

# GE 403

# Engineering Economy

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# Gradient Series

The gradient series arises when the value of an individual cash flow differs from the preceding cash flow by a constant,  $G$ .

$$P = G \left[ \frac{1 - (1 + ni)(1 + i)^{-n}}{i^2} \right]$$

$$P = G(P/G \ i\%, \ n)$$

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

$$A = G(A/G \ i\%, \ n)$$

$$F = G \left[ \frac{(1 + i)^n - (1 + ni)}{i^2} \right]$$

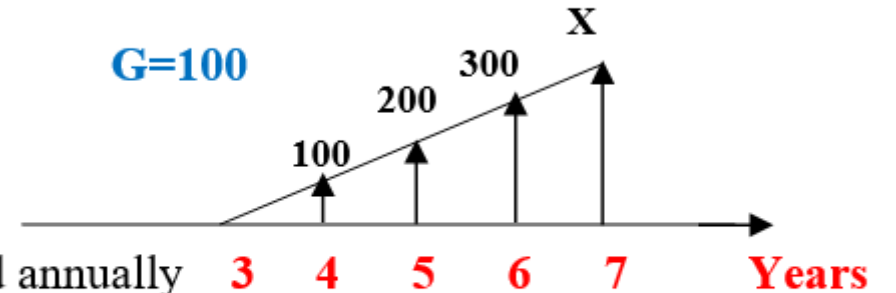
not provided  
in table

$$n = 7 - 3 + 1 = 5$$

$$X = G(t - 3)$$

$$X = 100(7 - 3) = 400$$

$i = 10\%$  compounded annually



$$P = G (P/G \ i\%, \ n) = 100(P/G \ 10\%, \ 5) \longrightarrow P \text{ at } t=2$$

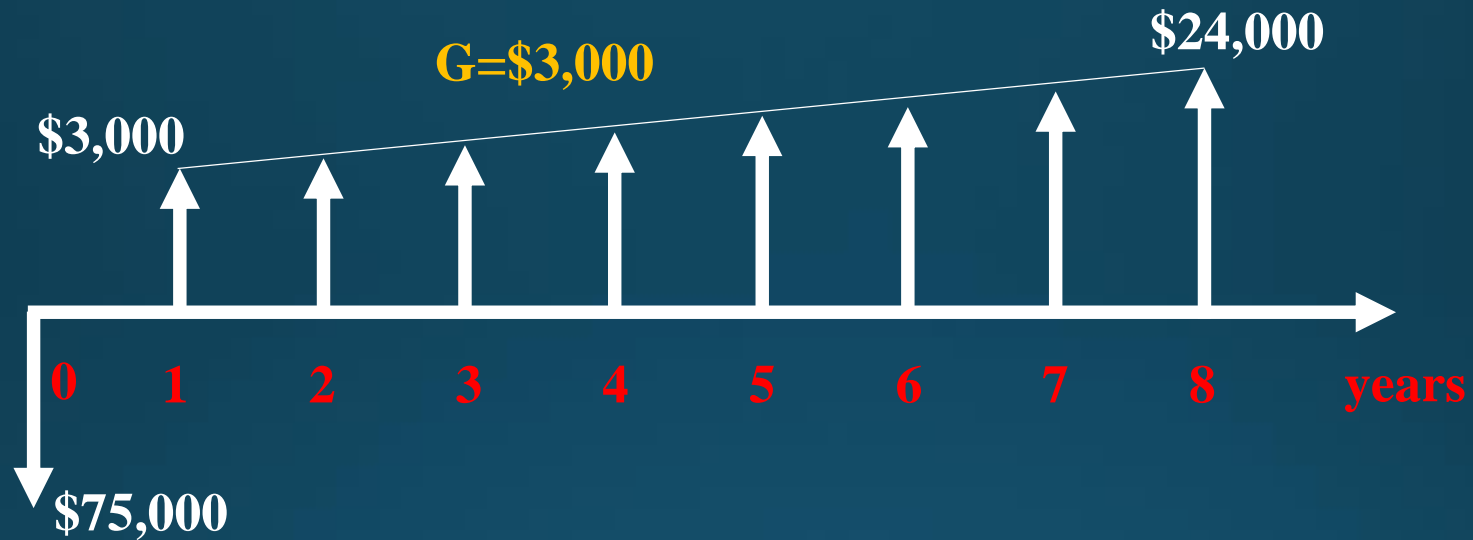
$$P_w = [100(P/G \ 10\%, \ 5)] \times (P/F \ 10\%, \ 2) = \checkmark$$

