

- (2) A cistern normally takes 4 hours to be filled by a tap but because of a leak, takes 2 hours more. In how many hours will the leak empty a full cistern?
- (a) 10 h (b) 14 h (c) 6 h (d) 12 h (e) 8 h

Hint: Use $E = \frac{f(f+x)}{x} = \frac{4(4+2)}{2} = 12$.

- (3) A cistern is normally filled by a tap in 5 hours, but suddenly a leak develops and it empties the full cistern in 30 hours. With the leak, the cistern is filled in
 (a) 8 h (b) 6 h (c) 10 h (d) $7\frac{1}{2}$ h (e) 20 h

Hint: Use $E = \frac{f(f+x)}{x} \therefore 30 = \frac{5(5+x)}{x} \therefore x = 1$ hour more \therefore cistern is now filled in 5 + 1 = 6 hours.

- (4) A cistern is filled by two taps in a hours and b hours respectively and is then emptied by a tap in c hours. If all three taps are open, the cistern is filled in F hours. The relation between F , a , b , and c are given by,

$$\begin{array}{ll} (a) F = (a+b)-c & (b) F = \frac{a \times b}{c} \\ (c) \frac{1}{F} = \frac{1}{a} + \frac{1}{b} + \frac{1}{c} & (d) F = \frac{1}{\frac{1}{a} + \frac{1}{b} - \frac{1}{c}} \\ (e) F = \frac{ab+bc}{ac} \end{array}$$

- (5) A tap can fill a swimming pool in h hours. What part of the pool is filled in y hours?

(a) yh (b) $\frac{h}{y}$ (c) $\frac{y}{h}$ (d) $y+h$ (e) $h-y$

- (6) From a leaking tap 'a' drop come out in 'b' min. If there are 'c' drops in a litre, then in how many hours. One litre of water will be wasted?

(a) $\frac{60a}{bc}$ (b) $\frac{a}{bc}$ (c) $\frac{abc}{60}$ (d) $\frac{bc}{60a}$ (e) $\frac{bc}{a}$

- (7) Two taps can fill a tank in 12 and 18 min. respectively. Both are kept open for 2 min. and the first is turned off. In how many min. more will the tank be filled?

(a) 15 min. (b) 20 min. (c) 11 min. (d) 13 min. (e) 8 min.

- (8) Filling pipe, if opened alone, takes 5 min. to fill a cistern. Suddenly, during the course of filling, the waste pipe (which is of similar size and flow as of fill pipe) is opened for 2 min., then the cistern will be filled in

(a) $3\frac{1}{7}$ min. (b) $3\frac{1}{3}$ min. (c) 5 min. (d) 3 min. (e) 7 min.

- (9) Two filling pipes can fill a cistern in 10 and 12 min. respectively and when the waste pipe is open, they can together fill it in 15 min. The waste pipe can empty the full cistern in

(a) 15 min. (b) 37 min. (c) $8\frac{4}{7}$ min. (d) $7\frac{1}{2}$ min. (e) 8 min.

- (10) Two taps can fill a cistern in 10 and 8 hours respectively. A third tap can empty it in 15 hours. If all the taps are opened together, the cistern will be filled in

- (11) Two fill pipes A and B can fill a tank in 30 and 20 hours respectively. Pipe B alone is kept open for half the time and both pipes are kept open for the remaining time. In how many hours, the tank will be completely full.

Hint: $\therefore B$ is open for total time and A is open for remaining time (i.e. $1 - \frac{1}{2} = \frac{1}{2}$) $\therefore \frac{x}{2 \times 30} + \frac{x}{20} = 1$.

- (12) Two fill pipes A and B can fill a tank in 15 and 12 hours respectively. Pipe B alone is kept open for $\frac{3}{4}$ of time and both pipes are kept open for remaining time. In how many hours, the tank will be full?

- (13) Two taps A and B can fill a cistern in 12 min. and 18 min. respectively. They are turned on at the same time. If the tap A is turned off after 4 min., how long will tap B take to fill the rest of the cistern?
 (a) 8 min. (b) 9 min. (c) 10 min. (d) 7 min. (e) 15 min.

- (14) A cistern can be filled by two pipes A and B in $7\frac{1}{2}$ h. Both of them are open for $2\frac{1}{2}$ h and then

B is closed. *A* alone now require $6\frac{2}{3}$ h more to fill cistern. How long would *A* take to fill the cistern working alone?

- (a) 8 h (b) 10 h (c) 9 h (d) $8\frac{1}{2}$ h (e) None

Hint: $\frac{5}{2} \left[\frac{1}{f_A} + \frac{1}{f_B} \right] + \frac{20}{3} \left[\frac{1}{f_A} \right] = 1 \Rightarrow \frac{5}{2} \times \frac{2}{15} + \frac{20}{3} \left[\frac{1}{f_A} \right] = 1 \Rightarrow f_A = 10 \text{ h.}$

- (15) A cistern has three pipes A , B and C the pipes A and B can fill it in 4 and 5 hours respectively and C can empty it in 2 hours. If the pipes are opened in order at 1, 2 and 3 a.m. respectively, when will the cistern be empty?

- (a) 3 p.m. (b) 4 p.m. (c) 5 p.m. (d) 6 a.m. (e) 7 a.m.

Hint: Use the method 12.1 for emptying.

- (16) Three pipes A, B and C can fill a cistern in 7 hours. After working at it together for 2 hours C is closed. Now A and B require 10 hours more to fill it. How long will C take to fill the cistern alone?
 (a) 12 h (b) 16 h (c) 14 h (d) 10 h (e) 20 h

- (17) A cistern, when full, is emptied by a waste pipe in 30 min., but if a tap (filling source) is opened, it takes 40 min. to empty the cistern. How long the cistern will take to become full when both the pipes are working? (SSC '90)

- (a) 140 min. (b) 120 min. (c) 160 min. (d) 180 min. (e) 110 min.

Answers

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

13

PROFIT, LOSS AND DISCOUNT

The following basic terms are very useful to solve the problems on Profit and Loss.

- (a) **Cost Price (C.P.):** The cost price of an article is the price at which the article is bought.
- (b) **Selling Price (S.P.):** The selling price of an article is the price at which the article is sold.
- (c) **Gain or Profit:** If selling price of an article is more than its cost price, there is gain.
- (d) **Loss:** If selling price of an article is less than its cost price, there is loss.

13.1 GAIN/LOSS AND % GAIN OR % LOSS

$$x \text{ (gain or loss)} = \text{Sale price} - \text{Cost price}$$

if x is $(-)$ ve, then it is loss, otherwise it is gain.

$$x \% \text{ (% gain or loss)} = \frac{\text{Sale price} - \text{Cost price}}{\text{Cost price}} \times 100\% = \left(\frac{\text{Sale price}}{\text{Cost price}} - 1 \right) \times 100\%$$

Note: % gain or % loss is always calculated with respect to cost price.

13.2 MULTIPLYING EQUIVALENTS TO FIND SALE PRICE

(Cost Price) \times

$$\boxed{1 + \frac{\% \text{ gain}}{100}}$$

or

$$\boxed{1 - \frac{\% \text{ loss}}{100}}$$

→ Sale Price

Multiplying Equivalent

For example, if there is 15% gain, then

$$\text{Sale price} = \left(1 + \frac{15}{100} \right) \times \text{Cost price}$$

$$= \underbrace{(1 + 0.15)}_{\text{multiplying equivalent}} \times \text{Cost Price}$$

Similarly, if there is 15% loss, then

$$\text{Sale Price} = \underbrace{(1 - 0.15)}_{\text{multiplying equivalent}} \times \text{Cost price}$$

13.3 RELATION AMONG COST PRICE, SALE PRICE, GAIN/LOSS AND % GAIN OR % LOSS

From 13.1, we have found that

$$\% \text{ gain (or loss)} = \frac{\text{Gain (or loss)}}{\text{Cost Price}} \times 100$$

$$\Rightarrow \frac{\text{Gain}^*}{\% \text{Gain}} = \frac{\text{Cost Price}}{100} \quad [\text{*Replace gain by 'loss' if loss is incurred}] \quad (\text{i})$$

Similarly, from 13.1, we can obtain,

$$\% \text{ gain (or loss)} = \frac{\text{Sale price} - \text{Cost price}}{\text{Cost price}} \times 100$$

$$= \left(\frac{\text{Sale price}}{\text{Cost price}} - 1 \right) \times 100$$

$$\Rightarrow \frac{\text{Sale price}}{\text{Cost price}} = 1 + \frac{\% \text{ gain}}{100}$$

$$\Rightarrow \frac{\text{Sale price}}{\text{Cost price}} = \frac{100 + \% \text{ gain}}{100}$$

$$\Rightarrow \frac{\text{Sale price}}{100 + \% \text{ gain}} = \frac{\text{Cost price}}{100} \quad (\text{ii})$$

Combining (i) and (ii), we get,

$$\frac{\text{gain}}{\% \text{ gain}^*} = \frac{\text{Cost price}}{100} = \frac{\text{Sale price}}{100 + \% \text{ gain}^*} \quad (1)$$

*In case of % loss, put (-)ve sign before it.

In the formula (1), we can equate any two parts to find out the unknowns as needed.

Example: If $6\frac{1}{4}\%$ gain fetches a profit of Rs 50 on an article, then find the cost price of the article.

Solution: Using the relation 13.3 (equation-1)

$$\frac{\text{gain}}{\% \text{ gain}} = \frac{\text{Cost price}}{100}$$

$$\Rightarrow \frac{50}{6\frac{1}{4}} = \frac{\text{Cost price}}{100}$$

$$\Rightarrow \text{Cost price} = \text{Rs } 800.$$

Example: If 30% loss on selling an article makes the trader to suffer a loss of Rs 45, then find the selling price of the article.

Solution: In the conventional method we have to find the cost price first and only then can we find the sale price, although the problem has not asked to find the cost price.

