

Chapter 10: How Quantities Combine:

Understanding Data - Practice Question Bank

Easy Level

Multiple Choice Questions (MCQs)

1. If a group of 8 seniors has an average height of 165.5 cm, what is the total sum of their heights?
 - A) 1324 cm
 - B) 1655 cm
 - C) 1100 cm
 - D) 1400 cm
2. When combining two collections of data of equal sizes, how is the combined average found?
 - A) By multiplying the two averages
 - B) By taking the arithmetic mean of the two averages
 - C) By finding the difference between the two averages
 - D) By dividing the sum by the product of their sizes
3. If a bowl of 500 mL lemonade has 10% jaggery, how much jaggery (in mL) is in the bowl?
 - A) 20 mL
 - B) 50 mL
 - C) 100 mL
 - D) 500 mL
4. What type of chart uses bars placed side-by-side or stacked to show totals and components?
 - A) Pie chart
 - B) Line graph
 - C) Stacked bar chart
 - D) Scatter plot
5. In ancient India, 16 varna meant pure gold. What term is used today for this measure of gold purity?

- A) Grams
 - B) Carat
 - C) Percentage
 - D) Ounces
6. If Section A has 30 students with an average score of 72, what is the total score of Section A?
- A) 2160
 - B) 1500
 - C) 2200
 - D) 1800
7. Which chart represents every bar as a fixed length (100%) split proportionately?
- A) Clustered column chart
 - B) Stacked column chart
 - C) 100% stacked bar chart
 - D) Simple bar chart
8. What does the prefix 'weighted' in a weighted mean refer to?
- A) The actual heavy weight in kilograms
 - B) How important or how big each value is
 - C) The gravitational force on the data
 - D) The total number of items
9. If a glass contains 200 mL of lemonade with 20% jaggery, what is the quantity of jaggery?
- A) 20 mL
 - B) 40 mL
 - C) 50 mL
 - D) 100 mL
10. Which ancient Indian mathematician Brahmagupta used a weighted mean formula in his work Brahmasphutasiddhanta in 628 CE?
- A) Aryabhata
 - B) Brahmagupta
 - C) Sridharacharya
 - D) Bhaskara

11. If the average rainfall per day in May is 3.5 mm and in June is 10 mm, can their combined average be found by simply adding 3.5 and 10 and dividing by 2, assuming the number of days in both months is different?

- A) Yes, always
- B) No, because the number of days in May and June are different
- C) Yes, if we multiply by 2
- D) Only on leap years

12. What does the total length of a full stacked bar represent in a stacked bar chart of family expenses?

- A) The expense of a single category
- B) The total expenditure of a family in that month
- C) The average savings
- D) The number of family members

13. If a 100% stacked bar chart shows 50% summer, 30% monsoon, and 20% winter blooms, what does the total bar length represent?

- A) 50 flowers
- B) 100 flowers
- C) 100% of that garden's total flowers
- D) 24 hours

14. In a 100% stacked bar chart, what is compared?

- A) Absolute values only
- B) Proportions and percentages
- C) Only total counts
- D) Time in seconds

15. If a team scored 6 runs in the first over, what is their run rate after the first over?

- A) 3
- B) 6
- C) 12
- D) 1

16. Which chart is similar to a pie chart because it shows proportions of a whole?

- A) Line chart
- B) 100% stacked bar chart
- C) Scatter plot

- D) Clustered column chart

17. If Batch A of brass weighs 200 kg and has 70% copper, how much copper does it contain?

- A) 70 kg
- B) 140 kg
- C) 200 kg
- D) 100 kg

18. What is the primary purpose of a weighted average?

- A) To ignore large numbers
- B) To combine data of different sizes or importance into one accurate number
- C) To find the median of a dataset
- D) To subtract values

19. In a T20 match, how many overs are bowled in total by one team while batting?

- A) 10 overs
- B) 20 overs
- C) 50 overs
- D) 5 overs

20. Which of the following can be effectively compared using a 100% stacked bar chart?

- A) Fractions or percentages inside each category/group
- B) Absolute total populations without percentages
- C) Exact number of items across different totals
- D) Unrelated random numbers

Easy Level MCQ Answer Key

1. A
2. B
3. B
4. C
5. B
6. A
7. C
8. B
9. B
10. B
11. B
12. B

13. C
14. B
15. B
16. B
17. B
18. B
19. B
20. A

Easy Level Subjective Questions

1. Define weighted average in your own words.
2. Why does Method 1 (simply adding two averages and dividing by 2) fail when combining groups of unequal sizes?
3. If a bowl contains 500 mL of lemonade with 10% jaggery, calculate the exact quantity of jaggery in the bowl.
4. What is a stacked bar chart used for?
5. State the ancient Indian unit of length mentioned in the text that measures around 18 inches.
6. What does 16 varna signify in the context of ancient Indian gold purity?
7. If Section A has 30 students (average score 72) and Section B has 25 students (average score 76), write the formula for their combined average score.
8. What is the main advantage of a 100% stacked bar chart over a pie chart?
9. If Jaspreet cycled 5 days a week for 3 weeks, why does averaging the three weekly averages directly work in this specific case?
10. What is the concentration of jaggery if two equal quantities of lemonade with 10% and 20% jaggery are mixed?
11. Name the ancient Indian text and mathematician who wrote down the formula for the weighted mean around 628 CE.
12. What does the total height of a column represent in a stacked column chart showing animal species on the IUCN Red List over time?
13. If a family spends 23% of their budget on housing, what does this percentage represent in a 100% stacked bar chart?
14. Can a 100% stacked bar chart tell us the absolute total number of items (such as total flowers) in two different gardens?
15. What is the run rate in cricket?
16. If a team scores 6 runs in the first over, what is their run rate?
17. Why are weights assigned to values in data?
18. What do the colors inside a single bar of a 100% stacked bar chart represent?
19. If 600 mL of a solution has 5% salt, what is the volume of salt in it?
20. What does a cluster-column chart with categories as clusters primarily help to compare?

