Topic: Transforming random variables

Question: Let X be a random variable with $\mu_X = 75$ and $\sigma_X = 8$. Let $Y = 6 + 2X$. Find μ_Y and σ_Y.

Answer choices:

A $\mu_Y = 75$ and $\sigma_Y = 8$

B $\mu_Y = 156$ and $\sigma_Y = 14$

C $\mu_Y = 156$ and $\sigma_Y = 16$

D $\mu_Y = 156$ and $\sigma_Y = 22$

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Solution: C

Since $Y = 6 + 2X$, we'll scale each value in our data set by the constant 2 and then add a constant of 6. The scaling by 2 will effect the mean and standard deviation, but the shifting by 6 will only effect the mean. The mean of Y will therefore be

$$\mu_Y = 6 + 2(\mu_X)$$

$$\mu_Y = 6 + 2(75)$$

$$\mu_Y = 156$$

And the standard deviation of Y will be

$$\sigma_Y = 2(\sigma_X)$$

$$\sigma_Y = 2(8)$$

$$\sigma_Y = 16$$

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Question: An employee at a candy store has the job of cutting fudge into 1 -inch cubes and weighing them. After a day at work she finds the mean and standard deviation of her fudge cubes to be 1.5 ounces and 0.3 ounces, respectively. At the end of the day her boss realizes the scale was not calibrated correctly. The weights of all the pieces were actually 0.1 less than recorded. Find the actual mean and standard deviation for the fudge that was cut today.

Answer choices:

A $\mu = 1.5$ and $\sigma = 0.3$

B $\mu = 1.4$ and $\sigma = 0.2$

C $\mu = 1.5$ and $\sigma = 0.2$

D $\mu = 1.4$ and $\sigma = 0.3$

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Solution: D

If all the pieces of fudge actually weighed 0.1 ounces less than what was recorded, the new mean will be lower than originally calculated. In fact, it will be 0.1 ounces less than the original.

$$\mu_{\text{new}} = \mu_{\text{old}} - 0.1$$

$$\mu_{\text{new}} = 1.5 - 0.1$$

$$\mu_{\text{new}} = 1.4 \text{ ounces}$$

The standard deviation won't change when we shift the data by a constant.

$$\sigma_{\text{new}} = \sigma_{\text{old}}$$

$$\sigma_{\text{new}} = 0.3 \text{ ounces}$$

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Question: A chemistry teacher gave a test to his students and calculated the following statistics for the class: median of 68, IQR of 12, and range of 58. He decides to "curve" the scores by using this formula:

$$\text{New score} = 1.05(\text{Old score}) + 4$$

Find the median, IQR, and range for the new set of test scores.

Answer choices:

A Median of 75.4, IQR of 12.6, and Range of 60.9

B Median of 71.4, IQR of 12.6, and Range of 60.9

C Median of 75.4, IQR of 16.6, and Range of 64.9

D Median of 75.4, IQR of 16, and Range of 62

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Solution: A

Each student's old score was substituted into the formula to give a new score for that student. For example, if a student had an old score of 75, we would compute his new score as

$$\text{New score} = 1.05(\text{Old score}) + 4$$

$$\text{New score} = 1.05(75) + 4$$

$$\text{New score} = 78.75 + 4$$

$$\text{New score} = 82.75$$

All old scores would be transformed into new, curved scores in this same way. We're only given the median, IQR, and range for the old test scores. The median measures the center for the test scores and the IQR and range both measure the spread in the scores. The median will be transformed in the same way as each individual score.

$$\text{New median} = 1.05(\text{Old median}) + 4$$

$$\text{New median} = 1.05(68) + 4$$

$$\text{New median} = 71.4 + 4$$

$$\text{New median} = 75.4$$

The measures of spread are transformed using only the scale factor of 1.05, but are not affected by adding 4 to each value. Remember that adding a constant k will move all of values up by k units, but won't make

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the data any more or less spread out. Therefore, we'll convert the IQR and range this way:

$$\text{New IQR} = 1.05(\text{Old IQR})$$

$$\text{New IQR} = 1.05(12)$$

$$\text{New IQR} = 12.6$$

and

$$\text{New range} = 1.05(\text{Old range})$$

$$\text{New range} = 1.05(58)$$

$$\text{New range} = 60.9$$

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