

*SCEA CERTIFICATION EXAM:
PRACTICE QUESTIONS AND STUDY AID*

Linear Regression Formulas Cheat Sheet

You may use the following notes on linear regression to work exam questions.

Let y be a dependent variable and x be an independent variable in the linear model

$$y = a \cdot x + b,$$

where a and b are constants.

The following x_i and y_i , $i = 1, \dots, n$; are the i th paired observations of x and y .

x	y
x_1	y_1
x_2	y_2
...	...
x_n	y_n

The formulas for a and b that determine a line best fitting the data—in the sense of minimizing the sum of the squared model errors—are:

$$a = \frac{\left(\sum_{i=1}^n (x_i \cdot y_i) - \bar{x} \cdot \sum_{i=1}^n y_i \right)}{\left(\sum_{i=1}^n (x_i^2) - \bar{x} \cdot \sum_{i=1}^n x_i \right)} = \frac{\left(n \sum_{i=1}^n (x_i \cdot y_i) - \left(\sum_{i=1}^n x_i \right) \cdot \left(\sum_{i=1}^n y_i \right) \right)}{\left(n \sum_{i=1}^n (x_i^2) - \left(\sum_{i=1}^n x_i \right)^2 \right)} \text{ and } b = \bar{y} - a \cdot \bar{x},$$

where $\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$, the average of the y_i and $\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$, the average of the x_i .

1. Solve the equation $a = 10^{(b + \sqrt{x})}$ for x.

$$x = (\log(a) - b)^2$$

2. Solve the equation for r. $r(s^2) = a - r(k)$

$$r = \left(\frac{a}{s^2 + k} \right)$$

3. At what point does the line: $y = x$ intersect the line $y = -2 - x$

$$(-1, -1)$$

4. At what point does the line: $y = 2 + 10x$ intersect the line $y = 5 - 3x$

$$(3/13, 56/13)$$

5. Consider the following production data:

Number of units produced	Labor hours observed
3	19
15	49
19	56
27	76
34	90

Estimate the labor hour requirements for:	to one decimal place using interpolation;	to one decimal place using linear regression
		$(Y = 12.996 + 2.296 X)$
23 units	66.0	65.8
17 units	52.5	52.0
12 units	41.5	40.5

6. Consider the following production data:

Number of units produced	Labor hours observed
3	19
15	49

Determine the slope and intercept of the line connecting the two observations of units produced and labor hours observed.

Estimate the labor hour requirements for:	to one decimal place using the slope and intercept of the line ($Y = 11.5 + 2.5 X$)
23 units	69.0
17 units	54.0
12 units	41.5

7. Define the following acronyms from EVM:

BCWP Budgeted cost of work performed	ACWP Actual cost of work performed	BCWS Budgeted cost of work scheduled	EAC Estimate at complete	BAC Budget at complete
CPI Cost performance index	SPI Schedule performance index	CV Cost variance	SV Schedule variance	

8. Match the term to its equation definition

CPI BCWP – ACWP
 SPI BCWP – BCWS
 CV BCWP / BCWS
 SV BCWP / ACWP

CPI	→	BCWP / ACWP
SPI	→	BCWP / BCWS
CV	→	BCWP – ACWP
SV	→	BCWP – BCWS

9. Which of the following generate:

	Direct costs? Why?	Indirect costs? Why?	G&A costs? Why?
Manufacturing labor	X		
Raw materials	X		
Material handling		X	
Lighting		X	
Finance department			X
Personnel department			X
<i>Generate your own examples</i>			
<i>Provide your rationale if you disagree with the suggested answers</i>			

10. Which of the following generate:

	Recurring costs? Why?	Nonrecurring costs? Why?
Raw materials	X	
Engineering drawings		X
Configuration management	X	
Software development		X
<i>Generate your own examples</i>		
<i>Provide your rationale if you disagree with the suggested answers</i>		

11. Which of the following generate:

	Fixed costs? Why?	Variable costs? Why?
Insurance	X	
Raw materials		X
Rent	X	
Manufacturing labor		X
<i>Provide your rationale if you disagree with the suggested answers</i>		

12. If the cost of the first unit is 100 hours and we observe a 90% cumulative average “learning slope,” what is the average unit cost of two units; what is the total cost of two units; what is the cost of the second unit?