In such case, relation 13.3 is useful to find out the sale price directly.

$$\frac{\text{loss}}{\% \text{ loss}} = \frac{\text{Sale price}}{100 - \% \text{ loss}}$$

$$\Rightarrow \frac{45}{30} = \frac{\text{Sale price}}{100 - 30}$$

$$\Rightarrow \text{Sale price} = \text{Rs } 105$$

13.4 AN ARTICLE SOLD AT TWO DIFFERENT SELLING PRICE

Since, the same article is sold at two different prices, so, cost price remains the same in both the cases. Using the relation (1), of 13.3,

$$\frac{\text{Cost price}}{100} = \frac{\text{Sale price}}{100 + \% \text{ gain}}$$

We can combine both the cases as

$$\frac{\text{Cost price}}{100} = \frac{\text{Sale price}_1}{100 + \% \text{ gain}_1} = \frac{\text{Sale price}_2}{100 + \% \text{ gain}_2}$$

it can be used directly.

Example: By selling an article for Rs 450, a man loses 25%. At what price will he sell in order to gain 50%?

Solution: Using the relation 13.4, we can directly find the second sale price, without finding the cost price of the article.

$$\frac{\text{Sale price}_1}{100 + \% \text{ gain}_1} = \frac{\text{Sale price}_2}{100 + \% \text{ gain}_2}$$

$$\frac{450}{100 - 25} = \frac{\text{Sale price}_2}{100 + 50}$$



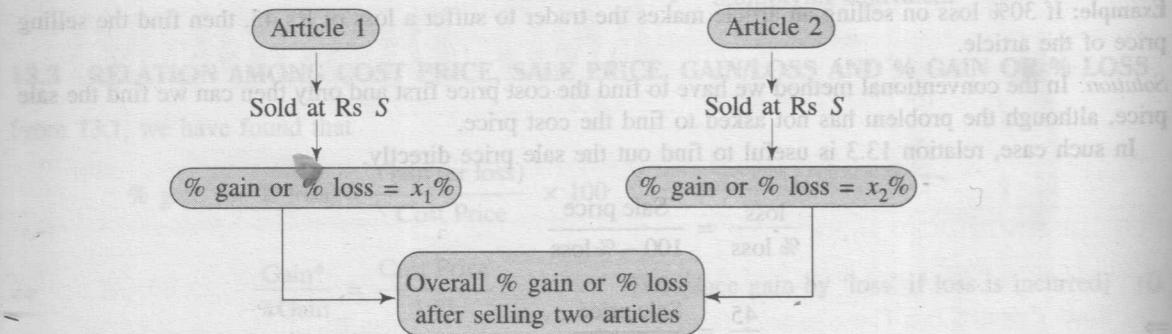
[(-)ve for % loss]

$$\text{Sale price}_2 = \text{Rs } 900.$$

13.5 TWO DIFFERENT ARTICLES SOLD AT SAME SELLING PRICE

(a) When % Gain or % Loss on Two Articles are not Same

Since the two articles are different, so, cost price of the articles are different. Now, these articles are sold at same price.



$$\text{Overall \% gain or \% loss} = \left[100 - \frac{2(100 + x_1)(100 + x_2)}{(100 + x_1) + (100 + x_2)} \right]$$

If it is (-)ve, then there is overall loss in the transaction, otherwise, it is gain.

Example: A man sold two almirahs for Rs 4800 each. On one, he gains 30% and on other, he loses 20%. How much does he gain or lose in the whole transaction?

Solution: In first almirah, % gain = 30% = x_1 (say)

in second almirah, % loss = -20% = x_2 (say)

Using the relation 13.5(a)

$$\begin{aligned}
 \text{Overall \% gain or \% loss} &= 100 - \frac{2(100 + x_1)(100 + x_2)}{(100 + x_1) + (100 + x_2)} \\
 &= 100 - \frac{2(100 + 30)(100 - 20)}{(100 + 30)(100 - 20)} \\
 &= 100 - \frac{2 \times 130 \times 80}{210} \\
 &= + 0.95\% \text{ (i.e. } 0.95\% \text{ profit)}
 \end{aligned}$$

(b) When % Gain on First Article = % Loss on Second Article

Here the two different articles are sold at same price and %gain on first article = %loss on second article, so, always there is overall loss in the transaction.

Putting $x_1 = x$ and $x_2 = -x$ in the relation 13.5 (a), we get,

$$\text{Overall \%loss} = -\left(\frac{x}{10}\right)^2$$

Example: Two watches were sold at Rs 850 each. On one, a gain of 15% is made and on the other, a loss of 15%. How much % loss or % gain is made in the whole transaction?

Solution: Here, the sale price of two watches are same.

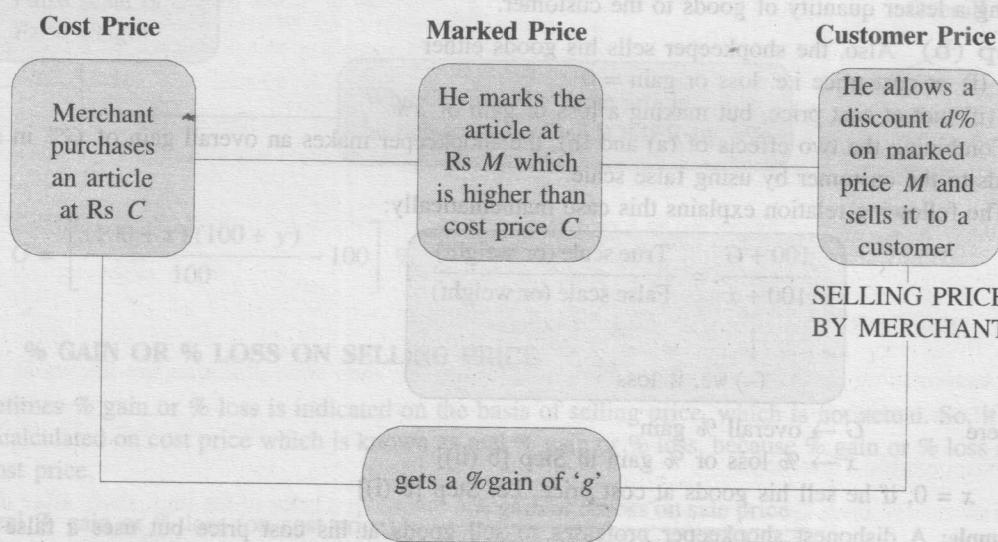
% gain on one watch = % loss on other watch = 15

Using the relation 13.5(b)

$$\text{Overall \% loss} = -\left(\frac{15}{10}\right)^2 \\ = -2.25\%$$

Therefore, a loss of 2.25% is made in the whole transaction.

13.6 DISCOUNT AND MARKED PRICE



From the given figure, it is found that

amount of discount allowed = $d\%$ of marked price

= amount of money a customer saves due to discount

= marked price – customer price

∴ Marked price – amount of discount = customer price (or selling price)

⇒ Marked price $(1 - d\%)$ = Customer price (or selling price) (i)

and Selling price = Cost price $(1 + g\%)$ (ii)

From (i) and (ii),

$$\text{Marked price } (1 - \text{ \% discount}) = \text{Selling price} = \text{Cost price } (1 + \text{ \% gain}) \\ \text{or} \\ \text{Customer price}$$

Example: A trader offers his customers 10% discount and still makes a profit of 26%. What is the actual cost to him of an article marked Rs 280.

Solution: Using the relation 13.6,

$$\text{marked price } (1 - d\%) = \text{cost price } (1 + g\%)$$

$$\Rightarrow 280 \left(1 - \frac{10}{100}\right) = \text{cost price} \left(1 + \frac{26}{100}\right)$$

$$\Rightarrow \text{cost price} = \frac{280 \times 90}{126}$$

$$= \text{Rs } 200.$$

∴ The actual cost of the article to the trader was Rs 200.

13.7 USE OF FALSE SCALE FOR SELLING AN ARTICLE

Step (a) A shopkeeper uses false scale (or false weight) to sell his goods to the customer. The value of false scale (or false weight) is lower than the true scale (or true weight). So, the shopkeeper gains by giving a lesser quantity of goods to the customer.

Step (b) Also, the shopkeeper sells his goods either

(i) at cost price i.e. loss or gain = 0

or (ii) not at cost price, but making a loss or gain of $x\%$

Combining the two effects of (a) and (b), the shopkeeper makes an overall gain of $G\%$ in selling his goods to the customer by using false scale.

The following relation explains this case mathematically:

$$\frac{100 + G}{100 + x} = \frac{\text{True scale (or weight)}}{\text{False scale (or weight)}}$$

↓
(-) ve, if loss

Where $G \rightarrow$ overall % gain

$x \rightarrow$ % loss or % gain in Step [b (ii)]

Put $x = 0$, if he sells his goods at cost price, i.e. Step [b (i)]

Example: A dishonest shopkeeper professes to sell goods at his cost price but uses a false weight of 950 gms, for each kilogram. Find his gain percentage.

Solution: Using the relation 13.7

$$\frac{100 + G}{100 + x} = \frac{\text{True weight}}{\text{False weight}}$$

(i) Since he sells his goods at cost price, so, $x = 0$

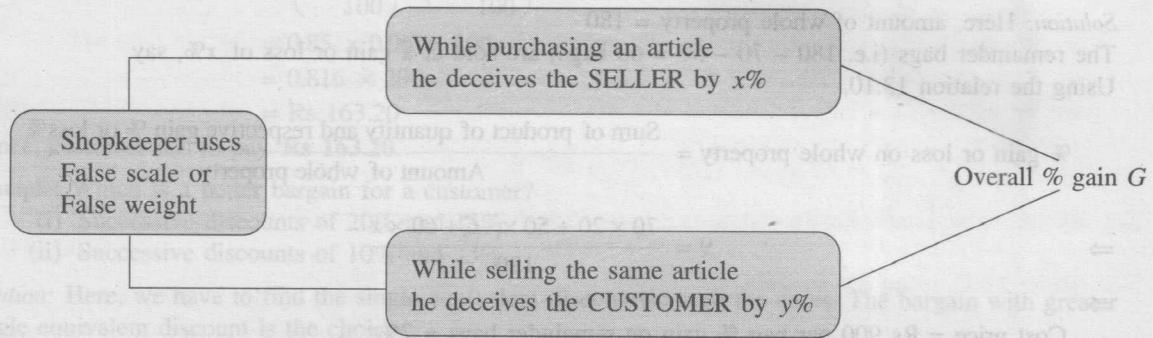
$$\frac{100 + G}{100} = \frac{1000}{950}$$

$$\Rightarrow 1 + \frac{G}{100} = \frac{20}{19}$$

$$\Rightarrow G = \frac{100}{19} = 5\frac{5}{19}\%$$

∴ The gain percentage of the shopkeeper is $5\frac{5}{19}\%$

13.8 USE OF FALSE SCALE FOR PURCHASING AND SELLING AN ARTICLE



$$G = \left[\frac{(100 + x)(100 + y)}{100} - 100 \right] \%$$

13.9 % GAIN OR % LOSS ON SELLING PRICE

Sometimes % gain or % loss is indicated on the basis of selling price, which is not actual. So, it needs to be recalculated on cost price which is known as real % gain or % loss, because % gain or % loss is always on cost price.

