$X \sim N(\mu, \sigma)$

a. The normal distributions above have means $\mu = 5$, $\mu = 10$ and $\mu = 0$. Identify which graph has which mean.

b. The normal distributions above have standard deviations of $\sigma = 0.5$, $\sigma = 1$ and $\sigma = 2$.
   Identify graph has which standard deviation.

The following are true for ANY normal probability distribution:

$P(\mu - \sigma < X < \mu + \sigma) = $ _____

The probability for the interval within ± 1 standard deviations from the mean ($\mu \pm 1\sigma$) is _____

$P(\mu - 2\sigma < X < \mu + 2\sigma) = $ _____

The probability for the interval within ± 2 standard deviations from the mean ($\mu \pm 2\sigma$) is _____
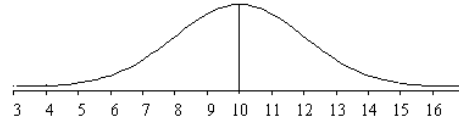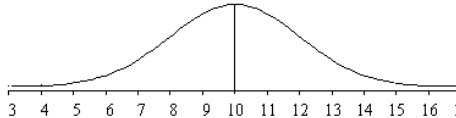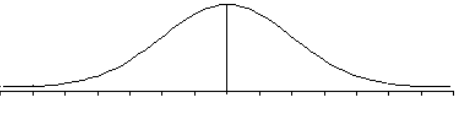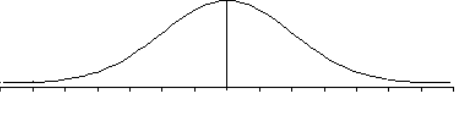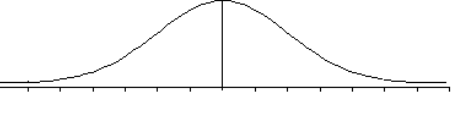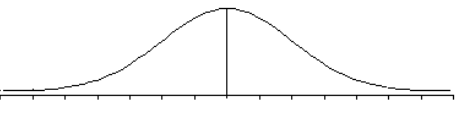
$P(\mu - 3\sigma < X < \mu + 3\sigma) = $ _____

The probability for the interval within ± 3 standard deviations from the mean ($\mu \pm 3\sigma$) is _____
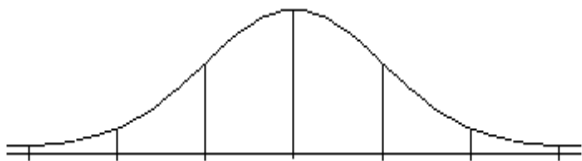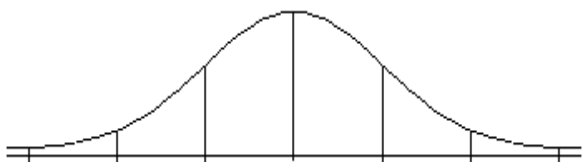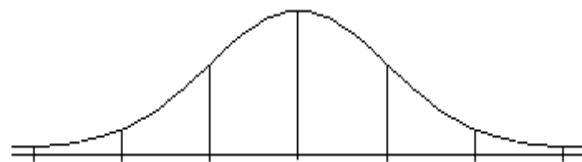
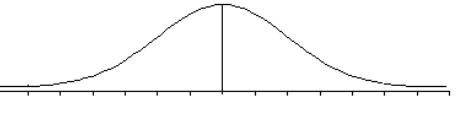## CHAPTER 6: THE NORMAL PROBABILITY DISTRIBUTION: Calculating Probabilities

- Shade the area representing the probability.
- Label the value of the mean μ and the X values along the horizontal axis
- Label area above or inside the graph.
- Use your calculator: 2nd Distr normaldcf to find the probabilities if given X
  or use 2nd Distr invnorm to find X if given the probability (invnorm *requires input of area to the* **left**)
- Write the answer as a mathematical probability statement using correct notation.

A botanist is studying the amount of time it takes for seeds to germinate (sprout) for certain type of plant. Suppose that the germination time is normally distributed with a mean (average) of 10 days with standard deviation 2 days. X = germination time for one seed

