Q.1 (a) Which fundamental concepts and methods in mathematics did the Babylonians introduce and develop?
Answer: The Babylonians (circa 2000–1600 BCE) made major contributions to early mathematics. Key concepts and methods they introduced or developed include: Positional numeral system based on base-60 (sexagesimal), enabling place-value notation. Standard computational algorithms for arithmetic (addition, subtraction, multiplication, division) adapted to sexagesimal notation. Advanced use of tables — e.g., multiplication tables, reciprocal tables, tables of squares and cubes — to speed computation. Solution methods for linear and quadratic equations, including problems equivalent to ax^2 + bx = c using geometric reasoning and algebraic recipes. Knowledge of Pythagorean triples and practical geometry for land measurement, expansions, and constructions. Early trigonometric ideas for astronomy and sexagesimal division of circles (360° division related to 60-based system). These innovations formed a foundation later civilizations built upon.

Q.1 (b) From A to B, Aryan travels 1 km. He travels back at a pace of three kilometers per hour faster than he did in the beginning. The travel takes 0.5 hours in total. Determine the pace for the initial and subsequent portions of the trip.
Answer (step-by-step):
Let the initial speed be v km/h. The return speed is v + 3 km/h. Distance each way = 1 km. Total time = time forward + time back = 1/v + 1/(v+3) = 0.5 hours.

We solve the equation:
1/v + 1/(v+3) = 1/2.

Combine terms: (v+3 + v) / (v(v+3)) = 1/2 → (2v + 3) / (v^2 + 3v) = 1/2.
Cross-multiply: 2(2v + 3) = v^2 + 3v → 4v + 6 = v^2 + 3v → 0 = v^2 - v - 6.

This is a quadratic: $v^2 - v - 6 = 0$. Factor: $(v - 3)(v + 2) = 0$. The positive solution is $v = 3$ km/h ($v = -2$ is rejected).

So initial pace = **3 km/h** and return pace = $v + 3$ = **6 km/h**.

Q.2 (a) Consider two candidates who appeared for the selection of the post of senior scientist. Both persons were thoroughly examined by a panel of examiners. Person A got 80 points out of 100, while Person B got 70 points out of 100. Scientist A got the position. Explain how numbers helped the panel of examiners to decide for selection.

Answer:

Numbers provide an objective, quantifiable basis for comparison. By scoring candidates on the same scale (out of 100), the panel can aggregate performance across criteria (knowledge, experience, interview, test). Person A scored 80 while Person B scored 70, so Person A performed better by 10 points — a clear numeric margin. The numeric scores can be used to rank candidates, compute averages, apply minimum thresholds, and justify decisions transparently. In short, standardized scoring reduces subjective bias and makes selection defensible.

Q.2 (b) In this case, the person who sold the pen for Rs. 96 made the same amount of money as the watch's cost price. If he sells it for twice as much as the percentage profit he made on it before, what will the new price be?

Answer (algebraic):

Let the cost price of the pen be C. He sold the pen for Rs. 96, so his monetary profit on the pen = 96 - C. The problem states this profit equals the watch's cost price (call it W), so W = 96 - C.

His percentage profit on the pen = (profit / cost) × 100% = $((96 - C)/C) \times 100\% = (96/C - 1) \times 100\%$.

If he sells the (same) pen now for twice as much as that percentage profit (interpreting “twice as much as the percentage profit” to mean he increases the selling price by twice the previous profit percentage), then the new selling price S_new is:
S_new = 96 × [1 + 2×((96 - C)/C)] = 96 × (1 + 2(96/C - 1)).

This expression simplifies to S_new = 96 × (192/C - 1).

Worked numeric example: To illustrate, pick a plausible cost price, e.g. C = 80. Then the original profit = 96 - 80 = 16 (which would equal the watch cost W = 16). The profit percent = 16/80 = 0.20 = 20%. Twice that percent = 40%. Increasing 96 by 40% gives S_new = 96 × 1.40 = Rs. 134.40.

Note: Numerical value depends on the unknown cost price C; the formula above gives the exact new price in terms of C.

Q.3 (a) Four shirts, four sets of pants, and two hats cost $560 in a store. Nine shirts, nine pairs of pants, and six hats total $1,290 in cost. How much does one shirt, one pair of pants, and one item cost altogether?