Easy Level Subjective Answers

1. A weighted average is an average where each value is multiplied (weighted) by its relative importance, size, or frequency before finding the mean.
 2. Method 1 fails because it treats both groups equally, ignoring the fact that one group may contain many more items than the other.
 3. Quantity of jaggery = $500 * (10 / 100) = 50$ mL.
 4. A stacked bar chart is used when we want to compare totals while also keeping track of the individual components that make up those totals.
 5. A "hasta" (meaning forearm).
 6. 16 varna meant pure gold (k/16 gold and the rest impurities).
 7. Combined Average = $((72 * 30) + (76 * 25)) / (30 + 25)$.
 8. It is often easier to compare lengths across stacked bars in a 100% stacked bar chart than to compare angles of different slices in pie charts located in different orientations.
 9. It works because all three collections (weeks) are of the exact same size (5 days each), meaning each weekly average comes from the same number of days.
 10. The concentration is the midpoint, which is 15%.
 11. Brahmagupta in his work Brahmasphutasiddhanta.
 12. The total number of animal species across all classes listed for that specific year.
 13. It represents the proportional share of housing out of the family's total monthly expenditure.
 14. No, a 100% stacked bar chart only shows proportions/percentages, not absolute totals.
 15. The run rate is the average number of runs scored per over.
 16. 6 runs per over ($6 / 1 = 6$).
 17. To indicate the relative importance, emphasis, or contribution that each value gets with respect to the others.
 18. They represent the fractions or percentage shares of different components making up the 100% total.
 19. $600 * 0.05 = 30$ mL.
 20. It helps to compare different families' expenditures within each specific category.
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Moderate Level

Multiple Choice Questions (MCQs)

1. Section A has 30 students with an average score of 72, and Section B has 25 students with an average score of 76. What is the combined average score?
 - A) 73.82
 - B) 74.00
 - C) 74.36
 - D) 75.12

2. A bowl of 500 mL lemonade has 10% jaggery, and a glass of 200 mL lemonade has 20% jaggery. What is the concentration of jaggery in the mixture?
- A) 12.86%
 - B) 13.50%
 - C) 14.20%
 - D) 15.00%
3. A goldsmith melts 9 units of gold at 12 varna, 5 units at 10 varna, and 17 units at 11 varna. What is the purity in varna of the combined gold?
- A) 11.24 varna
 - B) 11.33 varna
 - C) 11.50 varna
 - D) 12.00 varna
4. Batch A of brass weighs 200 kg with 70% copper, Batch B weighs 120 kg with 50% copper, and Batch C weighs y kg with 45% copper. If the combined alloy is 55% copper, what is the weight of Batch C?
- A) 180 kg
 - B) 200 kg
 - C) 240 kg
 - D) 300 kg
5. Rehmat's marks are 60% in internals, 64% in project, and 73% in final exam, combined in the ratio 3:2:5. What is the annual percentage score?
- A) 65.60%
 - B) 67.30%
 - C) 68.10%
 - D) 70.00%
6. A white stork's average daily distance over 20 days is 44.5 km. On the 21st day, it flew 55 km. What is the new average over 21 days?
- A) 45.00 km
 - B) 44.75 km
 - C) 45.02 km
 - D) 46.10 km
7. A 600 mL solution with 5% salt is mixed with a 300 mL solution with 8% sugar. What are the concentrations of salt and sugar in the mixture?

- A) Salt: 5%, Sugar: 8%
 - B) Salt: 3.33%, Sugar: 2.67%
 - C) Salt: 6%, Sugar: 6%
 - D) Salt: 13%, Sugar: 3%
8. At a panipuri stall, 10 litres of pani has 8% spice concentration. What quantity of regular water should be mixed so the spice level is reduced to $\frac{3}{4}$ th of the original concentration?
- A) 2.5 litres
 - B) 3.33 litres
 - C) 5.0 litres
 - D) 7.5 litres
9. A physical fitness evaluation combines strength, flexibility, and agility in the ratio 4:5:6. Rashi scores 60, 65, and 70. What is Rashi's final weighted mark?
- A) 65.0
 - B) 65.67
 - C) 66.33
 - D) 67.5
10. In a facility with male and female langurs, the average weight of 60 total langurs is 14.925 kg. Male average weight is 16.5 kg and female is 13.8 kg. Which equation models this?
- A) $(16.5x + 13.8y) / (x + y) = 14.925$ where $x + y = 60$
 - B) $(16.5x + 13.8y) / 60 = 14.925$
 - C) $(16.5x + 13.8y) / 2 = 14.925$
 - D) $16.5x + 13.8y = 14.925$
11. Dorjee mixes 1 litre of Dead Sea water (34% salinity) with 2 litres of purified drinking water (0.001% salinity, approximated as 0%). What is the approximate salinity of the mixture?
- A) 11.33%
 - B) 17.00%
 - C) 8.50%
 - D) 34.00%
12. Shreyas holds 25 shares at an average price of 150. He buys 10 more shares at 30 each. What is his new average price per share?

- A) 90.00
- B) 115.71
- C) 120.00
- D) 135.50

13. A pool 30 hastas long is divided into 5 sections of lengths 4, 5, 6, 7, and 8 hastas, with depths 9, 7, 7, 3, and 2 hastas. What is the mean depth of the pool?