Ex. Consider the following cash flow profile:

| <b>EOY</b> | <b>Cash Flow</b> | <b>EOY</b> | <b>Cash Flow</b> | <b>EOY</b> | <b>Cash Flow</b> |
|------------|------------------|------------|------------------|------------|------------------|
| <b>0</b>   | <b>-\$75,000</b> | <b>3</b>   | <b>\$9,000</b>   | <b>6</b>   | <b>\$18,000</b>  |
| <b>1</b>   | <b>\$3,000</b>   | <b>4</b>   | <b>\$12,000</b>  | <b>7</b>   | <b>\$21,000</b>  |
| <b>2</b>   | <b>\$6,000</b>   | <b>5</b>   | <b>\$15,000</b>  | <b>8</b>   | <b>\$24,000</b>  |

Using a gradient series factor, determine the present worth equivalent for the cash flow series using an annual compound interest rate of 6 percent.

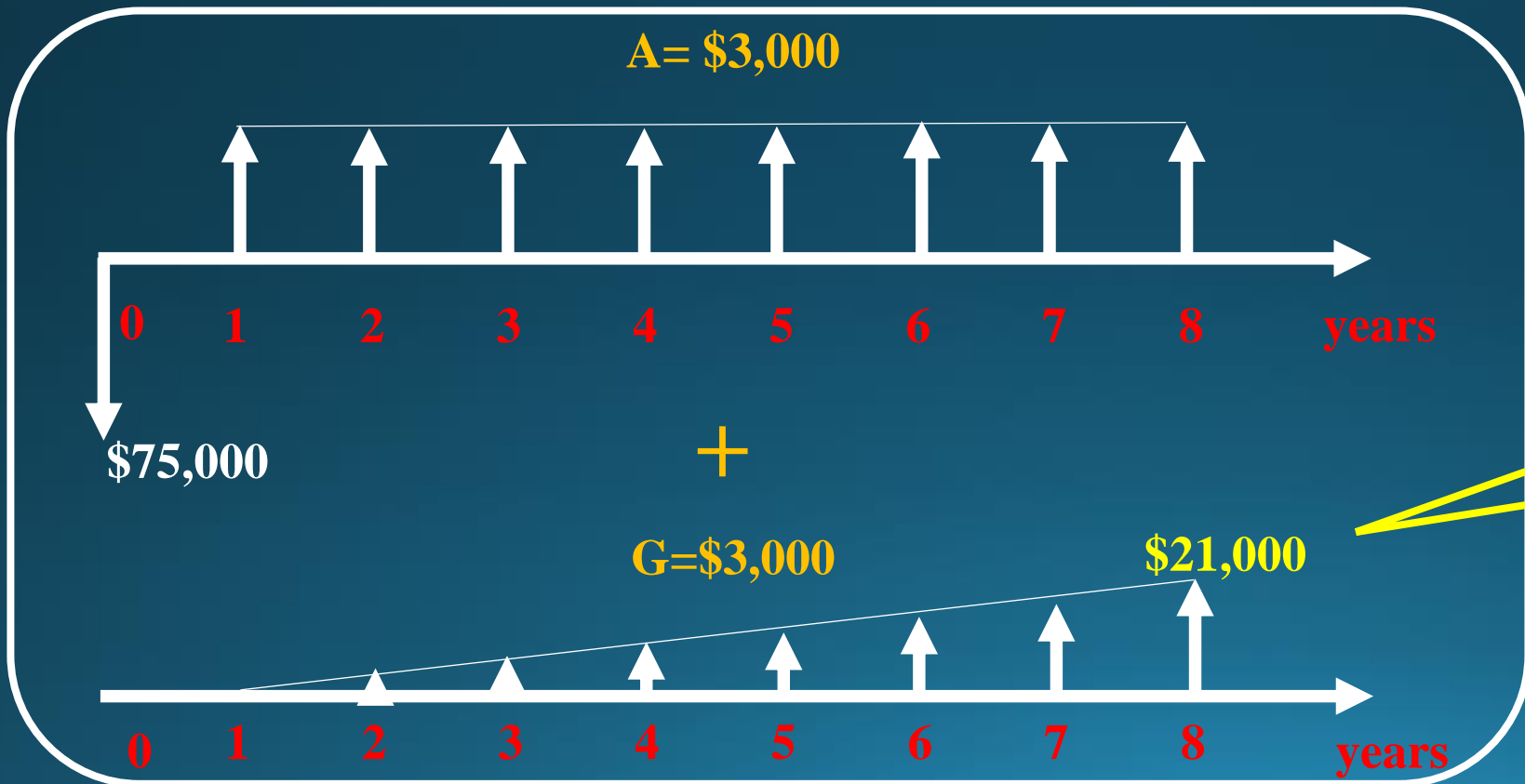
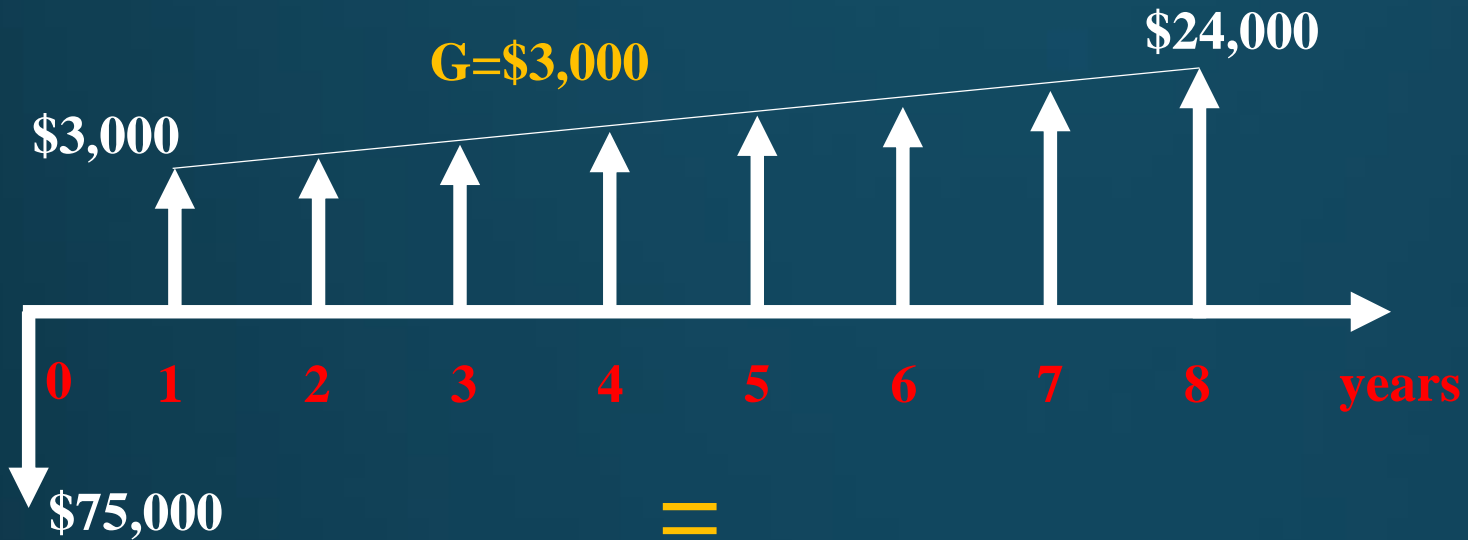
# Solution



$$P_w = -75,000 + 3000(P/A \ 6\%, \ 8) + 3000(P/G \ 6\%, \ 8)$$

$$P_w = -75,000 + 3000(6.20979) + 3000(19.84158)$$

$$P_w = \$3154.11$$



$G(t-1)$   
 $3000(8-1)$

## Ex.2

A \$90,000 investment is made. Over a 5-year period, return of \$30,000 occurs at the end of the first year. Each successive year yields a return that is \$3,000 less than the previous year's return. If money is worth 5 percent, use a gradient series factor to determine the equivalent present worth for the investment.

