S4 Physics Practice Paper: Force and Motion, Work Energy and Power, Momentum and Collisions, Waves and Sound, Light and Refraction, Electricity and Circuits (100 marks)

S4 | Physics | Time: 60 minutes | Total: 100 marks | 24 questions

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Part A: Force and Motion (16 marks)

Write the formula, substitute the values and give the unit.

1. A car starts from rest and accelerates uniformly at 2 m/s2. What is its velocity after 5 seconds? [4]

Answer: Answer: use v = u + at with u = 0, a = 2 m/s2 and t = 5 s, so v = 0 + 2 x 5 = 10 m/s.

2. In the same motion, what distance does the car travel in 5 seconds? [4]

Answer: Answer: s = ut + 1/2 a t^2 = 0 + 1/2 x 2 x 5^2 = 25 m.

3. A body of mass 4 kg experiences a net force of 12 N. What is its acceleration? [4]

Answer: Answer: from F = ma, a = F / m = 12 / 4 = 3 m/s2, in the direction of the net force.

4. A stone falls freely from a height of 45 m (take g = 10 m/s2, ignore air resistance). Find the time of fall and the velocity on landing. [4]

Answer: Answer: s = 1/2 g t^2, so t = sqrt(2h / g) = sqrt(2 x 45 / 10) = 3 s; v = g t = 10 x 3 = 30 m/s.

Part B: Work, Energy and Power (16 marks)

Power is measured in watts (W).

5. A force of 20 N pushes a body through 5 m along the direction of the force. How much work is done? [4]

Answer: Answer: W = F s = 20 x 5 = 100 J.

6. A body of mass 2 kg moves at 6 m/s. What is its kinetic energy? [4]

Answer: Answer: KE = 1/2 m v^2 = 1/2 x 2 x 6^2 = 36 J.

7. A body of mass 5 kg is lifted steadily through 3 m (take g = 10 m/s2). By how much does its gravitational potential energy increase? [4]

Answer: Answer: PE = m g h = 5 x 10 x 3 = 150 J.

8. A machine does 600 J of work in 20 seconds. What is its average power? [4]

Answer: Answer: P = W / t = 600 / 20 = 30 W.

Part C: Momentum and Collisions (17 marks)

Take the rightward direction as positive.

9. A ball of mass 0.5 kg moves to the right at 8 m/s. What is its momentum? [4]

Answer: Answer: p = m v = 0.5 x 8 = 4 kg m/s, directed to the right.

10. A body of mass 2 kg moving at 3 m/s collides with a stationary body of mass 1 kg. They stick together after the collision. Find their common velocity. [4]

Answer: Answer: momentum is conserved, 2 x 3 = (2 + 1) x v, so v = 6 / 3 = 2 m/s.

11. A force of 200 N acts on a ball of mass 0.2 kg for 0.05 s. Find the impulse and the change in velocity of the ball. [4]

Answer: Answer: impulse = F t = 200 x 0.05 = 10 N s; from F t = m (change in v), the change in velocity is 10 / 0.2 = 50 m/s.

12. Two bodies of 0.5 kg each move towards each other along the same horizontal line at 4 m/s (right) and 2 m/s (left). They stick together after the collision. Find the total momentum, the common velocity, and the kinetic energy lost. [5]

Answer: Answer: total momentum p = 0.5 x 4 - 0.5 x 2 = 1 kg m/s (to the right); common velocity v = 1 / 1 = 1 m/s. Kinetic energy before = 1/2 x 0.5 x 4^2 + 1/2 x 0.5 x 2^2 = 5 J; kinetic energy after = 1/2 x 1 x 1^2 = 0.5 J; energy lost = 4.5 J (inelastic collision, the energy becomes heat and sound).

Part D: Waves and Sound (17 marks)

Take the speed of sound in air as 340 m/s.

13. A wave has frequency 50 Hz and wavelength 4 m. What is its speed? [4]

Answer: Answer: v = f x wavelength = 50 x 4 = 200 m/s.

14. A wave has a frequency of 250 Hz. What is its period in seconds? [4]

Answer: Answer: T = 1 / f = 1 / 250 = 0.004 s, which is 4 ms.

15. A person shouts towards a wall and hears the echo 0.6 s later. How far is he from the wall? [4]

Answer: Answer: the sound travels there and back, so 2d = v t = 340 x 0.6 = 204 m and d = 102 m.

16. 20 crests pass a point in 0.5 s. Find the frequency and the period; if the wave speed is 340 m/s, find the wavelength. [5]

Answer: Answer: frequency f = 20 / 0.5 = 40 Hz; period T = 1 / f = 0.025 s; wavelength = 340 / 40 = 8.5 m.

Part E: Light and Refraction (17 marks)

Take the refractive index of water as 1.33 and of glass as 1.5.

17. A ray of light enters water from air at an angle of incidence of 30 degrees. Find the angle of refraction (sin 30 degrees = 0.5). [4]

Answer: Answer: n = sin i / sin r, so sin r = 0.5 / 1.33 = 0.376 and r is about 22 degrees. The refracted ray bends towards the normal because water is optically denser than air.

18. Light travels from glass to air. Find the critical angle (give the answer to one decimal place). [4]

Answer: Answer: sin c = 1 / n = 1 / 1.5 = 0.667, so c is about 41.8 degrees. Total internal reflection happens when the angle of incidence is greater than the critical angle.

19. The speed of light in a vacuum is 3.0 x 10^8 m/s. Find the speed of light in glass of refractive index 1.5. [4]

Answer: Answer: v = c / n = 3.0 x 10^8 / 1.5 = 2.0 x 10^8 m/s.

20. A pool is 2 m deep. How deep does the bottom appear when viewed from directly above the surface? Also, an object is placed 3 m in front of a plane mirror; what is the distance between the object and its image? [5]

Answer: Answer: apparent depth = real depth / n = 2 / 1.33, about 1.5 m, so the pool looks shallower than it is. The image in a plane mirror is 3 m behind the mirror, so the object and its image are 3 + 3 = 6 m apart.

Part F: Electricity and Circuits (17 marks)

Resistance is measured in ohms and voltage in volts.

21. A current of 0.5 A flows through a resistor of 6 ohms. What is the voltage across it? [4]

Answer: Answer: V = I R = 0.5 x 6 = 3 V.

22. Resistors of 4 ohms and 6 ohms are connected in series to a 12 V supply. Find the current and the voltage across the 6 ohm resistor. [4]

Answer: Answer: total resistance R = 4 + 6 = 10 ohms; I = V / R = 12 / 10 = 1.2 A; V = I R = 1.2 x 6 = 7.2 V.

23. A 6 ohm resistor and a 3 ohm resistor are connected in parallel. What is the equivalent resistance? [4]

Answer: Answer: 1 / R = 1 / 6 + 1 / 3, so R = (6 x 3) / (6 + 3) = 2 ohms.

24. A current of 0.5 A flows through a resistor of 24 ohms. Find its power and the energy it uses in 10 minutes. [5]

Answer: Answer: P = I^2 R = 0.5^2 x 24 = 6 W; t = 10 minutes = 600 s; E = P t = 6 x 600 = 3600 J.
