QREVIEW - QUALITY ENGINEERING REVIEW

Study Questions and Answers

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INTRODUCTION

The following questions include key concepts which are representative of the CQE examination. Each question should be worked out as completely as possible before looking at the answer. Some questions have been taken from previously published ASQ CQE exams.

BASIC QUALITY CONCEPTS

1. Certification of a company to the ISO 9002 standard does not include which of the following requirements?

    a) Servicing
    b) Design control
    c) Contract review
    d) Internal quality audits

2. A quality control program is considered to be

    a) a collection of quality control procedures and guidelines.
    b) a step by step list of all quality control check points.
    c) a summary of company quality control policies.
    d) a system of activities to provide quality of products and services.

3. The "quality function" of a company is best described as

    a) the degree to which the company product conforms to a design or specification.
    b) that collection of activities through which "fitness for use" is achieved.
    c) the degree to which a class or category of product possesses satisfaction for people generally.
    d) All of the above.

4. In preparing a product quality policy for your company, you should do all of the following except

    a) specify the means by which quality performance is measured.
    b) develop criteria for identifying risk situations and specify whose approval is required when there are known risks.
    c) include procedural matters and functional responsibilities.
    d) state quality goals.

5. What natural phenomenon created the necessity to control product and process quality?

a) Gravity
b) Variation
c) Human Error
d) Management

6. The three basic elements of a quality system are

a) Quality Management, Purchasing and Document Control
b) Quality Management, Quality Control and Quality Assurance
c) SPC, Inspection and Quality Assurance
d) Quality Control, Quality Costs and Control Charts

7. What are the two basic categories of quality?

a) Design and Conformance Quality
b) Good and Bad Quality
c) Defective and Non-Defective Quality
d) Attribute and Variable Quality

8. The Law of Large Numbers states that

a) individual occurrences are predictable and group occurrences are unpredictable.
b) group data always follows a normal pattern.
c) individual occurrences are unpredictable and group occurrences are predictable.
d) the standard deviation of group data will always be greater than ten.

9. Statistical quality control is best described as

a) keeping product characteristics within certain bounds.
b) calculating the mean and standard deviation.
c) the study of the characteristics of a product or process, with the help of numbers, to make them behave the way we want them to behave.
d) the implementation of ISO 9000.

10. Which of the following is the most important element in Statistical Quality Control?

a) The Feedback Loop
b) Make Operation
c) Inspection
d) Quality of Incoming Material

11. When measurements are accurate and precise,

a) the data are distributed randomly throughout the entire range.
b) the data are clustered closely around the central value.

    c) minimum variation will exist.
    d) the data are normally distributed.

12. All of the following are included in a quality system except

    a) document control.
    b) corrective action.
    c) management responsibility.
    d) employee salaries.

13. Which of the following best describes a statistical distribution?

    a) A model that shows how data are distributed over a range of measurements.
    b) An Analysis of Variance table.
    c) A sampling plan.
    d) A graph that contains data plotted on a normal curve.

14. Which of the following are two types of data used in statistical quality control?

    a) Design and Conformance Data
    b) Precise and Accurate Data
    c) Variables and Attributes Data
    d) Mean and Variance Data

15. The primary reason for evaluating and maintaining surveillance over a supplier's quality program is to

    a) perform product inspection at source.
    b) eliminate incoming inspection cost.
    c) motivate suppliers to improve quality.
    d) make sure the supplier's quality program is functioning effectively.

16. Which one of the following are ISO 9001 requirements?

    a) Process Flow Chart
    b) Quality Manual
    c) Operations Manual
    d) TQM Program

17. Which of the following does not generate product-quality characteristics?

    a) Designer
    b) Inspector

      c) Machinist
      d) Equipment engineer

18. Incoming material inspection is based most directly on

      a) design requirements.
      b) purchase order requirements.
      c) manufacturing requirements.
      d) customer use of the end product.

19. The acronym ISO means

      a) International Standards Organization.
      b) Internal Service Organization.
      c) equal.
      d) third party auditing organization.

20. Products should be subjected to tests which are designed to

      a) demonstrate advertised performance.
      b) demonstrate basic function at minimum testing cost.
      c) approximate the conditions to be experienced in customer's application.
      d) assure that specifications are met under laboratory conditions.

21. The advantage of a written procedure is

      a) it provides flexibility in dealing with problems.
      b) unusual conditions are handled better.
      c) it is a perpetual coordination device.
      d) coordination with other departments is not required.

