Qatar University

College of Engineering

GENG 360-Engineering Economics

Spring 2018

Midterm Exam

Name: KEY **Grade:** ____________

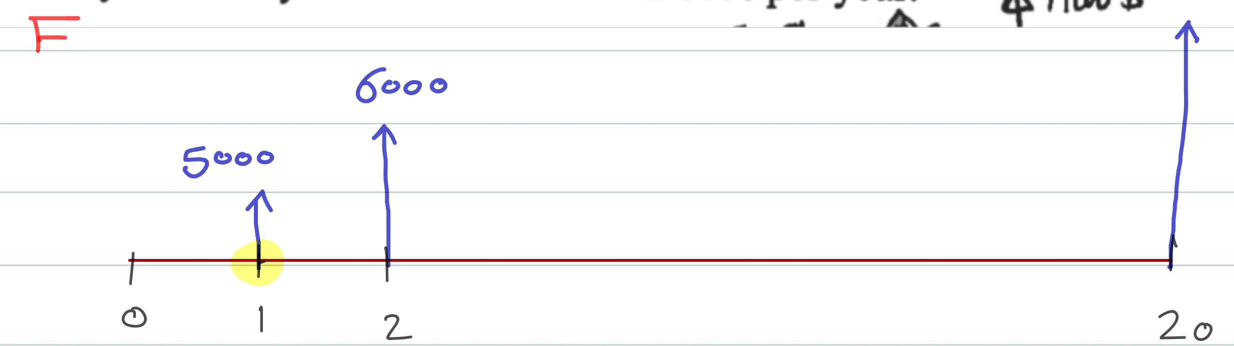
I.D. Number: ______________________

Instructions:

1. Answer all eight questions on the exam sheets provided.
2. Draw cash flow diagrams, when necessary.
3. Show all your work to receive full credit.
4. Equations and compound interest factor tables are provided.
5. The maximum points that you can earn are 50 points.
6. You have a total of 75 minutes to complete the exam.
7. Good luck.

Problem #1 (5 points):

In planning for your retirement, you expect to save \$5,000 in year 1, \$6,000 in year 2, and amounts increasing by \$1,000 each year through year 20. Find the amount that you will have at the end of year 20 if your investments earn 10% per year.



$A = 5000$

$G = 1000$

$i = 10\%$

$n = 20$

$$F = A\,(F/A, 10\%, 20) + G\,(F/G, 10\%, 20)$$

$$= 5000\,(57.275) + 1000\,(P/G)(F/P)$$

$$= 5000\,(57.275) + 1000\,(55.4069)(6.7275)$$

$$= 286375 + 372750$$

$$= 659125\ \$$$

Problem #2 (5 points):

Qatar Energy deposited 5,000 Qatari Riyals per year for 15 years for maintenance of field equipment. Major rework was done at an equivalent cost of 100,000 Qatari Riyals in year 15. What approximate rate of return (i) did this practice provide to the company?

$i = ??$

$$F = A\,(F/A, i, n)$$

$$100000 = 5000\,(F/A, i, 15)$$

$$(F/A, i, 15) = 20$$

$3\% \Rightarrow (F/A, 3\%, 15) = 18.5989$

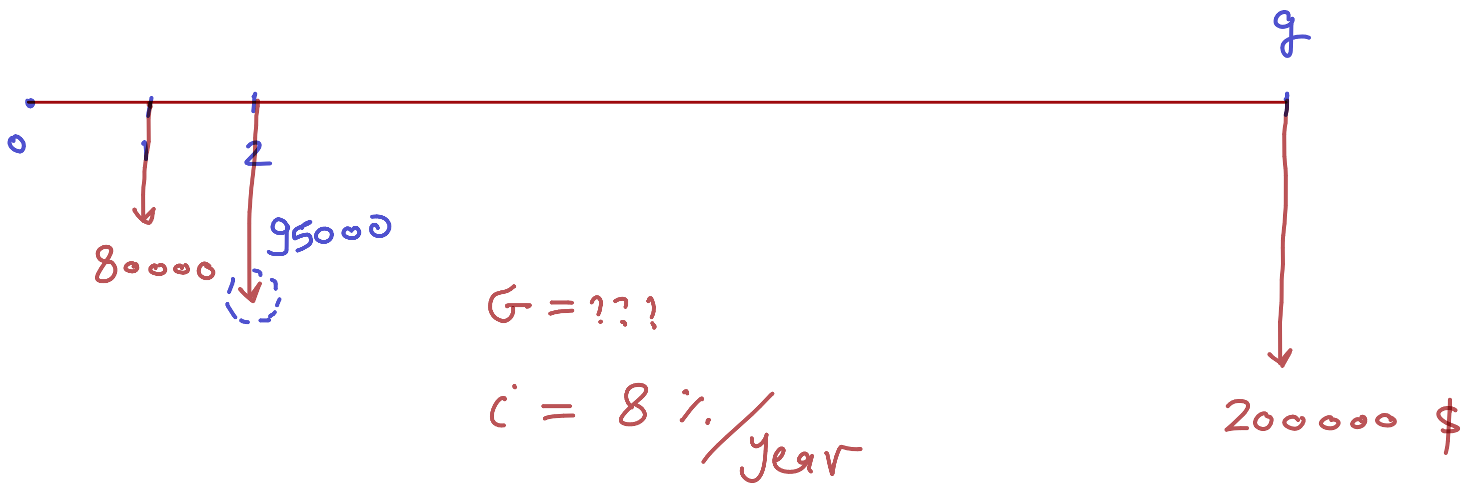
$4\% \Rightarrow (F/A, 4\%, 15) = 20.0236$

approximate RoR = 4% / year

Problem #3 (6 points):

Qatar University has initiated a logo-licensing program with a local company. Estimated fees (revenues) are $ 80,000 for the first year with uniform, equal increases to a total of $ 200,000 by the end of year 9. Use an interest rate of 8% per year.

a. Determine the gradient and construct a cash flow diagram that identifies the base amount and the gradient series.
b. Determine the equivalent present worth for the cash flow above.