# Solution

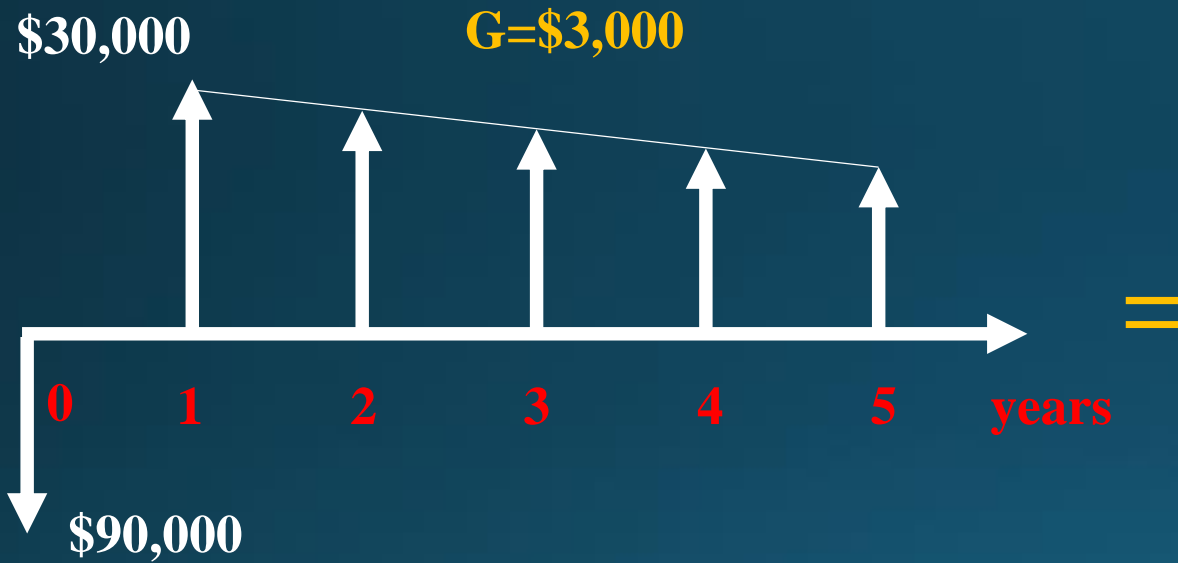


$$P_w = -90,000 + 30,000(P/A \ 5\%, \ 5) - 3000(P/G \ 5\%, \ 5)$$

