

E-10 The ratio of salary of a worker in July to that in June was $2\frac{1}{2} : 2\frac{1}{4}$. By what % was the salary of July more than salary of June? Also find by what %, salary of June was less than of July.

S-10 Let Salary of July = $\frac{5}{2} x$

and Salary of June = $\frac{9}{4} x$

Refer 5.5, here the basis of comparison is either the salary of June or the salary of July.
 Salary of July more than that of June by per cent

$$\begin{aligned} &= \frac{\text{Difference}}{\text{Salary of June}} \times 100 \\ &= \frac{\left(\frac{5}{2} - \frac{9}{4}\right)x}{\frac{9}{4}x} \times 100 = 11\frac{1}{9}\% \end{aligned}$$

Salary of June less than that of July by per cent

$$\begin{aligned} &= \frac{\text{Difference}}{\text{Salary of July}} \times 100 \\ &= \frac{\left(\frac{5}{2} - \frac{9}{4}\right)x}{\frac{5}{2}x} \times 100 = 10\%. \end{aligned}$$

E-11 In 1987, the enrolment in a school was 1,500. Next year it increased by 10 %. What was the enrolment in 1988?

S-11 Enrolment in 1988 = $1500 \times \frac{110}{100} = 1,650$.

E-12 The side of a square increases by $p\%$, then find by what % does its area increase?

S-12 Suppose, side of a square = b

Original area of the square = b^2 , i.e. result = $A \times B$

Here, both sides are increased by $p\%$,

So, for finding out the % change in area. Refer formula (2A).

$$\text{Net \% change in area} = x + y + \frac{xy}{100}, \text{ where, } x = y = + p$$

$$\Rightarrow \text{Net \% change in area} = p + p + \frac{p^2}{100}$$

$$= 2p + \frac{p^2}{100}$$

Hence area increases by $\left(2p + \frac{p^2}{100}\right)\%$.

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Note: This formula is also applicable when the radius of a circle is increased by $p\%$.

Then its area increases by $\left[2p + \left(\frac{p}{10} \right)^2 \right] \%$.

E-13 The daily wage is increased by 15 %, and a person now gets Rs 23 per day. What was his daily wage before the increase?

$$\begin{aligned} \text{S-13} \quad \text{Original daily wage} &= \frac{\text{Increased daily wage}}{100 + \% \text{ increase}} \times 100 \\ &= \frac{23}{115} \times 100 = 20 \end{aligned}$$

[Refer 5.8]

NB: → In case of decrease use (-) ve sign, before % value.

E-14 'p' litres of oil was poured into a tank and it was still $e\%$ empty. How much oil must be poured into the tank in order to fill it to the brim. Find the capacity of the tank.

S-14 Suppose, 'x' litres are to be poured to fill the tank completely, then, $x = e\%$ of capacity

$$\text{Now, } p + e\% \text{ of capacity} = \text{full capacity} \Rightarrow p + \frac{e}{100} \times \text{capacity} = \text{capacity}$$

$$\Rightarrow \text{capacity} = \frac{p \times 100}{100 - e}$$

$$\therefore x = e\% \text{ of capacity} = \frac{e}{100} \times \frac{p \times 100}{100 - e} \text{ litres} \quad p \text{ litre}$$

$$x = \frac{pe}{100 - e} \text{ litres} = \text{amount of oil to be poured to fill the tank completely.}$$

E-15 A student X passes his examination with 515 marks, having scored 3% above the minimum. If Y had obtained 710 marks, what % would he have been above the minimum?

$$\begin{aligned} \text{S-15} \quad \frac{\text{Marks of Y}}{\text{Marks of X}} &= \frac{100 + \% \text{ above minimum of Y}}{100 + \% \text{ above minimum of X}} \\ \frac{710}{515} &= \frac{100 + Y}{100 + 3} \Rightarrow Y = + 42 \% \end{aligned}$$

Hence Y gets 42% above minimum.

Note: Similarly, if the % marks is below minimum, formula would have been,

$$\begin{aligned} \frac{\text{Marks of Y}}{\text{Marks of X}} &= \frac{100 - \% \text{ below minimum of Y}}{100 - \% \text{ below minimum of X}} \end{aligned}$$

Remember,

$$\frac{\text{Marks of Y}}{\text{Marks of X}} = \frac{100 \pm \% \text{ above/below minimum of Y}}{100 \pm \% \text{ above/below minimum of X}}$$

$$\frac{\text{Marks of X}}{\text{Marks of Y}} = \frac{100 \pm \% \text{ above/below minimum of X}}{100 \pm \% \text{ above/below minimum of Y}}$$

Here, (+) ve sign indicates above minimum and (-)ve sign indicates below minimum.

E-16 If a is x more than b and b is $y\%$ less than a . find the relation between x and y .

S-16 [Refer 5.12]

$$\begin{aligned} y\% &= \frac{x}{100+x} \times 100\% \\ \Rightarrow y &= \frac{x \times 100}{100+x} \Rightarrow \frac{100+x}{100 \times x} = \frac{1}{y} \\ \Rightarrow \frac{1}{y} - \frac{1}{x} &= \frac{1}{100}. \end{aligned}$$

NB: y and x represent only the numerical value. i.e. if a is 3% more than b put only $x = 3$.

E-17 The ratio of number of boys and girls in a school is $3 : 2$ if 20% of the boys and 25% of the girls are holding scholarship, find the % of school students who

- (a) hold scholarship
- (b) do not hold scholarship

S-17 Percentage of scholarship holders

$$\begin{aligned} &= (\text{Boys} \times \% \text{ boys who are scholarship holders}) + (\text{Girls} \times \% \text{ girls who are scholarship holders}) \\ &= \left(\frac{3}{2+3} \times 20 \right) + \left(\frac{2}{3+2} \times 25 \right) = 22. \end{aligned}$$

$$\text{Similarly, percentage of non scholarship holders} = \left(\frac{3}{2+3} \times 80 \right) + \left(\frac{2}{2+3} \times 75 \right) = 78$$

(Since $100 - 20 = 80$, $100 - 25 = 75$)

E-18 Groundnut oil is now being sold at Rs 27 per kg. During last month its cost was Rs 24 per kg. Find by how much % a family should reduce its consumption, so as to keep the expenditure the same.

S-18 New rate = Rs 27/kg

Original rate = Rs 24/kg.

$$\therefore \text{Change in rate} = 27 - 24 = \text{Rs } 3$$

Here, the % change in consumption can be found out directly without finding the % change in rate by the following short-out method.

$$\text{Short-cut: Since, \% change in rate} = \frac{\text{rate change}}{\text{old rate}} \times 100$$

$$\text{So, \% change in consumption} = \frac{-\text{rate change}}{\text{New rate}} \times 100 \quad \text{(observe the difference in the denominator of these two formula)}$$

$$= \frac{-3}{27} \times 100 \% = -11\frac{1}{9} \%$$

Hence, family has to reduce its consumption by $11\frac{1}{9}\%$.

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E-19 A reduction of Rs 2 per kg enables a man to purchase 4 kg more sugar for Rs 16. Find the original price of sugar.

S-19 Here expenditure is fixed (= Rs 16), but as the rate **reduces** (by Rs 2/kg), so, the quantity of sugar available **increases** (by 4 kg). Let original price be Rs x /kg, using the formula 3 [Refer 5.11]

$$\frac{\text{Expenditure}}{x} + \text{change in quantity available} = \frac{\text{Expenditure}}{\text{New rate}}$$

$$\Rightarrow \frac{16}{x} + 4 = \frac{16}{x-2} \Rightarrow x^2 - 2x - 8 = 0 \Rightarrow (x+4)(x-2) = 0 \Rightarrow x = 4 \text{ or } -2$$

Considering the +ve value, original price = **Rs 4 per kg**.

E-20 If the price of coffee is increased by 3%, by how much % must a housewife reduce her consumption of coffee, so as to have no extra expenditure?

S-20 Refer 5.10.1

$$\text{For fixed expenditure, \% change in consumption} = \frac{\% \text{ change in rate}}{100 + \% \text{ change in rate}} \times 100$$

$$\therefore \text{decrease in consumption} = \frac{100 \times 3}{100 + 3} \% = \frac{300}{103} \%.$$

$$\therefore \% \text{ decrease in consumption} = 2 \frac{94}{103} \%$$

The housewife must reduce her consumption of coffee by $2 \frac{94}{103} \%$.

E-21 If from a man's salary of Rs 'S', $p\%$ is deducted on house rent, $k\%$ of the rest on education and $q\%$ of the rest on food, and still there is balance Rs 'b' left, find the value of 'S'.

