Sample Midterm 1

1. We would like to conduct a hypothesis test to examine whether there is evidence that the true mean amount spent on textbooks by a U of M student in one semester differs from \$400. A random sample of 50 students is selected and the mean amount they spent on textbooks for one semester is calculated to be \$430. Assume the population standard deviation is known to be \$165. What is the P-value for the appropriate hypothesis test?

   (A) 0.1970 (B) 0.1112 (C) 0.0630 (D) 0.0985 (E) 0.1260

2. We take a simple random sample of 16 adults and ask them how long they sleep on a typical night. The sample mean is calculated to be 7.2 hours. Suppose it is known that the number of hours adults sleep at night follows a normal distribution with standard deviation 1.8 hours. An 88% confidence interval for the true mean time adults sleep at night is:

   (A) (6.80, 7.60)
   (B) (6.30, 8.10)
   (C) (6.60, 7.80)
   (D) (6.70, 7.70)
   (E) (6.50, 7.90)

3. The Manitoba Department of Agriculture would like to estimate the average yield per acre of a new variety of corn for farms in southwestern Manitoba. It is desired that the final estimate be within five bushels per acre of the true mean yield. Due to cost restraints, a sample of no more than 65 one-acre plots of land can be obtained to conduct an experiment. The population standard deviation is known to be 17.33 bushels per acre. What is (approximately) the maximum confidence level that could be attained for a confidence interval that meets the Agriculture Department's specification?

   (A) 90% (B) 95% (C) 96% (D) 98% (E) 99%

4. A hypothesis test is conducted at significance level α to determine whether the mean of some population is greater than some value μ_0. Then $1 - \alpha$ is equal to:

(A) the probability of rejecting H_0 when H_0 is true.
(B) the probability of failing to reject H_0 when H_0 is true.
(C) the probability of rejecting H_0 when H_a is true.
(D) the probability of failing to reject H_0 when H_a is true.
(E) the probability that H_a is true.

5. A simple random sample of six male patients over the age of 65 is being used in a blood pressure study. The standard error of the mean blood pressure of these six men was calculated to be 7.8. What is the standard deviation of these six blood pressure measurements?

(A) 2.8 (B) 3.2 (C) 14.4 (D) 19.1 (E) 46.8

The next **two** questions (**6** and **7**) refer to the following:

The systems department of the Texaco Oil Company runs a large number of simulation programs on their mainframe computer. A manufacturer of new simulation software claims their program will run the simulation faster than the current mean of 30 minutes. The new program will be run 20 times. A hypothesis test of $H_0 : \mu = 30$ vs. $H_a : \mu < 30$ is to be conducted, and it is decided that H_0 will be rejected if $\bar{x} \leq 28.3$ minutes. Run times for the new program are known to follow a normal distribution with standard deviation 3.7 minutes.

6. The level of significance of the test is closest to:

(A) 0.01 (B) 0.02 (C) 0.03 (D) 0.04 (E) 0.05

7. What is the probability of making a Type II error if the true mean run time for the new program is actually 27 minutes?

(A) 0.0192 (B) 0.0244 (C) 0.0384 (D) 0.0475 (E) 0.0582

8. In which of the following situations is a Type I error more serious than a Type II error? Suppose you are deciding whether or not to:

(I) Jump from an airplane
H_0: Parachute will not open
H_a: Parachute will open

(II) Take a cheat sheet into an exam
H_0: Will not get caught
H_a: Will get caught

(III) Walk across the Red River in January
H_0: Ice will not break
H_a: Ice will break

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II and III

9. We take random samples of individuals from two normally distributed populations and record the value of some random varialbe X. Some summary statistics are shown below:

Population	Sample Size	Sample Mean	Sample Std. Dev.
1	7	29	4.0
2	14	25	9.2

We would like to contstruct a 95% confidence interval for the difference $\mu_1 - \mu_2$ in population means. What is the value of the standard error of $\bar{X}_1 - \bar{X}_2$?

(A) 2.24 (B) 1.86 (C) 3.27 (D) 2.89 (E) 3.45

The next **three** questions (**10**, **11** and **12**) refer to the following:

Coke and Pepsi are the two most popular brands of cola on the market. Do consumers prefer either one of the two brands of cola over the other? We conduct an experiment as follows: 20 volunteers participate in a blind taste test. Each volunteer tastes both Coke and Pepsi (in random order) and scores the taste of each cola on a scale from 0 to 100. Some information that may be helpful is shown in the table below:

Scores for Coke	Scores for Pepsi	Difference (Coke − Pepsi)
mean = 78	mean = 83	mean = −5
std. dev. = 27	std. dev. = 24	std. dev. = 13

10. Which of the following statements is/are **true**?

(I) The scores for Coke and Pepsi for each individual are independent.
(II) The scores for Coke and Pepsi for each individual are dependent.
(III) In order to conduct the matched pairs t test, we must assume that scores for Coke and scores for Pepsi both follow normal distributions.
(IV) In order to conduct the matched pairs t test, we must assume that the difference in scores (Coke − Pepsi) follow a normal distribution.

