | 24 questions

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Section A: Circular Motion and Centripetal Force (16 marks)

Show all working with units; give answers to 3 significant figures.

1. A car travels at a constant 20 m/s on a circular track of radius 50 m. Find its centripetal acceleration.

2. The car has mass 1200 kg. Find the net centripetal force acting on it.

3. A ball on a string of length 0.80 m moves in a vertical circle with speed 3.0 m/s at the top. Find the centripetal acceleration at the top.

4. For the car above, find the time to complete one lap.

Section B: Gravitation and Satellite Orbits (16 marks)

Take G = 6.67 x 10^-11 N m^2 kg^-2, Earth mass 5.97 x 10^24 kg, radius 6.37 x 10^6 m.

5. Find the gravitational field strength g at the Earth surface.

6. A satellite orbits at an altitude of 400 km. Find its orbital radius and speed.

7. Find the orbital period of this satellite in minutes.

8. A geostationary satellite has period 86164 s. Find its orbital radius and altitude.

Section C: Momentum and Collisions (18 marks)

All collisions occur on a smooth horizontal track; take rightward as positive.

9. A 2 kg object moving at 3 m/s hits a stationary 1 kg object and they stick together. Find their common velocity.

10. For the collision above, find the kinetic energy before and after, and the percentage of kinetic energy lost.

11. Two balls of mass 2 kg each collide elastically; A moves at 4 m/s and strikes stationary B. Find their velocities after collision.

12. A 0.15 kg ball hits a wall at 8 m/s and rebounds at 6 m/s; contact time is 0.02 s. Find the impulse and average force.

Section D: Electric Field and Potential (18 marks)

Take k = 8.99 x 10^9 N m^2 C^-2 and elementary charge 1.6 x 10^-19 C.

13. A point charge Q = 2.0 x 10^-6 C. Find the electric field strength at 0.30 m from it.

14. Find the electric potential at the same point (0.30 m from Q).

15. A charge of 3.0 x 10^-6 C is moved through a potential rise of 200 V. Find the work done by the electric field on this positive charge.

16. Two parallel plates 2.0 cm apart have a potential difference of 500 V. Find the uniform field between them and the force on an electron.

Section E: Capacitor Charging and Discharging (16 marks)

A 470 uF capacitor is charged through a 10 k ohm resistor from a 12 V supply.

17. Find the charge stored when fully charged.

18. Find the energy stored when fully charged.

19. Find the time constant of the charging circuit.

20. Find the voltage across the capacitor after charging for 2 tau.

Section F: Radioactive Decay and Half-life (16 marks)

Assume constant half-lives; give answers to 3 significant figures.

21. A nuclide has half-life 8.0 days. Find the fraction of nuclei remaining after 24 days.

22. A sample contains 80 g of a radioisotope with half-life 5.0 days. Find the mass remaining after 20 days.

23. Carbon-14 has a half-life of 5730 years. Find its decay constant in s^-1.

24. A sample has an initial count rate of 640 Bq. Find the count rate after 3 half-lives.

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