S-21 Here we know that this is a case of **dependent activity**, also refer the chapter on Fraction.

$$\therefore (1 - p\%) \times (1 - k\%) \times (1 - q\%) \text{ of } S = b.$$

$$\Rightarrow S = \frac{b}{(1 - p\%) \times (1 - k\%) \times (1 - q\%)},$$

E-22 From a man's salary, 10% is deducted on tax, 20% of the rest is spent on education, and 25% of the rest is spent on food. After all these expenditures, he is left with Rs 2,700. Find his salary.

S-22 Using the relation of E-21, we get,

$$\frac{(100 - 10)}{100} \times \frac{(100 - 20)}{100} \times \frac{100 - 25}{100} \times \text{salary} = 2700$$

$$\frac{90}{100} \times \frac{80}{100} \times \frac{75}{100} \times \text{salary} = 2700$$

$$\therefore \text{Salary} = \frac{2700}{90 \times 80 \times 75} \times 100 \times 100 \times 100 = 5000.$$

E-23 When the price of sugar was increased by 32%, a family reduced its consumption in such a way that the expenditure on sugar was only 10% more than before. If 30 kg were consumed per month before, find the new monthly consumption.

S-23 We know that, expenditure = price × consumption.

So, new expenditure becomes 110% of 30

$$\Rightarrow \frac{110}{100} \times 30 = \frac{132}{100} \times \text{new consumption} \quad [\text{Expenditure increases by } 10\%]$$

∴ New consumption = **25kg.**

E-24 A man's income is increased by Rs 1,200 and at the same time, the rate of tax to be paid is reduced from 12% to 10%. He now pays the same amount of tax as before. What is his increased income if 20% of his income is exempted from tax in both cases?

S-24 Since, the same percentage of his income is exempted from tax in both cases, this data is not to be considered.

Now, let x be the increased income.

Amount of Tax_1 = Amount of Tax_2

$$(x - 1200) \times 12\% = x \times 10\%$$

$$x = \text{Rs 7,200} = \text{income after increase.}$$

E-25 When N is reduced by 4, it becomes 80% of itself. What is the value of N ?

(Bank P.O. '91)

S-25 The problem implies that $(100 - 80)\%$ of $N = 4$

$$20\% \text{ of } N = 4 \quad N = \frac{4}{20} \times 100 \quad (\text{Since } 100 - 80 = 20)$$

∴ **$N = 20$.**

E-26 When N is increased by 6, it becomes 102% of itself. What is the value of N ?

(IA '84)

S-26 The problem implies that

$$(102 - 100)\% \text{ of } N = 6$$

$$\Rightarrow 2\% \text{ of } N = 6 \Rightarrow N = \frac{6 \times 100}{2}$$

∴ **$N = 300$.**

E-27 Increase

$$(i) 200 \text{ by } 60\% \qquad (ii) 11 \text{ by } 100\%$$

$$(iii) 35 \text{ by } 200\% \qquad (iv) 48 \text{ by } 12\frac{1}{2}\%$$

$$(v) 1000 \text{ by } 3.5\%$$

S-27 If a number (N) is to be increased by $p\%$ then multiply N by $\frac{100 + p}{100}$

[Refer 5.8]

$$(i) \text{ So, } 200 \text{ becomes } 200 \times \frac{(100 + 60)}{100}, \text{ i.e. } \mathbf{320}.$$

$$(ii) 11 \text{ increases to } 11 \times \frac{100 + 100}{100}, \text{ i.e. } \mathbf{22}.$$

$$(iii) \text{ Increased number } = N \times \frac{100 + p}{100}$$

$$= 35 \times \frac{100 + 200}{100} = \mathbf{105}.$$

$$(iv) \text{ Increased number} = N \times \frac{100 + p}{100}$$

$$= 48 \times \frac{100 + 12\frac{1}{2}}{100}$$

$$= 48 \times \frac{225}{200}$$

$$= 48 \times \frac{9}{8} = 54.$$

$$(v) \text{ Increased number} = N \times \frac{100 + p}{100}$$

$$= 1000 \times \frac{100 + 3.5}{100}$$

$$= 10 \times 103.5 = 1,035.$$

E-28 Decrease

$$(i) 200 \text{ by } 40 \%$$

$$(ii) 16 \text{ by } 25 \%$$

$$(iii) 216 \text{ by } 37\frac{1}{2} \%$$

$$(iv) 300 \text{ by } 2.5 \%$$

$$(v) 1000 \text{ by } \frac{1}{5} \%$$

$$(vi) 50 \text{ by } 12\frac{1}{2} \%$$

S-28 In order to decrease a number N by $p\%$, multiply N by $\frac{100 - p}{100}$.

[Refer 5.11]

$$(i) \text{ Decreased number} = N \times \frac{100 - p}{100}$$

$$= 200 \times \frac{100 - 40}{100} = 120.$$

$$(ii) \text{ Decreased number} = N \times \frac{100 - p}{100}$$

$$= 16 \times \frac{100 - 25}{100} = 12.$$

$$(iii) \text{ Decreased number} = N \times \frac{100 - p}{100}$$

$$= 216 \times \frac{100 - 37\frac{1}{2}}{100}$$

$$\begin{aligned}
 &= 216 \times \frac{\frac{62}{100} - \frac{1}{2}}{100} \\
 &= 216 \times \frac{125}{200} \\
 &= 216 \times \frac{5}{8} = 135.
 \end{aligned}$$

$$\begin{aligned}
 \text{(iv) Decreased number} &= N \times \frac{100 - p}{100} \\
 &= 300 \times \frac{100 - 2.5}{100} \\
 &= 3 \times 97.5 = 292.5. \\
 \text{(v) Decreased number} &= N \times \frac{100 - p}{100} \\
 &= 1000 \times \frac{\frac{100}{5} - \frac{1}{5}}{100} \\
 &= 10 \times \frac{499}{5} = 998.
 \end{aligned}$$

$$\begin{aligned}
 \text{(vi) Decreased number} &= N \times \frac{100 - p}{100} \\
 &= 50 \times \frac{\frac{100}{2} - \frac{12}{2}}{100} \\
 &= 50 \times \frac{175}{200} \\
 &= 50 \times \frac{7}{8} = 43.75.
 \end{aligned}$$

E-29 If 10% of an electricity bill is deducted, Rs 45 is still to be paid. How much was the bill?

S-29 Here Rs 45 refers to $(100 - 10)\%$ of the bill.

Since 90% of bill = 45

$$\Rightarrow 100\% \text{ of bill} = \frac{45}{90} \times 100 = 50$$

Hence the bill was 50.

E-30 The weight of a sand bag is 40 kg. In a hurry, it was weighed as 40.8 kg. Find the error percentage.

(Bank PO '89)

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S-30 % Error =
$$\frac{\text{False weight} - \text{Actual weight}}{\text{Actual weight}} \times 100$$

$$= \frac{40.8 - 40}{40} \times 100 = 2\%$$

∴ The error is **2%**.

E-31 If the price of one kg of cornflakes is increased by 25%, the increase is Rs 10. Find the new price of cornflakes per kg. (C.D.S '86)

S-31 Using the formula (1)

$$\text{Original price} = \frac{\text{Difference in price}}{\text{Difference in per cent}} \times 100$$

$$= \frac{10}{25} \times 100 = 40$$

$$\therefore \text{New price} = 40 \times \frac{125}{100} = 50$$

∴ New price of cornflakes per kg is **Rs 50**.

E-32 The price of a book is reduced by 25%, what is the ratio of

- (i) change in price to the old price?
- (ii) old price to the new price?

Also find

- (iii) the factor by which the old price should be multiplied to give the new price.

S-32 Consider the old price = Rs 100.

(i)
$$\frac{\text{Change in price}}{\text{Old price}} = \frac{25}{100} = \frac{1}{4}$$

(ii)
$$\frac{\text{Old price}}{\text{New price}} = \frac{100}{75} = \frac{4}{3}$$

- (iii) Refer 5.8

$$\text{Decreased price (new price)} = \text{old price} \times \frac{100 - p}{100}, \text{ where } p = 25$$

$$\text{New price} = \text{old price} \times \left(\frac{75}{100} \right)$$

So the required factor is $\frac{3}{4}$.

