①

4: -2
5: -2.5
6: -3

One mistake: -0.5
Two mistakes: -1
Three mistakes: -1.5

1. [+3] Dr. W. Edwards Deming is the "Father of Quality Control." Circle *all* the items that are "true" about him. There may be more than one correct answer.

Don't Be
Busy
Be
Productive

A. Created the fishbone diagram Ishikawa

B. Wrote "Out of the Crisis," one of the premier books in Quality Control

C. Invented the control chart Shewhart

D. Produced the movie: "If Japan Can … Why Can't We"

E. Helped bring Japan out of ruins after World War II

F. Has a Japanese quality award named after him

G. Used "silly activities" at his well-attended seminars to get across key points in Quality Control

H. Believed that quality should come from the top down, starting with upper management

I. Believed that slogans (like the one to the right) could inspire workers to be more productive No!

J. Believed that tampering with a process that only has common cause variation could ~~help re~~duce the variation increases variation

Missing 3: -3
Missing 1: -1
Missing 2: -2

2. [+3] After World War II, which of the following statements are true? Circle *all* that apply.

A. Japan rebuilt their destroyed country in less than 5 years

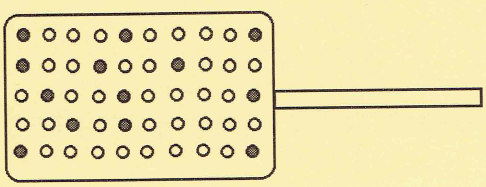
B. U.S. companies stopped worrying about quality

C. Japan welcomed Deming to their country to teach quality control to their management and workers

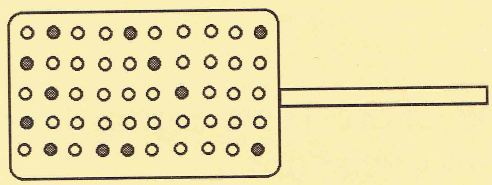
D. U.S. companies would not listen to Deming and discontinued applying quality methods to their products

3. [+3] The following diagram shows four successive dips of Deming's red bead paddle into a large barrel containing 70% white beads and 30% red beads. The number of red beads on these paddles varies by plus or minus a few beads. If we plotted the number of red beads on each paddle on a control chart, what type of variation would we be observing?

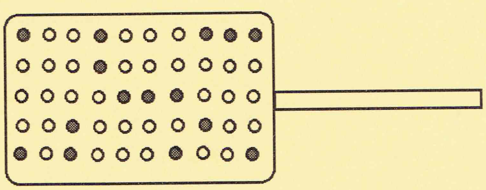
A. Common Cause Variation B. Special Cause Variation C. There is no variation!



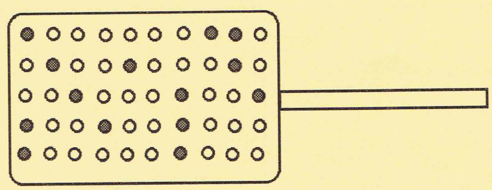
Deming's Red Bead Paddle



Deming's Red Bead Paddle



Deming's Red Bead Paddle



Deming's Red Bead Paddle

nothing "unusual" about the # of beads on each paddle

4. [+3] The **main** purpose of a control chart is to:

A. Estimate the proportion of output that is acceptable/unacceptable

B. Weed out defective items

C. Determine if the output meets customer specifications

D. Distinguish between common cause variation and special cause variation in a process

E. Combine a histogram with a time series plot

F. Monitor a process over time

+12

2

5. [+3] After I exercise in the early morning at Union Hospital, I shower in their locker room. Depending on the time of day and the number of other people using the locker rooms, the water temperature varies. I always start the temperature dial so it's pointing straight up.

- If the water is too hot, I turn the dial slightly to the right.
- Typically, the water gets too cold, so I adjust it back to the left.

As other people are using the sinks, toilets, and other showers, the temperature randomly changes. I continue with this back and forth rotation of the temperature dial until I finish. What I'm doing should remind you of an experiment that we discussed in class. Which one?

tampering w/ a system that only has common cause variation

A. Deming's Funnel Experiment
B. Deming's Red Bead Experiment
C. Shewhart's Control Chart Experiment at Western Electric
D. Juran's Juicy Fruits Experiment
D. Deming's 14 Points of Management

6. [+3] Elevator doors have a sensor that causes them to open when there is an obstruction. This prevents injury to someone trying to enter as the doors are closing. This safety prevention is most aligned with which of the following concepts?

error proofing; someone who isn't paying attention will not get seriously hurt

A. Poka Yoke
B. Ishikawa Diagram
C. Acceptance Sampling
D. ACSI
E. Benchmarking
F. Deming's Funnel Experiment
G. Deming's 14 Points of Management

7. [+3] This quality tool has consistently predicted future consumer spending and is an indicator of financial performance at both the company and industry level.