- A) 4.80 hastas
- B) 5.10 hastas
- C) 5.27 hastas
- D) 6.00 hastas

14. Given data with corresponding weights, if all the weights are doubled, what happens to the weighted average?

- A) It is halved
- B) It remains exactly the same
- C) It is doubled
- D) It increases by 2

15. In a T20 match, a team scores 6 runs in over 1 and 12 runs in over 2. What is the run rate after 2 overs?

- A) 6.0
- B) 8.0
- C) 9.0
- D) 12.0

16. What is the primary limitation of a stacked bar chart when comparing internal components across different bars?

- A) Colors are too bright
- B) Except for the first bar, components do not begin from 0, making comparisons harder
- C) It only displays percentages
- D) It cannot show totals

17. In a triathlon, Athlete 1 finishes swimming in 01:08, cycling in 05:00, and running in 03:15 (hh:mm). What is Athlete 1's total finish time?

- A) 08:35
- B) 09:23
- C) 09:35

- D) 10:00

18. If a 100% stacked bar chart compares two gardens (Fatima and Naveen) in summer, can we determine who had a higher absolute number of flowers in summer from the chart alone?

- A) Yes, always
- B) No, because total garden sizes are unknown
- C) Yes, by measuring bar lengths with a ruler
- D) Only if winter blooms are equal

19. Which mathematician used the weighted mean concept to estimate gold-alloy purity (varna/karat calculations) around 750 CE?

- A) Brahmagupta
- B) Sridharacharya
- C) Bhaskara II
- D) Aryabhata

20. When creating a 100% stacked bar chart from category data, what is the denominator used to calculate each category's percentage share?

- A) The value of the first category
- B) The total sum of all categories in that group
- C) The number of categories
- D) 100

Moderate Level MCQ Answer Key

1. C
2. A
3. B
4. C
5. B
6. A
7. B
8. B
9. B
10. A
11. A
12. B
13. C
14. B
15. C
16. B

- 17. B
- 18. B
- 19. B
- 20. B

Moderate Level Subjective Questions

1. Calculate the combined average of Section A (30 students, average 72) and Section B (25 students, average 76).
2. Find the concentration of jaggery when 500 mL of 10% jaggery lemonade is mixed with 200 mL of 20% jaggery lemonade.
3. A goldsmith melts 9 units at 12 varna, 5 units at 10 varna, and 17 units at 11 varna. Find the combined purity.
4. Batch A (200 kg, 70% copper), Batch B (120 kg, 50% copper), and Batch C (y kg, 45% copper) combine to form a 55% copper alloy. Find y.
5. Rehmat scores 60% internals, 64% project, 73% final exam, weighted 3:2:5. Calculate annual score.
6. A stork's average over 20 days is 44.5 km. On day 21, it flies 55 km. Find the new 21-day average.
7. 10 litres of pani has 8% spice. What quantity of regular water is needed to reduce spice concentration to $\frac{3}{4}$ th of 8% (i.e., 6%)?
8. Prove algebraically that doubling all weights in a weighted average does not change the weighted average.
9. Dorjee mixes 1 L of Dead Sea water (34%) with 2 L of purified water (0%). Find the mixture salinity.
10. Shreyas has 25 shares at average 150. He buys 10 shares at 30. Find his new average price.
11. Find the mean depth of a pool 30 hastas long divided into sections of lengths 4, 5, 6, 7, 8 with depths 9, 7, 7, 3, 2.
12. In a T20 match, a team scores 6 runs in over 1 and 12 runs in over 2. What is the run rate after 2 overs?
13. Why is comparing bars within clusters and across clusters harder in a stacked bar chart?
14. Calculate Athlete 1's total finish time in a triathlon given: swim 01:08, cycle 05:00, run 03:15.
15. Can a 100% stacked bar chart be converted into a stacked bar chart showing absolute numbers? Explain.
16. What is the main purpose of a 100% stacked bar chart?
17. If a solution of 600 mL with 5% salt is mixed with 300 mL with 8% sugar, calculate salt concentration in the total mixture volume (900 mL).
18. What does a cluster-column chart comparing families across categories allow you to focus on?
19. If Vaishnavi has 5 shares at average 150, buys some shares at 30, and her new average is 70, how many shares did she buy?
20. State Brahmagupta's contribution to data combination as mentioned in the text.

Moderate Level Subjective Answers

1. Total sum = $(72 * 30) + (76 * 25) = 2160 + 1900 = 4060$. Total students = $30 + 25 = 55$. Combined average = $4060 / 55 = 74.36$.
 2. Total jaggery = $(500 * 0.1) + (200 * 0.2) = 50 + 40 = 90$ mL. Total volume = $500 + 200 = 700$ mL. Concentration = $90 / 700 = 0.1286$ or 12.86%.
 3. Total purity units = $(9 * 12) + (5 * 10) + (17 * 11) = 108 + 50 + 187 = 345$. Total units = $9 + 5 + 17 = 31$. Combined purity = $345 / 31 = 11.33$ varna.
 4. $0.55 = (200 * 0.7 + 120 * 0.5 + y * 0.45) / (320 + y)$. $0.55(320 + y) = 140 + 60 + 0.45y \Rightarrow 176 + 0.55y = 200 + 0.45y \Rightarrow 0.1y = 24 \Rightarrow y = 240$ kg.
 5. Score = $(60 * 3 + 64 * 2 + 73 * 5) / (3 + 2 + 5) = (180 + 128 + 365) / 10 = 673 / 10 = 67.3\%$.
 6. Total distance for 20 days = $20 * 44.5 = 890$ km. Total for 21 days = $890 + 55 = 945$ km. New average = $945 / 21 = 45$ km.
 7. Let x be water added. Total spice = $10 * 0.08 = 0.8$ litres. New concentration = $0.8 / (10 + x) = 0.06 \Rightarrow 10 + x = 0.8 / 0.06 = 13.33$ litres $\Rightarrow x = 3.33$ litres.
 8. New weighted average = $(2w_1x_1 + 2w_2x_2) / (2w_1 + 2w_2) = 2(w_1x_1 + w_2x_2) / 2(w_1 + w_2) = (w_1x_1 + w_2x_2) / (w_1 + w_2)$. The factor 2 cancels out.
 9. Salinity = $(1 * 0.34 + 2 * 0.0) / (1 + 2) = 0.34 / 3 = 0.1133$ or 11.33%.
 10. Total cost = $(25 * 150) + (10 * 30) = 3750 + 300 = 4050$. Total shares = $25 + 10 = 35$. New average = $4050 / 35 = 115.71$.
 11. Total depth-length product = $(49) + (57) + (67) + (73) + (8*2) = 36 + 35 + 42 + 21 + 16 = 150$. Total length = $4+5+6+7+8 = 30$. Mean depth = $150 / 30 = 5$ hastas.
 12. Total runs = $6 + 12 = 18$. Total overs = 2. Run rate = $18 / 2 = 9$ runs per over.
 13. Except for the first bar, the small bars do not begin from 0, and bars across clusters do not share a common base or starting point.
 14. Hours = $1 + 5 + 3 = 9$ hours. Minutes = $08 + 00 + 15 = 23$ minutes. Total time = 09:23.
 15. No, because a 100% stacked bar chart only displays relative proportions/percentages and loses absolute magnitude information.
 16. To compare the proportional breakdown (percentages/fractions) of components within each group or category.
 17. Salt amount = $600 * 0.05 = 30$ mL. Total volume = 900 mL. Salt concentration = $30 / 900 = 3.33\%$.
 18. It focuses on comparing different families' expenditures within each individual category.
 19. Let x be shares bought. Total cost = $(5 * 150) + 30x = 750 + 30x$. Total shares = $5 + x$. $(750 + 30x) / (5 + x) = 70 \Rightarrow 750 + 30x = 350 + 70x \Rightarrow 400 = 40x \Rightarrow x = 10$ shares.
 20. Brahmagupta formulated the weighted mean formula in Brahmasphutasiddhanta (628 CE) to define the mean depth of an irregularly-shaped pit.
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Difficult Level