90; 180; 80

13. If the cost of the first unit is 100 hours and we observe a 90% cumulative average “learning slope,” what is the average unit cost of four units; what is the total cost of four units; what is the average unit cost of three units? what is the total cost of three units? what is the cost of the fourth unit? what is the cost of the third unit?

81; 324; 84.62; 253.86; 70.14; 73.86

14. If the total cost of four units is 400 hours and we observe a 90% cumulative average “learning slope,” what is the average cost of 8 units? what is the cost of the first unit?

90; 123.46

15. If the cost of the first unit is 100 hours, the cost of four units is 256, and we observe cumulative average learning theory, what is the “learning slope?”

80%

16. Using unit learning theory, estimate the cost in hours of the 48th unit if the cost of the 12th unit is 6400 hours and the learning curve slope is 75%. Round to the nearest hour.

3600

17. If the cost of the fourth unit is 100 hours, what is an approximate cost of the thirtieth unit – don’t use a calculator – if we assume a 90% learning slope under unit learning theory?

Calculate the answer for 32 units, which comprising three doublings of the base quantity of 4, yielding:
 $100 \times 0.9^3 = 72.90$.

The exact answer is $100 \times 0.9^K \approx 73.62$, where $K = \log(30/4)/\log(2)$ or $100 \times (30/4)^k \approx 73.62$, where $k = \log(0.90)/\log(2)$

18. A company experienced a 5000-hour first unit cost but experienced a 2200-hour cost for the 16th unit. On what unit theory learning slope did the company operate, to the nearest 1%?

81%

$2200 = 5000 \times (\text{learning slope percent}/100)^4$; solve for the learning slope by taking the fourth root of 2200/5000; Why?

19. An investment instrument earns 7.5% simple interest for 10 years on a \$100,000 principal. How much interest does the instrument earn during its life – to the nearest dollar?

\$75,000

20. An investment instrument earns 7.5% interest compounded annually for 10 years on a \$100,000 principal. How much interest does the instrument earn during its life – to the nearest dollar?

\$106,103

21. An investment instrument earns 7.5% compounded monthly for 10 years on a \$100,000 principal. How much interest does the instrument earn during its life – to the nearest dollar?

\$111,206

22. You are to prepare a bid for producing 100 brackets. The brackets are made on a punch press and screen printed with a part number. Screen printing is done in one batch of 100 brackets; the brackets are punch pressed in batches of 75. Punch press set-up time is 2 hours per set-up; run time is 0.01 hours per piece. Screen print set-up is 4 hours per set-up and 0.05 hours per print. Material cost is 50 cents per piece. Direct labor rate is \$10 per hour and overhead is 150% of direct labor. G&A is 20% of total material, labor and overhead cost. A 15% profit rate is expected. To the nearest dollar, what is your bid price for the 100 brackets? Assume no learning or attrition occurs in either process.

\$552

23. A supplier uses a 10% profit margin. The total estimated price to the customer, including profit, is \$12,345. What is the profit, rounded to the nearest dollar?

\$1122

24. A supplier expects a \$12,000 profit. The total bid price to the customer is \$50,890, including the profit. What is the profit percentage, to one decimal place?

30.9%

25. The firm had a fixed cost of \$5.67 and a variable cost of \$12.34 per unit. What is the minimum number of units the firm would have to sell to at least break even at a \$12.49 per unit selling price?

38

26. The following table documents the number of a firm's employees working at specified hourly labor rates. For example, 50 employees work at \$8.50 per hour.

