PERPETUITY, SINKING FUNDS & EMI

1. (A) Rs. 2000
2. (B) Rs. 800
3. (C) Rs. 2,480.57
4. (C) $\frac{R}{i}$
5. (B) Rs. 800
6. (C) 5% p.a.
7. (C) will increase
8. (C) 5 % p.a.
9. (B) ₹ 800
10. (B) ₹ 40000
11. (A) 5%
12. D
13. At

Sol.

Here, $\mathbf{R = 600, i = \frac{0.06}{4} = 0.015}$ **(1)**

So, $\mathbf{PV = \frac{R}{i} = \frac{600}{0.015} = ₹\ 40,000}$ **(1)**

14. Find

Solution:

Let P be the present value of the perpetuity.

Here, R = ₹18000 and $i = \frac{8}{100\times2} = 0.04$ **[1]**

$\therefore\ P = \frac{R}{i} = \frac{18000}{0.4} = ₹4,50,000$ **[1]**

15. Find

Sol.

Here, R = ₹4,200 and $i = \frac{5}{100} = 0.05$

$P = R + \frac{R}{i}$

$P = 4200 + \frac{4200}{0.05}$ **1**

$= 88,200$ **1**

Thus, present value of perpetuity is ₹88,200.

16. Find

Sol.

$P = \frac{R}{i}$

$P = \frac{5000}{0.05}$ **1**

$= 1,00,000$ **1**

Thus, present value of perpetuity is ₹1,00,000.

17. A man

18. Find

$R = ₹600$

$i = \frac{0.08}{4} = 0.02$ — 1

Present value of perpetuity $= P = \frac{R}{i}$

$\Rightarrow P = \frac{600}{0.02} = ₹30{,}000$ — 1

19. Find

Present value of ordinary annuity — 1

$= R\left(\frac{1-(1+r)^{-n}}{r}\right)$

$= 1000\left(\frac{1-(1.06)^{-5}}{0.06}\right)$

$= 1000\left(\frac{1-0.7473}{0.06}\right) = ₹4211.67$ — 1

20. Calculate

Sol.

$P = ₹\,5,00,000$

Interest $= \frac{PRT}{100}$

$= \frac{500000\times7.5\times5}{100} = ₹\,1{,}87{,}500$ — **1**

$n = 5$ years $= 60$ months — ½

$\therefore$ EMI $= \frac{P+I}{n}$

$= \frac{500000+187500}{60}$ — **1**

$= ₹\,11{,}458.33$ — ½

21. A

Sol.

Amount needed after 12 years $= ₹\,1{,}00{,}000 - ₹\,5{,}000 = ₹\,95{,}000$ — **1**

The payments into sinking fund consist of 12 annual payments at the rate of 5% per year.

$A = R\left[\frac{(1+i)^n-1}{i}\right]$

$95000 = R\left[\frac{(1.05)^{12}-1}{0.05}\right]$ — **2**

$\Rightarrow R = \frac{95000\times0.05}{0.7958} = ₹\,5968.84$ (or $\frac{4750}{0.8} = ₹\,5937.50$ using approximations) — **2**

22. Amrita

Sol.

Here P = ₹ 9,50,000, $i = \frac{15}{1200} = 0{\cdot}0125$ $(\frac{1}{2})$

n = 48 months $(\frac{1}{2})$

Using the reducing balancing method,

$E = \frac{Pi}{1-(1+i)^{-n}} = \frac{9,5,0000 \times 0{\cdot}0125}{1-(1+0{\cdot}0125)^{-48}}$ **(1)**

$= \frac{11875}{1-(1.0125)^{-48}} = \frac{11875}{1-0.5508565}$ $(\frac{1}{2})$

$(\frac{1}{2})$

= ₹ 26,439·21

23. Madhu

Solution:

Here, $i = \frac{9}{1200} = 0.0075$, n = 20 and E = ₹ 21,000

P = ₹ (650000 – 150000 – x) = (500000 $-x$) **[1]**

By the reducing balance method, we have

$E = \frac{Pi}{1-(1+i)^{-n}}$ **[1]**

$\Rightarrow \quad 21000 = \frac{(500000-x)(0.0075)}{1-(1.0075)^{-20}} = \frac{3750-0.0075x}{1-0.86118985} = \frac{3750-0.0075x}{0.1381015}$ $[\frac{1}{2}]$

$\Rightarrow \quad x =$ ₹ 1,11,332 $[\frac{1}{2}]$

24. A

[July, 2024]

Ans

Here, $A = ₹(3,00,000 - 30,000) = ₹2,70,000$ ½

We know, $A = R\left[\frac{(1+i)^n - 1}{i}\right]$

$\Rightarrow 270000 = R\left[\frac{(1+0.05)^7 - 1}{0.05}\right]$ 1

$\Rightarrow R = \frac{270000 \times 0.05}{(1.05)^7 - 1} = \frac{270000 \times 0.05}{0.407}$ 1

$\Rightarrow R =$ ₹33,169.53 ½

Hence, the company should deposit ₹33,169.53 at the end of each year for 7 years.