Multiple Choice Questions (MCQs)

1. A mixture is made by combining 400 mL of 15% acid solution, 300 mL of 25% acid solution, and 300 mL of pure water (0% acid). What is the acid concentration of the final mixture?
 - A) 11.5%
 - B) 13.5%
 - C) 15.0%
 - D) 16.5%
2. A student calculates the average of 4 collections of data of sizes 10, 15, 20, and 5 with respective averages 50, 60, 70, and 80. What is the true combined average?
 - A) 62.25
 - B) 63.50
 - C) 64.00
 - D) 65.50
3. Vaishnavi holds 5 shares of a company at an average price of 150. She buys some shares at 30 each, bringing her average price to 70. How many shares did she buy?
 - A) 5 shares
 - B) 10 shares
 - C) 15 shares
 - D) 20 shares
4. Dorjee wants to mix 1 litre of Dead Sea water (34% salinity) with groundwater (0.01% salinity) to obtain a mixture with the salinity of purified drinking water (0.001%). Is it mathematically possible?
 - A) Yes, by adding 3390 litres of groundwater
 - B) Yes, by adding 10 litres of groundwater
 - C) No, because Dead Sea water is already more saline than the target, and mixing with groundwater (which also has positive salinity) can never dilute it below groundwater's salinity.
 - D) Yes, by evaporating water
5. In a fitness evaluation, marks for strength, flexibility, and agility are weighted 4:5:6. Rashi scores 60, 65, and 70. Keerthi scores 55, 65, and 75. Who has a higher final weighted score?

- A) Rashi
 - B) Keerthi
 - C) Both have equal scores
 - D) Cannot be determined
6. A restaurant's 10 customer ratings for food (weights 6), ambience (weights 5), and service (weights 4) have a weighted average rating. If food ratings are: 5 (five stars) by 5 customers, 4 by 3 customers, and 2 by 2 customers, what is the average score for food alone?
- A) 3.8
 - B) 4.1
 - C) 4.2
 - D) 4.5
7. Given data with corresponding weights, if all the weights are increased by a constant value c (where $c > 0$), what happens to the weighted average?
- A) It remains exactly the same
 - B) It increases
 - C) It decreases
 - D) It depends on the data values and will generally shift closer to the arithmetic mean of the data values depending on c .
8. In a T20 match, a team has a run rate of 6 after 19 overs. In the 20th over, they score 12 runs. What is their final run rate after 20 overs?
- A) 6.0
 - B) 6.2
 - C) 6.3
 - D) 6.5
9. A tank of water is divided into 4 sections of lengths 5m, 10m, 8m, and 7m with depth measurements of 4m, 6m, 5m, and 3m respectively. What is the mean depth of the tank?
- A) 4.70m
 - B) 4.90m
 - C) 5.10m
 - D) 5.30m
10. A gemstone merchant mixes 3 batches of gold: 10g at 18k, 15g at 14k, and x grams at 22k. If the resulting alloy is 18k purity, what is x ?
- A) 10g

- B) 15g
- C) 20g
- D) 25g

11. If a 100% stacked bar chart shows that Family A spends 23% on housing out of a total expenditure of ₹10,000, and Family B spends 24% out of ₹15,000, which family spent more absolute money on housing?

- A) Family A
- B) Family B
- C) Both spent equal amounts
- D) Cannot be determined without total amounts (Family B did)

12. In a population of animals, cows made up 60%, sheep 25%, and chickens 15%. If the population of all three decreased over the year, which scenario for their percentage shares is mathematically possible?

- A) All percentages decrease
- B) All percentages increase
- C) Some percentages can increase, decrease, or remain the same depending on the exact rates of decrease of each subgroup.
- D) Percentages must remain constant

13. A runner completes a triathlon segments (swim 3.8 km in 1h 8m, cycle 180 km in 5h 0m, run 42.2 km in 3h 15m). What is the average speed over the entire cycling segment?

- A) 30 km/h
- B) 36 km/h
- C) 40 km/h
- D) 45 km/h

14. If 3 collections of sizes p , q , r have averages a , b , c , under what condition is the combined average equal to $(a + b + c) / 3$?