<u>Hourly rate (\$)</u>	<u>Number of employees at this rate</u>
8.50	50
15.00	199
10.20	150

What is the firm's mean hourly rate to the nearest cent? the firm's median hourly rate? the firm's modal hourly rate (i.e., the mode of the labor rate frequency distribution)? the firm's "most likely" hourly rate?

\$12.38, \$10.20, \$15.00, \$15.00

27. Explain the mechanics of the straight line depreciation method and of the declining balance depreciation method.

28. The following table documents the number of a firm's employees working at specified hourly labor rates. For example, 50 employees work at \$8.50 per hour.

<u>Hourly rate (\$)</u>	<u>Average hours worked per week</u>	<u>Number of employees at this rate</u>
8.50	46	50
15.00	42	199
10.20	43	150

Calculate composite hourly labor rate for the firm.

\$12.38

29. Read the first row of the following table as follows:

Labor code A employees collectively work 33 hours in the process of producing one unit of a specified item. The 1987 hourly labor rate for labor code A was \$12.00. Inflation adjustments for this category increase the labor rate by 4% in 1988, 5% in 1989, and 4% in 1990.

<u>Labor Code</u>	<u>Hours Spent</u>	<u>1987 Hourly Labor Rate</u>	<u>Annual Inflation Rate (%)</u>		
			<u>1988</u>	<u>1989</u>	<u>1990</u>
A	55	\$12.00	4	5	4
B	29	\$13.00	5	5	3
C	10	\$11.00	5	5	2
D	35	\$12.50	4	5	1

Calculate a composite 1990 inflation rate for the labor to producing one unit of the specified item. Express your answer in percent units rounded to two decimal places. Calculate the composite 1987 hourly labor rate; the median 1987 labor rate; the modal 1987 labor rate (mode of the labor rate frequency distribution); the overall escalation rate for labor category C;

2.81%, 12.28, 12.00, 12.00, 12.5%

30. Calculate $\log_2(100)$ to two decimal places. What does the answer mean?

$\log_2(100) = \log(100)/\log(2) \approx 6.64$; $2^{\log_2(100)} = 100 \rightarrow 2^{6.64} \approx 100$

31. Contrast "direct costs" with "indirect costs.?"

32. Contrast "recurring costs" with "nonrecurring costs."

33. Contrast "fixed costs" with "variable costs" with "semi variable costs."

34. Explain what we mean by a 90/10 share ratio in incentive fee contracts.

35. Suppose that an uncertain quantity x – e.g., cost – has one of the following probability distributions: normal, lognormal, uniform, triangular, beta. For which of the probability distributions:

Which of these have density functions that must be symmetric in shape? Why? Which can have one that is symmetric? Why? Which allow that indefinitely large values of “ x ” have some probability of occurring? Which require that values of “ x ” greater than a specified upper bound have zero probability of occurring?

36. If $y = 0.5x$ for all values of x what is the Pearson correlation of y with x ? Why?

1.00

37. Explain what we mean by “the variance” of an uncertain quantity x – e.g., cost?

38. Explain what we mean by; the coefficient of variation of an uncertain quantity.

39. Explain what we mean by “the method of least squares” in linear regression analysis.

40. What are the final price and profit for a firm fixed price contract if:

the target cost is \$100,000;

the negotiated price (i.e., cost plus fee) is \$110,000;

the target profit is \$10,000; and

The final cost is \$97,000

Final profit = \$13,000

Final price = \$110,000

The final cost is \$102,500

Final profit = \$7,500

Final price = \$110,000

The final cost is \$113,000

Final profit = - \$3000

Final price = \$110,000

41. Given the following data for a cost-plus-incentive-fee contract, what is the final price and profit:

Target cost is \$2,000,000

Target fee is \$100,000

Under target share ratio is 90/10

Over target share ratio is 80/20

Maximum fee (ceiling) is \$240,000

Minimum fee (floor) is \$60,000

Final cost is \$1,800,000

Final fee = \$120,000

Final price = \$1,920,000

Final cost is \$2,400,000

Final fee = \$60,000

Final price = \$2,460,000