S5 Combined Science Practice Paper (Set 2): Newtonian Motion, Work and Power; Series Circuits and Electrical Power; Mole Calculations and Molar Volume; Acid-base Titration and pH; Monohybrid Crosses and Genetic Ratios; Energy Flow and Mark-recapture Estimation

Senior Secondary Combined Science

S5 Combined Science Set 2: 24 parts, 100 marks, 60 min on force, power, series circuits, moles, titration, pH, genetics and energy flow, with full answers.

Question 1: Newtonian Motion, Work and Power

A car of mass 800 kg accelerates from rest to 20 m/s in 8 s. Ignore resistance.

#	Question
1	Calculate the average acceleration of the car (2 decimal places, with unit).
2	Using F = ma, calculate the net force on the car (1 decimal place).
3	Calculate the distance travelled in 8 s (use s = ut + 1/2 a t^2).
4	Calculate the work done by the net force and the average power in kW.

Question 2: Series Circuits and Electrical Power

A 12 V battery (negligible internal resistance) is connected to R1 = 4 ohm and R2 = 6 ohm in series.

#	Question
5	Calculate the total series resistance and the current through each resistor (2 decimal places).
6	Calculate the voltage across R1 and hence across R2 (2 decimal places).
7	Calculate the total power delivered by the battery and the power dissipated in R2 (2 decimal places).
8	If R2 burns out (open circuit), state how the current in R1 and the total power change, and explain why.

Question 3: Mole Calculations and Molar Volume

10.0 g of calcium carbonate (CaCO3, molar mass 100 g/mol) reacts with excess dilute hydrochloric acid: CaCO3 + 2HCl -> CaCl2 + CO2 + H2O. Take the molar volume as 24.0 dm^3/mol at room conditions.

#	Question
9	Calculate the number of moles in 10.0 g of calcium carbonate.
10	From the mole ratio in the equation, find the moles of carbon dioxide produced.
11	Calculate the mass of carbon dioxide produced (2 decimal places).
12	Calculate the volume of that carbon dioxide at room temperature and standard pressure in dm^3 (3 decimal places).

Question 4: Acid-base Titration and pH

25.0 cm^3 of dilute hydrochloric acid is titrated with 0.100 mol/dm^3 sodium hydroxide; 20.0 cm^3 of the alkali is used to reach the end point. NaOH + HCl -> NaCl + H2O.

#	Question
13	Calculate the moles of sodium hydroxide used (3 significant figures).
14	State the moles of hydrochloric acid and the mole ratio used.
15	Calculate the concentration of the acid in mol/dm^3 (3 decimal places).
16	What is the pH of separate 0.010 mol/dm^3 hydrochloric acid? What is the pH after a 10-fold dilution, and why?

Question 5: Monohybrid Crosses and Genetic Ratios

In peas the tall allele T is dominant to the dwarf allele t. Two heterozygous tall plants (Tt) are crossed, producing 240 offspring.

#	Question
17	State the gametes of the parents and the genotype ratio of the offspring.
18	Calculate the expected numbers of tall and dwarf offspring out of 240.
19	If two plants are picked at random, what is the probability that both are dwarf (decimal and percentage)?
20	To determine the genotype of a tall pea plant, what cross should be done? Give the expected ratios for both possible genotypes and explain.

Question 6: Energy Flow and Mark-recapture

Producers in a grassland fix 50 000 kJ of energy; the transfer efficiency is about 10%. In a pond study 40 snails are marked and released; a week later 50 are caught and 8 are marked.

#	Question
21	Calculate the energy available to the primary, secondary and tertiary consumers (in kJ).
22	What percentage of energy at each trophic level is not passed on, and where does it go?
23	Estimate the total number of snails using the Lincoln index (N = M x n / m), and give two reasons the estimate may be too low.
24	Give two assumptions of this method, and state whether the estimate would be too high or too low if marking made snails more likely to be eaten.