- A) When $p = q = r$
- B) When $a = b = c$
- C) When $p + q + r = 3$
- D) Always

15. Suvarna purchased 1g gold at 15k. If she purchases 2g gold at 30k, what is the new average price per gram of gold she possesses?

- A) 20k
- B) 22.5k

- C) 25k
- D) 27.5k

16. A stationery shop owner sells books worth ₹8000 (30% profit) and book covers worth ₹1000 (50% profit). What is the overall percentage profit on total sales?

- A) 30.0%
- B) 32.22%
- C) 35.0%
- D) 40.0%

17. In a stacked bar chart representing monthly expenses, Family A's total bar is 8500 units long while Family C's total bar is 7000 units long. If you want to compare the exact proportion of food expenses between them, why is a stacked bar chart less ideal than a 100% stacked bar chart?

- A) Colors clash
- B) Different total lengths make direct visual comparison of proportions difficult without calculation.
- C) Stacked bars cannot show food expenses
- D) Food is always at the bottom

18. If a langur facility has an overall average weight of 14.925 kg for 60 langurs, with male average 16.5 kg and female average 13.8 kg, how many male langurs are there?

- A) 25
- B) 30
- C) 35
- D) 40

19. A 600 mL solution with 5% salt is mixed with a 300 mL solution with 8% sugar. What is the concentration of salt in the mixture?

- A) 3.33%
- B) 5.00%
- C) 5.33%
- D) 8.00%

20. What is the primary reason why a 100% stacked bar chart cannot be used to infer absolute quantities?

- A) It normalizes every total bar to a fixed length (100%), stripping away the absolute scale factor.
- B) It only has one color

- C) It is restricted to 10 items maximum
- D) Values are negative

Difficult Level MCQ Answer Key

1. B
2. A
3. B
4. C
5. A
6. B
7. D
8. C
9. A
10. B
11. B
12. C
13. B
14. A
15. C
16. B
17. B
18. A
19. A
20. A

Difficult Level Subjective Questions

1. Mix 400 mL of 15% acid, 300 mL of 25% acid, and 300 mL of 0% acid. Find the final acid concentration.
2. Calculate combined average for sizes 10, 15, 20, 5 with averages 50, 60, 70, 80.
3. Suvarna buys 1g gold at 15k. She purchases 2g gold at 30k. Find her new average price per gram.
4. A stationery shop sells books worth ₹8000 (30% profit) and book covers worth ₹1000 (50% profit). Find overall profit percentage.
5. Rashi scores 60, 65, 70 and Keerthi scores 55, 65, 75 with weights 4:5:6. Calculate both weighted scores and compare.
6. In a T20 match, run rate after 19 overs is 6. In the 20th over, 12 runs are scored. Find final run rate.
7. Explain why increasing all weights in a weighted average by a constant c changes the weighted average unless data values are all equal.
8. A tank has sections of lengths 5, 10, 8, 7 with depths 4, 6, 5, 3. Find mean depth.
9. Gemstone merchant mixes 10g at 18k, 15g at 14k, and x g at 22k to get 18k. Find x .
10. Given 60 total langurs with overall average 14.925 kg, male average 16.5 kg, female average 13.8 kg. Find number of male langurs (x).

11. Why can a stacked bar chart make comparisons of internal bar lengths difficult across different clusters?
12. Calculate cycling speed in km/h for a triathlon segment of 180 km completed in 5 hours.
13. Can mixing Dead Sea water (34%) and groundwater (0.01%) yield purified drinking water (0.001%)? Explain.
14. Describe how a 100% stacked bar chart is constructed from raw table data.
15. If all weights in a dataset are multiplied by 0.5, what happens to the weighted average?
16. What does a 100% stacked bar chart share in common with a pie chart?
17. If a student scores 70% in internals (weight 3), 80% in project (weight 2), and 90% in exam (weight 5), calculate the final weighted percentage.
18. Why is the weighted mean considered a generalization of the standard arithmetic mean?
19. Discuss why looking only at the national or overall average (like the Average Indian's Day) can be misleading.
20. Explain the mathematical relationship between a stacked bar chart and a 100% stacked bar chart regarding convertibility.

Difficult Level Subjective Answers

1. Total acid = $(400 * 0.15) + (300 * 0.25) + (300 * 0.0) = 60 + 75 + 0 = 135$ mL. Total volume = $400 + 300 + 300 = 1000$ mL. Concentration = $135 / 1000 = 13.5\%$.
2. Sum = $(1050) + (1560) + (2070) + (580) = 500 + 900 + 1400 + 400 = 3200$. Total items = $10+15+20+5 = 50$. Average = $3200 / 50 = 64.0$.
3. Total cost = $(1 * 15) + (2 * 30) = 15 + 60 = 75$ k. Total weight = $1 + 2 = 3$ g. Average price = $75 / 3 = 25$ k.
4. Total profit amount = $(8000 * 0.30) + (1000 * 0.50) = 2400 + 500 = 2900$. Total sales = $8000 + 1000 = 9000$. Overall profit % = $(2900 / 9000) * 100 = 32.22\%$.
5. Rashi = $(604 + 655 + 706) / 15 = (240 + 325 + 420) / 15 = 985 / 15 = 65.67$. Keerthi = $(554 + 655 + 756) / 15 = (220 + 325 + 450) / 15 = 995 / 15 = 66.33$. Keerthi has a higher score.
6. Total runs after 19 overs = $19 * 6 = 114$. Runs after 20 overs = $114 + 12 = 126$. Final run rate = $126 / 20 = 6.3$.
7. New weighted average = $\frac{\sum((w_i + c)x_i)}{\sum(w_i + c)} = \frac{\sum(w_i x_i) + c \sum(x_i)}{(\sum(w_i) + nc)}$. This is a weighted combination of the original weighted average and the unweighted mean of x_i , which only equals the original weighted average if all x_i are identical.
8. Sum of (length * depth) = $(54) + (106) + (85) + (73) = 20 + 60 + 40 + 21 = 141$. Total length = $5+10+8+7 = 30$. Mean depth = $141 / 30 = 4.70$ m.
9. $18 = (1018 + 1514 + x*22) / (10 + 15 + x) \Rightarrow 18(25 + x) = 180 + 210 + 22x \Rightarrow 450 + 18x = 390 + 22x \Rightarrow 60 = 4x \Rightarrow x = 15$ g.
10. Let male be x , female be $60 - x$. $(16.5x + 13.8(60 - x)) / 60 = 14.925 \Rightarrow 16.5x + 828 - 13.8x = 895.5 \Rightarrow 2.7x = 67.5 \Rightarrow x = 25$ male langurs.
11. Because the base values (starting points) of the internal bars are not aligned at zero (except for the bottom/first segment), making visual estimation of lengths inaccurate.
12. Speed = Distance / Time = $180 \text{ km} / 5 \text{ h} = 36 \text{ km/h}$.