A. Poka Yoke
B. Ishikawa Diagram
C. Acceptance Sampling
D. ACSI
E. Benchmarking
F. Deming's Funnel Experiment
G. ISO 9001

consumer spending "quarter i" corresponds to economy in quarter i+1

8. [+3] ***True Story.*** On my way home from school last year, I saw mounds of smoke coming from the middle of my neighborhood. A lot of people burn wood in the neighborhood, but this was more than I was used to seeing. When I turned onto my street, the house 3 doors down was on fire!

When we smell smoke in our neighborhood, there are two alternative hypotheses:

H_0: Someone is simply burning wood; there are no serious issues or danger

H_a: Someone's house is on fire and it is a serious issue and dangerous

Suppose that someone's house really is on fire, but the fire department doesn't respond immediately because they think it's just another case of someone burning wood. What type of error has the fire department committed?

Type I   Type II   Neither   Both

there really is a fire, but the fire dept doesn't respond

9. [+4] A large random sample of size $n = 64$ units will be taken from a population with a known mean of $\mu = 10$ and known standard deviation of $\sigma = 2$. The population is not normally distributed. Which of the following is a true statement? Circle all that apply.

CLT

A. The approximate probability that the sample mean Xbar is greater than 11 can be determined by using the Central Limit Theorem. yes, n=64

B. The approximate probability that any ~~individual X~~ from the original population is greater than 11 can be determined because we know the population's mean and standard deviation. no - we don't know distribution of X

C. The approximate probability that any individual X from the original population is greater than 11 can be determined because the sample size ($n = 64$) is large.

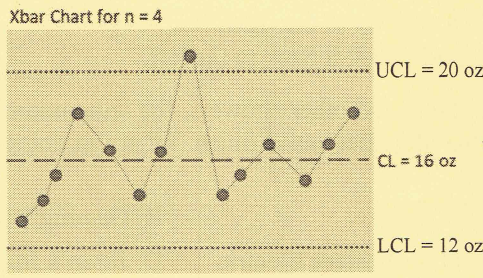
n=64 only helps in we are determining Xbar

D. The approximate probability that the sample mean Xbar is greater than 11 cannot be determined because the original population distribution is not normally distributed.

+28

3

Problems 10-14. Suppose engineers are overseeing a process that fills boxes with Chex mix. Let X represent the fill weight per box, which is reported to be 16 oz on the front of the box. We are using a control chart (shown below), to monitor the fill weights of the boxes for samples of size $n = 4$. Assume the fill weights are normally distributed.



the process in really in-control, but we decide it's out of control

10. [+4] Suppose that the process is truly **in-control**, but they decide to stop the assembly line filling the boxes due to the 8th point in the diagram above. Which one of the following is true?

A. A process should never be stopped by the 8th point. B. They committed a Type I error by stopping the line.

C. They committed a Type II error by stopping the line. D. They are tampering with the process.

D. Since the data is normal, they should use $n = 2$ to catch either type of error sooner than later

11. As shown in the control chart (above), the UCL = 20 oz and the LCL = 12 oz. If the control chart limits are set at our typical 3 standard deviations above and below the centerline, then …

(a) [+4] Determine the standard deviation of Xbar; that is, determine $\sigma_{\bar{X}}$ (sigma of $\bar{X}$). Sketch out your solution process.

For an $\bar{X}$ chart: We know that the UCL is $3\sigma_{\bar{x}}$ above the centerline $\mu_{\bar{x}}$

$$\text{So, } 16 + 3 \cdot \sigma_{\bar{x}} = 20$$

$$3 \cdot \sigma_{\bar{x}} = 4 \rightarrow \sigma_{\bar{x}} = 4/3$$

PROBLEM: $\sigma_{\bar{x}} = 2/3$

(b) [+3] Determine the standard deviation of the individual X's; that is, determine σ_X (sigma of X). Show your work.