E-33 If A is more than B by 10%, then find

- (i) $B = A \times ?$
- (ii) $A = B \times ?$

(iii) $\frac{A}{B} = ?$

→ 33 Since A is more than B by 10%,

$$(i) \text{ So } A = B \times \frac{100 + 10}{100}$$

$$\Rightarrow B = A \times \frac{10}{11}.$$

$$(ii) A = B \times \frac{11}{10}.$$

$$(iii) \frac{A}{B} = \frac{100 + 10}{100}$$

$$\therefore \frac{A}{B} = \frac{11}{10}.$$

→ 34 If X is 20% less than Y , then find

$$(i) \frac{X}{Y} = ?$$

$$(ii) \frac{Y - X}{Y} = ?$$

$$(iii) \frac{X}{Y - X} = ?$$

34 Since X is 20% less than Y , therefore

$$(i) \frac{X}{Y} = \frac{100 - 20}{100}$$

$$\frac{X}{Y} = \frac{4}{5}.$$

(ii) X is 20% less than Y , therefore, if Y is 100 then X is 80

$$\Rightarrow \frac{Y - X}{Y} = \frac{100 - 80}{100}$$

$$\therefore \frac{Y - X}{Y} = \frac{1}{5}.$$

$$(iii) \frac{X}{Y - X} = \frac{80}{100 - 80}$$

$$\frac{X}{Y - X} = \frac{4}{1}.$$

→ 35 If $2\frac{1}{2}\%$ of the weight of a table is 0.2 kg, then what will be 120% of it? (C.D.S '83)

35 $2\frac{1}{2}\%$ of weight = 0.2 kg (use the unitary method)

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$$\Rightarrow 120\% = \frac{0.2}{2} \times 120 = \frac{0.2 \times 120}{5} \times 2 = 9.6$$

∴ 120% of the weight of the table is 9.6 kg.

REGULAR PROBLEMS

- (1) The number 0.05 is what percentage of 20?
 (a) 1.5 (b) 0.025 (c) 0.25 (d) 2.5 (e) 25
- (2) 12 is 0.2% of?
 (a) 2400 (b) 600 (c) 240 (d) 6000 (e) 2
- (3) In an election, one of the two candidates got 30% of the total votes polled, but he lost by 210 votes. What was the total number of votes polled?
 (a) 525 (b) 700 (c) 610 (d) 300 (e) 520
- (4) There are 850 students in a class. Out of these, 44% are Muslims, 28% Hindus, 10% Sikhs and remaining students belong to the other communities. How many students are there of other communities?
(RRB Secunderabad, '01)
 (a) 173 (b) 143 (c) 153 (d) 163 (e) 133
- (5) The price of an article is cut by 10%, to restore to its original value, the new price must be increased by:
 (a) 10% (b) $9\frac{1}{11}\%$ (c) 11% (d) $11\frac{1}{9}\%$ (e) 90%

Hint: Use the concept: if A is $x\%$ less than B, then B exceeds A by $\frac{x}{100-x}\%$

new price original price

- (6) The difference between one-fifth of 1000 and one-fifth per cent of 1000 is:
 (a) 800 (b) 80 (c) 198 (d) 998 (e) 0
- (7) A man spends 80% of his income and saves the rest. What percentage of his expenditure does he save?
 (a) 20 (b) 25 (c) 30 (d) 40 (e) Data insufficient
- (8) 15% of x subtracted from x is equal to multiplying x by which number?
 (a) 0.15 (b) $\frac{23}{20}$ (c) 115 (d) $\frac{17}{20}$ (e) $\frac{0.85}{100}$
- (9) A pudding is made of 400 gm sugar, 200 gm of eggs, 800 gm of flour and 100 gm of dry fruit. The percentage of sugar present in the pudding is :
 (a) $11\frac{1}{9}\%$ (b) 40% (c) 20% (d) $26\frac{2}{3}\%$ (e) $12\frac{1}{2}\%$
- (10) If 16% of 40% of a number is 8 then the number is
 (a) 200 (b) 225 (c) 125 (d) 325 (e) 512
- (11) The radius of a circle is so increased that its circumference increases by 5%. Then the area of the circle will increase by:
 (a) 10% (b) 25% (c) 10.25% (d) 12.5% (e) 5%

Hint: Refer 5.10

- (12) 40% of the population of a town are men and 35% are women. If the number of children are 20000, then the number of men will be:
 (a) 3200 (b) 80000 (c) 32000 (d) 320,000. (e) 2,00,000.
- (13) A medical student has to secure 40% marks to pass. He gets 80 and fails by 60 marks. Find the maximum marks.
 (a) 150 (b) 250 (c) 350 (d) 450 (e) 500
- Hint:** Refer 5.4.1. Here, maximum marks is the (base) number, because % pass marks is referred as 40% of maximum marks
- (14) 40% of the students of a college are from West Bengal and out of this, 40% are from Kolkata. What % of the students are not from Kolkata?
 (a) 60 (b) 16 (c) 40 (d) 84 (e) 20
- (15) A school has a student population of 560. The number of girls is $14\frac{2}{7}\%$ of the number of boys. How many girls are in the school?
 (a) 100 (b) 70 (c) 80 (d) 140 (e) 240.
- Hint:** $14\frac{2}{7}\% = \frac{1}{7}$
- (16) A man saves $3\frac{1}{3}\%$ from his salary of Rs 750 every month. In how many months will he be able to save an amount equal to his monthly salary?
 (a) 40 months (b) 50 months (c) 30 months (d) 45 months (e) None of these
- (17) In an examination, 'P' scored 130 points, which are 10 points above 40%, and 'Q' scored 75%. The points scored by 'Q' are
 (a) 225 (b) 250 (c) 200 (d) 275 (e) 300
- (18) When 75% of a number is added to 75, the result is the number again. The number is
 (a) 150 (b) 300 (c) 100 (d) 450 (e) 350
- (19) The percentage of total quantity represented by a 12° sector in a circle graph (pie diagram) is.
 (a) 12% (b) 24% (c) $33\frac{1}{3}\%$ (d) $3\frac{1}{3}\%$ (e) 36%
- Hint:** Total quantity in a circle graph (pie diagram) = 360°
- (20) If the price of sugar is increased by 7%, then by how much per cent should a housewife reduce her consumption of sugar, to have no extra expenditure
 (a) 7 over 107% (b) 107 over 100% (c) 100 over 107%
 (d) 7%
- Hint:** Refer 5.10.1
- (21) What is the total number of customers in a shop on a particular day, when 31% of them purchases on credit, and the number of those who do cash purchase exceeds the number of credit purchases by 247?
 (a) 605 (b) 560 (c) 650 (d) 1650 (e) 620
- (22) 5 out of 2250 parts of the earth is sulphur. The percentage of sulphur in the earth is
 (a) 11 over 50% (b) 2 over 9 (c) 1 over 45 (d) 2 over 45 (e) None of these
- (23) In Mathematics examination, a student scored 30% in the first paper of 180 marks. How much % marks should he score in the second paper of 150 marks if he is to get an overall percentage of at least 50%
 (a) 20 (b) 74 (c) 30 (d) 65 (e) 70

Tips: Do not try to calculate the marks obtained in each paper, because here the % marks are used in the problem and also % marks is to be foundout. Total marks = 180 + 150 = 330. As per question, 50% (330) = 30% of 180 + x% of 150.

- (24)** Nagamani had a car to sell. Loknayak offered him a sum of money for the car that he refused as it was 13% below its value. Loknayak then offered Rs 450 more and the second offer was 5% more than the estimated value. What was the value of the car?
 (a) Rs 3000 (b) Rs 2500 (c) Rs 3800 (d) Rs 2800 (e) None

Answers

- | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (c) | 2. (d) | 3. (a) | 4. (c) | 5. (d) | 6. (c) | 7. (b) | 8. (d) | 9. (d) |
| 10. (c) | 11. (c) | 12. (c) | 13. (c) | 14. (d) | 15. (b) | 16. (c) | 17. (c) | 18. (b) |
| 19. (d) | 20. (a) | 21. (c) | 22. (b) | 23. (b) | 24. (b) | | | |

REAL PROBLEMS

- (1)** Which number is 40% less than 360?
 (a) 90 (b) 144 (c) 216 (d) 270 (e) 288
- (2)** p is 6 times that q . By what per cent is q less than p ?
 (a) 500 (b) $83\frac{1}{3}$ (c) 5 (d) 20 (e) $16\frac{2}{3}$
- (3)** If 90% of A = 30% of B and $B = x\%$ of A , then the value of x is
 (a) 600 (b) 800 (c) 900 (d) 300 (e) None
- (4)** If $\frac{1}{8}$ of $\frac{2}{3}$ of $\frac{4}{5}$ of a number is 12 then 30 per cent of the number will be
 (a) 48 (b) 64 (c) 54 (d) 42 (e) None of these
- (5)** A piece of cotton cloth 20 m long, shrinks by 0.5% after washing. The length of the cloth after washing is
 (a) 19.5 m (b) 19.9 m (c) 19.95 m (d) 19.92 m (e) 19.05 m.
- (6)** The percentage by which 120 is to be diminished to get 90 is:
 (a) 30 (b) 25 (c) 20 (d) $33\frac{1}{3}$ (e) None of these
- (7)** Two numbers are 20% and 25% less than the third number. By how much per cent is the second number to be enhanced to make it equal to the first number?
 (a) $6\frac{2}{3}$ (b) $6\frac{1}{4}$ (c) 25 (d) $33\frac{1}{3}$ (e) 20

Tips: When any number ' x ' is related to two or more than two numbers in terms of percentage, then it is convenient to assume $x = 100$.