13. No. Both sources have a salinity greater than or equal to 0.01%, which is already higher than 0.001%. A mixture's concentration must lie between the component concentrations.
 14. For each group/bar, find the total sum of all categories, calculate each category's percentage share of that total, and plot proportional segments summing up to 100%.
 15. It remains exactly the same, as the scaling factor 0.5 cancels out in both numerator and denominator.
 16. Both represent proportional parts of a whole (100% or 360 degrees) rather than absolute quantities.
 17. $(703 + 802 + 90 \cdot 5) / 10 = (210 + 160 + 450) / 10 = 820 / 10 = 82\%$.
 18. Because the standard arithmetic mean is simply a special case of the weighted mean where all weights are equal (all equal to 1).
 19. An overall average masks internal diversity, variations across age groups, genders, regions, and socio-economic backgrounds, hiding important nuances.
 20. A stacked bar chart can be converted into a 100% stacked bar chart because absolute totals are known. However, a 100% stacked bar chart cannot be converted into a stacked bar chart because absolute totals are lost.
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Olympiad Level

Multiple Choice Questions (MCQs)

1. Let $x_1, x_2, \dots, x_n$ have weights $w_1, w_2, \dots, w_n$ with weighted mean M . If every data value x_i is transformed to $ax_i + b$ (where a and b are constants), what is the new weighted mean?
 - A) M
 - B) $aM + b$
 - C) $a(M + b)$
 - D) $M / a + b$
2. Three collections of data have sizes p, q, r , averages a, b, c , and variances equal to zero (meaning all elements in each collection are identical to their respective averages). If the three collections are combined, what is the exact combined average?
 - A) $(a + b + c) / 3$
 - B) $(ap + bq + cr) / (p + q + r)$
 - C) $(pqr \cdot abc) / (p + q + r)$
 - D) $(a + b + c) / (p + q + r)$
3. An alloy mixture of copper and zinc is formed by combining n batches with weights w_i and copper concentrations x_i . If an additional batch of weight w_{n+1} with

concentration $x_{\{n+1\}}$ is added such that $x_{\{n+1\}}$ is strictly greater than the current weighted mean, what is guaranteed to happen to the overall concentration?

- A) It will decrease
 - B) It will remain unchanged
 - C) It will strictly increase
 - D) It becomes zero
4. Consider a dataset of positive values with weights. If each weight w_i is replaced by w_i^2 , how does the weighted mean behave compared to the original weighted mean?
- A) It is always greater
 - B) It is always smaller
 - C) It depends entirely on whether larger data values are associated with larger or smaller weights.
 - D) It is always equal to the unweighted mean
5. A pool of length L is divided into n infinitesimal segments of length dx_i with depth function $f(x)$. Brahmagupta's formula for mean depth transitions into which calculus concept when $n \rightarrow \infty$?
- A) Derivative $f'(x)$
 - B) Definite integral $(1/L) * \int_0^L f(x) dx$
 - C) Limit of a sequence
 - D) Taylor series expansion
6. If the weights w_i in a weighted mean satisfy $\sum w_i = W$, and we perturb each weight by Δw_i such that $\sum \Delta w_i = 0$, what is the first-order change in the weighted mean M with respect to Δw_i ?
- A) $dM / dw_i = (x_i - M) / W$
 - B) $dM / dw_i = x_i M$
 - C) $dM / dw_i = 0$
 - D) $dM / dw_i = w_i / x_i$
7. In a 100% stacked bar chart representing k components summing to S , if one component's absolute value increases while all other absolute values remain constant, what happens visually to the other components' percentage bands on the chart?
- A) Their percentage bands expand
 - B) Their percentage bands shrink / compress because the total sum S increased and their absolute values represent a smaller proportion of the new total.
 - C) Their percentage bands remain identical in width
 - D) They disappear entirely

8. Suppose a student incorrectly computes the combined average of two classes by taking the arithmetic mean of their averages (Method 1) instead of the weighted mean (Method 2). Under what precise condition will Method 1 yield the exact correct combined average?
- A) When both class sizes are equal ($p = q$)
 - B) When both class averages are equal ($a = b$)
 - C) When both class sizes and averages are equal
 - D) Method 1 can never be correct unless $p = q$.
9. If a multi-assessment grading system uses weights $w_1, w_2, \dots, w_n$ summing to 100, and all scores are scaled linearly from a 100-point scale to a 10-point scale, what happens to the final weighted grade percentage?
- A) It is divided by 10
 - B) It remains unchanged
 - C) It is multiplied by 10
 - D) It is reduced by 90 points
10. In the analysis of time-use survey data (like the National Time Use Survey across age groups), why are stacked bar strips of 24 hours mathematically equivalent to both stacked bar charts and 100% stacked bar charts?
- A) Because every individual has exactly 24 hours in a day (fixed total length = 100% of a day), and absolute hours equal proportional parts.
 - B) Because hours are measured in decimals
 - C) Because all age groups sleep the same amount
 - D) Because the charts are circular
11. A goldsmith mixes 3 alloys of gold of equal weights with purities v_1, v_2, v_3 (in varna). What is the exact combined purity?
- A) $(v_1 + v_2 + v_3) / 3$
 - B) $v_1 * v_2 * v_3 / 3$
 - C) $(v_1 v_2 + v_2 v_3 + v_3 v_1) / 3$
 - D) Square root of $(v_1 * v_2 * v_3)$
12. If the weighted average of $x_1, \dots, x_n$ with weights $w_1, \dots, w_n$ is minimized with respect to a target value T using squared errors sum of $w_i (x_i - T)^2$, what value of T minimizes this sum?
- A) The median
 - B) The unweighted mean