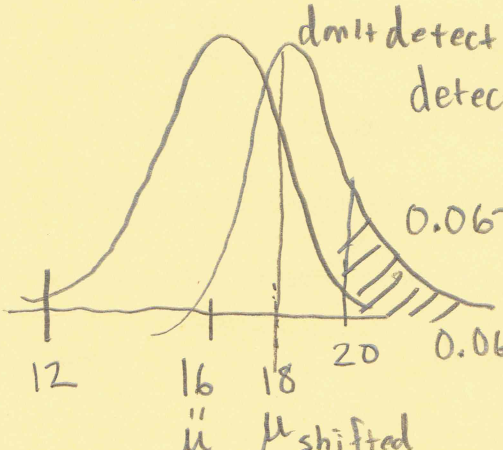
We know that $\sigma_{\bar{x}} = \sigma/\sqrt{n}$. So $4/3 = \sigma/\sqrt{4} \rightarrow 8/3 = \sigma$

$$\sigma = 8/3 \cong 2.667$$

$\sigma_x = 4/3$

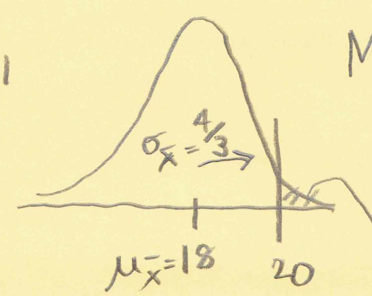
12. [+5] Again, suppose that the process was truly in-control, but between now and 6 p.m., the new center of the distribution **shifts to 18 oz.** making it **out-of-control**. What is the probability of detecting this shift **on the first subgroup drawn** after the shift occurs? Show your work: Provide a Minitab sketch, Maple integral, or z-score. Provide your answer correct to 4 decimal places.

don't detect – to the left of the UCL
detect – to the right of the UCL



$P(\bar{X} > 20) = 0.067$

if use $\sigma_{\bar{x}} = 2/3$, then $P(\bar{x} > 20)$ is



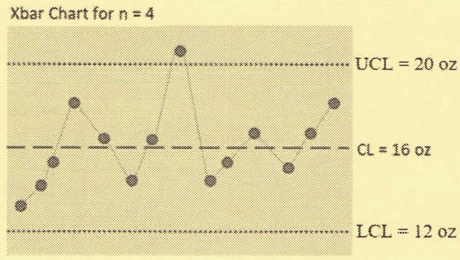
Minitab's Prob Dist Plot
$\mu = 18, \sigma = 1.333$

0.06676

+44

Problems 10-14. X represents the fill weight per box, which is reported to be 16 oz on the front of the box. We are using a control chart (shown below), to monitor the fill weights of the boxes for samples of size $n = 4$.

Grading:
1 mistake: -2
2 mistakes: -3
3 mistakes: -4



13. [+4] The engineers are interested in determining even the slightest shift in the process mean. So, they decide to increase their sample size from $n = 4$ to $n = 16$. Increasing the sample size will do which of the following? Circle ***all*** that apply.

doesn't change Type I error; as n↑, chance of Type II error goes down

A. Increase Type I error X
B. Decrease Type I error X
C. Increase Type II error
D. Decrease Type II error
E. Increase power (probability of detecting a Type II error)
F. Decrease power
G. Increase sampling costs [I'll say optimal ~ but larger n has larger cost)
H. Decrease sampling costs
I. Increase the average number of runs until there is an out-of-control point

Decrease - we'll see a point out-of-control sooner

14. [+3] Because of the number of boxes that are being overfilled while the engineers are trying to fix the problem, the project manager is angry! She directs her anger at the assembly line workers, suggesting 85% or more of the defects are being caused by them. She has threatened to fire some of her best line workers to make her point. Which tool that we've discussed is she failing to take into consideration?

I'll accept B as well

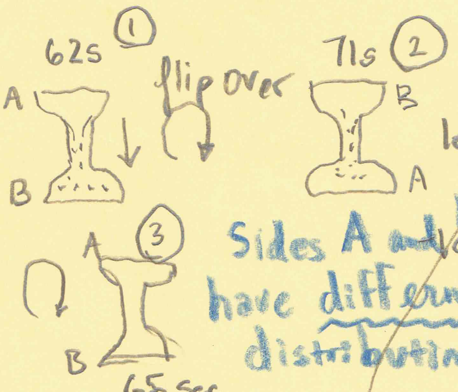
A. Deming's Funnel Experiment
B. Deming's Red Bead Experiment
C. Shewhart's Control Chart Experiment at Western Electric
D. Juran's Juicy Fruits Experiment
E. Deming's 14 Points of Management

