AP Environmental Science

Practical Skills ·

APES has no laboratory exam, but every paper contains data analysis and one design question, and both are marked to a formula: identify the variables, do the arithmetic with units shown, and connect the number to an environmental consequence.

Designing an investigation

Name the independent variable, the dependent variable and one controlled variable. All three are separately creditable.

Describe the control group as identical except for the independent variable – the phrase "all other conditions kept the same" is worth writing every time.

Say how you would measure the dependent variable, with a unit and a frequency.

State a testable hypothesis in "if … then …" form; a prediction with no mechanism does not earn the reasoning point.

Field studies cannot hold every variable constant, so they replace control with sampling: several random sites, the same method at each, and repeated visits. Say this when a question asks how the design could be made valid.

Calculations

SHOW THE SET-UP. A correct answer with no working can lose the working marks; an incorrect answer with correct set-up keeps most of them.

Carry units through the calculation and cancel them – dimensional analysis is the standard method and is credited.

Percentage change is (new − old) ÷ old × 100, and the sign matters; a decrease is negative.

For doubling time use the rule of 70: 70 divided by the percentage growth rate per year.

Half-life problems halve the quantity once per half-life; count the halvings rather than dividing by the total time.

Energy problems: watch the difference between power (kW) and energy (kWh), and convert time to hours before multiplying.

No calculator is assumed to be needed: write large numbers in scientific notation, multiply the front numbers and add the powers of ten.

Worked calculation: dimensional analysis

A town of 20 000 homes each uses 900 kWh of electricity a month, all from a coal-fired plant that emits 1.0 kg of CO_2 per kWh generated. How many metric tons of CO_2 does the town's electricity release in a year?

1. Energy per year $= 2 \times 10^4$ homes $\times$ 900 kWh/(home $\cdot$ month) $\times$ 12 months/year $= 2.16 \times 10^8$ kWh/year.

2. $CO_2 = 2.16 \times 10^8$ kWh/year $\times$ 1.0 kg CO_2/kWh $= 2.16 \times 10^8$ kg CO_2/year.

3. In metric tons (1 t = 1000 kg): $2.16 \times 10^8 \div 10^3 = 2.2 \times 10^5$ t CO_2 per year.

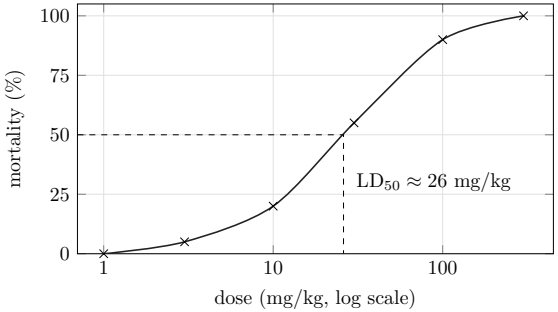
Write each conversion as a fraction whose units cancel (months/year, kg/kWh, t/kg); a step whose units do not cancel is the wrong way up.

Rule of 70 in the same style: a population growing at 2% per year doubles in $70 \div 2 = 35$ years. Percentage change: CO_2 rising from 320 to 415 ppm is $(415 - 320) \div 320 \times 100 = +30\%$.

Worked analysis: a dose–response curve

Groups of 20 rats were given one dose each of a pesticide; the percentage that died within 48 hours was recorded. The dose axis is logarithmic: each gridline is ten times the one before.

dose (mg/kg)	1	3	10	30	100	300
mortality (%)	0	5	20	55	90	100



Read across from 50% to the curve and down to the dose axis.

LD_{50} is the dose that kills 50% of the test population: about 26 mg/kg here. A LOWER LD_{50} means a MORE toxic substance, because less of it kills half.

The threshold is the highest dose with no observed effect – 1 mg/kg in this data. Regulators set human exposure limits far below it (often 100 to 1000 times lower) because people vary more than a laboratory strain, and rats are not humans.

Evaluate: 20 animals per dose is a small sample; one strain of one species; acute (48-hour) deaths say nothing about chronic effects such as cancer or endocrine disruption from long, low exposure.

Worked analysis: productivity from light and dark bottles

Three bottles were filled from the same pond. The dissolved oxygen (DO) in one was measured at once; one clear bottle and one bottle wrapped in foil were sealed and left in the pond for 24 hours.

bottle	DO (mg O_2/L)
initial	8.0
light, after 24 h	9.6
dark, after 24 h	6.8

1. Respiration (dark bottle: no photosynthesis) $= 8.0 - 6.8 = 1.2$ mg O_2/L/day.

2. Net primary productivity (light bottle) $= 9.6 - 8.0 = 1.6$ mg O_2/L/day.

3. Gross primary productivity = NPP + respiration $= 1.6 + 1.2 = 2.8$ mg O_2/L/day.

Controlled: the same pond water, the same depth and the same 24 hours for both bottles. Replicate bottles

at each depth would show how much the readings vary.

Worked calculation: mark–recapture :

40 snails were caught, marked with a dot of paint and released. A week later 50 were caught, of which 8 were marked.

1. Population estimate N = (first catch × second catch) ÷ marked in second catch.

2. N = (40 × 50) ÷ 8 = 250 snails.

The estimate assumes no births, deaths or migration between samples, that marks do not wear off or make an animal easier to see or catch, and that marked animals mix evenly with the rest. Name the assumption the question's scenario breaks.

Field and lab methods that FRQs assume

Dissolved oxygen – a probe or a titration kit, in mg/L. Most fish need more than about 5 mg/L. Warmer water holds less oxygen, and decomposers breaking down organic waste use it up (a high biological oxygen demand, BOD)

Nitrates and phosphates – color-comparison test kits. High levels from fertilizer runoff or sewage cause eutrophication: an algal bloom, then decomposition of the dead algae, then low DO and fish kills

Indicator species – kick-sample macroinvertebrates from a stream bed. Stonefly and mayfly larvae need clean, oxygen-rich water; leeches and midge larvae tolerate pollution. Many intolerant taxa means good water quality

Coliform bacteria – fecal coliforms grown on a membrane filter show contamination by human or animal waste, and so the possible presence of pathogens

Turbidity – a Secchi disk lowered until it disappears; the shallower that depth, the more suspended sediment or algae. Turbid water blocks light from submerged plants

Soil texture – shake soil with water in a jar and let it settle: sand settles first, then silt, with clay last. The percentages place the soil on the texture triangle. Sandy soil drains fastest and holds least water; clay the opposite

Quadrats and transects – random quadrats estimate the density or percentage cover of plants in an area; a transect records how species change along a gradient, such as away from a road or a shoreline

Biodiversity – species richness is the number of species; evenness is how equally individuals are spread among them. Two sites with the same richness can differ in diversity because one is dominated by a single species

Interpreting data

Describe a trend with direction AND magnitude, quoting the numbers: "rose from 320 to 415 ppm between 1960 and 2020".

Distinguish correlation from causation. A question asking whether the data PROVE a cause wants you to say they do not, and to name a confounding variable.

Identify the axis units before reading a graph – logarithmic scales and per-capita axes are routinely misread.

When a solution is asked for, give one that is specific and feasible, then state its drawback. Both halves are usually creditable.

What the scoring guidelines keep penalizing

A vague control: "keep everything the same" without saying what. Name a variable: the same volume of water, the same soil, the same light.

A pollutant named with no consequence. "Nitrates enter the lake" scores less than the chain to the end: algal bloom, decomposition, low DO, fish die.

An answer with a number but no unit, or a unit dropped halfway through the working.

A solution so broad it cannot be judged ("reduce pollution"). Name the action and who does it: "install buffer strips of vegetation along the stream".