22. In spite of the Quality Engineer's best efforts, situations may develop in which his
    decision is overruled. The most appropriate action would be to

      a) resign from the position based upon convictions.
      b) report findings to an outside source such as a regulatory agency or the press.
      c) document findings, report them to superiors and move on the next assignment.
      d) discuss findings with co-workers in order to gain support, thereby forcing action.

23. If a test data does not support a Quality Engineer's expectations, the best thing to do is

      a) adjust the data to support expectations if it is only slightly off.
      b) draw the expected conclusion omitting the data not supporting it.

      c) re-evaluate the expectations of the test based upon the data.

      d) report the data and expected conclusion with no reference to one another.

24. In case of conflict between contract specifications and shop practice,

      a) arbitration is necessary.

      b) the customer is always right.

      c) good judgment should be exercised.

      d) contract specifications normally apply.

25. A quality audit program should begin with

      a) a study of the quality documentation system.

      b) an evaluation of the work being performed.

      c) a report listing findings, the action taken and recommendations.

      d) a charter of policy, objectives and procedures.

26. Auditors should report to someone who is independent from

      a) the company being audited.

      b) management.

      c) the function being audited.

      d) None of the above.

27. Analysis of data on all product returns is important because

      a) failure rates change with length of product usage.

      b) changes in design and in customer use are often well reflected.

      c) immediate feedback and analysis of product performance becomes available.

      d) All of the above.

28. All of the following are considerations when a total quality management (TQM) program is implemented except

      a) the use of statistical tools and techniques.

      b) a program of continuous quality improvement.

      c) the manager responsible for product quality.

      d) total involvement from management to production associates.

29. According to Juran, all of the following are widespread errors in perception that have led many managers astray except

      a) the work force is mainly responsible for the company's quality problems.

      b) workers could do quality work but they lack the motivation to do so.

    c) quality will get top priority if upper management so decrees.
    d) return on investment is everything.

30. An essential technique in making training programs effective is to

    a) set group goals.
    b) have training classes which teach skills and knowledge required.
    c) feed back to the employee meaningful measures of his performance.
    d) post results of performance before and after the training program.

31. An engineer has the job of providing a written plan of quality related tasks to his manager, including a detailed timeline, for the following year. Which of the following tools should be used?

    a) Histogram
    b) Flow Chart
    c) Gantt Chart
    d) Frequency Distribution

BASIC PROBABILITY

32. The time it takes to answer a technical support line has a continuous uniform distribution over an interval from 17 to 20 minutes. All of the following are true except

   a) $P(x = 18.5) = 1/2$
   b) $P(x \leq 20) = 1$
   c) $P(17 \leq x \leq 18) = 1/3$
   d) $P(x \geq 17) = 1$

33. For two events, A and B, which one of the following is a true probability statement?

   a) $P(A \text{ or } B) = P(A) + P(B)$ if A and B are independent
   b) $P(A \text{ or } B) = P(A) + P(B)$ if A and B are mutually exclusive
   c) $P(A \text{ and } B) = P(A) \times P(B)$ if A and B are mutually exclusive
   d) $P(A \text{ or } B) = P(A) \times P(B)$ if A and B are independent

34. What is the probability of getting a head or a tail in 1 toss of a coin?

   a) 1/16
   b) 1/4
   c) 1/2
   d) 1

35. What is the probability of getting a head and a tail in 2 tosses of a fair coin? And, what is the probability of getting a head and a tail, in that order, in 2 tosses of a fair coin?

   a) 1/2, 1/2
   b) 1/4, 1/4
   c) 1/2, 1/4
   d) 1/4, 1/2

36. A coin is tossed 10 times. The first 9 tosses come up heads. What is the probability that the 10th toss will come up heads?

   a) 1/512
   b) 1/256
   c) 1/32
   d) 1/2

37. What is the probability of obtaining exactly 2 heads in 4 tosses of a fair coin?

   a) 1/4
   b) 3/8
   c) 1/2
   d) 1/6

38. What is the probability of getting a 3 when rolling a single die? (A die is one of a pair of dice)

    a) 1/5
    b) 3/5
    c) 1/6
    d) 1/3

39. What is the probability of getting an odd number when rolling a pair of dice? (Spots on the two dice sum to odd number)

    a) 1/4
    b) 1/2
    c) 1/3
    d) 3/10

40. What is the probability of obtaining a sum of 7 when rolling a pair of dice?

    a) 1/5
    b) 3/5
    c) 1/6
    d) 1/3

Use the following information to answer questions 41, 42 and 43. The probability is 1/2 that Bob will pass the CQE exam, 1/3 that Amy will pass and 3/4 that Jon will pass.