$G = ???$

$i = 8\%/\text{year}$

$A = 80000$

(a) $G = \dfrac{200000 - 80000}{9 - 1}$

$= 15000 \ \$/\text{year}$

$A = \text{Base-Value} = 80000 \ \$/\text{year}$

(b) $P_T = A\,(P/A, 8\%, 9) + G\,(P/G, 8\%, 9)$

$= 80000\,(6.2469) + 15000\,(21.8081)$

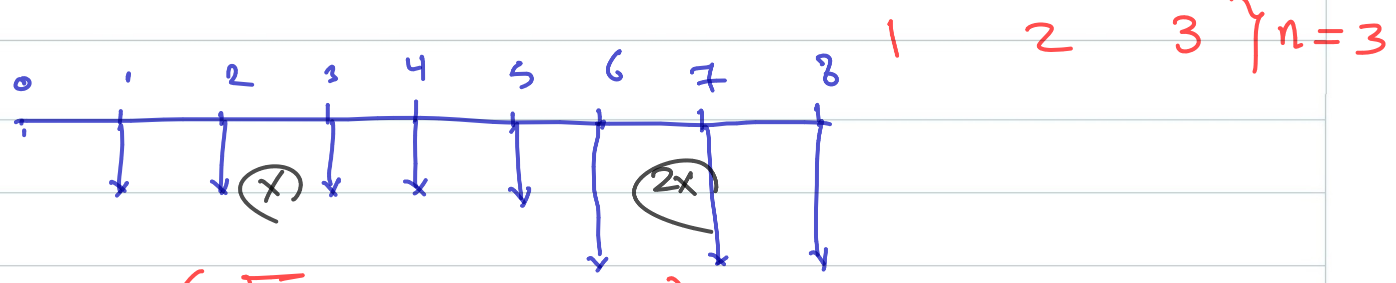
$= 499752 + 327122$

$\boxed{P_T = 826874 \ \$}$

Problem #4 (8 points):

For the cash flow shown below, determine the value of x that will make the future worth in Year 8 equal to $ -70,000 at an interest rate of 10% per year.

Year	0	1	2	3	4	5	6	7	8
Cash Flow ($)	0	x	x	x	x	x	2x	2x	2x



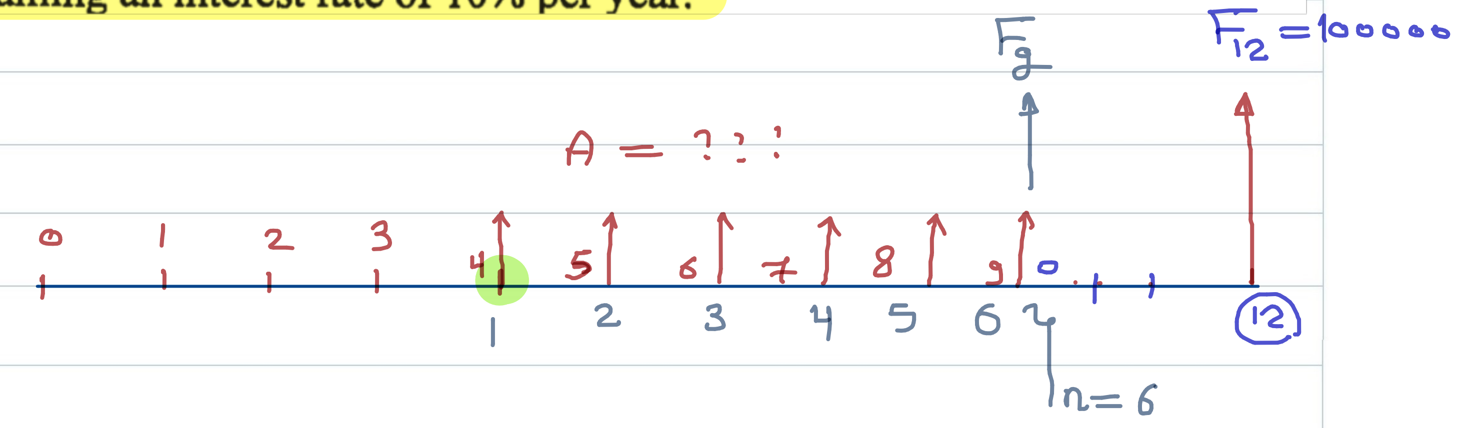
$$70000 = x\left(F/A, 10\%, 8\right) + x\left(F/A, 10\%, 3\right)$$

$$70000 = x\,(11.4359) + x\,(3.31)$$

$$x = 4747 \ \$/\text{year}$$

Problem #5 (6 points):

Mohammed wants to deposit equal amounts of money each year for 6 consecutive years starting 4 years from now so he can withdraw $ 100,000 twelve years from now. Find the annual deposit assuming an interest rate of 10% per year.



$$i = 10\% / \text{year}$$

$$F_9 = A\left(F/A, 10\%, 6\right)$$

$$F_{12} = F_9\left(F/P, 10\%, 3\right)$$

$$F_{12} = A\left(F/A, 10\%, 6\right)\left(F/P, 10\%, 3\right)$$

$$100000 = A\,(7.7156)(1.3310)$$

$$A = 9738 \ \$/\text{yr}$$

Problem #6 (4 points):

What is the effective rate per quarter if you have an interest rate of 8% per 6 months, compounded monthly?

3-Months

r

$r = 8\%$

$M = 6$

$\underbrace{i}_{\text{Monthly}} = \frac{r}{M} = \frac{8\%}{6} = 1.33\%/\text{Month}$

$\underset{\substack{\text{Quarter}\\(B)}}{i} = \left(1 + \underset{\substack{\text{Month}\\(s)}}{i}\right)^M - 1$

$= (1 + 0.0133)^3 - 1$

$= 0.0405 = 4.05\%/\text{Quarter}$

Problem #7 (2 points):

What nominal interest rate per year is equivalent to 12% per year, compounded monthly?