25. A

Cost of new machine $= ₹\,(50{,}000 + 30\% \times 50{,}000) = ₹\,65{,}000$ ½

$A =$ Amount required in sinking fund $= ₹\,(65{,}0000 - 6{,}000) = ₹\,59{,}000$ ½

$R\left[\frac{(1+i)^n-1}{i}\right] = A$

$R\left[\frac{(1.06)^8-1}{0.06}\right] = 59000$ 1

$R\left[\frac{1.6-1}{0.06}\right] = 59000$

$\Rightarrow R = \frac{59000\times0.06}{0.6} = ₹\,5900$

So, the required amount to be retained $= ₹\,5900$ 1

26. At

Q-21 Let rate of interest be r% per annum, then $i = \frac{r}{200}$

Given R = ₹1500 and P = Rs 20,000

$P = \frac{R}{i} \Rightarrow i = \frac{R}{P} = \frac{1500}{20000}$ 1 Mark

$\Rightarrow \frac{r}{200} = \frac{1500}{20000} \Rightarrow r = 15\%$ 1 Mark

27. Mr

Q-30 Here P = 5,00,000 ; I = 2,00,000; EMI = 12,500

$EMI = \frac{P+I}{n}$ 1½ Mark

$12{,}500 = \frac{5{,}00{,}000+2{,}00{,}000}{n} \Rightarrow n = \frac{7{,}00{,}000}{12{,}500} = 56$ months. 1½ Mark

28. Mr

Q-31 Let Rs. R be set aside biannually for 10 years in order to have ₹ 500,000 after 10 years

Here S = 500,000. ; n = 10 × 2 = 20

$i = \frac{5}{2\times100} = 0.025$ ½ Mark

$R = \frac{iS}{(1+i)^n-1} = \frac{0.025\times500{,}000}{(1.025)^{20}-1} = \frac{12{,}500}{1.6386-} = 19{,}574.07.$ 2½ Mark

29. Surjeet

[SQP 22-23]

Purchase = ₹ 40,00,000

Down payment = x

Balance = $40{,}00{,}000 - x$

$i = \frac{9}{1200} = 0.0075$, n = 25 x 12 = 300 1

E = ₹ 30,000

$\Rightarrow 30000 = \frac{(4000000 - x) \times 0.0075}{1 - (1.0075)^{-300}}$

$\Rightarrow 30000 = \frac{(4000000 - x) \times 0.0075}{1 - 0.1062}$ 2

$\Rightarrow x = 424800$

Down payment = ₹ 4,24,800

30. 10

n = 10 x 2 = 20, S = 10,21,760, $i = \frac{5}{200} = 0.025$, R = ? S =R $[\frac{(1+i)^n-1}{i}]$	1.5
$\Rightarrow 1021760 = R\,[\frac{(1+0.025)^{20}-1}{0.025}]$ $\Rightarrow 1021760 = R\,[\frac{1.6386-1}{0.025}]$ $\Rightarrow R = [\frac{1021760\times 0.025}{0.6386}]$ $\Rightarrow R = ₹\,40{,}000$ Mr Mehra set aside an amount of ₹ 40,000 at the end of every six months	1.5

31. Amrita

Sol.

$\mathbf{n = 2 \times 12 = 24}$,	$(\frac{1}{2})$
$\mathbf{i = \frac{20}{1200} = \frac{1}{60}}$	$(\frac{1}{2})$
$\text{EMI} = \frac{\mathbf{Pi}}{\mathbf{1-(1+i)^{-n}}}$	
$\mathbf{25448 = \frac{P\times\frac{1}{60}}{1-(1+\frac{1}{60})^{-24}}}$	(1)
$\mathbf{P = 25448 \times 60\left[1-\left(1+\frac{1}{60}\right)^{-24}\right]}$	(1)
$\mathbf{P = 25448 \times 60(1-0.67253)}$	$(\frac{1}{2})$
$= ₹\,\mathbf{5,00,000}$ approx.	(1)
Hence the actual price of the car is ₹ 7,50,000 approx.	$(\frac{1}{2})$

32. A

Sol.