Deming: Eliminate fear from the workplace

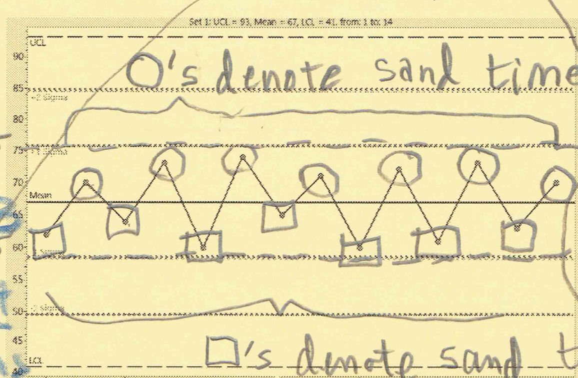
true story

15. At the beginning of the school year, I was timing my "sand timers" to see if they could consistently time 60 seconds. I turned the sand timer over in one direction, calculated the time, and put the point on a control chart (around 62 secs). I flipped it the opposite way, calculated the time, and put the point on the same control chart (around 71 secs). I flipped it over again, etc. I assumed the times would be normally distributed.

(a) [+3] Below is the control chart that I obtained. **List one "unusual" aspect of the chart** that may signify special cause variation. The dotted lines are drawn 1σ, 2σ, and 3σ (UCL) away from the centerline.



Sides A and B have different distributions



1σ

O's denote sand timer times standing in one position

"seesaw" pattern
jig-jag, many alternating pts in a row

□'s denote sand timer times standing in opposite position

(b) [+2] Does my timer produce identically distributed data? Yes **No**

All points are within 1σ on both sides of the centerline

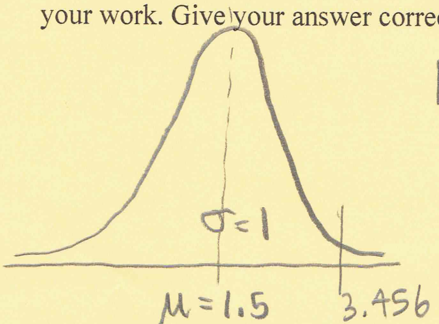
No. The higher pts are from 1 distribution. The lower pts are from another distribution.

+56

5

shift mean by 1.5σ

16. [+4] How many defects per million are associated with a process that has a 3.456 ***Short Term*** Sigma Level. Show your work. Give your answer correct to 3 decimal places.



Minitab's Prob Distributin Plot

Normal, $\mu = 1.5$, $\sigma = 1$

Right tail: 3.456

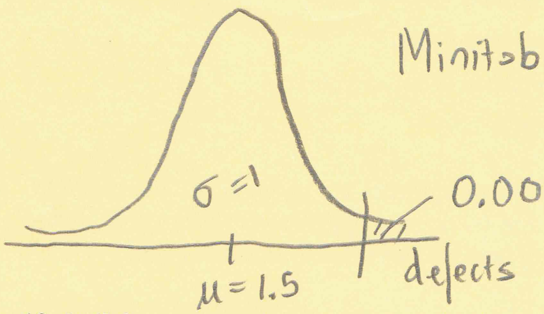
DPM: $0.02523 * 10^6$

$\sim 25{,}230$

17. [+5] The healthcare sector suffers many healthcare data breaches throughout the year, impacting over a million patient records. In fact, a recent report found **7 out of 1,000 employees breach patient privacy**.

With respect to Sigma Levels, what ***Short Term*** Sigma Level is associated with **7 out of 1,000 defects**, where a defect is a data breach? Report your value correct to 3 decimal places. Show your work – Minitab plot or Maple integration.

shift mean by 1.5σ



Minitab's Prob Distributn Plot

Normal, $\mu = 1.5$, $\sigma = 1$

Sigma Level: 3.957

$\mu + 1.5\sigma = 4 + 1.5(2) = 7$

18. [+4] Suppose we have a process that is normally distributed with mean $\mu = 4$ and standard deviation $\sigma = 2$. If we need to shift the mean $\mu = 4$ to the right by 1.5 standard deviations, then the new shifted mean will be centered at what value?