(A) I only
(B) I and III only
(C) I and IV only
(D) II and III only
(E) II and IV only

11. We will use the critical value method to conduct the test, with a 10% level of significance. Assuming the appropriate assumptions are satisfied, the rejection rule is to reject H_0 if:

(A) $|t| \geq 1.328$ (B) $t \geq 1.729$ (C) $|t| \geq 1.734$ (D) $t \geq 1.328$ (E) $|t| \geq 1.729$

12. Assuming the appropriate assumptions are satisfied, what is the value of the test statistic for the appropriate test of significance?

(A) −0.38 (B) −7.69 (C) −2.85 (D) −1.72 (E) −0.88

The next **two** questions (**13** and **14**) refer to the following:

Several workers in a large office building suspect that coffee vending machine A dispenses more coffee on average than vending machine B. To test this belief, several samples were taken from each machine. The amounts (in ounces) dispensed and some summary statistics are given below:

Machine	n	$\bar{x}$	s
A	12	11.74	0.56
B	8	11.18	0.79

13. Assuming fill volumes follow a normal distribution for both machines, the test statistic for the appropriate test of significance is:

(A) $$\frac{11.74 - 11.18}{\sqrt{0.46\left(\frac{1}{12} + \frac{1}{8}\right)}}$$

(B) $$\frac{11.74 - 11.18}{\sqrt{\frac{(0.56)^2}{12} + \frac{(0.79)^2}{8}}}$$

(C) $$\frac{11.74 - 11.18}{\sqrt{0.43\left(\frac{1}{12} + \frac{1}{8}\right)}}$$

(D) $$\frac{11.74 - 11.18}{\sqrt{\frac{(0.56)^2}{11} + \frac{(0.79)^2}{7}}}$$

(E) $$\frac{11.74 - 11.18}{\sqrt{0.68\left(\frac{1}{12} + \frac{1}{8}\right)}}$$

14. We would make a Type II error in this test if we concluded that:

(A) Machine A dispenses more on average than Machine B when in fact Machine B dispenses more on average than Machine A.

(B) there is no evidence that Machine A and B dispense the same amount on average when in fact Machine A does dispense more on average.

(C) Machine B dispenses more on average than Machine A when in fact Machine A dispenses more on average than Machine B.

(D) Machine A dispenses more on average than Machine B when in fact Machines A and B dispense the same amount on average.

(E) there is no evidence that Machine A dispenses more on average than Machine B when in fact Machine A dispenses more on average.

15. Two different alloys are being considered for making lead-free solder used in the wave soldering process for printed circuit boards. An important characteristic of solder is its melting point, which is known to follow a normal distribution. A study was conducted using a random sample of 15 pieces of solder made from an old alloy and 8 pieces of solder made from a new alloy. The temperature (in °C) at which each of the pieces melted was determined. We wish to test if the mean melting point of the new alloy is significantly higher than the old alloy. Some *JMP* output that may be helpful is shown below:

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Old	15	215.21	5.27	1.36	212.30	218.13
New	8	220.00	2.27	0.80	218.10	221.90

t Test

New-Old

Assuming equal variances

Difference	4.78667	t Ratio	
Std Err Dif	1.96756	DF	21
Upper CL Dif	8.87842	Prob > |t|	0.0240*
Lower CL Dif	0.69491	Prob > t	0.0120*
Confidence	0.95	Prob < t	0.9880

t Test

New-Old

Assuming unequal variances

Difference	4.78667	t Ratio	
Std Err Dif	1.57836	DF	20.47771
Upper CL Dif	8.07415	Prob > |t|	0.0065*
Lower CL Dif	1.49918	Prob > t	0.0032*
Confidence	0.95	Prob < t	0.9968

What is the value of the test statistic for the appropriate test of significance?

(A) 2.43 (B) 2.90 (C) 3.03 (D) 4.17 (E) 6.09

16. Random samples of contestants who have appeared on two popular game shows (*Wheel of Fortune* and *Jeopardy*) are selected. The Wheel of Fortune contestants in the sample won an average of \$5700 more than the Jeopardy contestants in the sample. A 95% confidence interval for the difference in the mean amount of money won by contestants on the two game shows is calculated to be (−1900, 13300). We would like to conduct a hypothesis test to determine whether the mean amounts won on the two game shows differ. Assume the appropriate normality assumptions are satisfied. We would:

(A) reject H_0 at the 5% level of significance since the value 0 is contained in the 95% confidence interval.