41. What is the probability that Bob, Amy and Jon will all pass the exam?

    a) 1/8
    b) 4/9
    c) 4/11
    d) 1/3

42. What is the probability that neither Bob, Amy nor Jon will pass the exam?

    a) 1/9
    b) 7/8
    c) 1/12
    d) 2/3

43. What is the probability that only one of the three will pass the exam?

    a) 1/4
    b) 1/3
    c) 3/4
    d) 3/8

44. Four people shoot at a target and the probability that each will hit the target is 1/2 (50%). What is the probability that the target will be hit?

    a) 1/16
    b) 15/16
    c) 1/2
    d) 1/4

45. A committee of 5 people is chosen at random from a room that contains 4 men and 6 women. What is the probability that the committee is composed of 2 men and 3 women?

    a) 1/2
    b) 10/21
    c) 5/21
    d) 1/3

46. A vendor is trying to sell you a box of 50 fuses that contains exactly 5 defective fuses. You select 2 fuses from the box for testing. If both are good you will buy the entire box. If one or both are defective, you will not buy the box. What is the probability that you will buy the box?

    a) .7533
    b) .8082
    c) .9769
    d) .8531

47. What is the probability of winning the Super Lotto? (Winning = getting all 6 numbers out of 47)

    a) 1/10,737,573
    b) 1/7,731,052,560
    c) 1/3,457,296
    d) 1/12,966,821

48. A box contains 12 connectors, 9 good and 3 defective. What is the probability of obtaining exactly 2 good and 1 defective connector in drawing 3 parts from the box without replacement?

    a) .4219
    b) .4909
    c) .5022
    d) .6915

49. A box contains 12 connectors, 9 good ones and 3 defective ones. What is the probability of obtaining exactly 2 good and 1 defective connector in drawing 3 parts from the box with replacement?

   a) .4219
   b) .4909
   c) .5022
   d) .6915

50. You have been asked to sample a lot of 300 units from a vendor whose past quality has been about 2% defective. A sample of 40 pieces is drawn from the lot and you have been told to reject the lot if you find two or more parts defective. What is the probability of rejecting the lot?

   a) 0.953
   b) 0.809
   c) 0.191
   d) 0.047

Use the following information to answer questions 51 and 52. A company produces capacitors by a process that normally yields 5% defective product. A sample of 4 capacitors is selected.

51. What is the probability that all 4 capacitors are good?

   a) .9790
   b) .9213
   c) .8617
   d) .8145

52. What is the probability that all 4 capacitors are defective?

   a) .1383
   b) .1855
   c) .0000258
   d) .00000625

Use the following information to answer questions 53, 54, 55 and 56. A company makes ball bearings that are found to be 10% defective in the long run. A sample of 10 bearings is selected.

53. What is the probability that 0 bearings will be defective?

   a) .3487
   b) .3874
   c) .4126
   d) .1110

54. What is the probability of obtaining exactly 1 defective bearing?

    a) .3487
    b) .3874
    c) .4126
    d) .2574

55. What is the probability of obtaining exactly 3 defective bearings?

    a) .0574
    b) .4448
    c) .7361
    d) .1562

56. What is the probability of obtaining more than 1 defective bearing?

    a) .3874
    b) .4126
    c) .2639
    d) .2285

57. How many defective connectors would be expected in a sample of 200 parts if the process averages 2% defective?

    a) 1
    b) 2
    c) 4
    d) 7

58. What is the probability of obtaining exactly 2 defective connectors in a sample of 6 parts if the process averages 2% defective?

    a) .0135
    b) .0055
    c) .0009
    d) .0001

59. All of the following are probabilistic events except

    a) the number rolled in a game of dice.
    b) the number of defects in a random sample.
    c) the acceleration of an apple when it drops from a tree.
    d) the number of games played in the world series.

Use the following information to answer problems 60, 61 and 62. A company produces integrated circuits (chips) by a process that normally yields 2000 ppm defective product for electrical test requirements (ppm = defective parts per million). A sample of 5 chips is selected and tested.