Same, since interest year and compounding period are different, then

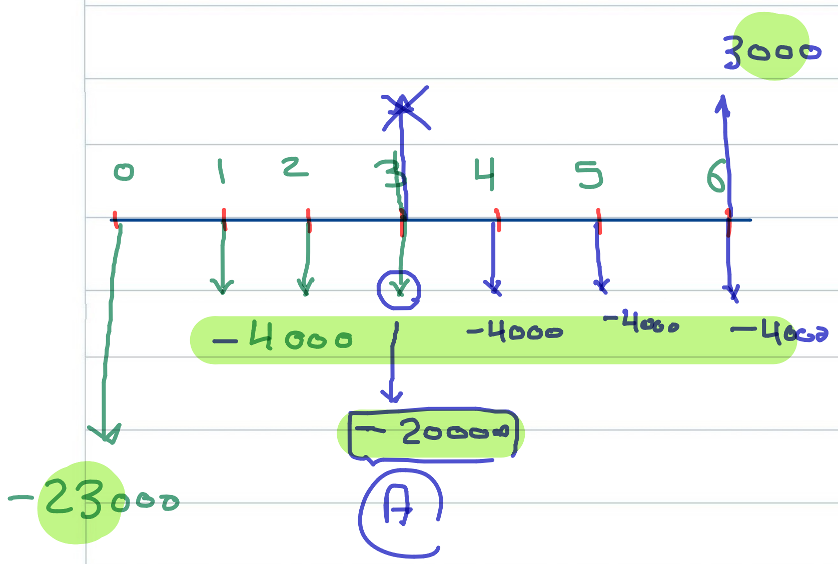
$r = 12\%/\text{yr}$, compounded monthly

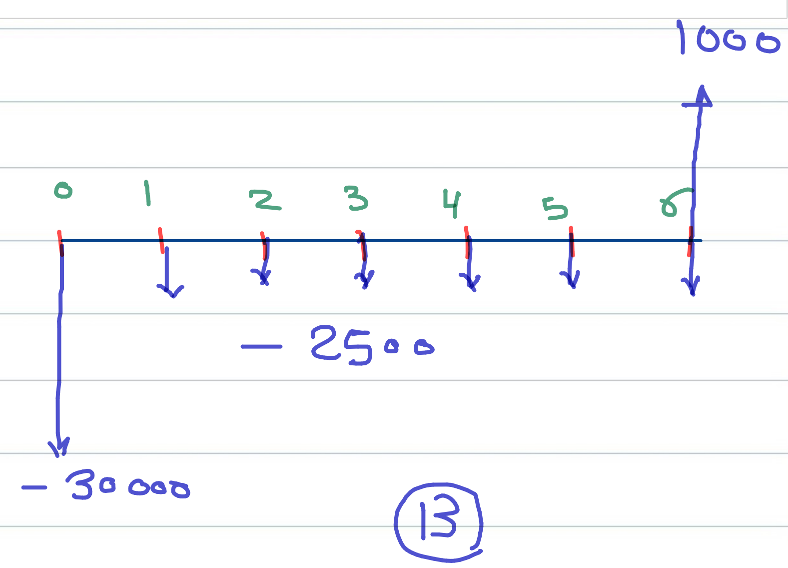
Problem #8 (14 points):

Compare the alternatives shown below on the basis of a future worth analysis, using an interest rate of 8% per year.

Alternative	**A**	**B**
First cost, $	-23,000	-30,000
Annual income, $ per year	6,000	8,000
Annual operating cost, $ per year	-10,000	-10,500
Salvage or future value, $	3,000	1,000
Life, years	3	6

-4000 $-4{,}000$ $/yr -2500





$$FW_A = -23000\,(F/P, 8\%, 6) - 4000\,(F/A, 8\%, 6) - 20000\,(F/P, 8\%, 3) + 3000$$

$$= -23000\,(1.5869) - 4000\,(7.3359) - 20000\,(1.2597) + 3000$$

$$FW_A = -88036 \ \$$$

$$FW_B = -30000\,(F/P, 8\%, 6) - 2500\,(F/A, 8\%, 6) + 1000$$

$$= -30000\,(1.5869) - 2500\,(7.3359) + 1000$$

$$FW_B = -64947 \ \$$$

Select B

Qatar University

College of Engineering

GENG 360-Engineering Economics (Section L52)

Spring 2016

Midterm Exam

Name: KEY

I.D. Number: ______________________

<u>Instructions</u>:

1. Answer all 8 questions on the exam sheets provided.
2. Draw cash flow diagrams, when necessary.
3. Show all your work to receive full credit.
4. **You will get zero marks for the question with no work shown.**
5. Equations and compound interest factor tables are provided.
6. The maximum points that you can earn are 50 points.
7. You have a total of 75 minutes to complete the exam.
8. Good luck.

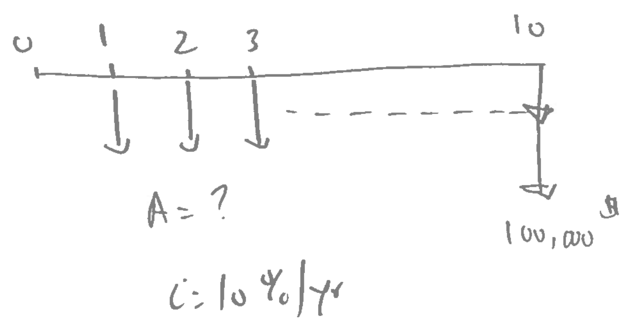
<u>Problem #1 (5 points)</u>:

By doing annual updating of a certain production line, a manufacturing company can avoid spending \$ 100,000 for a new system ten years from now. At an interest rate of 10% per year, determine the annual amount the company could afford to spend beginning one year from now.

$A = F(A|F, 10\%, 10)$

$A = 100,000\ (0.06275)$

$A = \underline{\underline{6,275\ \$/yr}}$



Problem #1 (5 points):

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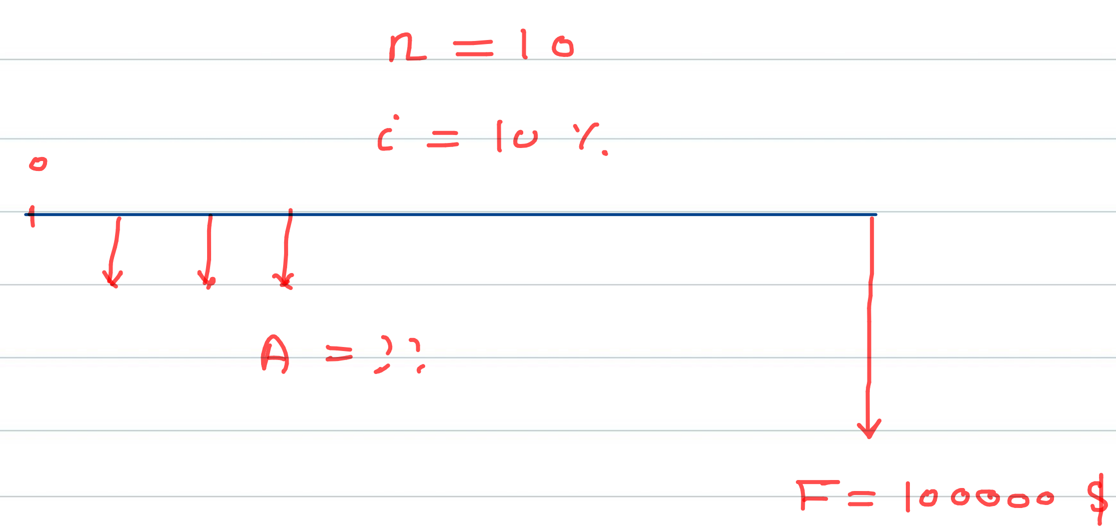