- (8)** 2 over 3 is? per cent of 5 over 7. The value of (?) is
 (a) 90 (b) 93.33 (c) 94 (d) 9 (e) None of these
- (9)** There is an increase of 30% in the production of milk chocolates in Amul Dairy in one month. If now it is 9100 milk chocolates per month, what was it one month ago?
 (a) 13000 (b) 10300 (c) 8400 (d) 7000 (e) 11700
- (10)** A positive number is by mistake divided by 6 instead of being multiplied by 6. What is the % error on the basis of correct answer?
 (a) 3 (b) 97 (c) 17 (d) 83 (e) 100

- 11) When 30 per cent of a number is added to another number the second number increases to its 140 per cent. The second number = $x\%$ of the first number. The value of x is
 (Bank of Baroda PO, '99)
- (a) 130 (b) 75 (c) $133\frac{1}{3}$ (d) $33\frac{1}{3}$ (e) 110
- 12) If the length of a rectangle is increased by 20% and the breadth is reduced by 20%, what will be the effect on its area?
 (Guwahati PO, '99)
- (a) 4% increase (b) 6% increase (c) 4% decrease (d) No change (e) None of these
- 13) If the height of a triangle is decreased by 40% and its base is increased by 40%, what will be the effect on its area?
 (SBI PO, '99)
- (a) No change (b) 16% increase (c) 8% decrease (d) 16% decrease (e) None of these
- 14) If two numbers are respectively 20% and 50% of the third number, then what % is the first number of the second?
 (a) 30 (b) 70 (c) 40 (d) 30 (e) 50.
- 15) In measuring the side of a square, an error of 5% in excess is made. The error percentage in the calculated area is
 (a) $10\frac{1}{4}$ (b) $10\frac{3}{4}$ (c) $1\frac{3}{4}$ (d) 25 (e) 5
- 16) A number exceeds by 40 when added by 20% of itself. The number is
 (a) 200 (b) 60 (c) 80 (d) 320 (e) 120
- 17) A rainy day occurs once in every 25 days. Half of the rainy days produce rainbows. The percentage of days having no rainbows is :
 (a) 2 (b) $12\frac{1}{2}$ (c) 98 (d) $87\frac{1}{2}$ (e) 50
- 18) In a class of 52 students, 25% are rich and others are poor. There are 20 females in the class, of whom 55% are poor. How many rich males are there in the class?
 (NABARD, '96)
- (a) 13 (b) 4 (c) 39 (d) 2 (e) 28
- 19) When any number is divided by 12, then dividend becomes $\frac{1}{4}$ of the other number. By how much per cent is first number greater than the second number?
 (BSRB, Chennai, 2000)
- (a) 200 (b) 150 (c) 300 (d) data inadequate (e) None
- 20) Naresh's monthly income is 30% more than that of Raghu. Raghu's monthly income is 20% less than that of Vishal. If the difference between the monthly incomes of Naresh and Vishal is Rs 800, what is the monthly income of Raghu?
 (Baroda PO, '99)
- (a) Rs 16000 (b) Rs 20000 (c) Rs 12000 (d) Data inadequate (e) None
- Hint:** Since the difference of income has been given in respect of Naresh and Vishal. So, at first, find the relation of income for Naresh with Vishal and equate the difference.
- 21) The rate for admission to an exhibition was Rs 5 and was later reduced by 20%. As a result, the sale proceeds increased by 44%.
- The percentage increase in attendance was:
 (a) 80 (b) 24 (c) 64 (d) 20 (e) None of these
- Hint:** Rate \times attendance = sale proceeds

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5-26 Quantitative Aptitude for Competitive Examinations

- (22) An ore contains 40% mass impurity, while the metal extracted from this ore contains 4% impurity. How much metal will 24 tons of the ore yield?
(a) 10 tons (b) 20 tons (c) 9 tons (d) 12 tons (e) 15 tons

Tips: Since only pure part of the ore yields metal. So, equate the pure (quantity) part in the ore and pure part in the metal.

- (23) At an examination in which maximum marks are 500, A got 10% less than B, B got 25% more than C, C got 20% less than D. If A got 360 marks, what percentage of marks was obtained by D?
(a) 60 (b) 72 (c) 55 (d) 80 (e) 40

Hint: Since D is the last in the % relation, so assume the marks obtained by D = x

Answers

1. (c) 2. (b) 3. (d) 4. (c) 5. (b) 6. (b) 7. (a) 8. (d) 9. (d)
10. (b) 11. (b) 12. (c) 13. (d) 14. (c) 15. (a) 16. (a) 17. (c) 18. (b)
19. (d) 20. (a) 21. (a) 22. (e) 23. (d)

6

AVERAGE

6.1 INTRODUCTION

The idea of **average** is not new to us. We all are familiar with the following types of statements

- (i) The average runs scored by Sachin Tendulkar in a series is 72.
- (ii) The average marks secured by Kana is 78%.

If a man earns Rs 40, Rs 50, Rs 56, Rs 46 and Rs 48 on five consecutive days of a week. then he earns a total of Rs $(40 + 50 + 56 + 46 + 48) = \text{Rs } 240$.

To find his average earning per day, his total earning is divided by the number of days, i.e.,

$$\text{Average} = \frac{240}{5} = \text{Rs } 48$$

Average earning does not mean that he earned Rs 48 everyday . But had he earned Rs 48 everyday, then his total earnings would have also been Rs 240 in 5 days.

Hence, to find the average of given quantities:

Step 1 The given quantities are added to get a **Sum**

Step 2 The **Sum** is divided by the **Number of items** to get the **Average**.

$$\therefore \frac{\text{Sum of all the items}}{\text{Number of items}} = \text{Average} \quad (1)$$

Note: The average is also called the Mean.

The quantities, whose average is to be determined, *should be in the same unit*.

Hence,

$$\text{Sum of all the items} = \text{Average} \times \text{no. of items} \quad (2)$$

6.2 AVERAGE OF DIFFERENT GROUPS

Sometimes, the average of two different groups are known and the average of a third group (made by combining these two groups) is to be found out.

Let,

$$\text{Group 1} + \text{Group 2} \text{ makes Combined Group (1 + 2)}$$

No. of items =	m	n	$m + n$
Average =	a	b	A
Sum of all items =	ma	nb	$ma + nb$

Therefore, average of combined group = $\frac{\text{Sum of all items}}{\text{No. of items}}$

$$A^* = \frac{ma + nb}{m + n} \quad (3)$$

*This formula is also applicable for more than two groups forming the combined group.

Example: The average weight of 17 girls is 20 kg and that of 23 boys is 22 kg. Find the average weight of the class.

Solution:	<u>Girls</u>	<u>Boys</u>
	No. in the class = 17	23
	Average = 20	22

$$\therefore \text{average weight of the class} = \frac{17 \times 20 + 23 \times 22}{17 + 23}$$

$$= 21.15 \text{ kg.}$$

6.3 ADDITION OR REMOVAL OF ITEMS AND CHANGE IN AVERAGE

Since, Average = $\frac{\text{Sum of the items}}{\text{Number of items}}$

So, the original average may change (increase/decrease), if number of items change. The number of items may change in the following two cases,

Case I

When one or more than one NEW items are added

Let the average of N items = A

Now, ' n ' New items are **added** and the average increases or decreases by x , then

$$\text{Average of New items added} = A \pm \left(1 + \frac{N}{n}\right)x$$

↓
Use $(-)$, when average decreases
 $(+)$, when average increases.

(4)

When only one New item is added, put $n = 1$, then

$$\text{Value* of the New item added} = A \pm (N + 1)x$$

Case II

When one or more than one items are removed

In this case, items are removed, so on placing $-\frac{N}{n}$ in place of $+\frac{N}{n}$ in formula (4), it becomes.

* Here, it deals with ONE item only, so, average has got no meaning and thus, 'average' is replaced by 'value' of that ONE item.

$$\text{Average of items removed} = A \pm \left(1 - \frac{N}{n}\right)x$$

↓
 Use (-), when average decreases
 (+), when average increases

(5)

When only ONE item is removed, put $n = 1$, then

$$\text{Value* of the item removed} = A \pm (1 - N)x$$

Example: The average age of 40 students in a class is 15 years. When 10 new students are admitted, the average is increased by 0.2 year. Find the average age of the new students.