Let R be the amount set aside each year.	
Price of new model = 52000 + 25% of 52000 = ₹ 65000	1
Scrap Value = ₹ 2500	
Net amount = ₹ 62500	1
$R = \frac{si}{(1+i)^n-1}$	
$= \frac{62500\times 0.035}{(1+0.035)^{25}-1} = \frac{62500\times 0.035}{1.3632}$	2
= ₹ 1604.68	1

33. Mahesh

Ans

We have, $P = ₹(70{,}00{,}000 - 15{,}00{,}000) = ₹\,55{,}00{,}000$ $n = 25\times 12 = 300$ and $i = \frac{9}{1200} = 0.0075$	1

(i) Let E be the monthly installment. Then,

$$E = \frac{Pi}{1-(1+i)^{-n}}$$

$$= \frac{5500000 \times 0.0075}{1-0.1062878338} \quad 1$$

$$= \frac{41250}{0.8937121662} = 46155.80 \quad 1$$

$\therefore$ The monthly installment is ₹ 46,155.80

(ii) Total interest $= nE - P$

$= 300 \times 46155.80 - 5500000 \quad 1$

$= 13846740 - 5500000$

$= ₹\ 83,46,740 \quad 1$

(Note: The student is allowed to use any approximate value of 0.1062878338)

34. A

Ans. Let each annual deposit to the sinking fund be ₹ R **2**

$$\therefore \mathbf{100000} = \boldsymbol{R}\left[\frac{(1+0.18)^4-1}{0.18}\right]$$

$$= \boldsymbol{R}\left[\frac{(1.18)^4-1}{0.18}\right]$$

$$= \boldsymbol{R}\left[\frac{0.4388}{0.18}\right] = \boldsymbol{R(5.2186)} \quad \mathbf{1\frac{1}{2}}$$

$$\Rightarrow \mathbf{R} = \frac{\mathbf{100000}}{\mathbf{5.2186}} = ₹\,\mathbf{19162.22} \quad \mathbf{1\frac{1}{2}}$$

35. A

Ans. Here, $P = ₹\ 10,00,000, i = \frac{6}{12\times100} = 0.005$ **1**

$n = 15$ years $= 180$ months

(i) Using flat rate method

$$\text{EMI} = P\left(i + \frac{1}{n}\right)$$

$$= 10,00,000\left(0.005 + \frac{1}{180}\right) = ₹\ 10555.55 \quad \mathbf{1+\frac{1}{2}}$$

(ii) Using reducing balancing method

$$\text{EMI} = \frac{Pi}{1-(1+i)^{-n}}$$

$$= \frac{10,00,000\times0.005}{1-(1.005)^{-180}} \quad \mathbf{1}$$

$$= \frac{5000}{1-0.4704824} = ₹\ 8438.57 \quad \mathbf{1\frac{1}{2}}$$

36. Mr.

Loan amount $= P = ₹\,(10{,}00{,}000 - 2{,}00{,}000) = ₹\,8{,}00{,}000$ ½

$i = \frac{10}{12\times100} = 0.0083$ ½

$n = 5 \times 12 = 60$ ½

$\text{EMI} = \frac{P\times i\times(1+i)^n}{(1+i)^n-1}$

$= \frac{800000\times0.0083\times(1+0.0083)^{60}}{(1+0.0083)^{60}-1}$ 1

$= \frac{800000\times0.0083\times1.64}{1.64-1} = ₹\,17{,}015$ 1½

Total interest paid $= n \times EMI - P$

$= ₹\,(17{,}015 \times 60 - 8{,}00{,}000)$

$= ₹\,(10{,}20{,}900 - 8{,}00{,}000) = ₹\,2{,}20{,}900$ 1

37. In

Amount needed after **4** years

= Replacement Cost - Salvage Cost = ₹ (**55,200** – 7**200**) = **₹ 48,000** 1

The payments into sinking fund consisting of 10 annual payments at the rate **7%** per year is given by

$$A = RS_{\overline{n}|i} = R\left[\frac{(1+i)^n-1}{i}\right]$$

$$\Rightarrow 48000 = R\left[\frac{(1+0.07)^4-1}{0.07}\right] = R\left[\frac{(1.07)^4-1}{0.07}\right]$$

$$\Rightarrow R = \frac{48000}{4.4385} = ₹\,10814.5$$ 2

Amount of Annual Depreciation $= \frac{36000-7200}{4} = \frac{28800}{4} = ₹\,7200$ 1

and rate of Depreciation $= \frac{7200}{36000-7200}\times100 = 25\%$ 1

38. Ramesh

Sol.