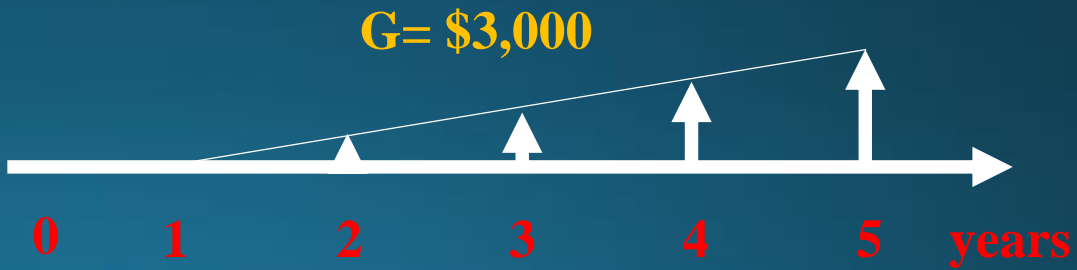
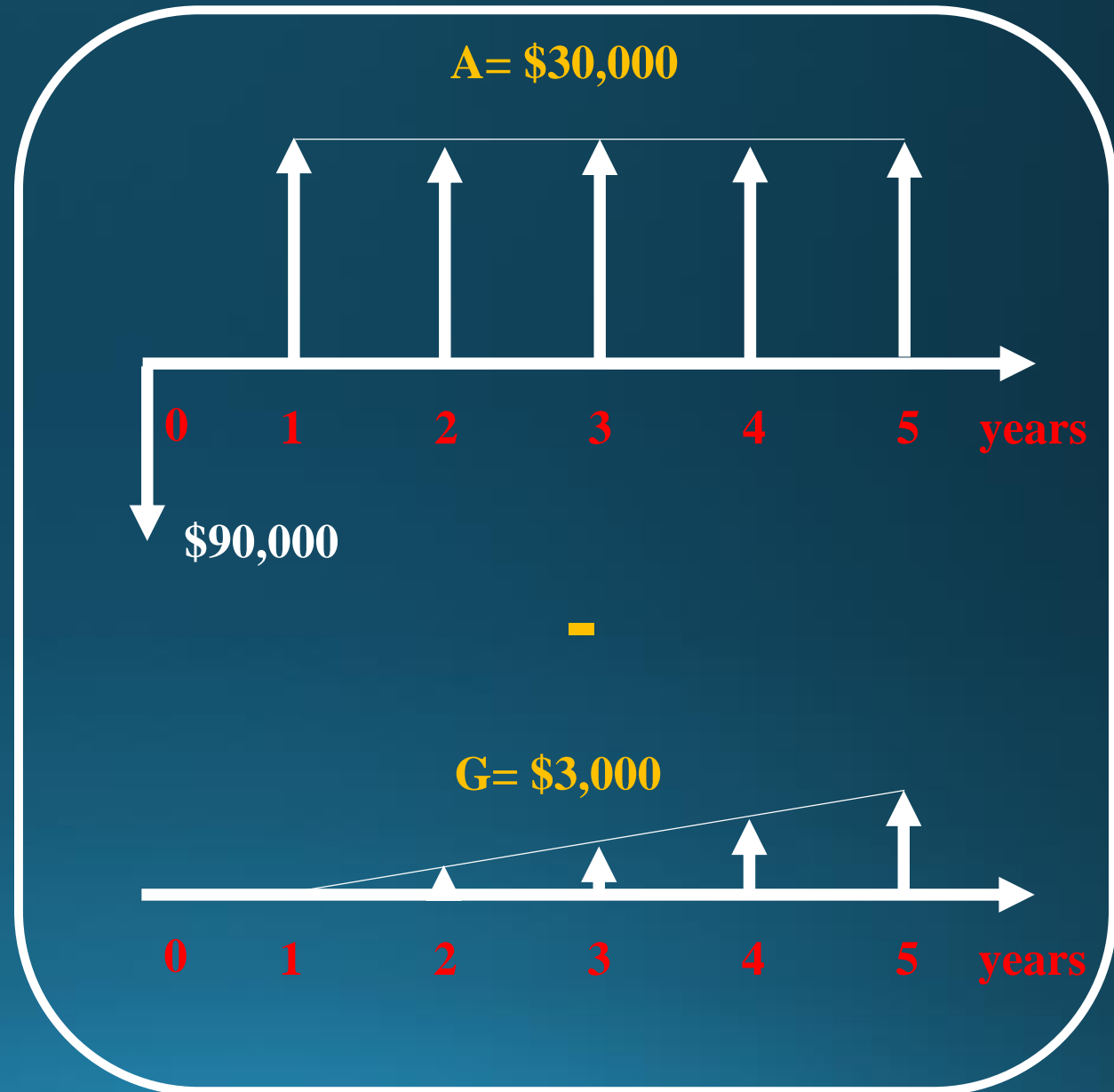
$$P_w = -90,000 + 30,000(4.32948) - 3000(8.23692)$$