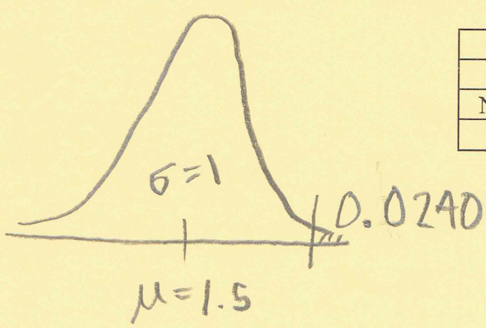
A. 2 B. 2.5 C. 5.5 D. 6 E. 7

F. 7.5 G. 8 H. 10 I. None of these

19. [+5] A customer is trying to decide between one of two companies to test some of his specialized electronics equipment. He is able to pull up the following table comparing the number of tests on similar equipment and number of failed attempts for each company. Determine the ***Short Term*** Sigma Level for Company "T" (on right). Report the Sigma Level correct to 3 decimal places and show your work (e.g. Minitab plot, Maple integral).

shift

	Company S	**Company T**
Number of tests	450	500
Number of failures	68	12
Percent failure	**15.11**	**2.40**



Minitab Prob Dist Plot

Normal, $\mu = 1.5$, $\sigma = 1$

Right tail: 0.0240

Sigma Level: 3.477

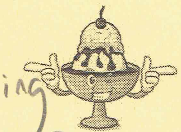
+74

Minitab's Probability Distribution Plot Used for Problem 20

20. There is A LOT of variation in the sizes of caramel sundaes that I have ordered from McDonalds. After researching this over the summer, the ice cream amounts are normally distributed with a mean of $\mu = 80$ ounces of ice cream. The standard deviation is $\sigma = 10$ ounces! Given this information, answer the following.

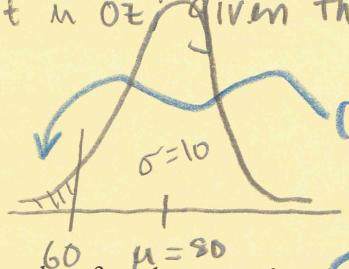
another true story

(a) [+4] What proportion of the time do I get a "small" amount of ice cream, where *small* is 2 standard deviations below the mean? Show your work. Give your answer correct to 4 decimal places.



X = ice cream amt in oz; given the $\mu = 80$, $\sigma = 10$

2 std dev below the mean: 60



0.02275

0.0228

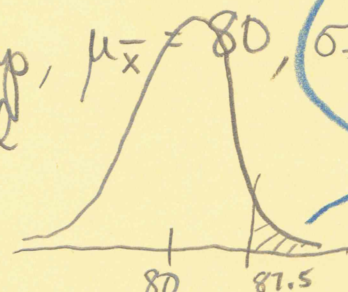
OR 2 std dev below the mean is finding area to the left of -2 on a $\mu = 0, \sigma = 1$ distribution

$\bar{X}$ problem

(b) [+5] Suppose I get sundaes four days a week and average the amounts to create an Xbar control chart for $n = 4$. What's the probability that for a given week, the 4 day average is greater than 87.5 ounces? Show your work. Give your answer correct to 4 decimal places.

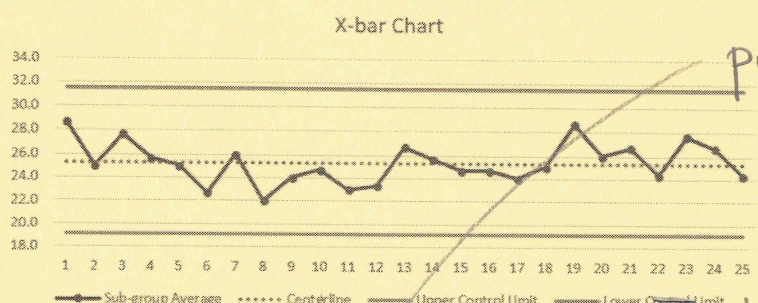
$\bar{X}$ = avg ice cream amt over $n = 4$ days, $\mu_{\bar{X}} = 80$, $\sigma_{\bar{X}} = 10/\sqrt{4} = 5$

Since X is normal, then $\bar{X}$ is normal



0.06681

21. [+10] Below is an Xbar chart for the **average** number of minutes that I talk to my Mom on the phone each week – an average of 7 days from Sunday to Sunday. The UCL and LCL are set at 3 standard deviations above and below, respectively, the centerline.



process shifted on $\bar{X}$ chart

process centered on $\bar{X}$ chart

We can only have Type I if there is no shift; We can only have Type II if there is a shift

Answer **True or False** to the following statements.

- It's impossible to have Type I error and Type II error at the same time. True False
- If the process is in statistical control, then the probability of Type I error is 0.0027. True False
- If the process is in statistical control, then it's impossible to have Type II Error. True False
- If the distribution of times that I talk to my Mom each day is symmetric, then it's very likely that Xbar will be normally distributed even for a sample size of $n = 6$.

  True False
- If we increased the UCL and LCL to 4 standard deviations away from the centerline, then the probability of a Type I error would increase.

  decrease

  True False

+93