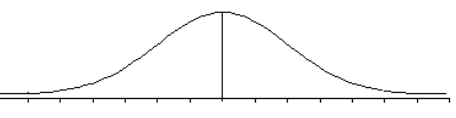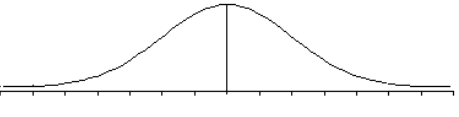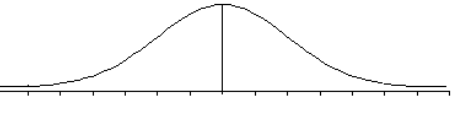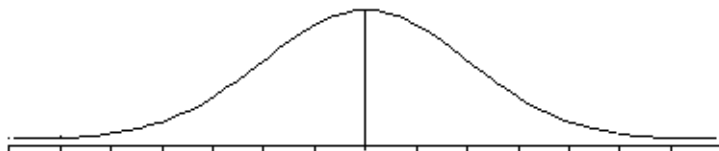| FINDING AREA IN BETWEEN **X ~ N(10, 2)** normalcdf(lower, upper, μ, σ)	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 **P(7 < X < 9)**	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 **P(11 < X < 14)**
FINDING AREA TO THE RIGHT **X ~ N(10, 2)** normalcdf(lower, 1E99, μ, σ) normalcdf(lower, 10^99, μ, σ)	**P(X > 9) =**	**P(X ≥ 13) =**
FINDING AREA TO THE LEFT **X ~ N(10, 2)** normalcdf((–) 1E99, upper, μ, σ) normalcdf((–) 10^99, upper, μ, σ) use (–) key for negative number	**P(X ≤ 8) =**	**P(X < 11.5) =**
FINDING PERCENTILES: FINDING X when we know the AREA TO THE LEFT **X ~ N(10, 2)** invnorm (area to the left, μ, σ)	**25th percentile**	**80th percentile**
FINDING X when we know the AREA TO THE RIGHT **X ~ N(10, 2)** First find the area to the left Then use the calculator invnorm (area to the left, μ, σ)	**P(X ≥ k) = 0.60 Find k**	**P(X > k) = 0.30 Find k**

X ~ N(10,2)

The middle 90% of values are between_____ and _____

In context of the example stated on page 2 for seed germination time of plants X~N(10,2) days,

The middle 90% of seed take between _____ and _____ days to sprout (germinate).

$P(c \leq X \leq d) = 0.90$ Find c and d:

1. First figure out the area to the left of the lower bound. 2. Then figure out area to the left of the upper bound	3. Then use the calculator with invnorm TWICE to find the lower and upper bounds: **lower bound =** $invnorm\left(\begin{array}{c}area\ to\ left\ of \\ lower\ bound\end{array}, \mu\ , \sigma\right)$ **upper bound =** $invnorm\left(\begin{array}{c}area\ to\ left\ of \\ upper\ bound\end{array}, \mu\ , \sigma\right)$

CHAPTER 6: THE NORMAL PROBABILITY DISTRIBUTION
Exploring Connections between Percentiles and Z-Scores

Two swimmers, Angie and Beth, from different wim teams want to compare who had the fastest time for the 50 meter freestyle race when compared relative to the other swimmers on her own team. Suppose we also know that times for each team follow a normal distribution.

Dean, S., & Illowsky, B. OpenStax Introductor Statistics Download for free at https://openstax.org/details/introductory-statistics

Swimmer	Swimmer's Time	Team Mean Time	Team Standard Deviation
Angie	26.2	27.2	0.8
Beth	27.3	30.1	1.4

Which swimmer's time would be considered better (Angie or Beth) when each is compared relative to the other swimmers on her own team?

X = time for a swimmer on Angie's team: X~_____

Y = time for a swimmer on Beth's team: Y~_____

Calculate and compare Z-scores (we did this in chapter 2; chapter 6 re-examines this concept)

Angie	Beth

Compare percentiles for Angie and Beth by calculating probabilities using their actual GPAs

Angie: Find $P(X \leq 26.2)$ for X~N(27.2, 0.8)	Beth: Find $P(Y \leq 27.3)$ using Y~N(30.1, 1.4)

Compare percentiles for Angie and Beth by calculating probabilities using their z-scores

Angie: Find $P(Z < -1.25)$ using $Z \sim N(0, 1)$	Beth: Find $P(Z < -2)$ using $Z \sim N(0, 1)$

CONCLUSION: _____'s time of _____ minutes is considered better than _____'s

time of _____ minutes when each is compared relative to other swimmers on her own team.

NOTE
- Using z-scores and percentiles lead to the equivalent results and the same conclusion..
- Using the specified normal distribution X~N(3.0, 0.7) and Y~N(80, 10) give the same probabilities and percentiles as are obtained by using the Z score with the standard normal distribution, Z ~ N(0, 1)

CHAPTER 6: THE NORMAL PROBABILITY DISTRIBUTION: PRACTICE

- Draw the graph and label all pertinent values.
- Label the value of the mean μ and the X values along the horizontal axis
- Label areas above or inside the graph.
- Use your calculator to find the requested values. Write your calculator commands.
- Write the answer as a mathematical probability statement using correct notation.

PRACTICE EXAMPLE N: In California, the wine and fruit industries invest significant resources in the study of growing grapes in order to improve crop yield and quality.
Suppose that a certain type of grape, when ripe, has diameter that is normally distributed with a mean of 1.8 cm with a standard deviation of 0.3 cm.

a. Find the probability that a randomly selected grape has diameter more than 2.2 cm

b. Find the probability that a randomly selected grape has diameter less than 1.6 cm.

c. The middle 80% of this type of grapes have diameters between _____ and _____cm.

d.Find the IQR (Interquartile Range) of diameters for this type of grape.

e. The largest 15% of grapes have diameters of at least _____ cm.

f. Find the probability that a randomly selected grape has diameter between 1.5 and 2.0 cm
   using each method as instructed below:

   (i) Use X~N(1.8, 0.3) when using normalcdf on your calculator

   (ii) Find z-scores for x = 1.5 and x = 2.0 and use Z~N(0,1) standard normal distribution
   when using normalcdf on your calculator