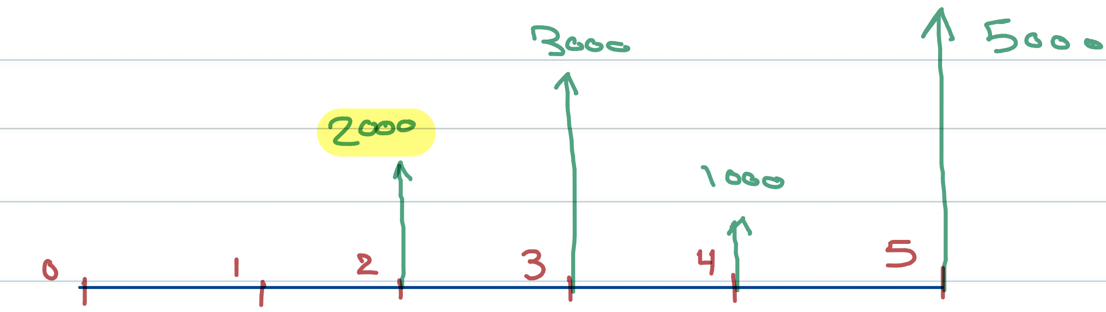
$$A = F\left(A/F, 10\%, 10\right)$$

$$= 100\,000\left(0.06275\right)$$

$$A = 6275 \ \$/yr$$

Problem #2 (7 points):

Income from a real estate investment is expected to be $ 2,000 in year two, $ 3,000 in year three, $ 1,000 in year four and $ 5,000 in year five. At an interest rate of 10% per year, determine the present worth of the cash flow.



$$P = 2000\left(P/F, 10\%, 2\right)$$

$$+ 3000\left(P/F, 10\%, 3\right)$$

$$+ 1000\left(P/F, 10\%, 4\right)$$

$$+ 5000\left(P/F, 10\%, 5\right)$$

$$= 2000\left(0.8264\right) + 3000\left(0.7513\right)$$

$$+ 1000\left(0.6830\right) + 5000\left(0.6209\right)$$

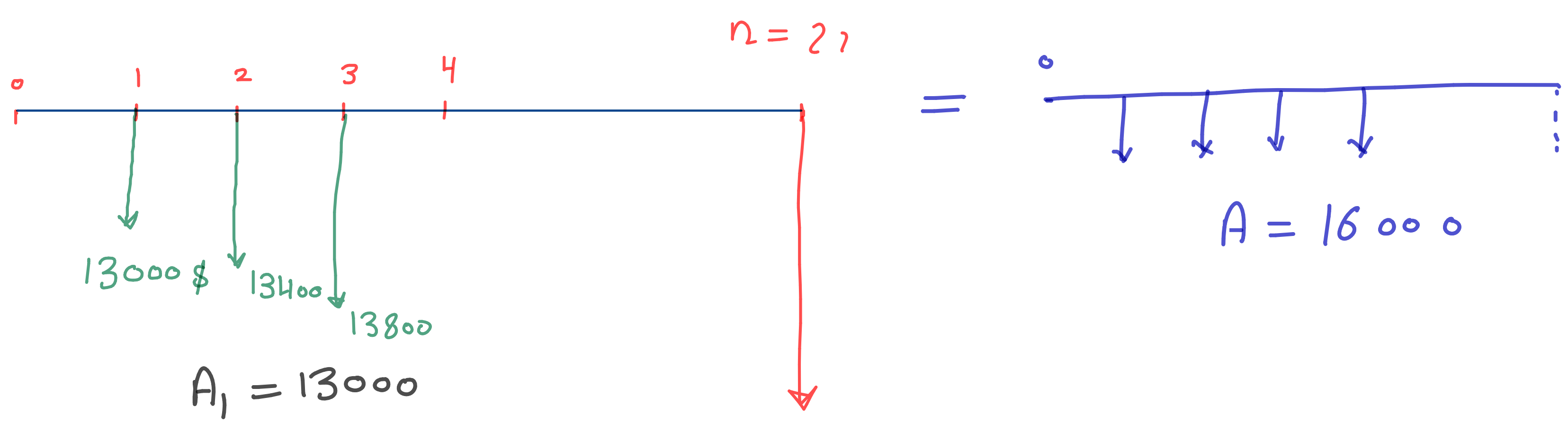
$$= 7694 \ \$$$

$\Rightarrow P = 1,652.8 + 2,253.7 + 665 + 3,10$

$\Rightarrow P = 7,694\ \$$

Problem #3 (7 points):

The energy costs of a company involved in powder coating of outdoor furniture are expected to increase at a rate of $400 per year. The cost at the end of the next year (year 1) is expected to be $13,000. How many years will it be from now before the equivalent annual cost is $16,000 per year, if interest is 8% per year? $G = 400\ \$/yr$ (A)