(i) $E = \frac{P\,i}{1-(1+i)^{-n}}$ or $\frac{P\,i\,(1+i)^n}{(1+i)^n-1}$ — **1**

(ii) $P = ₹\,7,00,0000, i = \frac{12}{1200} = 0.01, n = 12 \times 30 = 360$ months — **1**

(iii) $E = ₹\,\frac{7,00,000\times0.01}{1-(1.01)^{-360}}$ — **1**

$= \frac{7000}{0.97218332} = ₹\,7200.29$ (or $\frac{7000}{0.97} = ₹\,7216.49$ using approximations) — **1**

OR

(iii) $E = ₹\,\frac{7,00,000\times0.01}{1-(1.01)^{-240}}$ — **1**

$= \frac{7000}{0.90819416} = ₹\,7707.60$ (or $\frac{7000}{0.91} = ₹\,7692.31$ using approximations) — **1**

39. In

Sol.

Given P = ₹ 30,00,000, $i = \frac{7{\cdot}5}{1200} = 0{\cdot}00625$

and $n = 12 \times 20 = 240$ months

(i) $EMI = \frac{P\,i}{1-(1+i)^{-n}}$

$= \frac{30,00,000 \times 0{\cdot}00625}{1-(1{\cdot}00625)^{-240}-1}$ — $(\frac{1}{2})$

$= \frac{30,00,000 \times 0{\cdot}00625 \times 4{\cdot}4608}{3{\cdot}4608}$

$= ₹\,24167.82$ — $(\frac{1}{2})$

(ii) Interest paid on 150^{th} instalment

$= \frac{EMI \times [(1+i)^{240-150+1}-1]}{(1+i)^{240-150+1}}$

$= \frac{24167 \times [1{\cdot}7629-1]}{1{\cdot}7629}$ — $(\frac{1}{2})$

$= ₹\,10458.70$

$\Rightarrow$ Principal paid in 150^{th} instalment = EMI – interest

$= ₹\,(24167.82 - 10458.70)$ — $(\frac{1}{2})$

$= ₹\ 13709.12$

(iii) (a) Total Interest paid = n × EMI – P

$= ₹\ (240 \times 24167.82 - 30{,}00{,}000)$ **(1)**

$= ₹\ 28{,}00{,}276.80$ **(1)**

OR

(iii) (b) Total amount paid = n x EMI

$= 240 \times 2416.81$ **(1)**

$= ₹\ 5800276.8$ **(1)**

40. A

Solution:

(b) Cost of new machine = ₹300000; scrap value = ₹30000

$\Rightarrow$ Money required to buy new machine after 7 years is

₹ (300000 – 30000) = ₹ 270000 **[1]**

So, A = ₹ 270000, i = 0.05 and n = 7

Using the formula: $A = R\left[\frac{(1+i)^n-1}{i}\right]$ **[1]**

$\Rightarrow \quad 270000 = R\left[\frac{(1.05)^7-1}{0.05}\right]$

$\Rightarrow \quad R = \frac{270000\times0.05}{0.407} = ₹33169.33$ **[1+1]**

Hence, the company should put ₹ 33169.33 into sinking fund.

41. Calculate

(a) Here, P = ₹500000

$I = 500000 \times \frac{10}{100} \times 5 = ₹\ 250000$ **[1]**

n = 5 years = 5 × 12 months = 60 months **[1]**

$EMI = \frac{P+I}{n} = \frac{500000+250000}{60}$ **[1]**

$= ₹12500$ **[1]**

42. A

Sol.

$P = ₹\ 40,00,000,\ i = \dfrac{6.75}{1200} = 0.005625,\ n = 120$ months

(i) $\text{EMI} = \dfrac{Pi}{1-(1+i)^{-n}}$

$= \dfrac{4000000 \times 0.005625}{1-(1.005625)^{-120}}$ ½

$= \dfrac{22500}{1-0.510120} = \dfrac{22500}{0.48988}$

$\approx ₹\ 45,930$ ½

(ii) Principal outstanding at beginning of 61st instalment

$= \dfrac{E[(1+i)^{120-61+1}-1]}{i(1+i)^{120-61+1}}$

$= \dfrac{45930\ [(1.005625)^{60}-1]}{0.005625\ (1.005625)^{60}}$ ½

$= \dfrac{45930 \times (1.400115-1)}{0.005625 \times 1.400115}$

$= \dfrac{45930 \times 0.400115}{0.005625 \times 1.400115}$

$\approx ₹\ 23,33,431$ ½

(iii) (a) Interest paid in 61st instalment $= 2333431 \times 0.005625$ **1**

$\approx ₹\ 13,126$ **1**

43. Anil

44. Each

(i) Here, time = **25 years**

$\therefore$ Total number of payments = $25 \times 12 = 300$ ½

$R = 9\%$ per annum.

