S4 Physics Practice Paper: Newton's Laws and Friction, Momentum and Collisions, Work and Power, Circular Motion and Satellite Periods, Gas Laws, Lenses and Total Internal Reflection

S4 | Physics | Time: 75 minutes | Total: 100 marks | 24 questions

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Forces and Motion

Part A: Newton's laws and friction (16 marks)

1. A 2.0 kg trolley on a frictionless track is acted on by a horizontal net force of 6.0 N. Find its acceleration. [4]

2. A 5.0 kg box rests on a horizontal floor. The coefficient of kinetic friction is 0.30 and a horizontal push of 20 N is applied (g = 9.8 m/s^2). Find the friction, the net force and the acceleration. [4]

3. A 10 kg mass hangs from a rope inside a lift that accelerates upwards at 2.0 m/s^2. Find the tension in the rope. [4]

4. A 0.15 kg ball hits a wall at 8.0 m/s and rebounds at 6.0 m/s. The contact time is 0.050 s. Find the magnitude of the change in momentum and the average force from the wall. [4]

Momentum and Collisions

Part B: Momentum and collisions (16 marks)

5. A 2.0 kg object moving at 3.0 m/s collides with a stationary 1.0 kg object and they stick together. Find the common velocity. [4]

6. Two 2.0 kg objects make an elastic collision: the first moves at 3.0 m/s and hits the second, which is at rest. Find their velocities after the collision. [4]

7. Using the situation in question 5 (2.0 kg at 3.0 m/s sticks to a stationary 1.0 kg), find the kinetic energy lost and its percentage of the initial kinetic energy. [4]

8. A 3.5 kg rifle fires a 0.020 kg bullet horizontally at 400 m/s. Find the recoil speed of the rifle and the ratio of the bullet kinetic energy to the rifle kinetic energy. [4]

Work, Power and Energy

Part C: Work, power and energy (17 marks)

9. A 45 kg person runs up stairs to a height of 12 m in 8.0 s (g = 9.8 m/s^2). Find the average power used against gravity. [4]

10. A 1200 kg car accelerates from rest to 25 m/s. Find the kinetic energy gained. [4]

11. A motor takes in 4800 J of energy and raises a load whose gravitational potential energy increases by 1680 J. Find the efficiency of the motor. [4]

12. A 6.0 kg object is pushed 3.0 m up a ramp to rise 1.2 m. The efficiency of the ramp is 60%. Find the push needed and the energy lost to friction. [5]

Circular Motion and Satellites

Part D: Circular motion and satellite periods (17 marks)

13. A 0.50 kg object moves at 2.0 m/s in a circle of radius 0.80 m. Find the centripetal force and the period. [4]

14. A 900 kg car goes round a flat bend of radius 60 m; the maximum friction between tyres and road is 5400 N. Find the maximum safe speed. [4]

15. Two satellites have orbital radii in the ratio 1 : 4; the nearer one has a period of 3.0 hours. Find the period of the other (use T proportional to r^1.5). [4]

16. A geostationary satellite has an orbital radius of 4.2 x 10^7 m and a period of 24 hours. Find its orbital speed. [5]

Gas Laws

Part E: Gas laws (17 marks)

17. A fixed mass of gas has a volume of 2.0 L at 300 K. It is heated to 450 K at constant pressure. Find the new volume. [4]

18. A fixed mass of gas at 2.0 L has a pressure of 1.0 x 10^5 Pa. It is compressed to 0.50 L at constant temperature. Find the new pressure. [4]

19. Find the number of moles in 2.0 L of gas at 300 K and 1.0 x 10^5 Pa (R = 8.31 J mol^-1 K^-1). [4]

20. A 3.0 L container holds 0.10 mol of gas at 300 K. Find the pressure of the gas. [5]

Lenses and Refraction

Part F: Lenses and total internal reflection (17 marks)

21. A convex lens of focal length 10 cm has an object 30 cm in front of it. Find the image distance and magnification, and state the nature of the image. [4]

22. For the same convex lens (f = 10 cm) the object is 15 cm in front of the lens. Find the image distance and magnification. [4]

23. For the same convex lens (f = 10 cm) the object is 5.0 cm in front of the lens. Find the image distance, magnification and nature of the image. [4]

24. Light travels from glass (refractive index 1.50) into air. Find the critical angle and decide whether total internal reflection occurs at an angle of incidence of 45 degrees. [5]