$A_1 = 13000$

$G = 400$

$$A = A_1 + G(A/G, 8\%, n)$$

$$16000 = 13000 + 400(A/G, 8\%, n)$$

$$\frac{3000}{400} = (A/G, 8\%, n)$$

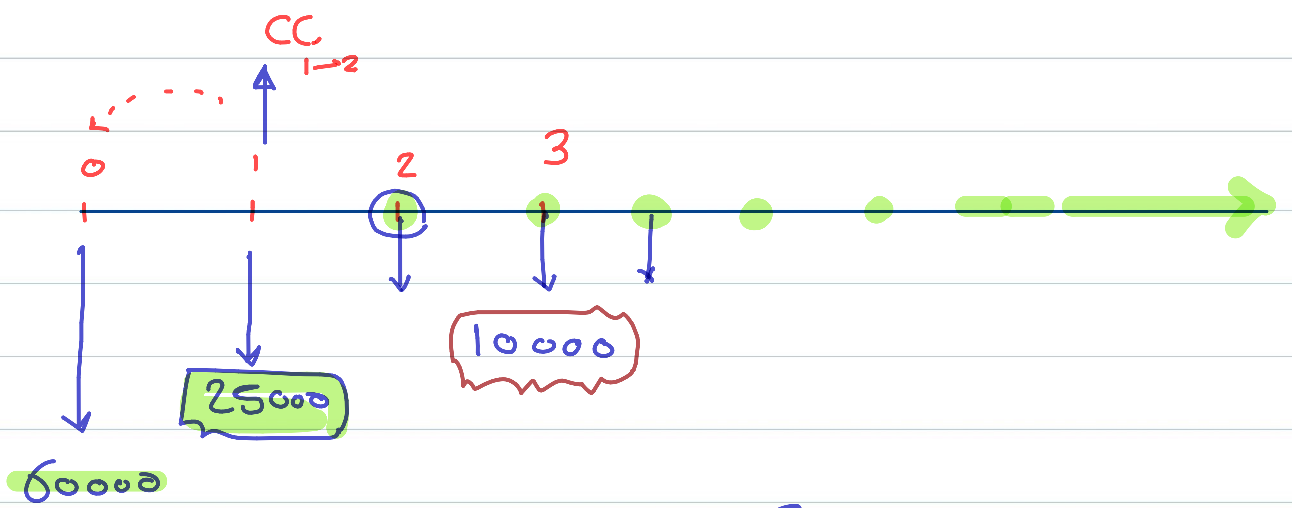
$$(A/G, 8\%, n) = 7.5$$

	n
7.294	21
7.5	$n = 21.8$ years
7.5412	22

Problem #4 (7 points):

7.294 21
7.50 ?
7.5412 22
$\Rightarrow n = 21.8$ yrs

Expenses for water treatment at a city park are expected to be $ 60,000 now, $ 25,000 in year one, and $ 10,000 per year thereafter forever (that is in year two until infinity). At an interest rate of 8% per year, determine the capitalized cost of the treatment.



$i = 8\%$

$$CC = \frac{A}{i}$$

$$CC_1 = -60000 \ \$$$

For 25000 $

$$CC_2 = -25000 \left(\frac{P}{F}, 8\%, 1\right)$$

$$= -25000 (0.9259)$$

$$= -23147.5 \ \$$$

$$CC_{1-2} = \frac{A}{i} = \frac{-10000}{0.08}$$

$$= -125000$$

$$CC_3 = -125000 \left(\frac{P}{F}, 8\%, 1\right)$$

$$CC_3 = -125000 (0.9259)$$

$$= -115737.5$$

$$C_T = CC_1 + CC_2 + CC_3$$

$$= -60000 - 23147.5 - 115737.5$$

$$= -198885 \ \$$$

$$C_T = \frac{A}{i}$$

$$A = C_T * 0.08 = \checkmark$$

Problem #5 (5 points):

~~The real interest rate of return for a company is 20% per year. If the company assumes the inflation rate is 8% per year, determine the market interest rate to account for inflation in a present worth calculation.~~

Problem #6 (4 points):

An interest rate of 21% per year (12 Month), compounded every 4 months, is equivalent to what effective interest rate per year?

$r = 21\%$

$M = \frac{12}{4} = 3$

$i_{4\text{-Month}} = \frac{21\%}{3} = 7\%$

$$i_a = \left(1 + i_{4\text{-Month}}\right)^M - 1$$

$$= (1 + 0.07)^3 - 1$$

$$= 0.225 = 22.5\% / \text{year}$$

Problem #7 (5 points):

Compute the effective annual interest rate equivalent to 5% nominal annual interest compounded daily. There are banking 250 days in a year.

$r = 5\%$

$M = 250$

$i_{daily} = \frac{0.05}{250} = 0.0002 = 0.02\%$ per day

$$i_a = \left(1 + i_{daily}\right)^M - 1$$

$$= (1 + 0.0002)^{250} - 1$$

$$= 0.051266 = 5.1266\% / \text{year}$$

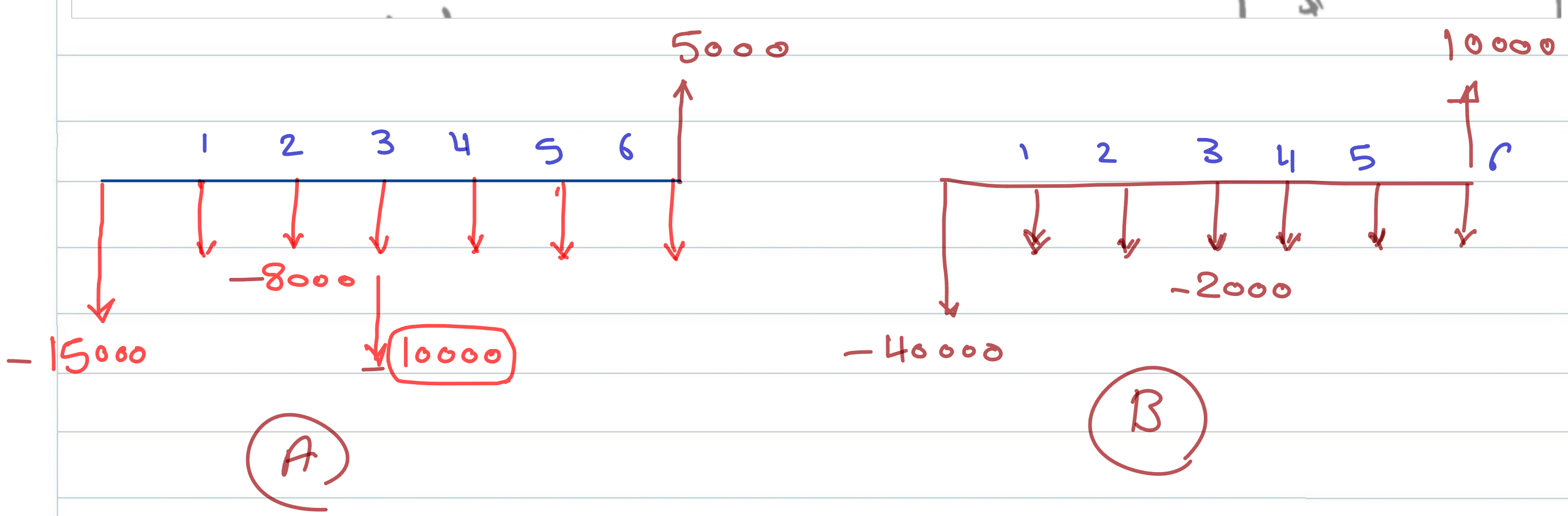
Problem #8 (10 points):

The data for new and used machines are shown below:

	Used Machine	New Machine
Initial cost ($)	15,000	40,000
Annual operating cost ($/year)	8,000	2,000
Salvage value ($)	5,000	10,000
Life (years)	3	6

LCM = 6 yrs

Select one of the two machines based on the Present Worth Analysis using an interest rate of 10% per year.



$$PW_A = -15000 - 8000\,(P/A,\ 10\%,\ 6) - 10000\,(P/F,\ 10\%,\ 3) + 5000\,(P/F,\ 10\%,\ 6)$$

$$= -15000 - 8000\,(4.3553) - 10000\,(0.7513) + 5000\,(0.5645)$$

$$PW_A = -54532\ \$$$

New Machine

$$PW_B = -40000 - 2000\,(P/A,\ 10\%,\ 6) + 10000\,(P/F,\ 10\%,\ 6)$$

$$= -40000 - 2000\,(4.3553) + 10000\,(0.5645)$$

$$= -43066\ \$$$

Select New Machine

Qatar University
College of Engineering
GENG 360-L03-Engineering Economics
Spring 2019

Midterm Exam

Problem 1 (10 points)

1. An investment of 122,900 QAR in equipment that will reduce the time for machining self-locking fasteners will save 20,000 QAR per year. At an interest rate of 10% per year, the number of years required to recover the initial investment is closest to:
a) 5 years
b) 10 years
c) 15 years
d) 20 years

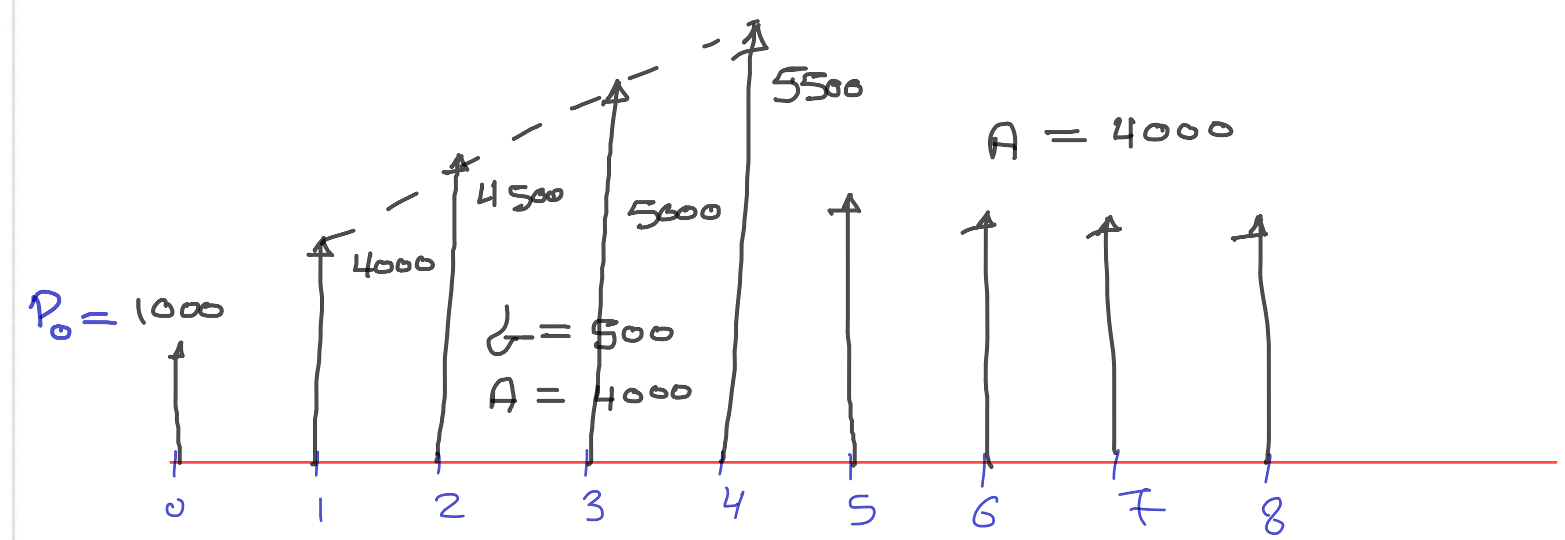
2. Assume that you have payments of 2,000 QAR in year three and increasing by 5% per year through year 8. The equivalent uniform payments in years five through eight at an interest rate of 10% per year is closes to:
a) -3,718.72
b) -4,718.72
c) -5,718.72
d) -10,718.72

3. In comparing different-life alternatives by the future worth method using the study period approach, the following statements are correct, except:
a) Each life cycle is repeated in exactly the same manner
b) Salvage value should be estimated at the end of study period
c) All cash flows after this study period are ignored
d) Study periods are commonly used in equipment replacement analysis

Problem 2 (20 points)
For the series of cash flow shown below:

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Cash flow	1,000	4,000	4,500	5,000	5,500	4,000	4,000	4,000	4,000

a) Draw the cash flow diagram (5 pts)
b) Calculate the annual value in years 1 through 8 using an interest rate of 10% per year (15pts)