Solution: Here, 10 students are added, and average increases by 0.2 year. Therefore, using formula (4).

$$\begin{aligned}\text{Average age of new students} &= A + \left(\frac{N}{n} + 1\right)x \\ &= 15 + \left(\frac{40}{10} + 1\right) 0.2 \\ &= 15 + 1 \\ &= 16 \text{ years.}\end{aligned}$$

Example: The average salary of 15 teachers is Rs 4500 per month. Three teachers left the school and the average salary of the remaining teachers dropped by Rs 175. Find the total salary of the teachers who left the school.

Solution: Here, 3 teachers have been removed from the group, and the average salary dropped by Rs 175. Therefore, using formula (5).

$$\begin{aligned}\text{Average salary of the teachers who left} &= A - \left(1 - \frac{N}{n}\right)x \\ &\quad \downarrow \\ &\quad (-) \text{ sign, because average decreases} \\ &= 4,500 - \left(1 - \frac{15}{3}\right) (175) \\ &= 4,500 - (-4) (175) \\ &= \text{Rs } 5,200\end{aligned}$$

$$\begin{aligned}\text{Hence, total salary of 3 teachers who left the school} &= 3 \times 5,200 \\ &= \text{Rs } 15,600\end{aligned}$$

6.4 REPLACEMENT OF SOME OF THE ITEMS

Sometimes, when a number of items of a group are removed and these are replaced with equal number of different items, then the average of the group changes, (increases or decreases) by x .

Let there are N items in the group, then

$$\text{Sum of New items added} - \text{Sum of removed items} = \pm Nx$$

↓
 (-)ve. when average decreases
 (+)ve. when average increases

(6)

6-4 Quantitative Aptitude for Competitive Examinations

Example: When a man weighing 80 kg is replaced by another man in a group of five persons, the average weight decreases by 3 kg. What is the weight of new man?

Solution: Using formula (6).

$$\begin{aligned} \text{Weight of new man} - \text{Weight of removed man} &= -Nx \text{ (-ve, average decrease)} \\ \Rightarrow \text{Weight of new man} - 80 &= -5 \times 3 \\ \Rightarrow \text{Weight of new man} &= 80 - 15 \\ &= 65 \text{ kg.} \end{aligned}$$

6.5 SOME PROBLEM-SPECIFIC FORMULAE

- (i) Before 't' years, the average age of 'N' members of a family was 'T' years. If the average remains same even after one more member joins the family, then present age of new member = $T - Nt$.

Example: Four years ago, the average age of six members of a family was 26 years. On the birth of a child in the family, the average remains the same. Find the present age of the child.

$$\begin{aligned} \text{Solution:} \quad \text{Present age of the child} &= 26 - 6 \times 4 \\ &= 2 \text{ years.} \end{aligned}$$

- (ii) Out of the given numbers, if the average of first 'n' numbers is 'x' and that of last 'n' numbers is 'y', then

$$\text{First number} - \text{last number} = n(x - y).$$

Example: The average temperature of June, July and August was 31°C . The average temperature of July, August and September was 30°C . If the temperature of June was 29°C , find the temperature of September.

Solution: In the given problem, four months have been indicated, i.e.

$$\begin{array}{cccc} \text{June,} & \text{July,} & \text{August,} & \text{September} \\ 1 \text{ (first)} & 2 & 3 & 4 \text{ (last)} \end{array}$$

Out of these, the average temperature of first three ($n = 3$) months = $31^{\circ}\text{C} = x$

and the average temperature of last three ($n = 3$) months = $30^{\circ}\text{C} = y$

Then, by the formula in (ii)

Temperature of first month - temperature of last month = $n(x - y)$

\Rightarrow temperature of June - temperature of September = $3(31 - 30)$.

$\Rightarrow 29 - \text{temp. of September} = 3$

\therefore Temperature of September = 26°C

Solved Examples

- E-1** The average age of students in section A of 40 students is 10 years and the average age of students in section B of 30 students is 12 years. Find the average age of students in both sections taken together.

S-1 Here, average of $40 + 30$ students is to be found out. Refer 6.2

$$\text{Average} = \frac{ma + nb}{m + n} = \frac{40 \times 10 + 30 \times 12}{(40 + 30)} = \frac{760}{70} = 10.855 \text{ years}$$

\therefore Average age of all the students = 10.86 years.

- E-2** The average of 5 quantities is 6. The average of three of them is 4. What is the average of remaining two quantities?

S-2 Let the average of two quantities be x .
 then as per question,

$$6 = \frac{3 \times 4 + 2 \times x}{5}$$

$$\Rightarrow x = 9$$

\therefore required average = 9.

E-3 30 pens and 75 pencils were purchased for Rs 510. If the average price of a pencil was Rs 2.00, find the average price of a pen.

S-3 [Refer 6.1], using the formula (2).

Average of quantities \times Number of quantities = Sum of quantities

Here quantity is the cost of pen.

Let average price of pen be Rs y

$$\therefore 30 \times y + 75 \times 2 = 510 = \text{Sum of the cost.}$$

$$\Rightarrow y = 12,$$

\therefore Average price of pen = **Rs 12**.

E-4 The average age of A and B is 20 years. If C were to replace A , the average would be 19 and if C were to replace B , the average would be 21. What are the ages of A , B and C ? (MBA '82)

S-4 Say, a , b , c are the ages of A , B , and C

Since the average age of A and B is 20 years, so,

$$\frac{a+b}{2} = 20$$

$$\Rightarrow a + b = 40 \quad (i)$$

As per question, when C replaces A , average drops by $19 - 20 = -1$.

So, using formula (6), we get. (refer 6.4)

$$c - a = -2 \times 1 \quad (ii)$$

Similarly, when C replaces B , average increases by $21 - 20 = +1$.

$$c - b = 2 \times 1 \quad (iii)$$

Adding (i), (ii) and (iii), we get

$$c = 20.$$

Then from (ii), $a = 22$ and from (iii), $b = 18$

\therefore Age of $A = 22$ yrs, age of $B = 18$ yrs, age of $C = 20$ yrs.

E-5 The average monthly expenditure of a family was Rs 2,200 during first 3 months, Rs 2,550 during next 4 months and Rs 3,120 during last 5 months of the year. If the total saving during the year was Rs 1,260, find average monthly income.

S-5 Total yearly income = yearly expenditure + yearly saving

$$= [2200 \times 3 + 2550 \times 4 + 3120 \times 5] + 1260 = \text{Rs } 33,660$$

$$\text{Average monthly income} = \frac{33660}{12} = \text{Rs } 2,805.$$

E-6 The average temperature on Tuesday, Wednesday and Thursday was 37°C . The average temperature on Wednesday, Thursday and Friday was 38°C . If the temperature on Friday was 39°C , find the temperature on Tuesday.

S-6 Average Temperature

$$37^{\circ}\text{C}$$

$$38^{\circ}\text{C}$$

It is same.

$$\begin{array}{l} \text{Tue} + \boxed{\text{Wed} + \text{Thurs}} \\ \text{Fri} + \boxed{\text{Wed} + \text{Thurs}} \end{array}$$

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6-6 Quantitative Aptitude for Competitive Examinations

Here, Tuesday is replaced by Friday. So, using the relation 6 for replacement of one quantity only.
 Replacing quantity - replaced quantity = Change in average \times Number of quantity

$$\therefore \text{Temperature of Friday} - \text{Temperature of Tuesday} = (+) 1 \times 3$$

$$\Rightarrow 39 - \text{Temperature of Tuesday} = +3$$

$$\Rightarrow \text{Temperature of Tuesday} = 39 - 3 = 36^{\circ}\text{C}.$$

E-7 The average weight of 29 students in a class is 48 kg. If the weight of the teacher is included, the average weight rises by 500 g. Find the weight of the teacher.

S-7 Here, weight of the teacher added and final average of the group increases by 0.5 kg. Since, here only one item (i.e. weight of one teacher) has been added, so using the formula [Refer 6.3]

$$\therefore \text{weight of teacher} = A + (N + 1) x \\ = 48 + (29 + 1) \times 0.5 = 63 \text{ kg}$$

E-8 There are 50 boys in a class. Their average weight is 45 kg. When one boy leaves the class, the average reduces by 100 g. Find the weight of the boy who left the class.