Real % gain or % loss (on cost price) = $\frac{\% \text{ gain or } \% \text{ loss on sale price}}{100 - \% \text{ gain or } \% \text{ loss on sale price}}$

Put (-)ve, when it is % loss.

13.10 % GAIN OR % LOSS ON WHOLE PROPERTY

Assume,

Percentage or part of the whole property being sold (A)	% Gain or % Loss incurred by selling (B)	Product $A \times B$
xth part or x% of whole or quantity x	% gain = $g_1\%$ (say)	$\Rightarrow x \times g_1$
yth part or y% of whole or quantity y	% loss = $l_1\%$	$\Rightarrow -y \times l_1^*$
Remaining zth part or z% of whole or rest quantity of whole (= z)	% gain = $g_2\%$	$\Rightarrow z \times g_2$

and so on, then.

[*(-)ve sign because it is loss]

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(compiled by Abhishek)

13-8 Quantitative Aptitude for Competitive Examinations

$$\% \text{ gain or } \% \text{ loss on whole property} = \frac{\text{Sum of product of quantity and respective gain or loss \%}}{\text{Amount of whole property}}$$

[quantity may be absolute or expressed as part or percentage of the whole property.]

Example: A trader purchased 180 bags of cement at Rs 900 per bag. He sold 70 bags at 20% profit and 50 bags at 6% loss. At what rate per bag should the remainder be sold so as to gain 9% on the whole transaction.

Solution: Here, amount of whole property = 180

The remainder bags (i.e. $180 - 70 - 50 = 60$ bags) are sold at a gain or loss of $x\%$, say

Using the relation 13.10,

$$\% \text{ gain or loss on whole property} = \frac{\text{Sum of product of quantity and respective gain \% or loss \%}}{\text{Amount of whole property}}$$

$$\Rightarrow 9 = \frac{70 \times 20 + 50 \times (-6) + 60 \times x}{180}$$

$$\Rightarrow x = +7\%$$

Cost price = Rs 900 per bag % gain on remainder bags = 7%

$$\Rightarrow \text{Sale price} = \frac{107}{100} \times 900 = \text{Rs 963 per bag.}$$

13.11 DISCOUNT SERIES AND NET SELLING PRICE

When two or more discounts are allowed one after the other, then such discounts are known as discount series or successive discounts.

Two Successive Discounts

If two successive discounts of $x\%$ and $y\%$ are allowed on the marked price of the item, then, **after discount**,

customer has to pay net selling price = $\left[\left(1 - \frac{x}{100}\right) \times \left(1 - \frac{y}{100}\right) \right] \times \text{marked price}$

When the calculation of $\left(1 - \frac{x}{100}\right) \times \left(1 - \frac{y}{100}\right)$ is time consuming and lengthy, we can find directly as

$$\text{net selling price} = \left(1 - \frac{A}{100}\right) \times \text{marked price}$$

where A = Single equivalent discount to two successive discounts of $x\%$ and $y\%$

$$= x + y - \frac{xy}{100}$$

Three Successive Discounts

If three successive discounts of $x\%$, $y\%$ and $z\%$ are allowed on the marked price of the item, then, after discount, customer has to pay

$$\text{Net selling price} = \left(1 - \frac{x}{100}\right) \left(1 - \frac{y}{100}\right) \left(1 - \frac{z}{100}\right) \times \text{marked price.}$$

Example: A shopkeeper offers 15% discount on all plastic toys. He offers a further discount of 4% on the reduced price to those customers who pay cash. What does a customer have to pay in cash for a toy of Rs 200?

$$\begin{aligned}\text{Solution: Net selling price} &= \left(1 - \frac{15}{100}\right) \times \left(1 - \frac{4}{100}\right) \times 200 \\ &= 0.85 \times 0.96 \times 200 \\ &= 0.816 \times 200 \\ &= \text{Rs } 163.20\end{aligned}$$

Hence, customer has to pay **Rs 163.20**.

Example: Which is a better bargain for a customer?

- (i) Successive discounts of 20% and 15%
- (ii) Successive discounts of 10% and 25%

Solution: Here, we have to find the single equivalent discount in both the cases. The bargain with greater single equivalent discount is the choice.

$$\begin{aligned}\text{(i) Single equivalent discount } A &= x + y - \frac{xy}{100} \\ &= 20 + 15 - \frac{20 \times 15}{100} \\ &= 32\%\end{aligned}$$

$$\begin{aligned}\text{(ii) Single equivalent discount } A &= x + y - \frac{xy}{100} \\ &= 10 + 25 - \frac{10 \times 25}{100} \\ &= 35 - 2.5 \\ &= 32.5\%\end{aligned}$$

Hence option (ii) is the better bargain for a customer.

Solved Examples

- E-1** (i) If C.P. = 125, S.P. = 96, then, Loss = ?
(ii) If C.P. = 112, S.P. = 132, then, Gain = ?
(iii) If C.P. = 120, S.P. = 90, then, Loss % = ?
(iv) If C.P. = 80, S.P. = 100, then, % Gain = ?
(v) If C.P. = 90, Gain % = 10%, then, S.P. = ?
(vi) If C.P. = 20, % Loss = 25%, then, S.P. = ?
(vii) If S.P. = 84, % Gain = 20%, then, C.P. = ?

- S-1** (i) [Refer 13.1] Using the formula, $x = S - C \Rightarrow x = 96 - 125 = -29$
 \therefore Loss = **Rs 29**.
(ii) $x = S - C \Rightarrow x = 132 - 112 = 20 \therefore$ Gain = **Rs 20**.

$$(iii) \% x = \frac{S - C}{C} \times 100 \Rightarrow \% x = \frac{90 - 120}{120} \times 100\% = - 25\%$$

\therefore % Loss = 25%.

$$(iv) \% x = \frac{S - C}{C} \times 100 \Rightarrow \% x = \frac{100 - 80}{80} \times 100 = 25\%$$

\therefore Gain = 25%.

$$(\text{Refer 13.2}), SP = \left(1 + \frac{\% \text{ gain}}{100}\right) CP$$

$$(v) SP = (1 + 0.1) \times 90 = 1.1 \times 90 = \text{Rs } 99$$

\therefore Sale Price = **Rs 99**

$$(vi) SP = (1 - 0.25) \times 20 = 0.75 \times 20 = 15$$

\therefore Sale Price = **Rs 15**

$$(vii) SP = 84 = (1 + 0.2) \times CP$$

$$\Rightarrow CP = \frac{84}{1.2} = 70 \quad \therefore \text{Cost Price} = \text{Rs } 70$$

- E-2** By selling an article for Rs 450, a man loses 25%. At what price he will sell in order to gain 25%? **(LIC '84)**

- S-2** [Refer 13.4], using the formula,

$$\frac{S_1}{100 + x_1} = \frac{S_2}{100 + x_2} \quad (S_1 \text{ and } S_2 \text{ are two selling prices})$$

$$\Rightarrow \frac{450}{100 + (-25)} = \frac{S_2}{100 + 25} \Rightarrow S_2 = 750. \quad [(-)\text{ve sign indicates loss}]$$

\therefore He sells the article at **Rs 750**.

- E-3** The cost price of 25 articles is equal to the selling price of 20 articles. Find the gain %.

(GIC '87)

$$\text{S-3} \text{ As per question, } 25 \times CP = 20 \times SP \Rightarrow \frac{SP}{CP} = \frac{25}{20}$$

Using 13.1,

$$\% \text{ gain} = \left(\frac{SP}{CP} - 1\right) \times 100 = \left(\frac{25}{20} - 1\right) \times 100 = 25\%$$

\therefore There is **25% gain** in the transaction.

- E-4** A person sells 36 oranges per rupee and suffers a loss of 4%. Find how many oranges per rupee to be sold to have a gain of 8%? **(Indian Airlines '89)**

$$\text{S-4} \text{ Always, find the unit price, i.e. for one orange. Here, Sale price per orange} = \text{Rs } \frac{1}{36} = S_1$$

- [Refer 13.4], using the formula,

$$\frac{S_1}{100 + x_1} = \frac{S_2}{100 + x_2} \Rightarrow \frac{\frac{1}{36}}{100 + (-4)} = \frac{S_2}{100 + 8} \Rightarrow S_2 = \frac{1}{32}$$

\therefore He sells **32 oranges** per rupee.

- E-5** A shopkeeper purchases 10 kg of rice at Rs 600 and sells at a loss as much the selling price of 2 kg of rice. Find the sale rate of rice/kg.

- S-5** Let Selling price be Rs x /kg. Loss = C.P. - S.P.

$$\Rightarrow 2 \times x = 600 - 10 \times x \Rightarrow x = \text{Rs } 5 \text{ per kg.}$$

(Since loss of 2 kg of S.P. of rice)

Hence the Selling price of rice is **Rs 5 per kg.**

E-6 By selling a horse for Rs 455, a man loses 9%. If he sells it for Rs 555, what would be his gain or loss per cent?

