Paper 6 asks you to describe an experiment you are not doing, read instruments from pictures, and process someone else's results. The marks are for the routine – the instrument, the repeat, the table, the graph – and the routine is short enough to learn. 实验替代卷考的是规范：仪器、重复测量、表格、图像。

Reading instruments 仪器读数

Always read with your eye level with the scale. Looking from an angle gives a parallax error, and saying so is worth a mark when the question asks how to read accurately.

Ruler 直尺 – read to the nearest millimetre. Start from the 0 mark, or subtract the reading you started at

Measuring cylinder 量筒 – read the BOTTOM of the meniscus, at eye level, on a flat surface

Thermometer 温度计 – read to the nearest 1 °C (or 0.5 °C if the scale allows); leave the bulb in the liquid while you read

Stopwatch 秒表 – reads to 0.01 s, but your reaction time is about 0.2 s – so time ten swings and divide by ten

Ammeter and voltmeter 电流表与电压表 – ammeter in series, voltmeter in parallel; read to the smallest division on the scale shown

When a picture shows a scale, write down every digit the scale gives and no more. Adding a digit the instrument cannot resolve loses the mark.

Tables and graphs 表格与图像

Head every column with the quantity and its unit, written as a ratio: 'l / cm', 't / s'.

Give every reading in a raw column the same number of decimal places.

Choose a scale that lets the points fill more than half the grid, and use easy numbers – 1, 2 or 5 units per 2 cm squares. Never use 3 per square.

Label both axes with quantity and unit, plot small neat crosses, and draw ONE thin best-fit line. Do not join point to point.

If a point is clearly off the line, circle it and call it an anomaly. Ignore it when drawing the line, and say that you would repeat that reading.

To find a gradient, draw a large triangle on the line, write the coordinates of its corners, and divide the change in y by the change in x – with the unit.

To read a value from a graph, draw dotted lines from the axis to the line and leave them on the page. They show the examiner where your number came from.

Describing an experiment 描述实验

Name what you change (the independent variable), what you measure (the dependent variable) and at least two things you keep the same. The controls are the marks candidates most often forget.

Say which instrument you use for each measurement, and how precisely it reads.

Say that you repeat each reading and take an average – and that you look for anomalies.

Describe the steps in order, in short numbered sentences. An examiner should be able to follow them without knowing what you were thinking.

Say what you would do with the results: which quantity you would calculate, or what graph you would plot and what its shape would show.

For a safety question, name a hazard that exists in THIS experiment and a precaution that matches it. 'Be careful' and 'wear goggles' with no reason score nothing.

Common experiments and what the scheme wants 常见实验与评分要点

Pendulum period 单摆周期 – time 10 or 20 complete swings from the middle of the swing (not the end), divide by the number, repeat; keep the amplitude small

Density of a solid 固体密度 – mass on a balance, volume by displacement in a measuring cylinder (final − initial), then $\rho = m/V$ with the unit g/cm^3

Resistance of a wire 电阻 – measure V and I, $R = V/I$; keep the current low so the wire does not heat, and switch off between readings

Specific heat capacity 比热容 – measure mass, temperature rise and the energy supplied; insulate the block and use a lid, because heat loss is the main error

Refraction through a block 折射 – use optical pins at least 5 cm apart, mark the outline of the block before removing it, and draw the normal with a set square

Focal length of a lens 透镜焦距 – focus a distant object on a screen; the distance from lens to screen is the focal length, and repeating with different distant objects gives a mean

Improving an experiment 改进实验

An improvement must reduce an error you have identified. Match them: heat loss → insulate and use a lid; reaction time → time more swings; parallax → read at eye level with a mirror scale; small readings → use a larger sample and divide.

'Repeat and take an average' improves reliability, not accuracy, and only reduces random error. It cannot fix a zero error on a balance.

'Use a more accurate instrument' scores only when you name it: 'use a micrometer instead of a ruler because it reads to 0.01 mm'.

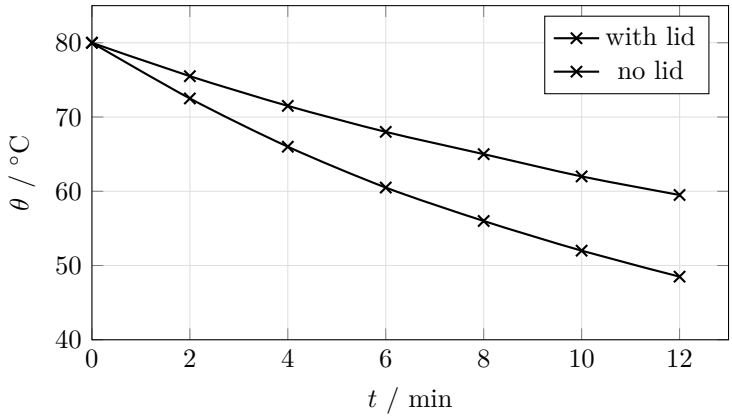
Never write 'be more careful', 'concentrate harder' or 'use a better ruler'. Examiner reports keep giving answers like these as worth nothing.