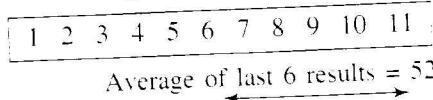
S-8 Since here only one item (i.e. weight of boy who leaves the class) has been removed, so, using formula (5). (here, average drops)

$$\text{Value of one item removed} = A - (1 - N) x \\ \Rightarrow \therefore \text{weight of boy who left} = 45 - (1 - 50) \times 0.1 \\ = 45 + 4.9 \\ = 49.9 \text{ kg.} \quad [100 \text{ gm} = 0.1 \text{ kg}]$$

\therefore weight of boy who left the class is **49.9 kg.**

E-9 The average of 11 results is 50. If the average of first six results is 49 and that of last six results is 52, find the sixth result.

S-9 Average of 11 results



$$\text{Average of first 6 results} = 49$$

From the above diagram, it is quite obvious that the 'sixth result' is included twice, once in the first six results and second in the last six results.

$$\therefore \text{Value of the sixth result} = (\text{Sum of first six results}) + (\text{Sum of last six results}) - (\text{Sum of 11 results}) \\ = 6 \times 49 + 6 \times 52 - 11 \times 50 = 56.$$

E-10 A batsman's runs just before the last match of the season, adds up to 750. In his last two innings, he scores only 6 runs, and his average drops by 2. Find his final average of the season.

S-10 For a batsman, average = $\frac{\text{Total runs scored}}{\text{Total number of innings playing}}$

Suppose,

Just before the last match, the batsman played "N" number of innings.

$$\therefore \text{Original average } A = \frac{750}{N}$$

Using formula (4).

$$\text{average of two innings added} = A - \left(1 + \frac{N}{n}\right)x$$

[(-)ve, average drops

$$\Rightarrow \frac{6}{2} = \frac{750}{N} - \left(1 + \frac{N}{2}\right) 2$$

$$\Rightarrow N^2 + 5N - 750 = 0$$

$$\therefore N = 25$$

\therefore Total no. of innings played before the last match = 25

$$\therefore \text{Original average} = \frac{750}{25} = 30$$

$$\therefore \text{Final average} = 30 - 2 = \mathbf{28 \text{ runs.}}$$

11 The average weight of 15 students in a class is increased by 1.5 kg when one of the students weighing 40 kg is replaced by a new student. Find the weight of the new student.

11 Using formula (6), for one item replacement,

$$\text{weight of new student} - \text{weight of removed student} = +Nx$$

$$\Rightarrow \text{weight of new student} - 40 = 15 \times 1.5$$

$$\therefore \text{weight of new student} = 40 + 22.5 = \mathbf{62.5 \text{ kg.}}$$

12 Find the average of

(a) 9 consecutive odd numbers $a, b, c, d, e, f, g, h, i$

(b) 7 consecutive even numbers k, l, m, n, o, p, q

(c) 6 consecutive odd numbers a, b, c, d, e, f

(d) 4 consecutive numbers j, k, l, m

12 (a) There are 9 (odd) consecutive odd numbers.

Hence, the average of 9 consecutive odd numbers is the middle number (i.e. 5th number)

\therefore the average is ' e '.

(b) There are 7 (odd) consecutive even numbers.

The average of 7 consecutive even numbers is the middle number (i.e. 4th number)

\therefore the average is ' n '.

(c) There are 6 (even) consecutive odd numbers.

The average of 6 consecutive odd numbers is the average of two middle numbers (i.e. 3rd and 4th number)

\therefore the average is $\frac{c+d}{2}$.

(d) There are 4 (four) consecutive numbers.

The average of 4 consecutive numbers is the average of two middle numbers (i.e. 2nd and 3rd numbers)

\therefore the average is $\frac{k+l}{2}$.

REGULAR PROBLEMS

1 The mean of marks secured by 25 students in section A of Class X is 47, that of 51 students of section B is 51 and that of 30 students of section C is 53. Find the mean of marks of the students of three sections of Class X.

(a) 50

(b) 50.6

(c) 52.5

(d) 54.5

(e) 51.5

(RBI, '96)

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6-8 Quantitative Aptitude for Competitive Examinations

- (2) There are Indians and Europeans in an army of 12,000. The average height of Europeans is 5'10" and that of Indians is 5'9" and the average height of the entire army is $5'9\frac{3}{4}''$. Find out the number of Indians in the army.

(RRB Ahmedabad, '97)

- (a) 2500 (b) 3000 (c) 2800 (d) 2200 (e) 2000

- (3) The average age of a family of five persons is 20 years. If the youngest member is x years old. What was the average age of the family at the birth time of the youngest member?

- (a) 12 years (b) 15 years (c) 18 years (d) 16 years (e) 23 years

Hint: Find the total age of the family now and 8 years earlier.

- (4) The average of five consecutive numbers is 16. The highest of these numbers is:

- (a) 21 (b) 20 (c) 18 (d) 19 (e) 22

Hint: Assume the first number as x , then consecutive numbers are $x + 1, x + 2, x + 3$ and $x + 4$.

- (5) The average of six numbers is 12. If each number is increased by 2, the new average is:

- (a) 8 (b) 4 (c) 14 (d) 24 (e) 12

Hint: Since each number is increased by same amount, so, average will also increase by same amount.

- (6) If the average of three numbers a, b and c is A , then the average of a, b, c and A is:

- (a) Data insufficient (b) $2A$ (c) $\frac{A}{2}$ (d) $4A$ (e) A

- (7) The average temperature of the first three days of a week is 27°C and of the next three days is 29°C . If the weekly average is 28.5°C , then the temperature of the last day is:

- (a) 31.5°C (b) 28°C (c) 42°C (d) 21°C (e) 26°C

- (8) A batsman has a certain average of runs for 9 innings. In the 10th innings, he makes a score of 100 runs thereby increasing his average by 8 runs. His new average is:

- (a) 32 (b) 36 (c) 25 (d) 40 (e) 28

Hint: While finding the average, always use the basic formula, i.e. average = $\frac{\text{Sum of all quantities}}{\text{No. of quantities}}$

- (9) The average age of 24 boys in a class is 16. If the teacher is included and one boy is excluded from the group, the average increases by one. The age of the teacher is:

- (a) 41 (b) 32 (c) 45 (d) 24 (e) Data insufficient

- (10) The average weight of 35 students in a class is 35 kg. If the teacher is also included, the average weight increases to 36 kg. The weight of the teacher is:

- (a) 36 kg (b) 35 kg (c) 70 kg (d) 71 kg (e) 34 kg

- (11) The average number of printing errors per page in a book of 512 pages is 4. If the total number of printing errors in the first 302 pages is 1208, the average number of printing errors per page in the remaining pages is:

- (a) 0 (b) 4 (c) 840 (d) 90 (e) 9

- (12) Of the three numbers, the first is four times the second and three times the third. If the average of all the three numbers is 95, then the third number is:

- (a) 57 (b) 76 (c) 38 (d) 60 (e) 130

- (13) The total production of 10 tea estates is 550 tonnes. By opening two new tea estates, the average increases by 3 tonnes. The average production of these two new tea estates (in tonnes) is:

- (a) 70 (b) 64 (c) 67 (d) 73 (e) 68

- (14) The average age of 10 members in a family is 21 years and due to death of one family member, the average age is reduced by 2 months. The age of the member who died is:
- (a) 20 years 10 months (b) $20\frac{1}{3}$ years (c) 22 years
 (d) $19\frac{1}{3}$ years (e) None
- (15) If a, b, c, d and e are five consecutive odd numbers, their average is:
- (a) $5(a + 4)$ (b) $\frac{abcde}{5}$ (c) $5(a + b + c + d + e)$
 (d) $a + 4$ (e) None of these
- (16) The average of a batsman for 40 innings is 50 runs. His highest score exceeds his lowest score by 172 runs. If these two innings are excluded, his average drops by 2 runs. His highest score is:
- (a) 86 (b) 92 (c) 174 (d) 170 (e) 88
- (17) The average of three numbers is 45. The first is as much more than the average as the second number is less than the average. Find the third number.
- (a) 40 (b) 41 (c) 20 (d) 45 (e) 43
- (18) A mathematics teacher tabulated the marks secured by 35 students of 8th class. The average of their marks was 72. If the marks secured by Reema was written as 36 instead of 86 then find the correct average marks up to two decimal places.
- (a) 73.41 (b) 74.31 (c) 72.43
 (d) 73.43 (e) cannot be determined
- Hint:** Correct average = $72 + \frac{(86 - 36)}{35}$, -36, because 36 is to be replaced
- (19) Among three numbers, the first is twice the second and thrice the third. If the average of three numbers is 49.50, then what is the difference between the first and the third number?
- (a) 54 (b) 28 (c) 39.50 (d) 41.50 (e) 33

Answers

1. (b) 2. (b) 3. (b) 4. (c) 5. (c) 6. (e) 7. (a) 8. (e) 9. (e)
 10. (d) 11. (b) 12. (d) 13. (d) 14. (c) 15. (d) 16. (c) 17. (d) 18. (d)
 19. (a)