(B) fail to reject H_0 at the 10% level of significance since the value 0 is contained in the 95% confidence interval.

(C) fail to reject H_0 at the 5% level of significance since the value 5700 is contained in the 95% confidence interval.

(D) reject H_0 at the 10% level of significance since the value 5700 is contained in the 95% confidence interval.

(E) fail to reject H_0 at the 5% level of significance since the value 0 is contained in the 95% confidence interval.

The next **three** questions (**17** to **19**) refer to the following:

Battery life of MP3 players is of great concern to customers. A consumer group tested four brands of MP3 players to determine the battery life. Samples of players of each brand were fully charged and left to run on medium volume until the battery died. The following table displays the number of hours each of the batteries lasted:

Brand

	A	B	C	D
	24	26	18	27
	19	28	20	24
	22	24	21	22
		25		24
mean	21.67	25.75	19.67	24.25
std. dev.	2.52	1.71	1.53	2.06

We would like to conduct an analysis of variance to compare the performance of the four brands. Suppose that all necessary assumptions have been satisfied. The ANOVA table (with some values missing) is shown below:

Source of Variation	*df*	Sum of Squares	Mean Squares	F
Groups				
Error			3.88	
Total		113.71		

17. What is the alternative hypothesis for the appropriate test of significance?

(A) H_a: All population variances are different.

(B) H_a: At least one sample mean differs.

(C) H_a: All population means are different.

(D) H_a: At least one population variance differs.

(E) H_a: At least one population mean differs.

18. What is the P-value of the appropriate test of significance?

(A) less than 0.001
(B) between 0.01 and 0.025
(C) between 0.025 and 0.05
(D) between 0.05 and 0.10
(E) greater than 0.10

19. We would like to construct a 95% confidence interval for the true mean battery life for all Brand B MP3 players. The 95% confidence interval is:

(A) (23.85, 27.65)
(B) (23.17, 28.33)
(C) (23.03, 28.47)
(D) (22.51, 28.99)
(E) (22.04, 29.46)

The next **two** questions (**20** and **21**) refer to the following:

We conduct an experiment to compare the responses to six different treatments. Volunteers are randomly assigned to receive one of the six treatments. The response variable is measured for each individual and an analysis of variance F test is conducted to assess the equality of the means for the six treatments. Responses for each of the six treatments are known to follow normal distributions. Some summary statistics are shown below:

Treatment	Sample Size	Sample Mean	Sample Std. Dev.
1	3	17	8
2	5	14	7
3	2	21	11
4	4	20	6
5	3	18	9
6	4	12	10

20. Under the null hypothesis, we assume all population means are equal. What is the estimate of this common population mean?

(A) 15.99 (B) 16.43 (C) 16.78 (D) 17.00 (E) 17.22

21. What is the 5% critical value for the appropriate test of significance?

(A) 2.57 (B) 2.68 (C) 2.79 (D) 2.85 (E) 2.90

The next **two** questions (**22** and **23**) refer to the following:

We conduct an experiment to compare the responses to five different treatments. Volunteers are randomly assigned to receive one of the five treatments. Each treatment is assigned to the same number of individuals. The response variable is measured for each individual and an analysis of variance F test is conducted to assess the equality of the means for the five treatments. Responses for each of the five treatments are known to follow normal distributions with common standard deviation. The ANOVA table (with some values missing) is shown below:

Source of Variation	*df*	Sum of Squares	Mean Squares	F
Groups		74.52		
Error	60		5.78	
Total				

22. How many individuals received each of the five treatments?

(A) 11 (B) 12 (C) 13 (D) 14 (E) 15

23. One assumption required in conducting and ANOVA F test is that all population standard deviations are equal. The estimate of this common population standard deviation is:

(A) 2.40 (B) 4.32 (C) 5.78 (D) 18.63 (E) 33.41

24. In a game of poker, you are dealt five cards from a deck of 52 cards. What is the probability that you get a flush (five cards of the same suit)?

(A) 0.0005 (B) 0.0010 (C) 0.0020 (D) 0.0030 (E) 0.0040

25. A hockey player scores a goal in 43% of his games. His team wins 65% of their games. In 31% of the team's games, the player scores a goal and the team wins. What is the probability that the team wins if the player does not score a goal?