S-6 [Refer 13.4], using the formula,

$$\frac{S_1}{100+x_1} = \frac{S_2}{100+x_2}$$

$$\Rightarrow \frac{455}{100+(-9)} = \frac{555}{100+x_2} \Rightarrow \frac{455}{100-9} = \frac{555}{100+x_2}$$

$$\therefore x_2 = +11\%.$$

\therefore The man has a **gain of 11%**.

[(+ve sign indicates it is gain.]

E-7 If a merchant estimates his profit as 20% of the selling price, what is his real profit per cent?

S-7 [Refer 13.9], using the formula,

$$\text{Real profit \% (\% profit on C.P.)} = \frac{\% \text{ profit on S.P.}}{100 - \% \text{ profit on S.P.}} \times 100$$

$$= \frac{20}{100-20} \times 100 = 25\%.$$

NB: Real % profit is always more than the % profit on S.P.

E-8 How much per cent above the cost price should a shopkeeper mark his goods so as to earn a profit of 26% after allowing a discount of 10% on the marked price?

S-8 [Refer 13.6], using the formula, Marked price $(1 - \% \text{ discount}) = \text{Cost price} (1 + \% \text{ gain})$

[M = Marked price, C = Cost price]

$$M(100-d) = C(100+g) \Rightarrow M(100-10) = C(100+26)$$

$$\Rightarrow M = \frac{126}{90} C = 1.4 C = (1+0.4) C$$

i.e. M is + 0.4 or 40% above C

Marked price is 40% above the cost price.

E-9 A vendor sells 10 oranges for a rupee gaining thereby 40%. How many oranges did he buy for a rupee?

S-9 Always the unit price is to be put.

i.e. Sale price for 1 orange = Rs $\frac{1}{10}$ [Refer 13.1], Using the formula, $\% x = \left(\frac{SP}{CP} - 1 \right) \times 100$.

$$\Rightarrow 40 = \left[\frac{1}{10 \times C} - 1 \right] \times 100 \Rightarrow \frac{1}{10 \times C} = \frac{40}{100} + 1 = \frac{14}{10}$$

$$\Rightarrow C = \frac{1}{14}. \text{ So, he bought 14 oranges per rupee.}$$

E-10 A cloth merchant says that due to slump in the market, he sells the cloth at 10% loss, but he uses a false metre-scale and actually gains 15%. Find the actual length of the scale. (AAO '82)

S-10 Here cost price is not equal to selling price because he sells the cloth at 10% loss.

[Refer 13.7], using the formula,

$$\frac{100+G}{100+x} = \frac{\text{True Scale}}{\text{False Scale}}$$

Here, overall gain G = 15% and loss x = -10%

[(-ve sign for loss)]

Let false scale length = l cm

$$\therefore \frac{100+15}{100-10} = \frac{100}{l} \Rightarrow l = \frac{90}{115} \times 100 = 78.25 \text{ cm.}$$

\therefore Actual length of scale is **78.25 cm** instead of 1 metre.

- E-11** A man sold two watches for Rs 1000 each. On one he gains 25% and on the other, 20% loss. Find how much % does he gain or lose in the whole transaction?

- S-11** Here, $S_1 = S_2$ and % gain \neq % loss. [Refer 13.5], using the formula,

$$\begin{aligned}\text{Overall \% gain or loss} &= \left[1 - \frac{2(100+x_1)(100+x_2)}{(100+x_1)+(100+x_2)} \right] \times 100 \% \\ &= \left[1 - \frac{2 \times (100+25)(100-20)}{(100+25)+(100-20)} \right] \times 100 \% \\ &= \left[1 - \frac{2 \times 125 \times 80}{205} \right] \times 100 \% = + \frac{100}{41} \%.\end{aligned}$$

\therefore The man had $2\frac{18}{41} \%$ gain in the whole transaction.

NB: If more than two articles are sold at same price, incurring some at % profit g_1, g_2, g_3 and some of them at % loss, l_1, l_2, l_3

Then,

$$\text{over all \% gain or \% loss} = \left[1 - \frac{n \times (1 + \% g_1) \times (1 + \% g_2) \times (1 - \% l_1) \times (1 - \% l_2) \dots}{(1 + \% g_1) + (1 + \% g_2) + (1 - \% l_1) + (1 - \% l_2) \dots} \right] \times 100$$

where n = Number of article sold at same price.

- E-12** A man purchases two watches at Rs 560. He sells one at 15% profit and other at 10% loss. Then he neither gains nor lose. Find the cost price of each watch.

- S-12** Since, the man neither gains nor lose in the whole transaction,

\therefore Amount of gain in one watch = Amount of loss in other watch.

$$\Rightarrow 0.15 \times CP_1 = 0.10 \times CP_2$$

$$\therefore \frac{CP_1}{CP_2} = \frac{0.10}{0.15} = \frac{2}{3} \quad [CP_1 + CP_2 = 560 \text{ (given)}]$$

$$\therefore CP_1 = \text{Cost price of 1st watch.} = \frac{2}{(2+3)} \times 560 = \text{Rs } 224$$

$$CP_2 = \text{Cost price of 2nd watch} = 560 - 224 = \text{Rs } 336.$$

- E-13** A man sells a book at a profit of 20%. If he had bought it at 20% less and sold it for Rs 18 less, he would have gained 25%. Find the cost price of the book.

- S-13** Assume the cost price of the book = Rs 100 $\xrightarrow{\text{sells at}} 100 \times 1.2 = 120 (= S_1)$

If he bought it at 20% less, i.e.

Rs 80

$\xrightarrow{\text{sells at}} 25 \% \text{ profit}$

$80 \times 1.25 = 100 (= S_2)$

So, $S_1 - S_2 = \text{Rs } 20$ when cost price is $\text{Rs } 100$
 but $S_1 - S_2 = \text{Rs } 18$, so, the cost price is $\text{Rs } 90$
 Hence, the cost price of the book is **Rs 90**.

E-14 A man bought 80 kg of salt for $\text{Rs } 88$ and was obliged to sell it at a loss of as much money he received for 20 kg. At what price did he sell the salt?

S-14 Let he sells the salt at $\text{Rs } x$ per kg.
 Since, Sale price – Cost price = Loss

$$\Rightarrow 80x - 88 = -20x \Rightarrow x = \frac{88}{100} = 0.88$$

So, he sold the salt at **88 paise per kg.**

E-15 What profit percent is made by selling an article at a certain price if by selling at $\frac{3}{4}$ of that price there may be a loss of 10%? (RBI '85)

S-15 $\frac{3}{4}$ (S.P.) = 90 % of C.P. \Rightarrow S.P. = 120% of C.P.

∴ The article has been sold at a profit of $(120 - 100)$, i.e **20%**.

E-16 By selling 66 metres of cloth, I gain the selling price of 22 metres. Find the gain percent.

S-16 Here Gain = **sell price** of 22 metres = x (say). Using the formula.

$$\% \text{ gain} = \frac{x}{N-x} \times 100 \%, \text{ where } x = 22 \text{ and } N = 66$$

$$\% \text{ gain} = \frac{22}{66-22} \times 100 \% = \mathbf{50\%}.$$

E-17 By selling 66 metres of cloth a person gains the cost price of 22 metres. Find the gain percent.

S-17 Here gain = cost price of 22 metres = Y (say)

$$\therefore \% \text{ gain} = \frac{Y}{N} \times 100 \%, \text{ where } N = 66$$

$$\therefore \% \text{ gain} = \frac{22}{66} \times 100 \% = \mathbf{33\frac{1}{3}\%}.$$

REGULAR PROBLEMS

(1) A watch costing $\text{Rs } 250$ has been sold for $\text{Rs } 300$. The percentage profit was:

(RRB Chandigarh, '98)

- (a) 20 (b) 15 (c) $16\frac{2}{3}$ (d) 25 (e) 40

(2) A man buys pencils at 10 for $\text{Rs } 3$ and sells at 8 for $\text{Rs } 3$. His gain percent is:

- (a) 20 (b) 25 (c) 30 (d) 27 (e) None of these

Tips: Find the unit price first

(3) A shopkeeper sells almonds at the rate $\text{Rs } 114$ a kg and bears a loss of 5%. If he sells it at $\text{Rs } 126$ per kg, what will be the result?

- (a) 15% gain (b) 5% loss (c) 5% gain (d) 15% loss (e) $12\frac{1}{2}\%$ gain

(RRB Mahendraghat, '01)

- (4) Rakesh on selling a lamp for Rs 450 bears a loss of 20%. To earn a profit of 20%, he should sell the article for:
 (a) Rs 675 (b) Rs 600 (c) Rs 625 (d) Rs 680 (e) Rs 650 **(Railway ASM, '01)**
- (5) A trader purchased a bag of rice containing 70 kg for Rs 175. He sold it at the rate of Rs 2.75 per kg. Find the profit or loss%.
 (a) 10% gain (b) 10% loss (c) 12.5% gain (d) 12.5% loss (e) None of these
- (6) A man sold his book for Rs 891, thereby gaining $\frac{1}{10}$ of its cost price. The cost price is:
 (a) Rs 850 (b) Rs 810 (c) Rs 851 (d) Rs 840 (e) None **(RBI, '97)**
- (7) 400 mangoes were bought at Rs 125 per hundred and were sold at a profit of Rs 100. The selling price per dozen is:
 (a) Rs 15 (b) Rs 1.5 (c) Rs 18 (d) Rs 10 (e) Rs 22

Hint: Find the selling price for 400 mangoes in first step

- (8) A man sells an article at a loss of 10%. If he had received Rs 9 more, he would have gained $12\frac{1}{2}\%$.
 The cost price of the article is:
 (a) Rs 40 (b) Rs 36 (c) Rs 32 (d) Rs 48 (e) None

Hint: Use $\frac{\text{Difference in sale price}}{\text{related \% difference of gain or loss}} = \text{cost price}$