Answer (step-by-step):

Let S = price of one shirt, P = price of one pair of pants, H = price of one hat. The statements give two equations:
4S + 4P + 2H = 560 ...(1)
9S + 9P + 6H = 1290 ...(2)

Divide (1) by 2: 2S + 2P + H = 280 → 2(S+P) + H = 280. ...(1')
Divide (2) by 3: 3S + 3P + 2H = 430 → 3(S+P) + 2H = 430. ...(2')

Let A = S + P. Then the system becomes:
2A + H = 280 ...(i)
3A + 2H = 430 ...(ii)

Solve (i) for H: H = 280 - 2A. Substitute into (ii):
3A + 2(280 - 2A) = 430 → 3A + 560 - 4A = 430 → -A = -130 → A = 130.
Then H = 280 - 2A = 280 - 260 = 20.
Therefore S + P + H = A + H = 130 + 20 = **$150**. So one shirt + one pair of pants + one hat cost **$150** altogether.

Q.3 (b) If the Golden Ratio is 1.618 and you have a piece of cardboard that is 7/8 ft wide. How long should you cut, so it follows the Golden Ratio?
Answer:
If width = 7/8 ft and length/width = 1.618, then length = 1.618 × (7/8) ft.
Compute: length = 1.618 × 0.875 ft = 1.415750 ft ≈ **1.415750 ft**.
So cut the cardboard to a length of approximately **1.415750 ft** so the rectangle follows the golden ratio.

Q.4 (a) Using the example of the population death rate and birth rate. Find in how many years the population has increased to 11000.
Answer (method and worked example):
The general model for population with a constant net growth rate r (per year) is $P(t) = P_0 (1 + r)^t$, where P_0 is initial population and t years later the population is P(t). To find t for $P(t) = P_{target}$: $t = \ln(P_{target} / P_0) / \ln(1 + r)$.

The problem statement omits P_0 and r; therefore we give a general formula above and a worked example. Suppose initial population P_0 = 10,000 and the net annual growth rate r = 2% (0.02). Then:
t = ln(11000 / 10000) / ln(1.02) = 4.813007 years ≈ **4.813 years** (about 57.8 months).

Interpretation: with a 2% annual net growth, it takes roughly 4.813 years to grow from 10,000 to 11,000. If you have different starting population or different net growth rate, plug them into the formula above.

Q.4 (b) What types of connections did prehistoric humans have with their surroundings, and how did their behavior impact the environment.

Answer:

Prehistoric humans had varied and evolving connections with their surroundings which shaped both culture and environment. Key points:

Subsistence & foraging: Early hunter-gatherers relied on local plant and animal resources. Their seasonal movement patterns followed food availability. **Tool use and technology:** Stone, bone, and wood tools improved hunting and processing of food; later innovations (e.g., controlled fire) allowed new diets and habitats. **Domestication and agriculture:** Transition to farming (Neolithic Revolution) created permanent settlements, crop cultivation, and animal husbandry, drastically altering landscapes. **Fire management:** Use of fire for clearing land, hunting, or habitat management changed plant communities and promoted certain species. **Social and ritual connections:** Spiritual beliefs and social structures influenced use of natural features (sacred groves, burial sites). **Environmental impacts:** Local extinctions of megafauna due to overhunting, deforestation for agriculture, soil erosion, and changes in biodiversity followed human expansion. Overall, prehistoric humans moved from minimal, mobile impacts to large-scale environmental modification with farming and settled life.

Q.5 (a) A weighing scale has an uncertainty of a maximum +5 grams per 1 kg. A load of 105kg is weighed on this scale. Find what could be a possible error that the scale can give when this

load is weighed?
Answer:
Uncertainty = ±5 grams per 1 kg. For 105 kg, maximum absolute error = 105 × 5 g = 525 g = 0.525 kg.
So the scale could show a measurement off by up to **±525 grams (±0.525 kg)** for a 105 kg load.

Q.5 (b) If you want to retire in 30 years and you estimate that you will need 10 lacs rupees for retirement, how much money do you need to save each month if your investments earn an average annual return of 8%?
Answer (step-by-step calculation):
We want monthly deposits PMT that accumulate to future value FV = 1,000,000 rupees in n = 30×12 = 360 months, with monthly interest rate i = 0.08/12 = 0.00666667.
Future value of an ordinary annuity: FV = PMT × [((1 + i)^n - 1) / i].
Solve for PMT: PMT = FV × i / ((1 + i)^n - 1).

Compute numerically:
Monthly interest rate i = 0.00666667. Number of months n = 360.
PMT = 670.98 rupees per month ≈ **Rs. 670.98**.

So you need to save about **Rs. 670.98 per month** assuming 8% annual return compounded monthly.