(A) 0.3595 (B) 0.4625 (C) 0.4985 (D) 0.5965 (E) 0.6345

26. Consider two independent events A and B. Suppose it is known that P(A) = 0.27 and P(A or B) = 0.5474. What is P(B)?

(A) 0.38 (B) 0.46 (C) 0.29 (D) 0.33 (E) 0.41

The next **three** questions (**27** to **29**) refer to the following:

Suppose we have the following facts about customers buying alcohol at the Liquor Mart:

- 45% buy wine (W).
- 37% buy beer (B).
- 20% buy wine **and** beer.
- 6% buy wine **and** vodka (V).
- 5% buy beer **and** vodka.
- 46% buy beer **or** vodka.
- 2% buy wine and beer and vodka.

27. If we randomly select a customer, what is the probability that he or she buys vodka?

(A) 0.14 (B) 0.15 (C) 0.16 (D) 0.17 (E) 0.18

28. If we randomly select a customer, what is the probability that he or she buys **only** wine?

(A) 0.17 (B) 0.18 (C) 0.19 (D) 0.20 (E) 0.21

29. If we know a customer buys wine, what is the probability that he or she also buys beer?

(A) 0.37 (B) 0.54 (C) 0.27 (D) 0.82 (E) 0.44

30. We roll two fair dice. Let X be the minimum of the two numbers rolled. The probability distribution of X is shown below:

x	1	2	3	4	5	6
$P(X = x)$	11/36	9/36	7/36	5/36	3/36	1/36

What is the expected value of X?

(A) 2.53 (B) 2.71 (C) 2.92 (D) 3.14 (E) 3.50

31. The time it takes a student to drive to university in the morning follows a normal distribution with mean 28 minutes and standard deviation 4 minutes. The time it takes the student to drive home from university in the afternoon follows a normal distribution with mean 25 minutes and standard deviation 3 minutes. Morning and afternoon commuting times are known to be independent. What is the probability that it takes the student longer to drive to university than to drive home?

(A) 0.5517 (B) 0.6664 (C) 0.7257 (D) 0.8707 (E) 0.9987

32. When an archer shoots an arrow, he hits the bullseye on the target 78% of the time. Whether he hits the bullseye on any shot is independent of any other shot. If he shoots ten arrows, what is the probability he hits the target at least 8 times?

(A) 0.2984 (B) 0.3185 (C) 0.4437 (D) 0.5689 (E) 0.6169

33. A random variable X follows a binomial distribution with parameters $n = 3$ and p. What must be the value of the parameter p if we know that $P(X = 2) = P(X = 3)$?

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{2}{3}$ (E) $\frac{3}{4}$

34. The number of customers entering a bank follows a Poisson distribution with parameter $\lambda = 2$ per minute. What is the probability that exactly 15 customers enter the bank in the first ten minutes after it opens?

(A) 0.0517 (B) 0.0623 (C) 0.0741 (D) 0.0859 (E) 0.0972

35. A random variable X follows a Poisson distribution with parameter λ. We are conducting a hypothesis test of H_0: $\lambda = 5$ vs. H_a: $\lambda < 5$. We decide to reject the null hypothesis if $X \leq 2$. What is the power of the test if $\lambda = 1$?

(A) 0.1912 (B) 0.3679 (C) 0.5518 (D) 0.7358 (E) 0.9197

Answer Key

1. A
2. E
3. D
4. B
5. D

6. B
7. E
8. A
9. D
10. E

11. E
12. D
13. C
14. E
15. C

16. E
17. E
18. B
19. A
20. B

21. E
22. C
23. A
24. C
25. D

26. A
27. A
28. E
29. E
30. A

31. C
32. E
33. E
34. A
35. E

Sample Midterm 2

1. Annual salaries of workers in a large union follow a normal distribution with standard deviation \$10,000. What sample size is required if we want to estimate the true mean salary to within \$2,000 with 93% confidence?

   (A) 82 (B) 85 (C) 88 (D) 94 (E) 97

2. A horticulturist wishes to estimate the true mean growth of seedlings in a large timber plot last year. A random sample of 20 seedlings is selected and the one-year growth for each of them is measured. The sampled seedlings have a mean growth of 5.6 cm and a standard deviation of 1.5 cm. One-year seedling growth is known to follow a normal distribution with standard deviation 2.0 cm. We wish to conduct a hypothesis test at the 10% level of significance to determine whether the true mean one-year seedling growth differs from 6.0 cm. The critical region for the test is:

   (A) $|z| > 1.645$
   (B) $t < -1.328$
   (C) $z < -1.282$
   (D) $|t| > 1.729$
   (E) $|z| > 1.282$

3. A random variable X follows a normal distribution with standard deviation $\sigma = 8$. We take a random sample of 25 individuals from the population and we calculate a confidence interval for μ to be **(36.7136, 43.2864)**. What is the confidence level of this interval?