Rate of interest per month $= \dfrac{9}{1200} = 0.0075$ ½

(ii) (a) Cost of house $= ₹\ 2500000$

Down Payment $= ₹\ 500000$

$\therefore$ Principal amount $= ₹(2500000 - 500000)$

$= ₹2000000$ ½

EMI (using ***reducing balance method***) $= \dfrac{P \times i}{1-(1+i)^{-n}}$

$= \dfrac{2000000 \times 0.0075}{1-(1+0.0075)^{-300}}$ 1

$= \dfrac{15000}{1-(1.0075)^{-300}}$

$= \dfrac{15000}{1-(0.1062)}$

$= \dfrac{15000}{0.8938} = 16782.27$ ½

Hence, monthly payment is ₹16782.27

OR

(ii) (b) Cost of house $= ₹2500000$

Down Payment $= ₹500000$

$\therefore$ Principal amount $= ₹(2500000 - 500000)$

$= ₹2000000$ ½

EMI (using ***flat rate method***) $= P\left(i + \dfrac{1}{n}\right)$

$= 2000000\left(0.0075 + \dfrac{1}{300}\right) = 2000000(0.0108333)$ 1

$= ₹21666.66$ ½

(iii) **EMI** (using ***reducing balance method***) = ₹16782.27

$\therefore$ **Total interest** $= n \times \text{EMI} - P$

$= 300 \times 16782.27 - 2000000$ ½

$= 3034681$ ½

Hence, total interest is ₹3034681

When **EMI** is calculated by (using ***flat rate method***), then

Total interest $= n \times EMI - \text{P} = 300 \times 21666.6 - 2000000$ ½

$= ₹4499980$ ½

45. A

The amount of sinking fund S at any time is given by $S = R\left[\frac{(1+i)^n-1}{i}\right]$ Where $R = Periodic\ payment$, $i = Interest\ per\ period$, $n = number\ of\ payments$ S= Cost of machine – Salvage value = 50,000-5000 = ₹45,000 $i = \frac{8\%}{4} = 0.02$	1
$\Rightarrow \quad 45000 = R\left[\frac{(1+.02)^{40}-1}{0.02}\right]$ $\Rightarrow \quad 45000 = R\left[\frac{2.208-1}{0.02}\right]$	$1\frac{1}{2}$
$\Rightarrow R = \frac{900}{1.208} \Rightarrow R = ₹745.03$	$1\frac{1}{2}$

46. A

Amortized Amount i.e., P= Cost of house-Cash down payment P= 15,00,000 – 4,00,000 = ₹11,00,000 $i = \frac{0.09}{12} = 0.0075$ $n = 10 \times 12 = 120$	1
EMI = $R = \frac{P}{a_{n\neg i}}$,	
$R = \frac{P \times i}{1-(1+i)^{-n}}$	1
$= \frac{11,00,000 \times 0.0075}{1-(1.0075)^{-120}} = \frac{8250}{1-0.4079}$	1
$= \frac{8250}{0.5921} = ₹13933.5$	
Total interest paid $= nR - R = 13933.5 \times 120 - 11,00,000$ =₹5,72,020	1

47. A

Face value of bond, F = ₹2000 Redemption value C = 1.05 × 2000 = ₹2100 Nominal rate =8% $R = C \times i_d = 2000 \times 0.08 = ₹160$	$1\frac{1}{2}$
Number of periods before redemption i.e., n = 10 Annual yield rate, i =10% or 0.1	
Purchase price $V = R\left[\frac{1-(1+i)^{-n}}{i}\right] + C(1+i)^{-n}$ $= 160\left[\frac{1-(1+0.1)^{-10}}{0.1}\right] + 2100(1+0.1)^{-10}$ $= 160 \times 6.14 + 2100 \times 0.3855$ $= 982.4 + 809.6 = 1792$	$1\frac{1}{2}$
Thus present value of the bond is ₹1792.	1