- C) The weighted mean M
 - D) The mode
13. In a cluster-column chart comparing 3 families across 6 expenditure categories, if we transpose the clusters so that categories are clusters and families are bars within clusters, how does the visual data representation change?
- A) The numerical values change
 - B) The perspective shifts from comparing categories within a family to comparing families across each category.
 - C) The total expenditure doubles
 - D) It becomes a pie chart
14. Consider an iterative mixture problem where 1 litre of solution A (concentration C_0) is repeatedly mixed with an equal volume of solution B (concentration C_b). As the number of mixing steps approaches infinity, what does the concentration approach?
- A) C_0
 - B) C_b
 - C) $(C_0 + C_b) / 2$
 - D) Zero
15. If a dataset has weights w_i and values x_i , and we define a new weighted average using weights $w'_i = w_i * x_i$ (assuming $x_i > 0$), what statistical measure does this weighted average represent?
- A) The arithmetic mean
 - B) The weighted harmonic mean
 - C) The ratio of the second moment to the first moment (related to weighted mean of squares)
 - D) The geometric mean
16. In the IUCN Red List species count chart, if a stacked bar shows total species growing from 7,851 to 14,234 over 12 years, what mathematical property ensures that the height of each segment accurately reflects cumulative species addition?
- A) Additivity of disjoint subsets
 - B) Exponential decay
 - C) Trigonometric identity
 - D) Logarithmic scaling
17. If a runner's pace in a triathlon varies across swimming, cycling, and running, why is the overall average speed over the total distance NOT equal to the arithmetic mean of the three segment speeds?

- A) Because distances (weights) of each segment are vastly different (3.8 km, 180 km, 42.2 km), requiring a harmonic or weighted time-distance calculation.
 - B) Because speed is measured in knots
 - C) Because swimming is in water
 - D) Speed is always an arithmetic mean
18. If all weights w_i are multiplied by a non-zero constant k , and all data values x_i are divided by k , what happens to the resulting weighted average?
- A) It is multiplied by k^2
 - B) It is divided by k
 - C) It remains exactly invariant
 - D) It becomes zero
19. In ancient Indian mathematics, Sridharacharya's work Patiganita (c. 750 CE) used weighted averages primarily for what practical application?
- A) Calculating planetary orbits
 - B) Estimating gold-alloy purities (varna/karat calculations)
 - C) Measuring grain volume in cylindrical silos
 - D) Calculating interest rates on loans
20. What is the fundamental topological or geometric difference between a cluster-column chart and a stacked column chart?
- A) Clustered columns place component bars side-by-side from a common baseline (0), whereas stacked columns place component bars end-to-end sequentially.
 - B) Clustered columns use circles instead of rectangles
 - C) Stacked columns cannot display numbers
 - D) There is no difference

Olympiad Level MCQ Answer Key

1. B
2. B
3. C
4. C
5. B
6. A
7. B
8. A
9. A
10. A

11. A
12. C
13. B
14. C
15. C
16. A
17. A
18. B
19. B
20. A

Olympiad Level Subjective Questions

1. Prove algebraically that if every data value x_i is transformed to $ax_i + b$, the new weighted mean is $aM + b$.
2. Derive the partial derivative of the weighted mean M with respect to a weight w_i , assuming sum of $w_i = W$ is constant.
3. Explain why the harmonic mean or weighted harmonic mean is theoretically more appropriate than the arithmetic weighted mean when calculating average speed across varying distances.
4. If the weights w_i are all multiplied by a scalar $k > 0$, prove that the weighted mean remains invariant.
5. Discuss the conditions under which a stacked bar chart can successfully convey both absolute totals and relative proportions without visual ambiguity.
6. Prove that minimizing the weighted sum of squared residuals $\sum w_i (x_i - T)^2$ yields $T = M$ (the weighted mean).
7. Analyze why Sridharacharya's varna formula in Patiganita is mathematically identical to modern weighted average alloy concentration formulas.
8. Evaluate the statement: "A 100% stacked bar chart is merely a nonlinear normalization of a stacked bar chart." Is this true or false? Justify.
9. Explain how Brahmagupta used the weighted mean concept in Brahmasphutasiddhanta for irregular physical structures.
10. If a dataset has weights w_i and values x_i , and we define new weights $w'_i = w_i \cdot x_i$, what does the resulting weighted average represent physically?
11. Describe how time-use survey data (such as the 24-hour day of an average Indian) bridges the gap between bar charts and 100% stacked bar charts.
12. What happens to the weighted average if weights w_i are replaced by ranks or ordinal importance metrics instead of cardinal quantities? Explain the mathematical implications.
13. Prove that if all data values x_i are equal to a constant c , the weighted mean is equal to c regardless of the weights.
14. Analyze the mathematical limitation of comparing proportions across different categories in a 100% stacked bar chart when categories are arranged in different vertical stacks.
15. Discuss how the concept of "average of averages" fails under simple arithmetic mean of group averages but succeeds under weighted mean, providing the algebraic proof.