   (A) 90% (B) 95% (C) 96% (D) 98% (E) 99%

4. A test of $\mathrm{H_0} : \mu = 100$ vs. $\mathrm{H_a} : \mu \neq 100$ is conducted for the mean μ of some population. We take a sample of ten individuals and calculate a sample mean of 104. A 98% confidence interval for μ is calculated to be (101, 107). Which of the following statements is **true**?

(A) We fail to reject $\mathrm{H_0}$ at a 4% level of significance, since 100 is not contained in the 98% confidence interval.

(B) We fail to reject $\mathrm{H_0}$ at a 2% level of significance, since 104 is contained within the 98% confidence interval.

(C) We reject $\mathrm{H_0}$ at the 1% level of significance, since 100 is not contained within the 98% confidence interval.

(D) We fail to reject $\mathrm{H_0}$ at the 4% level of significance, since 104 is contained within the 98% confidence interval.

(E) We reject $\mathrm{H_0}$ at a 2% level of significance, since 100 is not contained within the 98% confidence interval.

5. A statistician conducted a test of $\mathrm{H_0} : \mu = 1$ vs. $\mathrm{H_a} : \mu > 1$ for the mean μ of some population. Based on the gathered data, the statistician concluded that $\mathrm{H_0}$ could be rejected at the 1% level of significance. Using the same data, which of the following statements must be **true**?

(I) A test of $\mathrm{H_0} : \mu = 1$ vs. $\mathrm{H_a} : \mu > 1$ at the 10% level of significance would also lead to rejecting $\mathrm{H_0}$.

(II) A test of $\mathrm{H_0} : \mu = 0$ vs. $\mathrm{H_a} : \mu > 0$ at the 1% level of significance would also lead to rejecting $\mathrm{H_0}$.

(III) A test of $\mathrm{H_0} : \mu = 1$ vs. $\mathrm{H_a} : \mu \neq 1$ at the 1% level of significance would also lead to rejecting $\mathrm{H_0}$.

(A) I only

(B) I and II only

(C) I and III only

(D) II and III only

(E) I, II and III

6. We conduct a hypothesis test of $H_0 : \mu = 20$ vs. $H_a : \mu \neq 20$ for the mean of some population at the 5% level of significance. Using a sample of size 30, we determine that H_0 should be rejected if $\bar{x} < 17$ or $\bar{x} > 23$. The power of the test against the alternative $H_a : \mu = 25$ is calculated to be 0.8621.

   Which of the following statements is **true**?

   (A) If we had instead used a sample size of 50, the probability of a Type II error would increase.

   (B) If we used a 5% level of significance and a sample of size 50, the power of the test would decrease.

   (C) The power of the test against the alternative $H_a : \mu = 15$ is 0.1379.

   (D) If we had instead used a 1% level of significance, the probability of a Type II error would decrease.

   (E) If we had instead used a 10% level of significance, the power of the test would increase.

7. The Winnipeg Transit Commission claims that the average time taken by the Number 60 bus to travel from the University of Manitoba to downtown is 27 minutes. A student who takes this route often believes that the true mean time is greater than 27 minutes. The student records the time for a sample of five trips. These trips had a mean time of 30 minutes and a standard deviation of 4 minutes. Suppose it is known that trip times have a normal distribution.

   The P-value for the appropriate test of significance to test the student's suspicion is:

   (A) between 0.01 and 0.02.

   (B) between 0.02 and 0.025.

   (C) between 0.025 and 0.05.

   (D) between 0.05 and 0.10.

   (E) between 0.10 and 0.15.

8. Bottles of a certain brand of apple juice are supposed to contain 300 ml of juice. There is some variation from bottle to bottle because of imprecisions in the filling machinery. A consumer advocate inspector selects a random sample of 36 bottles and tests the hypotheses $\mathrm{H_0} : \mu = 300$ vs. $\mathrm{H_a} : \mu < 300$ at the 10% level of significance. Fill volumes are known to follow a normal distribution with standard deviation 3 ml. What is the power of the test if the true mean fill volume is actually 298 ml?

(A) 0.9925 (B) 0.9943 (C) 0.9957 (D) 0.9967 (E) 0.9977

9. In a study of iron deficiency among infants, random samples of infants following different feeding programs were compared. One group contained breast-fed infants, while the children in another group were fed a standard baby formula without any iron supplements. Summary results on blood hemoglobin levels at 12 months of age are shown below.