REAL PROBLEMS

- (1) The average of two numbers is XY . If one number is X , then the other number is:
- (a) Y (b) $\frac{Y}{2}$ (c) $2XY - X$ (d) $X(Y - 1)$ (e) $\frac{XY}{2}$
- (2) Of three numbers whose average is 60, the first is $\frac{1}{4}$ th of the sum of other two. The first number is:
- (a) 30 (b) 60 (c) 36 (d) 24 (e) 20

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6-10 Quantitative Aptitude for Competitive Examinations

- (3) Out of four numbers, the average of the first three is 15 and that of the last three is 16. If the last number is 19, then first number is:

(a) 15 (b) 16 (c) 18 (d) 19 (e) 22

Tips:

1	2	3	4
---	---	---	---

 \downarrow \downarrow
15 16

- (4) A cricket player makes 200 runs in the 15th over. In doing so, his average at the end of the 14th over increases by 10. What was his average at the end of 15th over? **(RRB Guwahati, '97)**

(a) 60 (b) 50 (c) 40 (d) 45 (e) 35

- (5) The average of Suresh's marks in English and History is 55. His average marks in English and Science is 65. What is the difference between the marks that he obtained in History and Science? **(Baroda Bank PO, '97)**

(a) 40 (b) 60 (c) 20 (d) data inadequate (e) None

- (6) A body weighs 121 grams and 125.44 grams on two different pans of a faulty balance. Its true weight will be:

(a) 4.44 gms (b) 120 gms (c) 123.22 gms (d) 130 gms (e) 122 gms

- (7) The average of three consecutive odd numbers is 14 more than one-third of the first of these numbers. What is the last of these numbers?

(a) 17	(b) 19	(c) 15
(d) data inadequate	(e) None of these	

- (8) Ten years ago, the average age of a family of four members was 24 years. Three children having been born, the average age of the family is same today. What are the present ages of children, if two children are identical twins and differ by two years from the younger one?

(a) 12, 12, 10 (b) 8, 8, 6 (c) 13, 13, 11 (d) 14, 14, 12 (e) None

- (9) The captain of a cricket team of 11 players is 25 years and the wicket keeper is 3 years older. If the age of these two are excluded, the average age of the remaining players is 1 year less than the average age of the whole team. The average age of the whole team is

(a) 24 years (b) 21 years (c) 26 years (d) 22 years (e) 25 years

- (10) What fraction must be subtracted from the sum of $\frac{1}{4}$ and $\frac{1}{6}$ to have an average of $\frac{1}{12}$ of all the two fractions?

(a) $\frac{1}{3}$	(b) $\frac{1}{2}$	(c) $\frac{1}{4}$	(d) $\frac{1}{8}$	(e) None of these
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- (11) In a coconut groove, $(x + 2)$ trees yield 60 nuts per year, x trees yield 120 nuts per year and $(x - 2)$ trees yield 180 nuts per year. If the average yield per year is per tree be 100. Then the value of x is

(a) 8 (b) 4 (c) 12 (d) 10 (e) 14

- (12) If the average weight of boys of Ram's age and height is 105 kg, and if Ram weighs 110% of the average, then the weight of Ram is

(a) 105 kg	(b) data insufficient	(c) 115.5 kg
(d) 110 kg	(e) 107.5 kg	

- (13) After a certain number of matches, a bowler has had 200 runs knocked off him. In the next match, he takes 3 wickets for 52 runs and his average goes up by 1. The new average of the bowler is

(a) 9	(b) $8\frac{1}{3}$	(c) $9\frac{1}{3}$	(d) 8	(e) either (a) or (c)
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Hint: Bowler's average = $\frac{\text{runs knocked off}}{\text{no. of wickets taken}}$, Refer formula no. 4

- (14) A batsman has scored an average of 46 runs for a certain number of innings played in England. When he came back to India, he played another two test matches of two innings each and scored at an average of 55 runs. For the innings in England and in India taken together, he has improved his average by 2 runs over the matches played in England. The number of innings played in England was
 (a) 7 (b) 9 (c) 14 (d) 18 (e) 11

(15) A batsman's scores in a particular innings is twice the average score in 4 previous innings. The percentage improvement in his average score now is:
 (a) 6 (b) 20 (c) 5 (d) 10 (e) 12

(16) If the average of a, b, c be M and $ab + bc = -ca$, then the average of a^2, b^2, c^2 is:
 (a) M^2 (b) $3M^2$ (c) $9M^2$ (d) $27M^2$ (e) None of these

Hint: $a^2 + b^2 + c^2 + 2(ab + bc + ca) = (a + b + c)^2$

(17) Among three numbers, the first number is thrice the second number and one-fourth of the third number. The average of all three numbers is 64. What is the average of first and third number?
 (a) 30 (b) 24 (c) 90 (d) 78 (e) 48

Tips: Since the first number is related to both the second and the third number in the given condition, so, it is better to assume the first number = x]

(18) The average of ' n ' numbers is A . If the number Y is replaced by the number Y^0 , then the average becomes A^0 . Which of the following equations is true?

Tips: Since the first number is related to both the second and the third number in the given condition, so, it is better to assume the first number = x]

- (18) The average of ' n ' numbers is A . If the number Y is replaced by the number Y^0 , then the average becomes A^0 . Which of the following equations is true?

(a) $A = A^0 \frac{(Y - Y^0)}{n}$

(b) $A = A^0 + n(Y - Y^0)$

(c) $A^0 = \frac{Y}{n} + \frac{Y^0}{A}$

(d) $A^0 + \frac{Y}{n} = A + \frac{Y^0}{n}$

(e) $\frac{A}{A^0} = n + \frac{Y}{Y^0}$

Answers

- 1.** (c) **2.** (c) **3.** (b) **4.** (a) **5.** (c) **6.** (c) **7.** (d) **8.** (e) **9.** (d)
10. (c) **11.** (b) **12.** (c) **13.** (e) **14.** (c) **15.** (b) **16.** (b) **17.** (c) **18.** (d)

RATIO AND PROPORTION

INTRODUCTION

Ratio A ratio is a comparison of two numbers (quantities) by division. The ratio of a to b is written as,

$$a : b = \frac{a}{b} = a \div b$$

In the ratio $a : b$, a and b are called the terms of the ratio; ' a ' is the antecedent ' b ' is the consequent. A ratio is a number, so to find out the ratio of two quantities, they must be expressed in the same units.

Proportion A proportion is an expression which states that two ratios are equal.

e.g. $\frac{3}{12} = \frac{1}{4}$ is a proportion. It can also be expressed as $3 : 12 = 1 : 4$ or $3 : 12 :: 1 : 4$.

Each quantity in proportion is called **term** or **proportional**. The first and the last terms are called the **extremes**, whereas the second and the third terms are called the **middle terms**. When four quantities are in proportion, the last quantity is said to be **fourth proportional** to the other three and also we find, **product of middle terms = product of extremes**.

$$\text{2nd term} \times \text{3rd term} = \text{1st term} \times \text{4th term}$$

e.g. In $4 : 8 = 12 : 24$, we have

$$8 \times 12 = 4 \times 24$$

(Thus, if $a : b = x : y$, then

$$bx = ay).$$

PROPERTIES OF RATIO

In a ratio, **two** quantities are **compared**. So, the quantities must be of the same kind, i.e. they must be expressed in the same units.

The ratio of two quantities determines how many times one quantity is contained by the other.

The order of the terms in a ratio $a : b$ is very important. Since $4 : 5$ is different from $5 : 4$.

DIVIDING A GIVEN NUMBER IN THE GIVEN RATIO

'A' be the given number. The given ratio is $a_1 : a_2$

'A' is to be divided in the ratio $a_1 : a_2$.

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7-2 Quantitative Aptitude for Competitive Examinations

It implies that A is divided in two parts such that value of first part : value of second part = $a_1 : a_2$.
Therefore,

$$\text{first part} = \frac{a_1}{a_1 + a_2} \times A = \text{first term of ratio} \times \left(\frac{\text{Sum of parts}}{\text{Sum of terms of ratio}} \right)$$

$$\text{second part} = \frac{a_2}{a_1 + a_2} \times A = \text{Second term of ratio} \times \left(\frac{\text{Sum of parts}}{\text{Sum of terms of ratio}} \right)$$

Since, A has been divided into two parts, so, first part + second part = A .

Example: Two numbers are in the ratio 8:9. If the sum of the numbers is 119, find the numbers.

Solution: Since the sum of two numbers is 119, so, the problem implies that 119 is divided in two parts in the ratio 8:9.