* $P_o = 1000$

From year ① → ④

* $P_A \Rightarrow P_A = 4000\,(P/A, 10\%, 4)$

$= 4000\,($

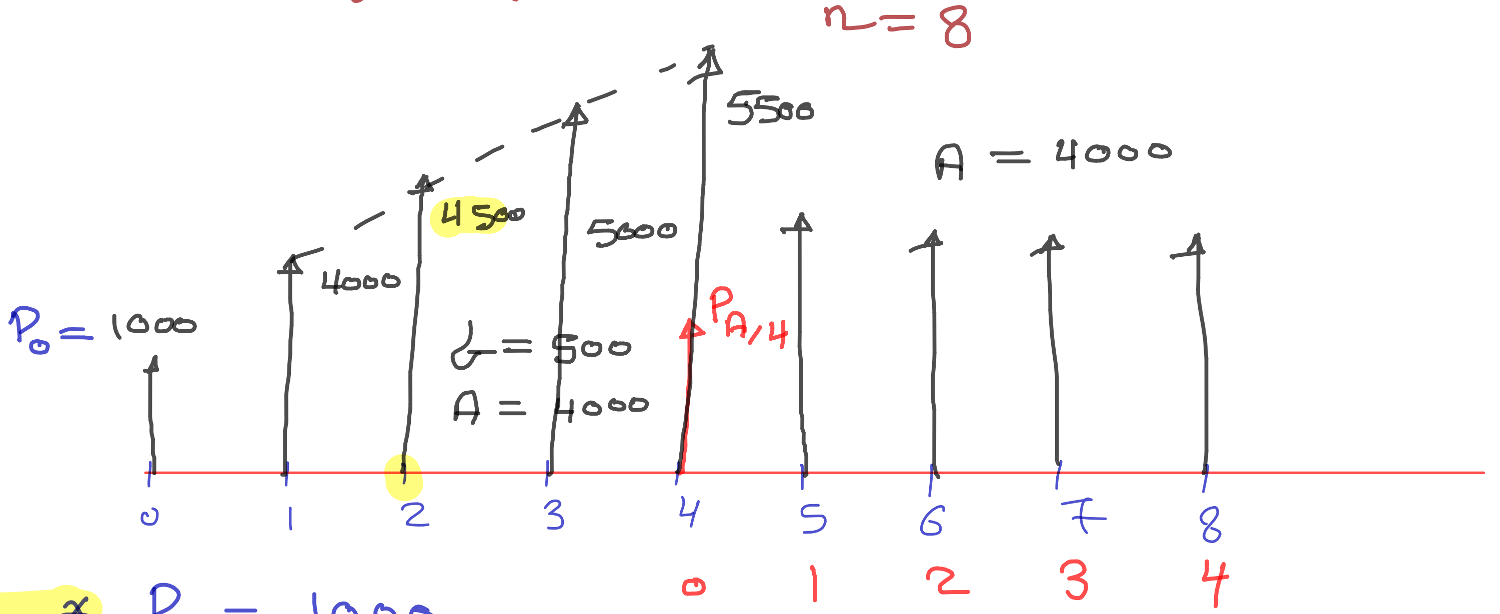
*

Problem 2 (20 points)
For the series of cash flow shown below:

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Cash flow	1,000	4,000	4,500	5,000	5,500	4,000	4,000	4,000	4,000

a) Draw the cash flow diagram (5 pts)
b) Calculate the annual value in years 1 through 8 using an interest rate of 10% per year (15pts)

$n = 8$



* $P_0 = 1000$

From year 1 → 4

* $P_A \Rightarrow P_A = 4000\,(P/A, 10\%, 4)$

$= 4000\,(3.1699) = 12679.6$

* P_G $\quad P_G = G\,(P/G, 10\%, 4)$

$= 500\,(4.3781) = 2189.05$

* From year 5 → 8

$\Rightarrow P_{A,4} = A\,(P/A, 10\%, 4)$

$P_A = P_{A,4}\,(P/F, 10\%, 4)$

$P_A = 4000\,(P/A, 10\%, 4)(P/F, 10\%, 4)$

$= 4000\,(3.1699)(0.6830)$

$= 8660.2$

$P_T = 1000 + 12679.6 + 2189.05 + 8660.2$

$= 24528.85$

$A = P_T\,(A/P, 10\%, 8)$

$= 24528.85\,(0.18744)$

$= 4597.68$

Problem 3 (10 points)
Write whether the given rates are nominal or effective in the second column. Then, convert the given interest rates in the first column into the rates listed in the last three columns. Each answer must be written in the associated cell.

Interest rate statement	**Effective or nominal** (4 pts)	**What is the annual effective rate?** (6 pts)
18% per year, compounded quarterly	nominal	$i_a = (1 + r/m)^m - 1$ $= (1 + \frac{0.18}{4})^4 - 1$ $= 0.1925 = 19.25\%$
Effective 5% per semiannual compounded weekly	effective	$i_a = (1 + i_{semi})^M - 1$ $\boxed{M=2}$ $= (1 + 0.05)^2 - 1$
10% per two years	effective	$i_s = (1 + i_b)^{1/M} - 1$ $i_a = (1 + 0.1)^{1/2} - 1$ $= 0.0488$

$= 4.88\%$

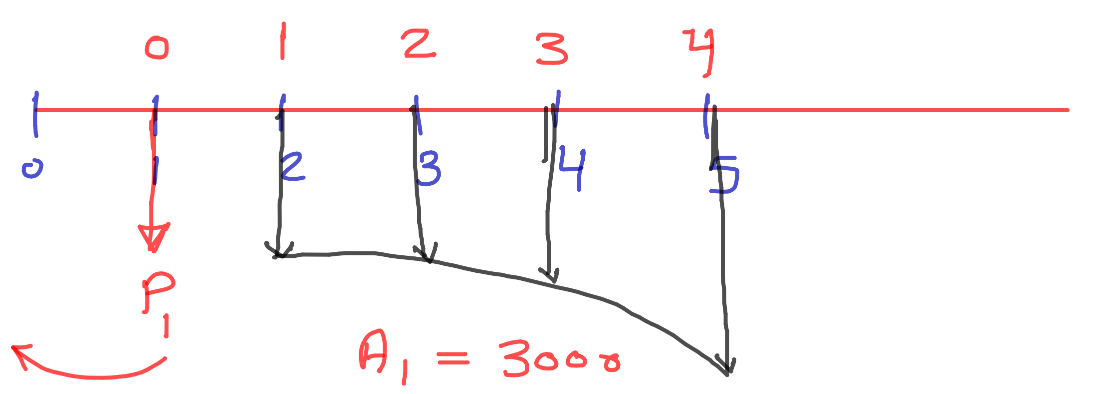
Problem 4: (10 points)
How long does it take to pay off a loan of 2,600 QAR (received today) when making equal payments of 1,150 QAR annually starting years from year 2? Assume the interest is 10%.

Problem 5 (10 points)

The cost of maintaining a certain piece of equipment is 3,000 QAR in year 2 and increasing according to a geometric gradient at a rate of 10% per year until year 5.

a) Draw the cash flow diagram (3 points)

b) Find the present worth of these costs, at an interest rate of 10% per year. (7 points)