60. What is the probability that all 5 chips are good?

   a) .9900
   b) .9603
   c) .9213
   d) .8563

61. What is the probability that 1 or more chips are defective?

   a) .0051
   b) .0009
   c) .0269
   d) .0100

62. What is the probability that more than 1 chip is defective?

   a) .01931
   b) .00510
   c) .00008
   d) .01000

Use the following information to answer problems 63, 64 and 65. A capability study was made to determine the defective rate of 28AZ transistors. The study showed the rate to be 5000 ppm. Ten of the transistors were shipped to a customer.

63. What is the probability that the shipment contains no defective transistors?

   a) .9511
   b) .9066
   c) .8512
   d) .9213

64. What is the probability that the shipment contains exactly 1 defective transistor?

   a) .0001
   b) .0478
   c) .1048
   d) .1165

65. What is the probability that the shipment contains 2 or more defective transistors?

    a) .0001
    b) .0478
    c) .0237
    d) .0011

Use the following information to answer problems 66, 67 and 68. A circuit board operation yields 2 defects per board on the average. A sample of 1 board is selected at random.

66. What is the probability of finding exactly 2 defects on the selected board?

    a) .3522
    b) .2706
    c) .1550
    d) .0295

67. What is the probability of finding less than 2 defects on the selected board?

    a) .4060
    b) .6352
    c) .3522
    d) .3849

68. What is the probability of finding more than 2 defects on the selected board?

    a) .4060
    b) .2706
    c) .3522
    d) .3235

Use the following information to answer problems 69, 70 and 71. In manufacturing material for automobile seats it was found that each 100-foot roll contained, on average, 2 defects (flaws). A sample of 1 roll is selected at random from the process.

69. What is the probability that the selected roll contains 0 defects?

    a) .1353
    b) .2707
    c) .8647
    d) .7293

70. What is the probability that the selected roll contains exactly 1 defect?

    a) .1353
    b) .7293
    c) .8647
    d) .2706

71. What is the probability that the selected roll contains more than 1 defect?

    a) .3233
    b) .5941
    c) .7293
    d) .8647

Use the following information to answer problems 72 and 73. A firm that makes T-shirt decals has determined that their process yields, on average, 3 defects per day. Fifty decals are inspected each day.

72. What is the probability of finding exactly 2 defective decals in any given day? (Assume one defect per defective decal.)

    a) .7361
    b) .1494
    c) .2240
    d) .0746

73. What is the probability of buying a decal that contains more than 1 defect?

    a) .0005
    b) .0042
    c) .0001
    d) .0017

74. A parts dealer buys parts from a warehouse. Parts are made by either Company A or Company B but are not identified as to which company produces them. One company produces all parts in one shipment or lot. On the average, we know:

                    Company A produces 2.5% defective parts.
                    Company B produces 5.0% defective parts.

    The warehouse states that 70% of parts will come from Company A and 30% from Company B. If the dealer selects 4 parts at random from a lot and finds 1 defective part, what is the probability that the lot was produced by Company A?

    a) .4422
    b) .5580
    c) .6915
    d) .3085

STATISTICS

75. What is the expected value of the random variable x for the following data?

x	f(x)
12	0.2
10	0.5
14	0.1
20	0.2

    a) 13.6
    b) 14.0
    c) 12.8
    d) 14.5

76. In the standard normal table, what value of z has 5% of the area in the tail beyond it?

    a) 1.960
    b) 1.645
    c) 2.576
    d) 1.282

77. Which distribution should be used to determine a confidence interval when σ is not known and the sample size is 10?

    a) z
    b) t
    c) F
    d) χ^2

78. Which of the following methods should be used to test 6 population means for statistical significance?

    a) Chi Square Test
    b) Analysis of Variance
    c) F Test
    d) Duncan's Multiple Range Test

79. A sample size of 120 is taken from a process and is represented graphically on a histogram. What is the appropriate number of histogram cells to use?

    a) 1 - 8
    b) 9 - 20
    c) 21 - 35
    d) 120

80. Which of the following conditions makes it possible for a process to produce a large

obtained:

Sample Number	Length (inches)
1	3.1
2	3.1
3	3.2
4	3.7
5	3.6
6	3.7
7	3.1

85. What is the mean length of the rivets?

   a) 3.20 inches
   b) 3.36 inches
   c) 4.00 inches
   d) 3.65 inches

86. What is the standard deviation of the length of the rivets (estimate of population standard deviation)?

   a) 0.27 inches
   b) 2.16 inches
   c) 0.29 inches
   d) 2.00 inches

Note: In the following 4 problems, the sample sizes are less than 30 and the t statistics should be used to solve the problems. Analyses of this type usually involve sample sizes of 30 or greater. Handle the problems just as if the sample sizes were greater than 30 and use the z statistics.