- (9) John buys a telephone handset for Rs 600 from Kolkata and sells it at Ranchi at a gain of 25%. If his overhead expenses are 5% of the selling price, then he sold the telephone handset for
 (a) Rs 1000 (b) Rs 780 (c) Rs 750 (d) Rs 800 (e) Rs 720
- (10) A person marks his goods 20% higher than cost price and allows a discount of 5%. The percentage profit is:
 (a) 15 (b) 20 (c) 5 (d) 14 (e) None
- (11) A shopkeeper earns a profit of 12% on selling a book at 10% discount on the printed price. The ratio of the cost price and the printed price of the book is:
 (a) 45 : 56 (b) 50 : 61 (c) 99 : 125 (d) 36 : 79 (e) 63 : 92 **(Bank PO, '96)**

Tips: Assume printed price = Rs 100

- (12) What is a single discount equivalent to a discount series of 10% and 20%?
 (a) 25 (b) 30 (c) 28 (d) 15 (e) 27
- (13) A dishonest shopkeeper professes to sell potatoes at the cost price, but he weighs 950 gm, instead of one kg. What is the percentage of profit?
 (a) 50 (b) 5 (c) 6.5 (d) 5.26 (e) 6 **(RRB Guwahati, '97)**

Tips: Since the shopkeeper sells at the cost price so his profit is only due to underweighting

- (14) A shopkeeper by selling 44 calculators, earns a profit equal to the selling price of 11 calculators. His profit percentage is:
 (a) $33\frac{1}{3}$ (b) 20 (c) 25 (d) 30 (e) 40 **(NABARD, '98)**

Hint: Refer solved problems

- (15) A shopkeeper increased the price of a product by 50% and later on he reduce the price by 50%. Shopkeeper's loss was:
 (a) 0% (b) 2.5% (c) 25% (d) 0.25% (e) 100%
- (16) A trader bears a loss of 25% by selling 40 needles for a rupee. How many needles should he sell for a rupee in order to earn a profit of 20%?
 (a) 23 (b) 20 (c) 25 (d) 27 (e) 30

Tips: Always consider the unit sale price in such problem, Unit sale price means sale price of one

$$\text{needle. So, } \frac{\frac{1}{40}}{100 - 25} = \frac{\frac{1}{x}}{100 + 20}$$

- (17) A shopkeeper purchased an electric heater marked at Rs 200 at successive discounts of 10% and 15% respectively. He spent Rs 7 on packaging and sold the electric heater for Rs 200. Find his gain percent.
 (a) No loss or gain (b) 25 (c) 30
 (d) 40 (e) 50
- (18) A CD-music system when sold at a certain price gives a gain of 20%. If sold for thrice that price, the gain percent will be:
 (a) 60 (b) 160 (c) 360 (d) 200 (e) 260
- (19) What is the equivalent discount of the 20%, 10%, 5% discount series?
 (a) 35 (b) $17\frac{1}{2}$ (c) 28 (d) 31.6 (e) 33

Hint: Refer text

- (20) A shopkeeper bought 150 calculators at the rate of Rs 250 per calculator. He spent Rs 2500 on transportation and packing. If the marked price of calculator is Rs 320 per calculator and the shopkeeper gives a discount of 5% on the marked price, what will be the percentage profit gained by the shopkeeper?
 (a) 20 (b) 14 (c) 15 (d) 16 (e) None of these
- (BSRB Hyderabad PO, '99)
 (ITI, '93)
- (21) The cost price of 20 pencils is equal to the selling price of 25 pencils. The loss percent in the transaction is:
 (a) 5 (b) 20 (c) 25 (d) 30 (e) 40
- (22) Anindita sells her car for Rs 5 lakhs and loses something. Had she sold it for Rs 5.60 lakh, her gain would have been double the former loss. Find the cost price of the car.
 (a) Rs 5.50 lakhs (b) Rs 6.20 lakhs (c) Rs 5.20 lakhs (d) Rs 5.40 lakhs (e) None
- Hint:** Follow the concept of cost price and sale price
- (23) A dishonest milkman buys milk at Rs 6 per litre and adds one third of water to it and sells the mixture at Rs 7.20 per litre. The gain is:
 (a) 40% (b) $\frac{80}{3}\%$ (c) 60% (d) 25% (e) 20%

Tips: Water added is also sold at Rs 7.20 per litre

- (24) A trader had 6 quintals of rice. He sold a part of it at 7% profit and the rest at 17% profit, so that he made a total profit of 11%. How much rice did he sell at 17% profit?
 (a) 200 kg (b) 220 kg (c) 240 kg (d) 260 kg (e) None of these

Hint: Refer text 13.10

Answers

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

REAL PROBLEMS

- (1) A man sells his table clock for Rs 144. If his percentage of profit is equal to his cost price, then the cost price of the watch is:

(a) Rs 90 (b) Rs 85 (c) Rs 80 (d) Rs 75 (e) Rs 64

Hint: Do not waste your time by trying to solve the equation formed with x meant for cost price. But try out with the given alternatives that satisfy the given condition of the problem.

- (2) An article when sold for Rs 200 fetches 25 percent profit. What would be the percentage profit/loss if 6 such articles are sold for Rs 1056? (BSRB Kolkata PO, '99)

(a) 10% loss (b) 10% profit (c) 5% loss (d) 5% profit (e) None

- (3) Ben purchased 125 stools at the rate of Rs 120 per stool. The transport expenditure was @ Rs 10 for 5 stool. He paid an octroi @ Rs 2 per stool and coolie charges were Rs 250. what should be the selling price of each stool, if he wants profit of 10%?

(a) Rs 125 (b) Rs 145 (c) Rs 150 (d) Rs 140 (e) None

- (4) A shopkeeper sells cashewnut at the rate of Rs 114 per kg and incurs a loss of 5%. What will happen when he sells it at the rate of Rs 126 per kg?

(a) 15% gain (b) 15% loss (c) 5% gain (d) 5% loss (e) 10% gain

Tips: Do not try to find cost price, as it is not required in the problem

- (5) A person purchased an article at $\frac{9}{10}$ th of its selling price and sold it at 8% more than its selling price.

His gain per cent is

(a) 8 (b) 12 (c) 20 (d) 15 (e) 16

- (6) Five kg of butter was bought by a shopkeeper for Rs 300. One kg becomes unsaleable. He sells the remaining in such a way that on the whole he incurs a loss of 10%. At what per kg was the butter sold?

(a) Rs 67.50 (b) Rs 52.50 (c) Rs 60 (d) Rs 72.50 (e) Rs 65

- (7) A man sells a horse for Rs 600 gaining thereby $\frac{1}{5}$ th of the selling price. At what price would he have

sold it to lose $\frac{1}{4}$ th of the then selling price?

(a) Rs 384 (b) Rs 350 (c) Rs 375 (d) Rs 348 (e) Rs 400

Tips: You do not require to find the cost price, because the data given relates to selling price only.

- (8) A lamp is bought for Rs 850 and sold at a gain of $x\%$. The selling price of the lamp is:

(a) Rs $\frac{85x}{100}$ (b) Rs $\frac{850 + x}{100}$ (c) Rs $\frac{8500x}{100}$

(d) Rs $850 + \frac{17x}{2}$ (e) Rs $\frac{850}{x + 100}$

(9) A milkman makes a profit of 20% on the sale of milk. If he were to add 10% water to the milk, by what % would his profit increase?

- (a) 30 (b) 32 (c) 22 (d) 10 (e) 12

(10) Kaberi buys a computer at three-fourths of its value and sells it for 20% more than its value. What will be her profit percentage?

- (a) 50 (b) 40 (c) 60 (d) 70 (e) None

(11) A man buys some mangoes @ 9 for a rupee and an equal number @ 7 for a rupee. After that, he sells them @ 8 for a rupee. His gain or loss percent is

- (a) 0 (b) $3\frac{1}{8}\%$ gain (c) $3\frac{1}{8}\%$ loss (d) $1\frac{9}{16}\%$ loss (e) $\frac{25}{16}\%$ gain

(12) By selling a pen for Rs 24, a shopkeeper gains as much percent as the number of rupees he paid for it. The gain percent, x , will satisfy the following equation:

$$(a) x = \frac{24 - x}{100}$$

$$(b) x = 24 - \frac{x}{100}$$

$$(c) x = 10\sqrt{24 - x}$$

$$(d) \frac{x - 24}{100} = x^2$$

$$(e) 24 = \left(x - \frac{x}{100}\right) \times 100$$

(13) How much % must be added to the cost price of goods so that a profit of 20% must be made after throwing off a discount of 10% from the marked price?

- (a) 20 (b) 30 (c) $33\frac{1}{3}\%$ (d) 25 (e) 40

Tips: Always remember that % discount is allowed on marked (printed) price and % gain is calculated on cost price.

(14) By how much should the sale price of an almirah be greater than its cost, so that after allowing a trade discount of 20% and a cash discount of 6.25%, a net gain of 20% on the cost is made?

- (a) 26.25% (b) $32\frac{3}{4}\%$ (c) 21% (d) 25% (e) 60%

(15) A sells a watch to B at a gain of 20% and B sells it to C at a loss of 10%. If C pays Rs 216, what had it cost A? (Comm. Clerk & TC Exam, '01)

- (a) Rs 200 (b) Rs 216 (c) Rs 100 (d) Rs 250 (e) Rs 233

Tips: Here gain % and loss % are whole numbers, i.e. **do not have any fraction**, so to save your time you can **mentally** calculate by assuming the cost price of A as Rs 100 & proceeding as per the condition of the problem.

(16) Animesh purchased a horse and a carriage for Rs 1,800. He sold the horse at a profit of 20% and

the carriage at a profit of 30%. His total profit was $25\frac{5}{6}\%$. The cost price of the horse is:

- (a) Rs 1,050 (b) Rs 1,200 (c) Rs 750 (d) Rs 975 (e) Rs 1,125

(17) By what % must the cost of goods be marked up so that even after a discount of 20% the same amount is realised as before the discount?