$g = 10\%$

$i = 10\%$

$$P_1 = A_1 \left(P/A, i, g, n \right)$$

$$= A_1 \left(\frac{n}{1+i} \right)$$

$$= 3000 \left(\frac{4}{1+0.1} \right) = 10909.1$$

$$P = P_1 \left(P/F, 10\%, 1 \right)$$

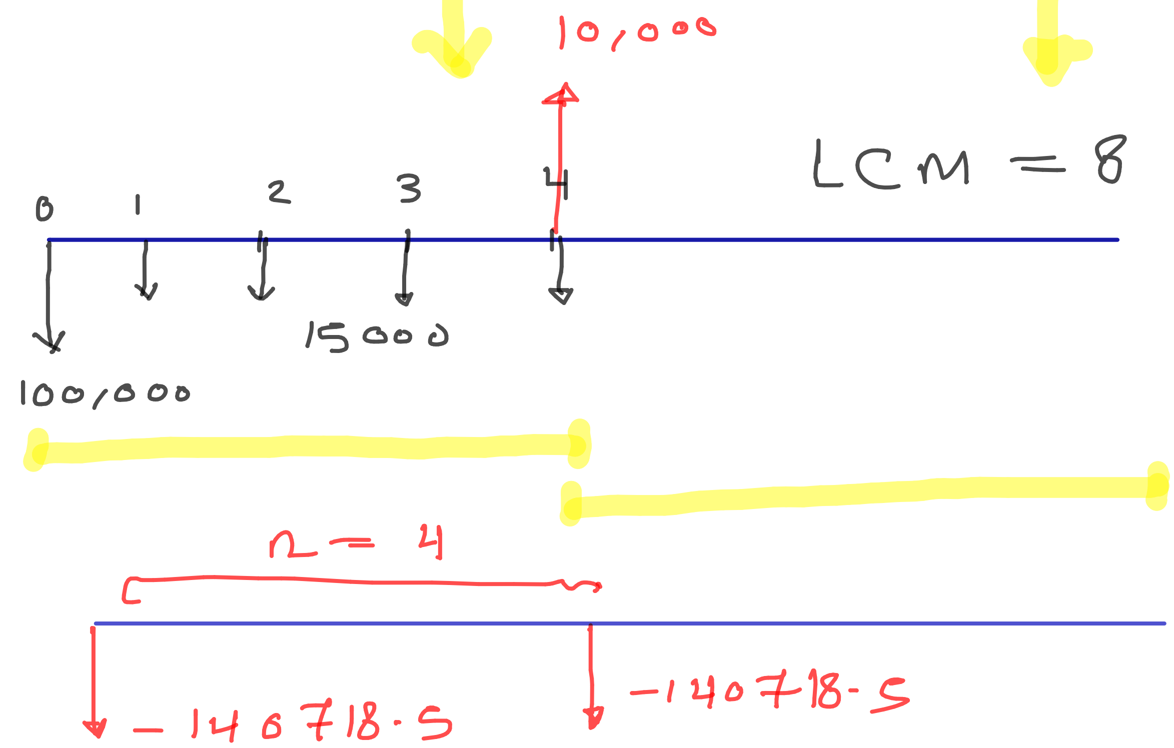
$$= 10909.1 * 0.9091 = 9917.45$$

Problem 6: (25 points)
Two alternatives below are being considered for recovering aluminum from garbage. If the interest rate is 10%, which alternative is preferred using **present worth analysis**?

	Alternative 1	Alternative 2
First cost	100,000	120,000
Annual operating cost	15,000	20,000
Salvage value	+ 10,000	15,000
Life in years	4	8

Alt

LCM = 8



$$P = -100{,}000 - 15000\,(P/A,\ 10\%,\ 4) + 10{,}000\,(P/F,\ 10\%,\ 4)$$

$$= -100{,}000 - 15000\,(3.1699) + 10{,}000\,(0.6830)$$

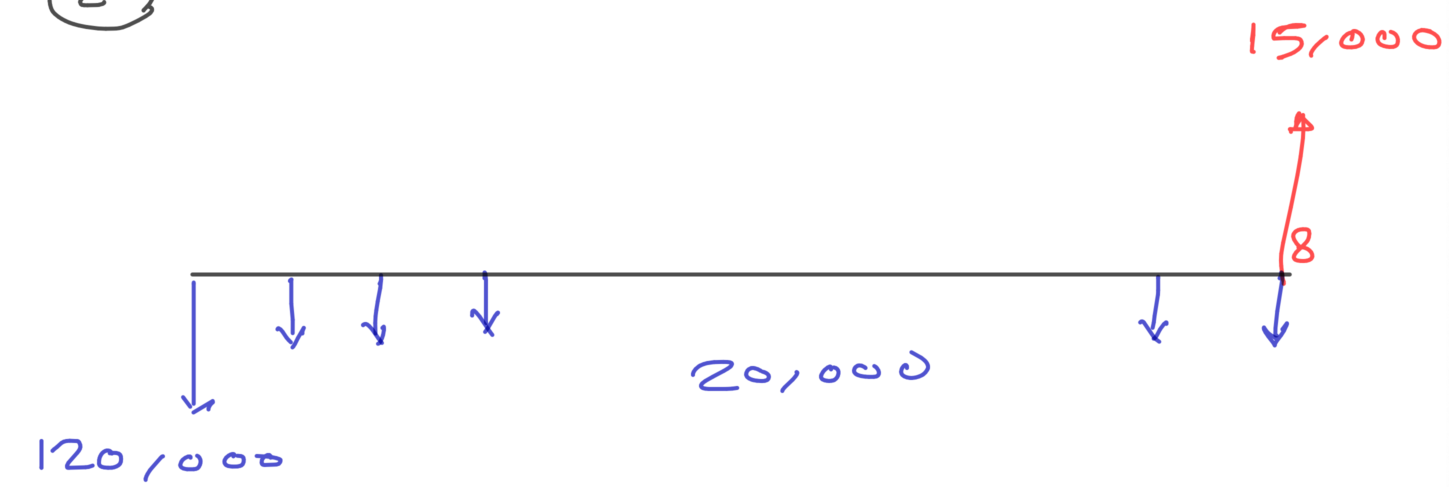
$$= -140718.5$$

$$P = -140718.5 - 140718.5\,(P/F,\ 10\%,\ 4)$$

$$= -140718.5 - 140718.5\,(0.6830)$$

$$= -236829.23$$

Alt 2



$$P = -120{,}000 - 20{,}000\,(P/A,\ 10\%,\ 8) + 15{,}000\,(P/F,\ 10\%,\ 8)$$

$$= -120{,}000 - 20{,}000\,(5.3349) + 15000\,(0.4665)$$

$$= -219700.5$$

Choose alt 2 because it's better

Problem 7: (15 points)
Compare the alternatives shown below on the basis of their **capitalized costs** and an interest rate of 10% per year to determine which of these mutually exclusive alternatives is economically the best.

	Alternative A	Alternative B
First cost	200,000	750,000
Annual operating cost	45,000 in year 1 and decreasing by 5,000 until year 4	12,000
Salvage value	25,000	100,000
Life in years	4	∞