87. What percentage of rivets have lengths less than 2.80 inches?

   a) 2.69%
   b) 5.00%
   c) 1.22%
   d) 3.23%

88. What percentage of rivets have lengths greater than 3.65 inches?

   a) 17.1%

b) 14.2%
c) 15.9%
d) 7.10%

89. What percentage of rivets have lengths between 3.1 inches and 3.9 inches?

a) 89.7%
b) 78.4%
c) 52.5%
d) 99.7%

90. In the shipment of 1000 rivets, how many good parts will we find if a good part is defined as having a minimum of 3 inches and a maximum of 4 inches?

a) 999
b) 967
c) 912
d) 878

The following information is used to answer problems 91 - 95. Data are taken from a manufacturing process that produces optical glass. The sample size is 5 parts and the characteristic measured is the diameter of the plates.

Sample Number	Diameter (mm)
1	30
2	31
3	29
4	33
5	34

91. What is the mean diameter of the optical glass?

a) 31.4 mm
b) 29.0 mm
c) 31.0 mm
d) 34.0 mm

92. What is the standard deviation of the population?

a) 1.00 mm
b) 2.07 mm

c) 2.22 mm
d) 1.22 mm

93. The specifications for the glass plates are 30.5 ± 2 mm. What percentage of parts made by this company will not meet specifications?

    a) 32.5%
    b) 5.00%
    c) 35.0%
    d) 37.9%

94. What percentage of parts will be less than 29.5 mm?

    a) 17.9%
    b) 7.21%
    c) 15.9%
    d) 24.3%

95. What percentage of parts will be greater than 33 mm?

    a) 78.5%
    b) 24.3%
    c) 15.9%
    d) 22.1%

96. The Zoglen Corporation markets a product, which is a blend of 3 ingredients (A, B, C). If the individual tolerances for the weight of the 3 ingredients are as shown, what should the tolerance be for the net weight of the product?

    A: 40.5 ± 2.236 grams,   B: 30.4 ± 2.000 grams,   C: 18.1 ± 1.732 grams

    a) 89.0 ± 2.443 grams
    b) 89.0 ± 3.464 grams
    c) 89.0 ± 5.968 grams
    d) 89.0 ± 4.732 grams

97. A random sample of size n is to be taken from a large population that has a standard deviation of 1 inch. The sample size is determined so that there will be a 95% chance that the sample average will be within ± 0.1 inch of the true mean. Which of the following values is nearest to the required sample size?

a) 385
b) 200
c) 100
d) 40

98. All of the following conditions must be met for the process capability to be within the specification limits except

a) $C_{pk} \geq 1.0$
b) $C_p \geq 1.0$
c) $C_p = C_{pk}$
d) a stable process.

99. A value on the abscissa of the t distribution is 1.093. What is the area to the right of this value if the sample size is 11?

a) 0.30
b) 0.15
c) 0.05
d) 0.10

100. The spread of individual observations from a normal process capability distribution may be expressed numerically as

a) $6\overline{R}/d_2$
b) $2 \times A_2\overline{R}$
c) $\overline{R}/d_2$
d) $D_4\overline{R}$

101. What percentage of data will normally fall within a process capability?

a) 99.00%
b) 99.73%
c) 1.00%
d) 0.27%

Use the following information to answer problems 102 - 105. A winding machine wraps wire around a metal core to make small transformers. The design engineers have determined that the nominal number of windings are to be 10,060 with a minimum of 10,025 and a maximum of 10,095. A sample of 300 transformers was selected in a three month period and the wire was unwrapped on each part to determine the number of windings. The results were:

$$\overline{x} = 10,052 \text{ windings and } s = 10 \text{ windings}$$

102. What is the process capability?

    a) 10020 - 10100
    b) 10052 - 10020
    c) 10022 - 10082
    d) 10020 - 10060

103. Compute the value of C_p?

    a) 30.0
    b) 10.0
    c) 0.67
    d) 1.17

104. Compute the value of C_{pk}?

    a) 0.90
    b) 0.72
    c) 3.22
    d) 2.67

105. What is the expected percent defective?

    a) 1.00%
    b) 0.35%
    c) 2.13%
    d) 0.49%

STATISTICAL INFERENCE

106. Which of the following cannot be a null hypothesis?

    a) The population means are equal.
    b) $p = 0.5$
    c) The sample means are equal.
    d) The difference in the population means is 3.85.