- (a) 20 (b) 25 (c) 40 (d) 10 (e) $12\frac{1}{2}\%$

- (18) Two musical instruments were purchased for Rs 8,000. The first was sold at a profit of 40% and the second at a loss of 40%. If the sale price was the same in both the cases, then the cost price of the cheaper instrument was:
 (a) Rs 3,600 (b) Rs 5,600 (c) Rs 2,400 (d) Rs 3,800 (e) Rs 3,500
- (19) If a merchant estimates his loss at 36% of the selling price, then what is his real loss percent, as per definition?
 (a) 36 (b) $56\frac{1}{4}$ (c) $26\frac{8}{17}$ (d) 0 (e) 64

Hint: Refer solved examples

- (20) A discount of 16% on the marked price of a book enables a man to buy a pen that costs Rs 80. How much did he pay for the book?
 (a) Rs 420 (b) Rs 480 (c) Rs 500 (d) Rs 350 (e) Rs 340
- * (21) For a certain article, if discount is 25%, the profit is 25%. If the discount is 10%, then the profit is:
 (a) 15% (b) 50% (c) 150% (d) 35% (e) 65%

Tips: For same article, the cost price is obviously the same, assume it as Rs 100. Then, assume the marked price as Rs x and proceed as per given condition.

- (22) A man sells a TV at a profit of 25% of the cost. Had he sold it at a profit of 25% of the selling price, his profit would have increased by 5% of the cost price plus Rs 100. The cost of the TV is:
 (a) Rs 11,500 (b) Rs 7,000 (c) Rs 9,600 (d) Rs 8,000 (e) Rs 12,000

Hint: The problem relates to the change of profit

- (23) When a discount of 10% is given on an item being sold at a profit of 20% on the cost price, the sales volume trebles. What is the ratio of new profit to original profit?
 (a) 8 : 3 (b) 3 : 4 (c) 3 : 2 (d) 4 : 3 (e) None of these

Hint: Assume x as the original volume

- (24) A manufacturer of patent medicines gives one dozen extra bottles of the medicine for every order of 12 dozens. A discount of 25% is also offered to the trader on the marked price. If a bottle is marked Rs 113, find the lowest price at which a bottle can be sold without any loss. (approx. price)
 (a) Rs 78 (b) Rs 83 (c) Rs 65 (d) Rs 72 (e) Rs 90

Answers

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

14

SIMPLE INTEREST

14.1 AMOUNT BECOME = PRINCIPAL + SIMPLE INTEREST
 $P + \frac{PRT}{100}$

14.1 DEFINITION

If a person A borrows some money from another person B for a certain period, then after that specified period, the borrower has to return the money borrowed as well as some additional money. This additional money that borrower has to pay is called **interest**. The actually borrowed money by A is called **principal (SUM)**. The principal and the interest together is called **amount**. The interest that the borrower has to pay for every 100 rupees borrowed each year is known as **rate per cent per annum**. It is denoted as $R\%$ per annum $= \frac{R}{100}$.

The time for which the borrowed money has been used is called the **time**. It is denoted as T years. The interest is directly proportional to the principal, the rate and the time for which the borrowed sum is used.

If the interest on a certain sum borrowed for a certain period is reckoned uniformly, then it is called **Simple Interest** and denoted as $S.I.$

$$\therefore \text{Simple Interest (S.I.)} = P \times \frac{R}{100} \times T,$$

where P = Principal or the sum borrowed

R = Rate per cent per annum

T = Number of years for which the borrowed money has been used.

Now, simple interest + principal = amount

$$\Rightarrow \text{Simple interest} = \text{amount} - \text{principal}$$

If amount is denoted by ' A ', then

$$\text{Simple interest} = A - P = \frac{PRT}{100} \quad * \quad (1)$$

14.2 EFFECT OF CHANGE OF P , R AND T ON SIMPLE INTEREST

$$\text{Since, Simple interest} = \frac{PRT}{100}$$

* Special Memory Clips for use of relation (1)

$$(1) \text{ SI} = \frac{PRT}{100} \text{ can be rearranged as per requirement of the problem as } P = \frac{100 \times SI}{RT}, R = \frac{100 \times SI}{PT}$$

and $T = \frac{100 \times SI}{RT}$, so, in each case we find the numerator as $100 \times SI$ and the denominator as product of other two.

$$(2) \text{ Two different cases can be compared by using the relation as } \frac{A_1 - P_1}{A_2 - P_2} = \frac{P_1 R_1 T_1}{P_2 R_2 T_2}$$

so, if the value of P , R or T changes, then the value of simple interest (SI) will also change.

It implies that

- all three parameters P , R and T may change
- any two of these may change and one parameter remains fixed
- any one parameter may change and remaining two parameters are fixed

In all these cases, simple interest (SI) will change

In such cases,

$$\text{Change in simple interest} = \frac{\text{Product of fixed parameters}}{100} \times (\text{difference of product of variable parameters})$$

Changing

Example: At 5% simple interest, a sum of Rs 500 fetches Rs 36 more than the amount of interest accrued on Rs 380 for the same period and rate. Find the time.

Solution: Here, only the principal is variable. The time and rate are fixed. Using the relation (in 14.2).

$$\text{Change in simple interest} = \frac{\text{product of fixed parameters}}{100} \times (\text{difference of product of variable parameters})$$

$$36 = \frac{T \times 5}{100} \times (500 - 380) \quad \begin{matrix} \text{it is only difference because} \\ \text{there is one variable parameter} \end{matrix}$$

$\Rightarrow T = 6 \text{ years}$

Example: The simple interest on a certain sum for 4 years at 7.5% per annum is Rs 95 less than the simple interest on the same sum for 3.5 years at 10% per annum. Find the sum.

Solution: Here the principal is fixed. Let the principal (sum) be Rs P

Time and rate are variable (changing)

Using the relation (in 14.2),

$$\text{Change in simple interest (SI)} = \frac{\text{product of fixed parameters}}{100} \times (\text{difference of product of variable parameters})$$

$$95 = \frac{P}{100} \times (4 \times 7.5 - 3.5 \times 10) \quad (\text{here, } P \text{ is only fixed parameter})$$

$$\Rightarrow P = 95 \times 20 = 1900$$

Hence, the required sum = Rs 1900

14.3 AMOUNT

PRINCIPAL (SUM)
 → actually borrowed money

+

SIMPLE INTEREST
 → interest accrued on the sum borrowed

=

AMOUNT
 → money to be returned by the borrower

$$A = \text{Amount} = \text{Principal} + \text{Simple Interest} = P + SI$$

$$\text{In terms of principal, } A = P + SI = P + \frac{PRT}{100} = P \left(1 + \frac{RT}{100}\right)$$

$$\text{In terms of simple interest, } A = P + SI = \frac{100 \times SI}{RT} + SI = SI \left(1 + \frac{100}{RT}\right)$$

$$A = P \left(1 + \frac{RT}{100}\right) = SI \left(1 + \frac{100}{RT}\right) \quad (3)$$

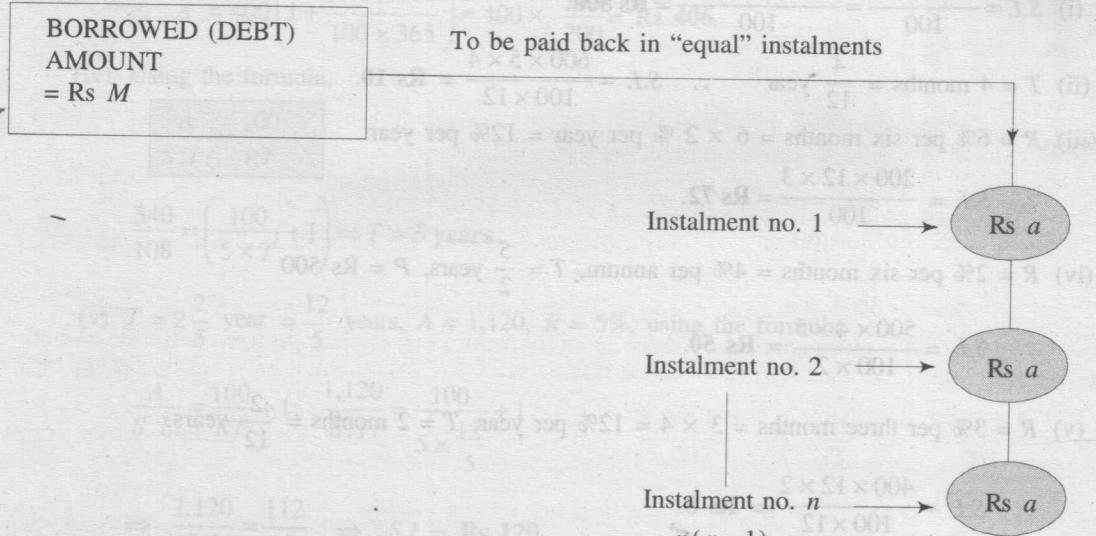
14.4 AMOUNT BECOMES N TIMES THE PRINCIPAL

PRINCIPAL	RATE OF INTEREST	TIME	AMOUNT BECOMES
If $\rightarrow P$	$R\% \text{ p.a.}$	T	$N \times P$

then, following relation is useful,

$$R \times T = 100(N - 1)$$

14.5 REPAYMENT OF DEBT IN EQUAL INSTALMENTS



$$\text{BORROWED AMOUNT (DEBT)} = M = na + \frac{ra}{100 \times y} \times \frac{n(n-1)}{2}$$

where, r = rate of interest per annum

y = no. of instalments per annum

$y = 1$, when each instalment is paid yearly

$y = 2$, when each instalment is paid half-yearly

$y = 4$, when each instalment is paid quarterly

$y = 12$, when each instalment is paid monthly

14.6 RATE AND TIME ARE NUMERICALLY EQUAL

Here, Rate per cent per annum = R

Time = T numeric value of $R = T$

Principal = P

Simple Interest = SI

$$R \text{ or } T = \sqrt{\frac{100 \times SI}{P}}$$

Solved Examples

E-1 Find the simple interest, If

- $P = \text{Rs } 1,000, R = 20\% \text{ per annum}, T = 4 \text{ years.}$
- $P = \text{Rs } 600, R = 5\% \text{ per annum}, T = 4 \text{ months.}$
- $P = \text{Rs } 200, R = 6\% \text{ per six months}, T = 3 \text{ years.}$
- $P = \text{Rs } 500, R = 2\% \text{ per six months}, T = \frac{5}{2} \text{ years.}$
- $P = \text{Rs } 400, R = 3\% \text{ per three months}, T = 2 \text{ months.}$
- $P = \text{Rs } 730, R = 10\% \text{ per annum}, T = 120 \text{ days.}$