Therefore,

$$\text{first number} = \frac{8}{8+9} \times 119 = 56$$

$$\text{second number} = \frac{9}{8+9} \times 119 = 63 \quad \text{or} \quad (119 - 56 = 63)$$

Note: These relations are also true for dividing a given number into more than two ratios (i.e. more than two parts).

When any number A is divided in more than one ratio such as $a : b : c : d : \dots$, then,

$$\text{value of any part} = \frac{\text{its related ratio term}}{a+b+c+\dots} \times A$$

$$\text{e.g. third part} = \frac{c}{a+b+c+\dots} \times A$$

Example: Dividing Rs 3,200 among P, Q, R in the ratio 5:2:9, find the amount received by Q .

Solution: Amount received by Q = $\frac{\text{its related ratio term}}{\text{sum of ratio terms}} \times \text{Total amount}$

$$= \frac{2}{5+2+9} \times 3200 \\ = \text{Rs } 400$$

7.4 COMPARISON OF RATIOS

Let $a : b$ and $c : d$ be two ratios. Then

$$a : b > c : d \quad \text{if} \quad ad > bc$$

$$\text{i.e. } \frac{a}{b} > \frac{c}{d} \quad \text{if} \quad ad > bc$$

$$\Rightarrow \frac{6}{2} = \frac{750}{N} - \left(1 + \frac{N}{2}\right) 2$$

$$\Rightarrow N^2 + 5N - 750 = 0$$

$$\Rightarrow N = 25$$

∴ Total no. of innings played before the last match = 25

$$\therefore \text{Original average} = \frac{750}{25} = 30$$

∴ Final average = $30 - 2 = 28$ runs.

E-11 The average weight of 15 students in a class is increased by 1.5 kg when one of the students weighing 40 kg is replaced by a new student. Find the weight of the new student.

S-11 Using formula (6), for one item replacement,

$$\text{weight of new student} - \text{weight of removed student} = +Nx$$

$$\Rightarrow \text{weight of new student} - 40 = 15 \times 1.5$$

$$\therefore \text{weight of new student} = 40 + 22.5 = 62.5 \text{ kg.}$$

E-12 Find the average of

- (a) 9 consecutive odd numbers $a, b, c, d, e, f, g, h, i$
- (b) 7 consecutive even numbers k, l, m, n, o, p, q
- (c) 6 consecutive odd numbers a, b, c, d, e, f
- (d) 4 consecutive numbers j, k, l, m

S-12 (a) There are 9 (odd) consecutive odd numbers.

Hence, the average of 9 consecutive odd numbers is the middle number (i.e. 5th number)

∴ the average is 'e'.

(b) There are 7 (odd) consecutive even numbers.

The average of 7 consecutive even numbers is the middle number (i.e. 4th number)

∴ the average is 'n'.

(c) There are 6 (even) consecutive odd numbers.

The average of 6 consecutive odd numbers is the average of two middle numbers (i.e. 3rd and 4th number)

∴ the average is $\frac{c+d}{2}$.

(d) There are 4 (four) consecutive numbers.

The average of 4 consecutive numbers is the average of two middle numbers (i.e. 2nd and 3rd numbers)

∴ the average is $\frac{k+l}{2}$.

REGULAR PROBLEMS

(1) The mean of marks secured by 25 students in section A of Class X is 47, that of 51 students of section B is 51 and that of 30 students of section C is 53. Find the mean of marks of the students of three sections of Class X.

- (a) 50 (b) 50.6 (c) 52.5 (d) 54.5 (e) 51.5

(RBI, '96)

- (2) There are Indians and Europeans in an army of 12,000. The average height of Europeans is 5'10" and that of Indians is 5'9" and the average height of the entire army is $5' 9\frac{3}{4}''$. Find out the number of Indians in the army.

(RRB Ahmedabad, '97)

- (a) 2500 (b) 3000 (c) 2800 (d) 2200 (e) 2000

- (3) The average age of a family of five persons is 20 years. If the youngest member is 8 years old. What was the average age of the family at the birth time of the youngest member?
 (a) 12 years (b) 15 years (c) 18 years (d) 16 years (e) 23 years

Hint: Find the total age of the family now and 8 years earlier.

- (4) The average of five consecutive numbers is 16. The highest of these numbers is:
 (a) 21 (b) 20 (c) 18 (d) 19 (e) 22

Hint: Assume the first number as x , then consecutive numbers are $x+1, x+2, x+3$ and $x+4$.

- (5) The average of six numbers is 12. If each number is increased by 2, the new average is:
 (a) 8 (b) 4 (c) 14 (d) 24 (e) 12

Hint: Since each number is increased by same amount, so, average will also increase by same amount.

- (6) If the average of three numbers a, b and c is A , then the average of a, b, c and A is:

- (a) Data insufficient (b) $2A$ (c) $\frac{A}{2}$ (d) $4A$ (e) A

- (7) The average temperature of the first three days of a week is 27°C and of the next three days is 29°C . If the weekly average is 28.5°C , then the temperature of the last day is:
 (a) 31.5°C (b) 28°C (c) 42°C (d) 21°C (e) 26°C

- (8) A batsman has a certain average of runs for 9 innings. In the 10th innings, he makes a score of 100 runs thereby increasing his average by 8 runs. His new average is:
 (a) 32 (b) 36 (c) 25 (d) 40 (e) 28

Hint: While finding the average, always use the basic formula, i.e. average = $\frac{\text{Sum of all quantities}}{\text{No. of quantities}}$

- (9) The average age of 24 boys in a class is 16. If the teacher is included and one boy is excluded from the group, the average increases by one. The age of the teacher is:

- (a) 41 (b) 32 (c) 45 (d) 24 (e) Data insufficient

- (10) The average weight of 35 students in a class is 35 kg. If the teacher is also included, the average weight increases to 36 kg. The weight of the teacher is:
 (a) 36 kg (b) 35 kg (c) 70 kg (d) 71 kg (e) 34 kg

- (11) The average number of printing errors per page in a book of 512 pages is 4. If the total number of printing errors in the first 302 pages is 1208, the average number of printing errors per page in the remaining pages is:
 (a) 0 (b) 4 (c) 840 (d) 90 (e) 9

- (12) Of the three numbers, the first is four times the second and three times the third. If the average of all the three numbers is 95, then the third number is:
 (a) 57 (b) 76 (c) 38 (d) 60 (e) 130

- (13) The total production of 10 tea estates is 550 tonnes. By opening two new tea estates, the average increases by 3 tonnes. The average production of these two new tea estates (in tonnes) is:
 (a) 70 (b) 64 (c) 67 (d) 73 (e) 68

- (14) The average age of 10 members in a family is 21 years and due to death of one family member, the average age is reduced by 2 months. The age of the member who died is:
- 20 years 10 months
 - $20\frac{1}{3}$ years
 - 22 years
 - $19\frac{1}{3}$ years
 - None
- (15) If a, b, c, d and e are five consecutive odd numbers, their average is:
- $5(a + 4)$
 - $\frac{abcde}{5}$
 - $5(a + b + c + d + e)$
 - $a + 4$
 - None of these
- (16) The average of a batsman for 40 innings is 50 runs. His highest score exceeds his lowest score by 172 runs. If these two innings are excluded, his average drops by 2 runs. His highest score is:
- 86
 - 92
 - 174
 - 170
 - 88
- (17) The average of three numbers is 45. The first is as much more than the average as the second number is less than the average. Find the third number.
- 40
 - 41
 - 20
 - 45
 - 43
- (18) A mathematics teacher tabulated the marks secured by 35 students of 8th class. The average of their marks was 72. If the marks secured by Reema was written as 36 instead of 86 then find the correct average marks up to two decimal places.
- 73.41
 - 74.31
 - 72.43
 - 73.43
 - cannot be determined
- Hint:** Correct average = $72 + \frac{(86 - 36)}{35}$, -36, because 36 is to be replaced
- (19) Among three numbers, the first is twice the second and thrice the third. If the average of three numbers is 49.50, then what is the difference between the first and the third number?
- 54
 - 28
 - 39.50
 - 41.50
 - 33

Answers

- (b)
- (b)
- (b)
- (c)
- (c)
- (e)
- (a)
- (e)
- (e)
- (d)
- (b)
- (d)
- (d)
- (c)
- (d)
- (c)
- (d)
- (a)

REAL PROBLEMS

- (1) The average of two numbers is XY . If one number is X , then the other number is:
- Y
 - $\frac{Y}{2}$
 - $2XY - X$
 - $X(Y - 1)$
 - $\frac{XY}{2}$
- (2) Of three numbers whose average is 60, the first is $\frac{1}{4}$ th of the sum of other two. The first number is:
- 30
 - 60
 - 36
 - 24
 - 20