$$P_w = \$15173$$

# Solution



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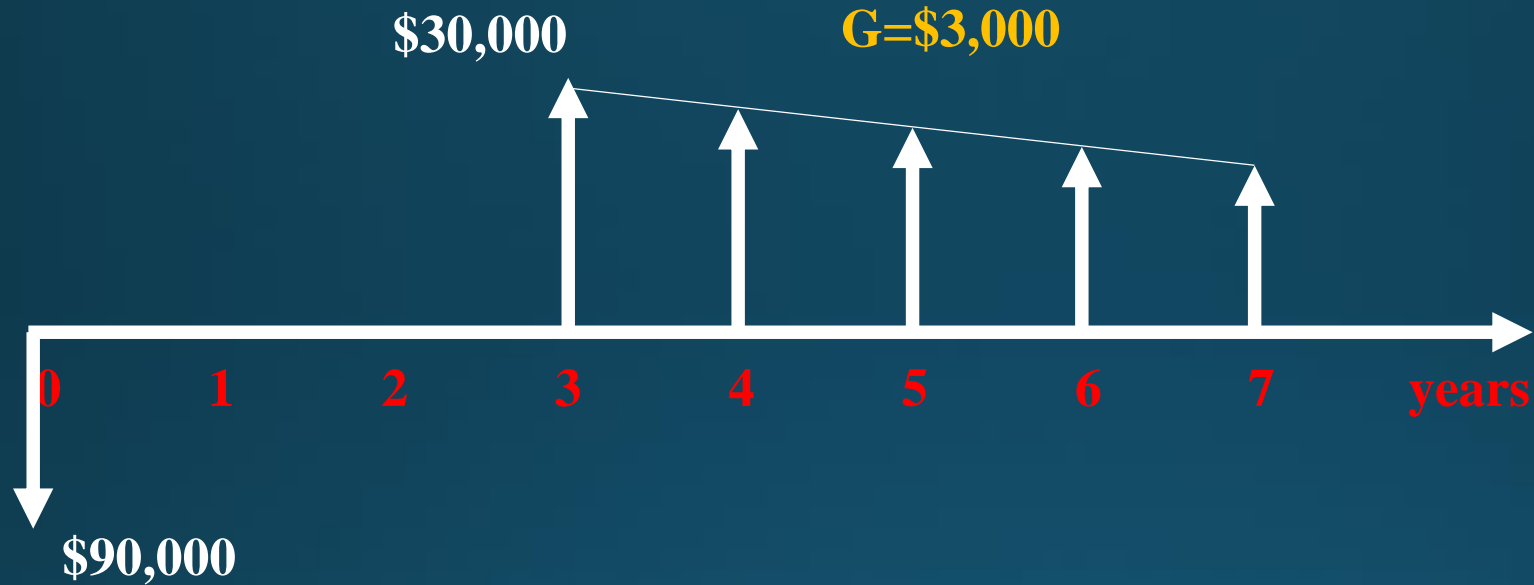




### Ex.3

A \$90,000 investment is made. Over a 5-year period, return of \$30,000 occurs at the end of the **third** year. Each successive year yields a return that is \$3,000 less than the previous year's return. If money is worth 5 percent, use a gradient series factor to determine the equivalent present worth for the investment.