Group	Sample Size	Sample Mean	Sample Std. Dev.
Breast-fed	7	10.1	1.3
Formula-fed	11	9.4	1.8

A 98% confidence interval for the difference in true mean hemoglobin levels for the two populations of infants is:

(A) 0.7 ± 2.00 (B) 0.7 ± 2.04 (C) 0.7 ± 2.08 (D) 0.7 ± 2.12 (E) 0.7 ± 2.15

The next **two** questions (**10** and **11**) refer to the following:

Eight males and eight females volunteered to be part of an experiment. All 16 people were Caucasian and between the ages of 18 and 24. Each of the eight male participants was randomly assigned a night club, and each of the eight females was randomly assigned to one of these same eight night clubs. One Friday night, all 16 people went out to the bar. Each person then went up to the bar to order a drink (within 5 minutes of one another, with the order randomly determined.) The time (in seconds) until each customer was served was recorded. The table below contains some information that may be helpful:

Females	Males	Difference (d = Female − Male)
mean = 48	mean = 62	mean = −14
std. dev. = 18	std. dev. = 23	std. dev. = 15

The question of interest in this experiment is whether females receive faster service at bars on average than males. Assume the appropriate normality assumptions are satisfied.

10. What are the hypotheses for the appropriate test of significance?

(A) $H_0 : \mu_d = 0$ vs. $H_a : \mu_d < 0$

(B) $H_0 : \bar{X}_d = 0$ vs. $H_a : \bar{X}_d > 0$

(C) $H_0 : \mu_F = \mu_M$ vs. $H_a : \mu_F > \mu_M$

(D) $H_0 : \bar{X}_d = 0$ vs. $H_a : \bar{X}_d < 0$

(E) $H_0 : \mu_d = 0$ vs. $H_a : \mu_d > 0$

11. What is the P-value for the appropriate test of significance?

(A) between 0.005 and 0.01

(B) between 0.01 and 0.02

(C) between 0.02 and 0.025

(D) between 0.025 and 0.05

(E) between 0.05 and 0.10

The next **two** questions (**12** and **13**) refer to the following:

The following data represent the fat content found in samples of two popular brands of ice cream:

Brand	Fat					sample mean	sample variance
A	6.3	5.1	6.8	6.9	7.4	6.50	0.77
B	6.3	5.7	5.9	6.4	5.1	5.88	0.27

12. We would like to conduct a hypothesis test to determine whether the true mean fat content differs for the two brands of ice cream. Assuming fat content follows a normal distribution for both brands, we should use:

(A) a matched pairs t test with 4 degrees of freedom.

(B) a pooled two-sample t test with 8 degrees of freedom.

(C) a conservative two-sample t test with 7 degrees of freedom.

(D) a pooled two-sample t test with 9 degrees of freedom.

(E) a conservative two-sample t test with 8 degrees of freedom.

13. The P-value for the appropriate test of significance is calculated to be 0.21. We interpret this value to mean:

(A) If the true mean fat content was equal for the two brands, the probability of incorrectly concluding that the means differ would be 0.21.

(B) The probability that the true mean fat content is equal for the two brands is 0.21.

(C) The probability that the true mean fat content differs for the two brands is 0.21.

(D) If the true mean fat content were equal for the two brands, the probaility of observing a difference in sample means at least as extreme as 0.62 would be 0.21.

(E) If the true mean fat content differed for the two brands, the probaility of observing a difference in sample means at least as extreme as 0.62 would be 0.21.

14. The following table displays the serum calcium measurements for samples of two breeds of cows. Serum calcium levels are known to follow a normal distribution for both breeds.

Chester White	116	112	82	63	117	69
Hampshire	62	79	80	85	60	71

We would like to conduct a hypothesis test to determine whether the true mean serum calcium level differs for the two breeds. Some *JMP* output that may be helpful is shown below:

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Hampshire	6	72.8333	10.2258	4.175	62.102	83.56
Chester White	6	93.1667	24.7501	10.104	67.193	119.14

t Test

Chester White-Hampshire
Assuming equal variances

Difference	20.333	t Ratio	
Std Err Dif	10.933	DF	10
Upper CL Dif	44.693	Prob > |t|	
Lower CL Dif	-4.026	Prob > t	
Confidence	0.95	Prob < t	

t Test

Chester White-Hampshire
Assuming unequal variances

Difference	20.333	t Ratio	
Std Err Dif	10.933	DF	6.658692
Upper CL Dif	46.456	Prob > |t|	
Lower CL Dif	-5.789	Prob > t	
Confidence	0.95	Prob < t	

The P-value for the appropriate test of significance is:

(A) between 0.01 and 0.02

(B) between 0.025 and 0.05

(C) between 0.05 and 0.10

(D) between 0.10 and 0.20

(E) between 0.20 and 0.30

15. A student would like to conduct a hypothesis test to determine whether the true mean exam score for students in Dr. E. Zee's class is greater than that for student's in Dr. D. Ficult's class. Exam scores are known to follow a normal distribution for each of the two classes. The student selects random samples of students from each professor's class. Some summary statistics for their exam scores are shown below:

Group	Sample Size	Sample Mean	Sample Std. Dev.
Dr. E. Zee	14	74	6
Dr. D. Ficult	10	53	14

What is the value of the test statistic for the appropriate test of significance?

