Quantitative Skills and Mental Maths

Interview preparation summary · SC track

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INT.KQ.1.a · Fast arithmetic

Calculate percentages, percentage changes and fractions quickly in your head, keeping percentages and percentage points apart and using the right base.

A case interviewer watches how you handle numbers because a consultant who is slow or sloppy with them loses the client's trust in the room. Build any percentage from easy blocks: 10% is a decimal shift, 5% is half of that, 1% is a hundredth, so 17.5% is 10% plus 5% plus half of 5%. Learn the fractions that recur: 12.5% is one eighth, 16.7% one sixth, 33.3% one third, 37.5% three eighths. Percentage change is the change divided by the starting figure, not the finishing one, so 80 to 68 is a fall of 15%, and recovering needs a rise of 17.6% because the base is now smaller. A move in a share or a margin is in percentage points, and the relative change is a separate figure: 12% to 15% is 3 points and a 25% increase. Successive changes compound rather than add. The usual errors are the wrong base, mixing points with percent, and a slipped decimal. Say the method, then the answer with its units, then a quick check on size.

WORKED EXAMPLE: A RAPID-FIRE ROUND OF FOUR QUESTIONS

The interviewer asks four questions in a row with no calculator. First, what is 17.5% of 480? Second, a division's revenue falls from 80m to 68m: what is the percentage fall, and what rise is needed to get back to 80m? Third, market share moves from 12% to 15%: how do you describe that? Fourth, what is three eighths of 2.4bn? Say the method each time and sense-check each answer.

Answer: 17.5% of 480 is 84; revenue fell 15% and needs a rise of 17.6% to recover; share is up 3 percentage points, a 25% relative increase; three eighths of 2.4bn is 0.9bn.

> **Interview tip:** Say the method before the answer, for example ten percent is 48, half of that is 24, so far 72, and the last 12 makes 84. Always name the base of a percentage change and say points when a share or margin moves. If you slip, say so and restart the last step rather than going quiet.

INT.KQ.1.b · Fast arithmetic

Work out growth rates, compound growth and CAGR quickly, using the rule of 72 and simple compounding checks, and say how accurate each shortcut is.

Growth questions test whether you understand compounding, which most people underestimate. The compound annual growth rate (CAGR) is the single steady yearly rate that turns the start value into the end value, so it is the end divided by the start, raised to one over the number of years, less one. By hand, bracket it: if 1.10 to the power of 4 is 1.46 and 1.11 to the power of 4 is 1.52, a rise of 50% over four years is about 10.7% a year. The rule of 72 says money doubles in 72 divided by the yearly rate in years, and it is reliable roughly between 6% and 12%; use 70 at low rates. Dividing the total growth by the number of years overstates the rate, and two changes of plus 20% and minus 10% give plus 8%, not plus 10%. Two plans with similar rates and horizons can end up close together, so calculate when the choice matters. Always state the period, the rate and the end value.

WORKED EXAMPLE: IS A GROWTH TARGET REALISTIC?

A client has revenue of 100m and its board wants 150m in four years. What yearly growth rate is needed? How would you show a partner that a simple average of the growth would give the wrong rate? Then, as a second check, a 25m business grows at 8% a year: roughly what is it after 9 years? And what happens to revenue if it rises 20% in one year and falls 10% in the next?

Answer: About 10.7% a year is needed; the 12.5% simple average would overshoot; 25m at 8% is about 50m after 9 years; plus 20% then minus 10% is plus 8%.

> **Interview tip:** Give the answer as a range first, between 10% and 11%, and then refine it. Interviewers like a candidate who brackets a number and checks it rather than guessing. Say the period and the rate together: about 10.7% a year for four years.

INT.KQ.1.c · Fast arithmetic

Handle large numbers, units, ratios and rounding in a calculation, using multiplication and division shortcuts and stating how big the rounding error is.

Most mental maths errors in a case are errors of units, not of method: a million treated as a thousand, a monthly figure used as a yearly one, bn mixed with m. Write the units with every number, count zeros in groups of three (thousand, million, billion), and convert before you multiply: 3.6m customers x 48 a month is 172.8m a month, and times 12 is about 2.07bn a year. Use shortcuts that round to friendly numbers: 25 x 36 is 100 x 9; 48 x 52 is 50 x 50 less 4. When you round, round one number up and another down where you can, so the errors offset, and say which way the answer is biased. Rounding 3.6 to 4 and 48 to 50 overstates the total by more than 15%, which is too coarse to quote. A ratio such as 5:3:2 is shared by dividing by the sum, here 10. Finish by saying the answer in sensible units and checking its order of magnitude.

WORKED EXAMPLE: ANNUAL SPEND OF A LOYALTY SCHEME AND A THREE-WAY SPLIT

A retailer has 3.6m loyalty members who each spend an average of 48 a month. What is the annual spend of the scheme? Show that rounding to 4m and 50 is too coarse, find a better rounding and its error, and then split the total between online, stores and the app in the ratio 2:5:3.

Answer: The scheme's annual spend is about 2.07bn; rounding both inputs up gives 2.4bn, which is 15.7% too high; the split is 414.7m online, 1,036.8m stores and 622.1m app.

> **Interview tip:** Say the unit change aloud: 3.6 million times 48 is 172.8 million a month, times 12 gives just over 2 billion. When you round, say which direction the error goes. That tells the interviewer you know how far to trust the figure.