107. In a sampling distribution which of the following represents the critical region?

    a) α
    b) β
    c) $1 - \beta$
    d) $1 - \alpha$

108. In a hypothesis test which of the following represents the acceptance region?

    a) α
    b) β
    c) $1 - \beta$
    d) $1 - \alpha$

109. The Chi Square distribution is

    a) a distribution of averages.
    b) a distribution of variances.
    c) a distribution of standard deviations.
    d) a distribution of frequencies.

110. Which of the following is a number derived from sample data that describes the data in some useful way?

    a) constant
    b) statistic
    c) parameter
    d) critical value

111. A null hypothesis assumes that a process is producing no more than the maximum allowable rate of defective items. What does the type II error conclude about the process?

    a) It is producing too many defectives when it actually isn't.
    b) It is not producing too many defectives when it actually is.
    c) It is not producing too many defectives when it is not.

d) It is producing too many defectives when it is.

112. A quality engineer wants to determine whether or not there is any difference between the means of the convolute paperboard cans supplied by two vendors, A and B. A random sample of 100 cans is selected from the output of each vendor. The sample from vendor A yielded a mean of 13.59 with a standard deviation of 5.94. The sample from vendor B yielded a mean of 14.43 with a standard deviation of 5.61. Which of the following would be a suitable null hypothesis?

a) $\mu_A = \mu_B$
b) $\mu_A > \mu_B$
c) $\mu_A < \mu_B$
d) $\mu_A \neq \mu_B$

113. A chi square test for independence has a 4 x 3 contingency table and a calculated chi square value of 11.5. At a .05 level of significance, which of the following are true about the decision regarding the null hypothesis?

a) 7 df, accept H_o
b) 6 df, reject H_o
c) 6 df, accept H_o
d) 11 df, accept H_o

114. A supplier states that the average diameter of optical glass plates is 37.50 mm. The specifications are 37.50 mm $\pm$ .40 mm. A shipment of 500 plates is received and a sample of 10 plates is selected and the diameters of each are measured. The following data are obtained:

| 37.42 mm | 37.84 | 37.50 | 37.48 | 37.75 |
| 37.63 | 37.82 | 37.78 | 37.79 | 37.51 |

Does the entire population have an average diameter of 37.5 mm? Test at a level of significance of .05.

a) t = +2.97, Reject H_o
b) t = +2.26, Accept H_o
c) t = -2.26, Accept H_o
d) t = +1.05, Accept H_o

115. Given: n = 40, $\bar{p}$ = .20 defects/unit

Could this sample have possibly come from a process whose process average is .14 defects/unit? Test at a level of significance of .01.

a) z = +1.75, Do not reject H_o
b) z = -.075, Reject H_o
c) z = +1.01, Do not reject H_o
d) z = +2.47, Reject H_o

116. A study of 26 families across a certain state indicated that the average family income during 1989 was $33,400 with a Standard Deviation of $3680. Test the hypothesis that the true average income in this state during 1989 was $32,000 against the alternative that it was not $32,000. Test at a level of significance of .05.

    a) $t = +.900$, Accept H_o
    b) $t = +1.94$, Accept H_o
    c) $t = -2.95$, Reject H_o
    d) $t = +3.16$, Reject H_o

117. An inspection yields the following results:

$$n = 20, \quad \bar{x} = 10.5 \text{ lb.}, \quad s = 1.2 \text{ lb.}$$

Could this data have reasonably come from a process which usually has an average of 11.3 lb. or greater? Test at a level of significance of .01.

    a) $t = +3.10$, Reject H_o
    b) $t = -1.67$, Accept H_o
    c) $t = -2.98$, Reject H_o
    d) $t = +2.10$, Accept H_o

118. In a hypothesis test what determines whether the test is one tailed or two tailed?

    a) Critical Region
    b) Alternate Hypothesis
    c) Null Hypothesis
    d) α

119. Pooled variance is best described as

    a) the variance of a sample that has been pulled from a population.
    b) the combination of variances of two or more samples.
    c) the combination of variances from multiple samples with dependant means.
    d) $(n_1 - 1) s_1{}^2 + (n_2 - 1)s_2{}^2 + \ldots + (n_n - 1)s_n{}^n$

120. Goodness of Fit is best described as

    a) how well two sample data standard deviations vary from each other.
    b) a test to determine if two or more samples follow the same distribution.
    c) a statistical tool for analyzing data using the χ^2 distribution.
    d) the comparison of an observed sample distribution with a theoretical distribution.