(A) 3.77 (B) 4.46 (C) 5.04 (D) 6.62 (E) 7.13

16. In which of the following situations are the matched pairs t procedures appropriate?

(I) We would like to compare the mean number of mosquitoes caught in two different types of mosquito traps. A sample of 20 locations is selected in Winnipeg, and one of each type of trap is placed at each location.

(II) We would like to compare the mean commuting times from home to work for workers in Winnipeg and Toronto. A sample of 30 workers in each city is selected.

(III) We would like to compare the mean summer temperatures in Winnipeg and Brandon (Manitoba's second largest city, 200 km west of Winnipeg). On a sample of 25 days, we measure the temperature in each city.

(A) I only

(B) II only

(C) III only

(D) I and II only

(E) I and III only

17. A horticulturist is investigating the phosphorous content of tree leaves from three different varieties of apple trees. Phosphorous content is known to follow a normal distribution for each of the three varieties. Random samples of four leaves from each of the three varieties are analyzed for phosphorous content. Population variances are known to be equal for all three varieties. We would like to test the hypothesis of equal population means for the three varieties at the 10% level of significance. The critical value for the appropriate hypothesis test is:

(A) 1.36 (B) 2.81 (C) 3.01 (D) 5.22 (E) 9.38

18. Which of the following statements about the analysis of variance F test is **false**?

(A) The test statistic compares the variability between sample means to the variability within individual samples.

(B) The test is "many-sided", as there are many different inequalities in means that will lead us to reject the null hypothesis.

(C) The test gives the same results we would observe if we compared each pair of means separately using pooled two-sample t tests.

(D) The ANOVA procedures are quite robust against non-normality.

(E) The ANOVA procedures are not very sensitive to the case of unequal population variances.

19. We take simple random samples from two normally distributed populations and measure the value of some variable X. We conduct a pooled two-sample t test to determine whether there is evidence that the population means differ. We calculate a test statistic of $t = 2.47$ and a P-value of 0.04. Suppose we had instead conducted the test using an analysis of variance. What would be the value of the test statistic and the P-value?

(A) 6.10 and 0.04

(B) 2.47 and 0.0016

(C) 1.57 and 0.04

(D) 6.10 and 0.0016

(E) 2.47 and 0.20

20. We are conducting an analysis of variance to compare the means of four populations. In conducting this test, we will commit a Type I error if we:

(A) fail to conclude that all four means differ when in fact this is the case.

(B) conclude that at least one of the means differs when in fact they are all equal.

(C) conclude that all four means differ when in fact they are all equal.

(D) fail to conclude that at least one mean differs when in fact this is the case.

(E) conclude that one mean differs when in fact all four means differ.

The next **three** questions (**21** to **23**) refer to the following:

A medical researcher wants to compare three different techniques designed to lower blood pressure in patients with hypertension. Five subjects are assigned to each of the three groups. The first group exercises, the second group meditates and the thrid group takes medication. After five weeks, the reduction in each person's blood pressure is recorded. The researcher wants to determine if there is any difference in the effectiveness of the three techniques. The ANOVA table (with some values missing) is shown below:

Source of Variation	*df*	Sum of Squares	Mean Squares	F
Groups		102		
Error				
Total		282		

21. What is the P-value of the test?

(A) less than 0.001
(B) between 0.001 and 0.01
(C) between 0.01 and 0.025
(D) between 0.025 and 0.05
(E) between 0.05 and 0.10

22. What is the estimate of the common variance for the three treatments?

(A) 4 (B) 7 (C) 13 (D) 15 (E) 51

23. We would like to construct a 95% confidence interval for the difference in the mean response for the exercise and medication groups. The margin of error for the appropriate confidence interval is:

(A) 5.25 (B) 5.34 (C) 5.65 (D) 9.53 (E) 12.49

The next **three** questions (**24** to **26**) refer to the following:

A coffee store owner compiles the following information:

- A customer gets a coffee (C) in 35% of the store's transactions.
- A customer gets a donut (D) in 40% of the store's transactions.
- In 45% of the store's transactions, a customer gets a coffee or a muffin (M).
- In 61% of the store's transactions, a customer gets a donut or a coffee.
- In 10% of the store's transactions, a customer gets a donut and a muffin.
- In 26% of the store's transactions, a customer gets a coffee and a muffin.
- In 4% of the store's transactions, a customer gets a donut, a coffee and a muffin.