16. If the population of three animal groups (cows 60%, sheep 25%, chickens 15%) all experience absolute population decreases over a year, explain how their percentage shares can move in opposite directions (some increase, some decrease).
17. Derive the effect on the weighted mean if a single new data point (x_{new} , w_{new}) is added to an existing dataset with weighted mean M and total weight W .
18. Explain why cluster-column charts are preferred over stacked bar charts when the primary analytical goal is comparing individual categories across groups.
19. In the context of the IUCN Red List animal species data, why is a stacked column chart an effective visualization tool for multi-class ecological data over time?
20. Summarize the historical evolution of the weighted mean from ancient Indian mathematics (Brahmagupta, Sridharacharya) to modern statistical applications.

Olympiad Level Subjective Answers

1. Let $M = \sum(w_i x_i) / \sum(w_i)$. The new weighted mean is $\sum(w_i (ax_i + b)) / \sum(w_i) = (a \sum(w_i x_i) + b \sum(w_i)) / \sum(w_i) = a * \sum(w_i x_i) / \sum(w_i) + b * \sum(w_i) / \sum(w_i) = aM + b$.
2. Let $M = \sum(w_j x_j) / W$. Taking the derivative with respect to w_i : $dM / dw_i = (x_i * W - 1 * \sum(w_j x_j)) / W^2 = (x_i - M) / W$.
3. Average speed is defined as Total Distance / Total Time. Since time equals distance divided by speed ($t_i = d_i / s_i$), the reciprocal of average speed is the weighted average of the reciprocals of speeds (weighted by distances), which is the weighted harmonic mean.
4. $M_{\text{new}} = \sum((k w_i) x_i) / \sum(k w_i) = k \sum(w_i x_i) / (k \sum(w_i)) = \sum(w_i x_i) / \sum(w_i) = M$. Thus, scaling all weights by a constant does not alter the weighted mean.
5. A stacked bar chart successfully conveys totals through the full bar length and proportions for the bottom-most segment (which starts at 0). However, for intermediate segments, ambiguity arises because their bases do not start at zero, requiring visual subtraction or auxiliary gridlines.
6. Let $f(T) = \sum(w_i (x_i - T)^2)$. Differentiating with respect to T and setting to zero: $df/dT = -2 \sum(w_i (x_i - T)) = 0 \Rightarrow \sum(w_i x_i) - T \sum(w_i) = 0 \Rightarrow T = \sum(w_i x_i) / \sum(w_i) = M$. Since the second derivative $2 * \sum(w_i) > 0$, this is a global minimum.
7. Varna measured gold purity as parts out of 16 ($k/16$). When melting multiple gold pieces of weights w_i and purities v_i , the total pure gold content is $\sum(w_i v_i)$ and total weight is $\sum(w_i)$, giving the combined purity $\sum(w_i v_i) / \sum(w_i)$, which is the standard weighted mean.
8. It is false. The transformation from a stacked bar chart to a 100% stacked bar chart is a linear scaling per bar (dividing each segment by that bar's total sum S_j), mapping absolute lengths to proportions in $[0, 1]$, rather than a nonlinear distortion.
9. Brahmagupta calculated the mean depth of an irregularly-shaped pit by dividing the pit into longitudinal segments of lengths w_i with respective depths x_i , computing $\sum(w_i x_i) / \sum(w_i)$ to find the effective uniform depth.
10. It represents $\sum(w_i x_i^2) / \sum(w_i x_i)$, which is the ratio of the second weighted moment to the first weighted moment, often appearing in physics (e.g., center of mass of discrete mass distributions with linear density weighting).

11. Because the total duration is strictly fixed at 24 hours (100% of a day), absolute time spent on each activity directly equals its percentage proportion of the whole day, making the chart function simultaneously as a standard stacked bar (in hours) and a 100% stacked bar (in percentages).
12. Replacing cardinal weights with ordinal ranks distorts the proportional influence of data points because ordinal ranks do not preserve relative magnitudes or differences between importance levels, biasing the weighted mean toward uniformly spaced weight assumptions.
13. If $x_i = c$ for all i , then $M = \sum(w_i c) / \sum(w_i) = c * \sum(w_i) / \sum(w_i) = c$.
14. When comparing a non-bottom category across different bars, the vertical displacement (different baseline starting points) creates visual illusion and parallax, making accurate visual comparison of lengths difficult without aligned baselines.
15. Simple arithmetic mean assumes equal group sizes: $(a+b)/2$. The true average is $(an+bm)/(n+m)$. They are equal if and only if $n = m$. If $n \neq m$, the simple mean misrepresents the population center, whereas the weighted mean accounts for group sizes n and m correctly.
16. Percentage shares depend on relative rates of decrease. If cows decrease by 50%, sheep by 10%, and chickens by 5%, the absolute numbers drop for all, but sheep and chicken populations shrink much less, causing their percentage shares of the total remaining population to increase while the cow share decreases.
17. $M_{\text{new}} = (W * M + w_{\text{new}} * x_{\text{new}}) / (W + w_{\text{new}}) = M + (w_{\text{new}} * (x_{\text{new}} - M)) / (W + w_{\text{new}})$. The new mean shifts toward x_{new} proportional to the relative weight of the new data point.
18. Clustered columns place all group bars for a given category side-by-side from a common baseline (0), allowing direct visual comparison of heights, whereas stacked bars obscure intermediate categories behind non-zero baselines.
19. It allows the viewer to simultaneously track two critical metrics: the total number of species across time (total column height) and the changing composition of individual classes (colored segments) within that total.
20. Originating in 7th-century India with Brahmagupta for geometric depth and Sridharacharya for alloy purities, the weighted mean evolved through medieval and 18th-century European mathematics into a foundational tool in statistics, economics, and data science for aggregating heterogeneous data by size, importance, or frequency.