S5 Combined Science Practice Paper 2 | Kinematics, momentum, circuits, waves, mole calculations, neutralisation and rates

Senior Secondary Combined Science

S5 Combined Science practice paper with answers: kinematics, momentum, resistors, wave speed and refraction, mole calculations, neutralisation and reaction rates.

1. Uniform acceleration and average speed (16 marks)

Show working throughout; take g = 10 m/s^2.

#	Question	Answer and marking notes
1	(a) A car accelerates uniformly from rest at 2 m/s^2 for 6 s. Find its final speed.	v = u + a t = 0 + 2 x 6 = 12 m/s.
2	(b) Find the distance travelled during the acceleration.	s = 1/2 a t^2 = 0.5 x 2 x 36 = 36 m.
3	(c) It then runs at 12 m/s for 10 s, then decelerates uniformly at 3 m/s^2 to rest. Find the steady-speed distance, braking time and braking distance.	Steady 120 m; braking t = 4 s; braking distance s = v^2/(2 a) = 144/6 = 24 m.
4	(d) Find the average speed for the whole journey.	Total distance 180 m, total time 20 s; average speed = 9 m/s.

2. Force, impulse and conservation of momentum (18 marks)

Show working throughout; state the direction in (c).

#	Question	Answer and marking notes
5	(a) A resultant force of 20 N acts on a body of mass 5 kg. Find the acceleration.	a = F/m = 20/5 = 4 m/s^2.
6	(b) A lift of mass 800 kg accelerates upwards at 2 m/s^2. Find the tension in the cable.	T = m (g + a) = 800 x 12 = 9600 N.
7	(c) A 0.5 kg ball hits a wall at 8 m/s and rebounds at 6 m/s; the contact time is 0.02 s. Find the change in momentum and the average force.	dp = 0.5 x (8 + 6) = 7 kg m/s (away from the wall); F = dp/t = 7/0.02 = 350 N.
8	(d) A 2 kg trolley moving at 3 m/s collides with a stationary 1 kg trolley and they stick together. Find the common speed.	2 x 3 = (2 + 1) x v, so v = 2 m/s.

3. Resistors in series and parallel, and power (18 marks)

Show working throughout; the supply is 9 V d.c.

#	Question	Answer and marking notes
9	(a) Resistors of 6 ohm and 3 ohm are in series across a 9 V supply. Find the total resistance and the current.	R = 6 + 3 = 9 ohm; I = 9/9 = 1.0 A.

#	Question	Answer and marking notes
10	(b) Find the voltage across each resistor and the total power.	V(6 ohm) = 6 V, V(3 ohm) = 3 V; P = V I = 9 x 1 = 9 W.
11	(c) The same resistors are reconnected in parallel across the 9 V supply. Find the total resistance and total current.	R = (6 x 3)/(6 + 3) = 2 ohm; I = 9/2 = 4.5 A.
12	(d) Find the total power in parallel and the percentage increase over the series case.	P = 9 x 4.5 = 40.5 W; increase = (40.5 - 9)/9 x 100% = 350%.

4. Wave speed, frequency and refraction (16 marks)

Show working throughout; give angles to 1 decimal place.

#	Question	Answer and marking notes
13	(a) Sound travels in air at 340 m/s with frequency 680 Hz. Find the wavelength.	wavelength = v/f = 340/680 = 0.5 m.
14	(b) Find the period in milliseconds (1 decimal place).	T = 1/680 = 0.00147 s, about 1.5 ms.
15	(c) Light passes from air into glass of refractive index 1.5 at an angle of incidence of 30 degrees. Find the angle of refraction.	sin r = sin 30/1.5 = 0.3333, r = 19.5 degrees.
16	(d) Water waves pass from deep water (0.5 m/s) into shallow water (0.3 m/s) at an angle of incidence of 40 degrees. Find the angle of refraction.	sin r = (0.3/0.5) x sin 40 = 0.3857, r = 22.7 degrees.

5. Moles and stoichiometry (16 marks)

Take Mg = 24, H = 1; molar volume at room conditions = 24 dm^3/mol.

#	Question	Answer and marking notes
17	(a) Find the number of moles in 24 g of magnesium.	n = 24/24 = 1 mol.
18	(b) Magnesium reacts with excess dilute hydrochloric acid: Mg + 2HCl -> MgCl2 + H2. Find the volume of hydrogen at room conditions.	n(H2) = 1 mol; V = 1 x 24 = 24 dm^3.
19	(c) Find the mass of this hydrogen and the number of molecules (Avogadro constant 6.02 x 10^23).	m = 1 x 2 = 2 g; number of molecules = 6.02 x 10^23.
20	(d) If the acid is 2 mol/dm^3, find the volume of acid needed for complete reaction in cm^3.	n(HCl) = 2 mol; V = 2/2 = 1 dm^3 = 1000 cm^3.

6. Neutralisation and rate of reaction (16 marks)

Show working throughout; the reaction is 1:1 in moles.

#	Question	Answer and marking notes
21	(a) Find the number of moles in 25 cm^3 of 0.2 M sodium hydroxide.	n = 0.025 x 0.2 = 0.005 mol.

#	Question	Answer and marking notes
22	(b) What volume of 0.1 M hydrochloric acid neutralises it, in cm^3?	V = 0.005/0.1 = 0.05 dm^3 = 50 cm^3.
23	(c) An experiment collects 48 cm^3 of gas in 40 s. Find the average rate of gas production.	rate = 48/40 = 1.2 cm^3/s.
24	(d) If the temperature rises from 20 C to 50 C and the rate doubles for every 10 C rise, find the new average rate and explain why.	The rise of 30 C is three 10 C steps, so the rate is x 2^3 = 8; new rate = 1.2 x 8 = 9.6 cm^3/s. Reason: particles have greater average kinetic energy, so collisions are more frequent and more of them exceed the activation energy.