24. What is the probability that a randomly selected customer gets a muffin?

(A) 0.29 (B) 0.36 (C) 0.41 (D) 0.44 (E) 0.52

25. What is the probability that a customer who buys a coffee also buys a donut and a muffin?

(A) 0.04 (B) 0.08 (C) 0.11 (D) 0.14 (E) 0.27

26. Which of the following statements is **true**?

(A) The events C and D are independent.
(B) The events C and D are mutually exclusive.
(C) The events C and M are independent.
(D) The events C and M are mutually exclusive.
(E) The events D and M are independent.

27. A tourist is flying home from Cairo, Egypt to Winnipeg. She must change planes in Berlin, London and Toronto. Her suitcase is placed on her plane flying from Cairo to Berlin. Suppose we have the following facts:

- 5% of all suitcases are lost at the airport in Berlin.
- 8% of all suitcases are lost at the airport in London.
- 7% of all suitcases are lost at the airport in Toronto.

What is the probability that the tourist's suitcase arrives safely in Winnipeg?

(A) 0.80 (B) 0.81 (C) 0.82 (D) 0.83 (E) 0.84

The next **two** questions (**28** and **29**) refer to the following:

The following six games are being played in the National Hockey League one night. The values in parentheses are the probabilities of each team winning their respective game:

Game 1:	Tampa Bay Lightning (0.47)	vs.	New York Rangers (0.53)
Game 2:	Carolina Hurricanes (0.58)	vs.	New York Islanders (0.42)
Game 3:	Winnipeg Jets (0.27)	vs.	Washington Capitals (0.73)
Game 4:	Chicago Blackhawks (0.60)	vs.	Dallas Stars (0.40)
Game 5:	Colorado Avalanche (0.31)	vs.	Detroit Red Wings (0.69)
Game 6:	San Jose Sharks (0.46)	vs.	Vancouver Canucks (0.54)

28. The outcome of interest is the set of winners for each of the six games. How many outcomes are contained in the sample space?

(A) 12 (B) 32 (C) 36 (D) 64 (E) 128

29. What is the probability that Winnipeg wins **or** that **both** New York teams win?

(A) 0.4325 (B) 0.4522 (C) 0.4724 (D) 0.4926 (E) 0.5123

30. The time it takes a student to drive to university in the morning follows a normal distribution with mean 28 minutes and standard deviation 4 minutes. The time it takes the student to drive home from university in the afternoon follows a normal distribution with mean 25 minutes and standard deviation 3 minutes. Morning and afternoon commuting times are known to be independent. What is the probability that the student's total travel time to and from school one day exceeds one hour?

(A) 0.0040 (B) 0.0808 (C) 0.1587 (D) 0.2296 (E) 0.3897

31. It is known that 17% of individuals in some population have blue eyes. If we take a random sample of 12 individuals from this population, what is the probability that four of them have blue eyes?

(A) 0.053 (B) 0.063 (C) 0.073 (D) 0.083 (E) 0.093

The next **two** questions (**32** and **33**) refer to the following:

A small deck of cards contains five red cards, four blue cards and one green card. We will shuffle the deck and select three cards without replacement. Let X be the number of blue cards that are selected. The probability distribution of X is shown below:

x	0	1	2	3
$P(X = x)$	0.167	0.500	0.300	0.033

32. What is the variance of X?

(A) 0.56 (B) 0.61 (C) 0.68 (D) 0.72 (E) 0.85

33. What would be the variance of X if we had instead selected the three cards **with replacement**?

(A) 0.56 (B) 0.61 (C) 0.68 (D) 0.72 (E) 0.85

34. The number of goals scored in a hockey game follows a Poisson distribution with a mean of 0.1 per minute. What is the probability that at least two goals are scored in a 60-minute game?

(A) 0.9554 (B) 0.9723 (C) 0.9826 (D) 0.9899 (E) 0.9937

35. A random variable X follows a Poisson distribution with parameter λ. If we know that $P(X = 1) = P(X = 3)$, then what is the value of λ?

(A) $\sqrt{2}$ (B) $\sqrt{3}$ (C) $\sqrt{5}$ (D) $\sqrt{6}$ (E) $\sqrt{8}$

Answer Key

1. A
2. A
3. C
4. E
5. B

6. E
7. D
8. D
9. B
10. A

11. B
12. B
13. D
14. D
15. B

16. E
17. C
18. C
19. A
20. B

21. E
22. D
23. B
24. B
25. C

26. A
27. B
28. D
29. A
30. B

31. E
32. A
33. D
34. C
35. D