AP® Statistics
2002 Sample Student Responses

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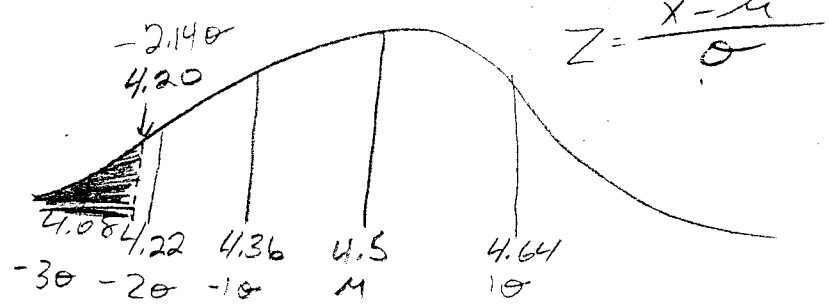
3. There are 4 runners on the New High School team. The team is planning to participate in a race in which each runner runs a mile. The team time is the sum of the individual times for the 4 runners. Assume that the individual times of the 4 runners are all independent of each other. The individual times, in minutes, of the runners in similar races are approximately normally distributed with the following means and standard deviations.

	Mean	Standard Deviation
Runner 1	4.9	0.15
Runner 2	4.7	0.16
Runner 3	4.5	0.14
Runner 4	4.8	0.15

(a) Runner 3 thinks that he can run a mile in less than 4.2 minutes in the next race. Is this likely to happen? Explain. $\mu = 4.5 \quad \sigma = .14$

$$P(x \leq 4.2)$$
$$= P\left(z \leq \frac{4.2 - 4.5}{.14}\right)$$
$$= P(z \leq -2.14)$$
$$= .0162 = 1.62\%$$



It is highly unlikely that runner 3 can run a mile in less than 4.2 minutes, if the mean and standard deviation given above are true of the population. Runner 3 would only be able to run a mile in less than 4.2 minutes about 1.62% of th tim

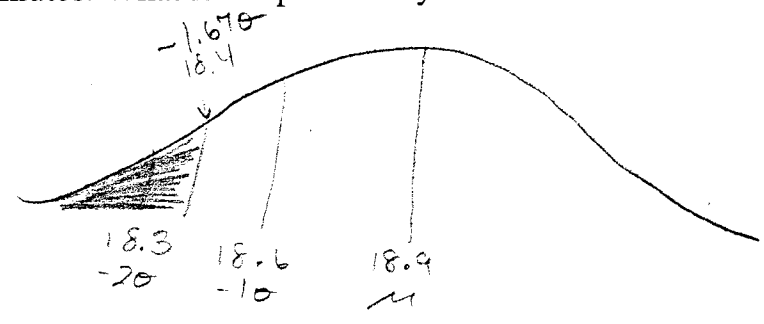
(b) The distribution of possible team times is approximately normal. What are the mean and standard deviation of this distribution?

$$\mu = 4.9 + 4.7 + 4.5 + 4.8 \therefore \boxed{\mu = 18.9}$$
$$\sigma = \sqrt{\sigma^2}$$
$$\sigma^2 = (.15)^2 + (.16)^2 + (.14)^2 + (.15)^2 \therefore \sigma^2 = .0902$$
$$\sigma = \sqrt{.0902} \qquad \boxed{\sigma = .3003}$$

(c) Suppose the team's best time to date is 18.4 minutes. What is the probability that the team will beat its own best time in the next race?

$Z = \frac{x - \mu}{\sigma}$

$$P(t < 18.4)$$
$$= P\left(z < \frac{18.4 - 18.9}{.3003}\right)$$
$$= P(z < -1.67)$$
$$\boxed{= .0475 = 4.75\%}$$



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(a) Runner 3 thinks that he can run a mile in less than 4.2 minutes in the next race. Is this likely to happen? Explain.

With a mean of 4.5 and standard deviation of .14 the probability of Runner 3 running less than 4.2 minutes is the area to the left of $\left(\frac{4.2-4.5}{.14}\right)$ on the z-curve. This is $P(z<-2.1429)$ which equals .0162. This is unlikely to happen.

(b) The distribution of possible team times is approximately normal. What are the mean and standard deviation of this distribution?

The mean is $4.9+4.7+4.5+4.8 = 18.9$ minutes

The s.d. is $\sqrt{(.15)^2+(.16)^2+(.14)^2+(.15)^2} = .3003$ minutes

(c) Suppose the team's best time to date is 18.4 minutes. What is the probability that the team will beat its own best time in the next race?

The probability is the area to the left of $z = \frac{18.4-18.9}{.3003} = -1.66$ on the z-curve. This probability is approximately .143.