S-1

$$(i) S.I. = \frac{P \times R \times T}{100} = \frac{1,000 \times 20 \times 4}{100} = \text{Rs } 800.$$

$$(ii) T = 4 \text{ months} = \frac{4}{12} \text{ year} \quad \therefore S.I. = \frac{600 \times 5 \times 4}{100 \times 12} = \text{Rs } 10.$$

$$(iii) R = 6\% \text{ per six months} = 6 \times 2 \% \text{ per year} = 12\% \text{ per year.}$$

$$\therefore S.I. = \frac{200 \times 12 \times 3}{100} = \text{Rs } 72.$$

$$(iv) R = 2\% \text{ per six months} = 4\% \text{ per annum}, T = \frac{5}{2} \text{ years, } P = \text{Rs } 500$$

$$\therefore S.I. = \frac{500 \times 4 \times 5}{100 \times 2} = \text{Rs } 50.$$

$$(v) R = 3\% \text{ per three months} = 3 \times 4 = 12\% \text{ per year, } T = 2 \text{ months} = \frac{2}{12} \text{ years.}$$

$$\therefore S.I. = \frac{400 \times 12 \times 2}{100 \times 12} = \text{Rs } 8.$$

$$(vi) T = 120 \text{ days} = \frac{120}{365} \text{ year} \quad (\text{Since } 365 \text{ days} = 1 \text{ year})$$

$$\therefore S.I. = \frac{730 \times 10 \times 120}{100 \times 365} = \text{Rs } 24.$$

E-2 Find the following:

- $P = \text{Rs } 100, R = 3\% \text{ per annum, } T = 2 \text{ year, } A = ?$
- $P = \text{Rs } 500, R = 6\% \text{ per annum, } T = 4 \text{ months, } A = ?$
- $P = \text{Rs } 400, R = 3.65\% \text{ per annum, } T = 150 \text{ days, } A = ?$
- $A = 540, S.I. = \text{Rs } 108, R = 5\% \text{ per annum, } T = ?$

$$(v) A = \text{Rs } 1,120, R = 5\%, T = 2 \frac{2}{5} \text{ years, } S.I. = ?$$

S-2 Using the formula,

$$(i) (\text{Refer 14.3}) A = P \left(1 + \frac{RT}{100} \right)$$

$$A = 100 \left(1 + \frac{3 \times 2}{100} \right) = 100 \times \frac{106}{100} = \text{Rs } 106.$$

(ii) $R = 6\%$ per annum, $T = 4$ months $= \frac{4}{12}$ years.

$$\therefore A = 500 \left(1 + \frac{6 \times 4}{100 \times 12} \right) = 500 \times \frac{102}{100} = \text{Rs } 510.$$

(iii) $T = 150$ days $= \frac{150}{365}$ year

$$\therefore A = 400 \left(1 + \frac{3.65 \times 150}{100 \times 365} \right) = 400 \times \frac{203}{200} = \text{Rs } 406.$$

(iv) Using the formula,

$$\boxed{\frac{A}{S.I.} = \frac{100}{RT} + 1}$$

$$\frac{540}{108} = \left(\frac{100}{5 \times T} + 1 \right) \Rightarrow T = 5 \text{ years.}$$

(v) $T = 2 \frac{2}{5}$ year $= \frac{12}{5}$ years, $A = 1,120$, $R = 5\%$, using the formula,

$$\frac{A}{S.I.} = \frac{100}{RT} + 1; \quad \frac{1,120}{S.I.} = \frac{100}{5 \times \frac{12}{5}} + 1$$

$$\Rightarrow \frac{1,120}{S.I.} = \frac{112}{12} \Rightarrow S.I. = \text{Rs } 120.$$

E-3 On what sum of money lent out at 9% per annum simple interest for 6 years does the simple interest amount to Rs 810? (RBI '82)

S-3 [Refer 14.1] Using the formula

$$P = \frac{100 \times S.I.}{R \times T} = \frac{100 \times 810}{9 \times 6} = \text{Rs } 1,500.$$

E-4 At what rate of interest per annum will a sum double itself in 8 years?

S-4 [Refer 14.4], Using the formula,

$$R \times T = 100 \times (N - 1); \text{ Here } T = 8 \text{ yrs. } N = 2 \text{ times } R = ?$$

$$\Rightarrow R \times 8 = 100 \times (2 - 1) \Rightarrow R = \frac{100}{8} = 12 \frac{1}{2}\%.$$

E-5 A sum when reckoned at simple interest $2 \frac{1}{2}\%$ per annum amounts to Rs 630 after 2 years. Find the sum.

S-5 [Refer 14.3],

$$A = P \left[1 + \frac{RT}{100} \right] \quad A = 630, P = ?$$

$$R = 2 \frac{1}{2}\% = \frac{5}{2}\%, T = 2 \text{ yrs.}$$

$$630 = P \left[1 + \frac{2 \times 5}{100 \times 2} \right] = 630 = P \times \frac{105}{100}$$

$\Rightarrow P = 600$. \therefore The sum is Rs 600.

E-6 A sum of money lent out at simple interest amounts to Rs 720 after 2 years and to Rs 1,020 after a further period of 5 years. Find the sum and the rate %.

S-6 Using relation (1), $A - P = \frac{PRT}{100}$, we find that R and P do not change here

$$\text{so, } \frac{A_1 - P}{A_2 - P} = \frac{PRT_1}{PRT_2} \Rightarrow \frac{720 - P}{1,020 - P} = \frac{2}{5}$$

$$\Rightarrow P = 600$$

\therefore sum = Rs 600

Putting $P = 600$ in above relation, we get

$$720 - 600 = \frac{600 \times R \times 2}{100}$$

$$\Rightarrow R = 10$$

\therefore Rate = 10% p.a.

E-7 Simple Interest on a certain sum is 16 over 25 of the sum. Find the rate per cent and time, if both are equal. (UTI '90)

$$\text{S-7 } S.I. = \frac{P \times R \times T}{100} \Rightarrow \frac{16}{25} \times P = \frac{P \times R \times R}{100}$$

(Since $R = T$ given) [Refer 14.6]

$$\Rightarrow R^2 = \frac{1,600}{25} = 64 \Rightarrow R = 8, \text{ Hence, } R = 8\%, T = 8 \text{ years.}$$

E-8 A milk man borrowed Rs 2,500 from two money lenders. For one loan, he paid 5% p.a. and for the other, he paid 7% p.a. The total interest paid for two years was Rs 265. How much did he borrow at each rate? (MBA '86)

S-8 A simple interest for the total amount = Rs 265

Rate of Interest on total amount, $R_m = ?$

$$R_m = \frac{100 \times S.I.}{T \times P} = \frac{100 \times 265}{2,500 \times 2} = \frac{11}{2}\%$$

$$\text{By Rule of Alligation, } \frac{\text{Sum borrowed at } 5\% \text{ p.a.}}{\text{Sum borrowed at } 7\% \text{ p.a.}} = \frac{7 - \frac{11}{2}}{\frac{11}{2} - 5} = \frac{3}{1}$$

\therefore Sum at 5% p.a.

$$= \frac{3}{1+3} \times 2,500 = \text{Rs } 1,875$$

Sum at 7% p.a.

$$= \frac{1}{1+3} \times 2,500 = \text{Rs } 625.$$

- E-9** Out of a certain sum, $\frac{1}{3}$ rd is invested at 3%, $\frac{1}{6}$ th at 6% and the rest at 8%. If the simple interest for 2 years from all these investments amounts to Rs 600, find the original sum. (BSRB '88)

S-9 Rest part $= 1 - \left(\frac{1}{3} + \frac{1}{6} \right) = \frac{1}{2}$

Average rate % per annum on the total sum $= \left(\frac{1}{3} \times 3 \right) + \left(\frac{1}{6} \times 6 \right) + \left(\frac{1}{2} \times 8 \right) = 6 \%$

$$\therefore P = \frac{100 \times SI}{R \times T} = \frac{100 \times 600}{6 \times 2} = \text{Rs } 5,000.$$

The original sum is **Rs 5,000**.

- E-10** What annual instalment will discharge a debt of Rs 4,200 due in 5 years at 10% simple interest? (AAO '82)

S-10 (Refer 14.5), Using the formula,

$$M = na + \frac{r \times a}{100 \times y} \times \frac{n(n-1)}{2}$$

Here $M = \text{Rs } 4200$, $n = 5$, $y = 1$, $r = 10\%$, a = annual instalment = ?

$$4,200 = 5a + \frac{10 \times a}{100} \times \frac{5 \times 4}{2} \Rightarrow 4,200 = 6a$$

$$\Rightarrow a = \text{Rs } 700 \text{ per year.}$$

- E-11** A sum of Rs 2 is lent to be paid back in 3 equal monthly instalments of Re. 1 each. Find the rate per cent.

S-11 (Refer No. 14.5), Using the formula,

$$M = na + \frac{r \times a}{100 \times y} \times \frac{n(n-1)}{2}$$

Here $M = \text{Rs } 2$, $a = \text{Re } 1$, $n = 3$, $y = 12$, $r = ?$

$$2 = 3 \times 1 + \frac{r \times 1}{100 \times 12} \times \frac{3 \times 2}{2} \Rightarrow r = 400\%.$$

∴ The rate % p.a. is **400%**.

- E-12** If Rs 85 amounts to Rs 95 in 3 years, what Rs 102 will amount to in 5 years at the same rate per cent? (MBA '81)

S-12 [Refer 14.1], Using the formula (1) we get,
$$\frac{A_1 - P_1}{A_2 - P_2} = \frac{P_1 \times R_1 \times T_1}{P_1 \times R_2 \times T_2}$$

$$\text{Here, } \frac{95 - 85}{A_2 - 102} = \frac{85 \times R \times 3}{102 \times R \times 5} \Rightarrow A_2 - 102 = 20, \Rightarrow A_2 = 122.$$

∴ The amount is **Rs 122**.