INT.KQ.2.a · Business arithmetic

Calculate margins, mark-ups, contribution and break-even volume or revenue, and use them to test a price or cost decision.

Profitability cases run on four relationships. Margin is profit divided by price, and mark-up is profit divided by cost, so a product bought for 75 and sold for 100 has a 25% margin and a 33.3% mark-up; candidates often mix them up. Contribution per unit is price less variable cost, and fixed costs are paid out of the total contribution. Break-even volume is fixed costs divided by contribution per unit, and break-even revenue is fixed costs divided by the contribution margin. To hit a target profit, add it to the fixed costs before dividing. A price change alters contribution per unit, so the volume needed to stand still is the old contribution divided by the new one. A price cut of 10% on a product with a 40% contribution margin needs volume to rise by a third, not by 10%. Always state what is fixed and what varies, because a cost that looks variable in the short run may be fixed over a month, and say whether the volume needed is realistic.

WORKED EXAMPLE: A BAKERY SITE: MARGIN, BREAK-EVEN AND A PRICE RISE

A bakery loaf costs 4.50 in ingredients and packaging and sells for 6.00. A site has fixed costs of 54,000 a month and capacity of 60,000 loaves a month. What are the margin and the mark-up? How many loaves must it sell to break even, and what share of capacity is that? How many are needed for a profit of 30,000? And what happens to break-even if the price rises by 0.30?

Answer: Margin is 25% and mark-up 33.3%; break-even is 36,000 loaves (60% of capacity); a 30,000 profit needs 56,000 loaves; with a price of 6.30 break-even drops to 30,000 loaves.

> **Interview tip:** Say which base each percentage uses, for example a 25% margin on price, and give the break-even as a share of capacity so the interviewer can judge whether it is realistic. Then offer the lever: a small price rise moves break-even a lot.

INT.KQ.2.b · Business arithmetic

Judge an investment with payback, simple NPV and perpetuity values, and work out the cash tied up in working capital.

Consultants are asked whether a project, a purchase or a new line is worth doing, and the maths is simple even when the setting is not. Payback is the investment divided by the yearly cash flow, in years; it is easy to say but ignores timing and every cash flow after the payback date. Net present value (NPV) discounts each future cash flow by one divided by one plus

the rate for each year, adds them up and subtracts the investment; a positive NPV creates value at that rate. A perpetuity is a flow that goes on forever, worth the yearly cash flow divided by the discount rate, or by the rate less the growth rate if the flow grows at a steady pace and the next year's flow is the starting point. The annual flow must come after tax and investment, and the rate must exceed the growth rate. Working capital, the cash held in stock and customer debts net of supplier credit, is a cash cost at the start that is often recovered at the end. State your conventions: year-end cash flows, ignore tax.

WORKED EXAMPLE: A 60M PLATFORM: PAYBACK, NPV AND PERPETUITY

A client is considering a 60m loyalty platform that adds 18m of cash a year for five years. Convention: year-end cash flows, a 10% discount rate, no tax. What is the payback? What is the NPV? What would the value be if the 18m a year went on forever? And what happens to the NPV if the project also needs 5m of working capital at the start, recovered at the end of year five?

Answer: Payback is 3.3 years; the five-year NPV is 8.2m; as a perpetuity the flow is worth 180m, an NPV of 120m; adding working capital reduces the NPV to 6.3m.

> **Interview tip:** State your conventions first, then give payback as a quick filter and NPV as the decision measure. Say which assumption drives the result, here how long the 18m a year really lasts, and what you would ask the client to check.

INT.KQ.2.c · Business arithmetic

Use weighted averages and split a change in revenue into price, volume and mix effects, then sanity-check the result against its order of magnitude.

Averages across segments hide the story, so a consultant separates what changed in each part from how the parts shifted. A weighted average multiplies each segment's value by its share and sums them; a simple average of the segment values is wrong unless the shares are equal. Revenue change then splits into three effects. Volume is the change in total units at last year's average price; mix is the effect of units moving between higher- and lower-priced products at last year's prices; price is the change in each product's price on this year's units. The three add up to the total, which is the check. The average price per unit can rise with no price rise at all, if mix moves to dearer products, so a price claim needs a like-for-like view. Close by sanity-checking size against something familiar, such as revenue per customer, per seat or per employee, and ask what assumption would have to be wrong if it looks far out.

WORKED EXAMPLE: A REVENUE BRIDGE FOR TWO PRODUCTS

A client sells two products. Last year it sold 100,000 units of A at 50 and 50,000 units of B at 120. This year it sold 90,000 of A at 54 and 70,000 of B at 118. Revenue rose from 11.00m to 13.12m. How much of the 2.12m rise is volume, mix and price, and what should the client conclude about its pricing?

Answer: Volume adds 0.73m, mix 1.17m and price 0.22m, a total of 2.12m; the average price rose 11.8% but nearly all of that is mix, not pricing.

> **Interview tip:** Give the answer first: the revenue rise is mostly mix, only a tenth is price. Then show the three numbers and the check that they sum to the total. Say what you would ask for next, such as the margin on each product.

Summary of the Charta interview-preparation topic. Companies and figures in the examples are invented. Draft content, not yet expert reviewed.