# Solution

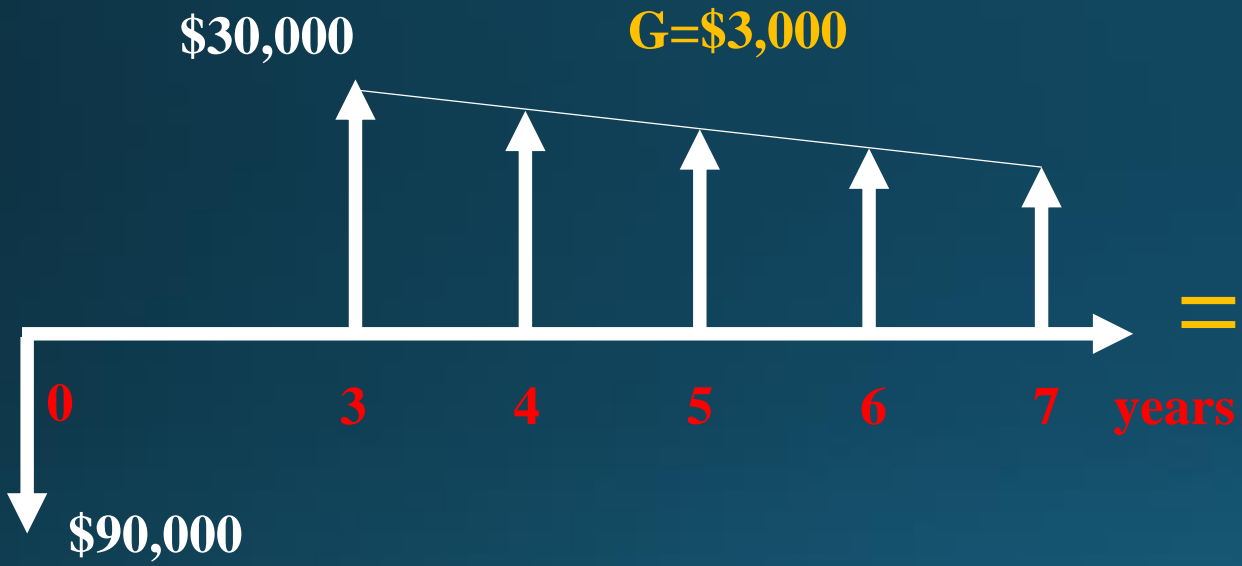


$$P_w = -90,000 + [30,000(P/A\ 5\%,\ 5) - 3000(P/G\ 5\%,\ 5)](P/F\ 5\%,\ 2)$$

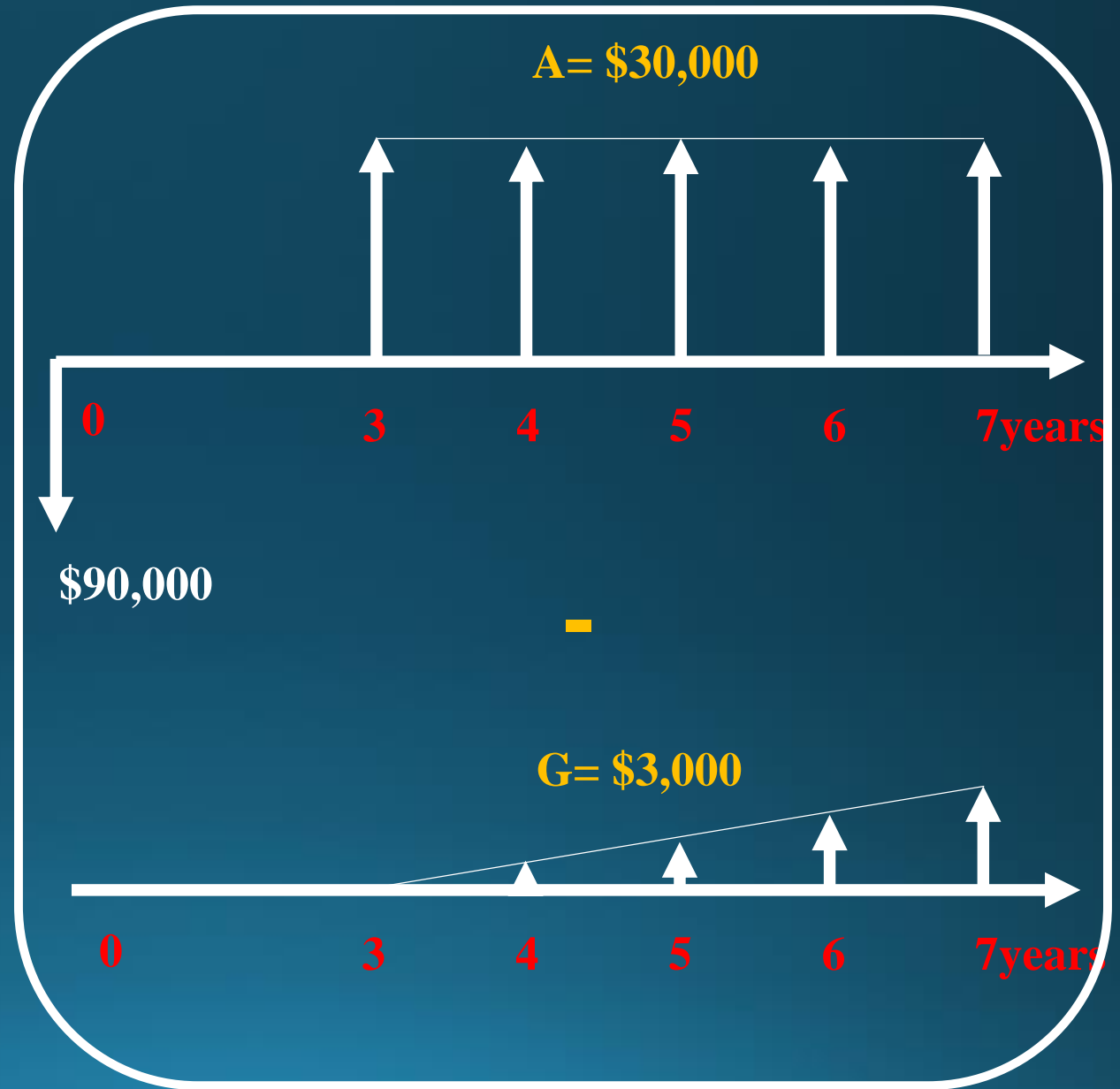
$$P_w = -90,000 + [30,000(4.32948) - 3000(8.23692)](0.90703)$$

$$P_w = \$5,395.7$$

# Solution



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$G = \$3,000$