E-13 A sum was put at simple interest at a certain rate for 4 years. Had it been put at 2% higher rate, it would have fetched Rs 56 more. Find the sum. (Bank '89)

S-13 Here rate % p.a. is changed, so, value of simple interest also changes. [Refer 14.2]

$$\text{Change in simple interest} = \frac{\text{Product of FIXED parameter}}{100} \times \left[\begin{array}{l} \text{difference of product of} \\ \text{VARIABLE parameter} \end{array} \right]$$

where, fixed parameters are P and T , given, $T = 4$ years.

only one variable parameter is R , given, $R_1 - R_2 = 2$

also, given, $SI_1 - SI_2 = \text{Rs } 56$.

$$\Rightarrow 56 = \frac{P \times 4}{100} [2] \quad \Rightarrow P = 700.$$

∴ The sum is **Rs 700.**

E-14 A sum of Rs 3,800 is lent out in two parts in such a way that the interest on one part at 8% for 5

years is equal to that on another part at $\frac{1}{2}\%$ for 15 years. Find the sum lent out at 8%.

S-14 Let the sum lent out at 8% = P_1 ; sum lent out at $\frac{1}{2}\% = P_2$

since $(SI)_1 = (SI)_2$

$$P_1 \times 8 \times 5 = P_2 \times \frac{1}{2} \times 15 \Rightarrow \frac{P_1}{P_2} = \frac{15}{2 \times 8 \times 5} = \frac{3}{16}$$

$$\therefore P_1 = \text{Sum lent out at } 8\% = \frac{3}{(3+16)} \times 3,800 = \text{Rs } 600.$$

REGULAR PROBLEMS

- (1) At what rate per cent per annum a sum of Rs 1,800 will become Rs 2,700 in 10 years?
 (a) 5% (b) 6% (c) 10% (d) 6.75% (e) None of these
- (2) A sum of Rs 1,600 lent at simple interest of 12.5% per annum will become twice in (Bank '81)
 (a) 6 years (b) $7\frac{1}{2}$ years (c) 8 yrs. (d) $9\frac{1}{4}$ yrs. (e) None of these
- (3) Rakesh took a loan for 6 years at 5% p.a. simple interest. If the total interest paid was Rs 1,230, the principal was
 (a) Rs 4,100 (b) Rs 5,000 (c) Rs 5,300 (d) Rs 4,920 (e) None of these
- (4) If Rs 1,200 amounts to Rs 1,440 in 5 years at simple interest, the rate % p.a. is
 (a) 10% (b) 12% (c) 4% (d) 5% (e) None of these
- (5) If a sum of Rs 1,600 gives a simple interest of Rs 252 in two years and 3 months, then the rate % p.a. is
 (a) $5\frac{1}{2}\%$ (b) 8% (c) 7% (d) 6% (e) 5%
- (6) In what time will Rs 72 become Rs 81 at $6\frac{1}{4}\%$ p.a. simple interest? (MBA '79)
 (a) 1 yr 6 months (b) 2 yrs. (c) $2\frac{1}{4}$ yrs.
 (d) $2\frac{1}{2}$ yrs. (e) 1 year

- (7) A sum of money doubles itself in 10 years at simple interest. In how many years would it treble itself?
 (a) 10 (b) 15 (c) 20 (d) 25 (e) None of these (Bank PO '78)
- (8) At what rate per cent (simple interest) will a sum of money double itself in 16 years?
 (a) 50% (b) 5% (c) $6\frac{1}{4}\%$ (d) 10% (e) 20%
- (9) On retirement, a person gets 1.53 lakhs of his provident fund which he invests in a scheme at 20% p.a. His monthly income from this scheme will be
 (a) Rs 2,450 (b) Rs 2,500 (c) Rs 2,550 (d) Rs 2,600 (e) Rs 2,700
- (10) Find out the capital required to earn a monthly interest of Rs 600 at 6% simple interest.
 (a) Rs 1.0 lakhs (b) Rs 1.2 lakhs (c) Rs 1.1 lakhs
 (d) Rs 1.3 lakhs (e) None of these
- (11) A sum of money lent out at simple interest amounts to Rs 2,520 in 2 years and Rs 2,700 in 5 years. Find the rate % p.a.
 (a) 3% (b) 4% (c) $2\frac{1}{2}\%$ (d) 5% (e) None of these
- (12) A sum of money doubles itself in 7 yrs. In how many years it becomes four fold?
 (a) 10 yrs. (b) 35 yrs. (c) 14 yrs. (d) 21 yrs. (e) 28 yrs.

Hint: Use, $\frac{RT_1}{RT_2} = \frac{N_1 - 1}{N_2 - 1}$ ∴ $\frac{7}{T_2} = \frac{2 - 1}{4 - 1}$ ∴ $T_2 = 21$.

- (13) I gave some money at simple interest and at the end of 10 yrs, got back twice the sum. The rate % p.a. was
 (a) 2% (b) 4% (c) 5% (d) 10% (e) 20%
- Hint:** Use $RT = (N - 1) \times 100$.
- (14) A man pays 40 times the annual rent to purchase a building. The rate % p.a. he derives from his investment is
 (a) 25% (b) 2.5% (c) 5% (d) 40% (e) 4%

Tips: Rate% p.a. = $\frac{100}{\text{No. of times the annual rent}}\%$.

- (15) If Re 1 produces Rs 9 in 60 years at simple interest, the rate % p.a. is
 (a) $13\frac{1}{3}\%$ (b) 14% (c) 15% (d) $12\frac{1}{2}\%$ (e) None of these
- Hint:** If investment (P) = 1 Re $S.I. = \text{Rs } 9$.
- (16) If Re 1 becomes Rs 9 in 60 years at simple interest, the rate % p.a. is
 (a) 15% (b) $12\frac{1}{2}\%$ (c) $13\frac{1}{3}\%$ (d) 12% (e) None of these

Hint: If investment (P) = Re 1 then $S.I. = 9 - 1 = \text{Rs } 8$.

- (17) If x is the simple interest on y and y is the simple interest on z , the rate % and the time being the same in both cases, what is the relation between x , y and z ? (MBA '80)
 (a) $x^2 = yz$ (b) $y^2 = xz$ (c) $z^2 = xy$ (d) $xyz = 1$ (e) $x = 2y + z$

- (18) The simple interest on a sum of money is $\frac{1}{9}$ of the principal and the number of years is equal to the rate % p.a. The rate % p.a. is

- (a) 3% (b) $3\frac{1}{3}\%$ (c) 10% (d) $\frac{1}{3}\%$ (e) 9%.

- (19) The simple interest on a certain sum of money at 4% p.a. for 4 years is Rs 19 more than interest on the same sum for 3 years at 5% p.a. Find the sum of money

- (a) 6,700 (b) 7,500 (c) 8,000 (d) 8,750 (e) 9,500

- (20) The simple interest on Rs 800 at 6% per month for 9 months is
 (a) Rs 250 (b) Rs 360 (c) Rs 432 (d) Rs 360 (e) None of these

- (21) If Rs 450 amount to Rs 540 in 4 years, what will it amount to in 6 years at the same rate %?
 (a) Rs 600 (b) Rs 585 (c) Rs 700 (d) Rs 640 (e) None of these

Tips: Since Principal and Rate are same in both cases; So, simple interest per year will be the same. This concept is used here.

- (22) The interest-on a sum of money at the end of $2\frac{1}{2}$ years is $\frac{4}{5}$ of the sum. The rate per cent per year is

- (a) 10% (b) 20% (c) 16% (d) 32% (e) 40%

- (23) A man lent Rs 600 for 2 years and Rs 200 for 3 years, at the same rate at simple interest and received only Rs 90 as interest. What was the rate % p.a.?

- (a) 12% (b) 5% (c) 6% (d) $8\frac{1}{3}\%$ (e) 4%

Hint: Rate is same $\therefore \frac{R[P_1 T_1 + P_2 T_2]}{100} = SI$

- (24) A certain sum of money amounts to $\frac{5}{4}$ of itself in 5 years. The rate per cent p.a. is

- (a) 10% (b) 5% (c) 7% (d) 11% (e) $12\frac{1}{2}\%$

- (25) In what time will a sum of money double itself at 3% per annum at simple interest?

- (a) $33\frac{1}{3}$ yrs. (b) 30 yrs. (c) $13\frac{1}{3}$ yrs. (d) 6 yrs. (e) $23\frac{1}{3}$ yrs.

- (26) Namrata deposited Rs 8,000 which amounted to Rs 9,200 after 3 years at simple interest. Had the interest been 2% more, she would get how much?

- (a) Rs 1,680 (b) Rs 9,860 (c) Rs 9,980 (d) Rs 9,680 (e) Rs 10,620

- (27) The rate of interest on a sum of money is 3% p.a. for the first four years, 5% p.a. for the next four years and 6% p.a. for the period beyond 8 years. If the simple interest accrued on the sum for a total period of 9 years is Rs 817, the sum is

- (a) Rs 21.50 (b) Rs 18.50 (c) Rs 29.00 (d) Rs 215 (e) None

- (28) What quarterly payment will discharge a debt of Rs 2,280 due in two years at 16% p.a. simple interest?
 (a) Rs 260 (b) Rs 450

- (a) Rs 1,000 (b) Rs 1,600 (c) Rs 250 (d) Rs 360 (e) Rs 450

- (Bank PO, 89)

Answers

1. (a) 2. (c) 3. (a) 4. (c) 5. (c) 6. (b) 7. (c) 8. (c) 9. (c)
10. (b) 11. (c) 12. (d) 13. (d) 14. (b) 15. (c) 16. (c) 17. (b) 18. (b)
19. (c) 20. (c) 21. (b) 22. (d) 23. (b) 24. (b) 25. (a) 26. (d) 27. (e)
28. (c)