Worked example: does a lid slow the cooling? 实例: 盖子能减缓冷却吗

Two identical beakers each hold 100 cm^3 of water at 80.0 °C, one with a lid. The temperature of each is read every 2 minutes for 12 minutes, with a thermometer that reads to 0.5 °C.

t / min	0	2	4	6	8	10	12
no lid: θ / °C	80.0	72.5	66.0	60.5	56.0	52.0	48.5
lid: θ / °C	80.0	75.5	71.5	68.0	65.0	62.0	59.5

Every reading to the nearest 0.5 °C, so every reading has one decimal place.



Smooth curves of best fit, not dot-to-dot. Both curves are steepest at the start, when the water is hottest.

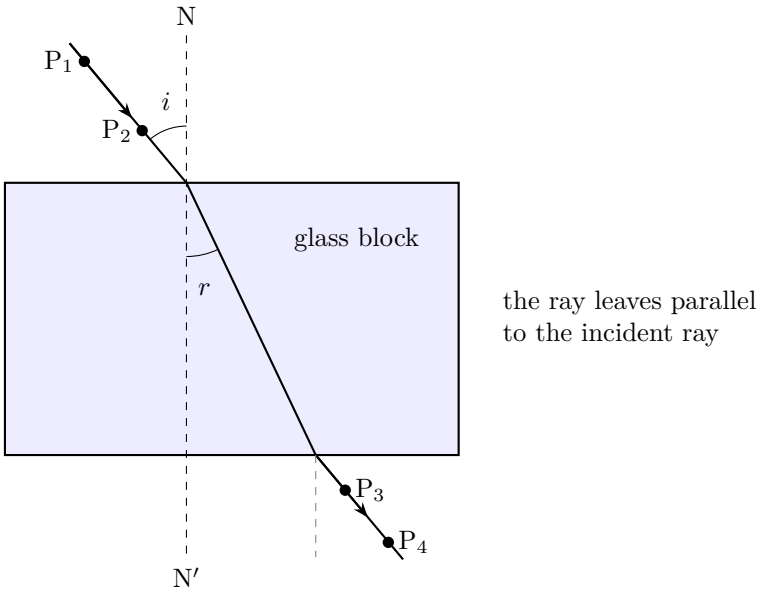
Conclusion with numbers: in 12 minutes the water without a lid fell by 31.5 °C, the water with a lid by only 20.5 °C, so the lid reduces the rate of cooling. A lid stops the warm water evaporating and stops convection currents carrying energy away from the surface.

Why both start at the same temperature: the rate of cooling depends on how much hotter the water is than the room, so a fair comparison needs the same starting temperature – as well as the same volume of water and the same beaker.

Improvement that scores: stir before each reading so the thermometer reads the average temperature, not a hot or cold layer. 'Use a more accurate thermometer' scores only with a named precision: 'a digital thermometer reading to 0.1 °C'.

Worked example: refraction through a glass block 实例: 玻璃砖的折射

The outline of a rectangular glass block was drawn on paper and a normal NN′ drawn at right angles to one side with a set square. Pins P_1 and P_2 were placed on a line at an angle of incidence i to the normal. Looking through the block, pins P_3 and P_4 were placed in line with the images of P_1 and P_2. The block was removed, P_3P_4 was joined to the block, and the refracted ray was drawn inside it.



Both angles are measured from the NORMAL, not from the surface of the block.

i / °	**20**	**30**	**40**	**50**	**60**
r / °	13	20	25	31	35
$\sin i / \sin r$	1.52	1.46	1.52	1.49	1.51

Refractive index n = sin i ÷ sin r. Mean of the five values = 1.50, given to 2 or 3 significant figures like the data. Plotting sin i against sin r gives a straight line through the origin of gradient n, which uses all the readings at once.

Sources of inaccuracy: pins not exactly vertical; the thickness of the pins and of pencil lines; the block moving on the paper. Improvements: pins at least 5 cm apart, so a small error in placing one changes the angle less; thin, sharp pencil lines; draw round the block again at the end to check it did not move.

Small angles of incidence give small angles of refraction, so a 1° error in measuring r is a large percentage error – 1° in 13° is almost 8%. Values from small angles are the least reliable; use angles of incidence from 30° to 70°.