SAMPLING

121. The Dodge-Romig Tables are designed to minimize which parameter?

   a) AOQL
   b) AQL
   c) ATI
   d) AOQ

122. What are the two unique quantities that determine a single sampling attributes plan?

   a) AQL and LTPD
   b) Sample Size and Acceptance Number
   c) AQL and Producers Risk
   d) LTPD and Consumer's Risk

123. Characteristics for which 100% inspection may be practicable include all of the following except

   a) dimensions subject to measurements or go/no-go gaging.
   b) performance characteristics subject to non-destructive testing.
   c) characteristics observable by visual inspection.
   d) ultimate physical properties (tensile strength, viscosity).

124. The term AQL as used in sampling inspection, means

   a) that level of lot quality for which there is a large risk of rejecting the lot.
   b) the Average Quality Limit.
   c) the maximum percent defective that can be considered satisfactory as a process average.
   d) the quality level.

125. Which of the following best describes what an operating characteristic curve shows?

   a) The probability of accepting lots of various quality levels by sampling methods.
   b) The operating characteristics of a machine.
   c) How to operate a machine for best quality results.
   d) The probability that a lot contains a certain number of rejects.

126. In ANSI/ASQ Z1.4, the AQL is always determined at what P_a on the OC curve?

   a) 0.05
   b) 0.10
   c) 0.90
   d) None of the above

127. Which of the following best describes what an average outgoing quality curve shows?

a) The producer's risk.
b) The outgoing quality level versus the incoming quality level.
c) The probability of accepting lots of various quality levels.
d) The consumer's risk.

Use the following information to answer problems 128 - 134. A sampling plan is needed which will satisfy the following requirements:

- Accept *acceptable* quality product almost all (90%) of the time.
- Accept *rejectable* quality product almost none (12%) of the time.
- *Acceptable* quality is defined as a process average of 1% defective.
- *Rejectable* quality is defined as a process average of 7% defective.

128. What is the value of α?

a) 90%
b) 88%
c) 12%
d) 10%

129. What is the value of β?

a) 88%
b) 12%
c) 95%
d) 2.5%

130. What is the value of the AQL?

a) 3%
b) 99%
c) 1%
d) 97%

131. What is the value of the LTPD?

a) 7%
b) 10%
c) 1%
d) 5%

132. What is the sample size that will satisfy the requirements stated above?

a) 35
b) 40
c) 45
d) 50

133. What is the acceptance number that will satisfy the requirements stated above?

a) 1
b) 3
c) 5
d) 23

134. What is the approximate value of the AOQL?

a) .0165
b) .2000
c) .1375
d) .9999

Use the following data to answer problems 135 - 137.
Given: AQL = .015 (1.5% defective), RQL = .050 (5.0% defective), α = .05, β = .10

135. What is the sample size of the sampling plan?

a) 30
b) 75
c) 140
d) 200

136. What is the acceptance number of the sampling plan?

a) 1
b) 3
c) 6
d) 9

137. What is the value of AOQL?

a) .2000
b) .0160
c) .0107
d) .0029

138. A sampling plan specifies a sample size of 50 and an acceptance number of 3. What is
the value of the AQL if α = .05?

a) .0165
b) .0107
c) .1375
d) .0280

139. A sampling plan specifies a sample size of 50 and an acceptance number of 3. What is the approximate value of the AOQL?

a) .0280
b) .0107
c) .0370
d) .0490

140. All of the following are methods for checking product except

a) constant percentage sampling.
b) random spot checking.
c) no checking at all.
d) safeguard checking.

141. All of the following are characteristics of lot by lot single sampling except

a) a sample size is selected randomly from the lot.
b) if the number of defects in a sample exceed the acceptance number, the entire lot is rejected.
c) rejected lots are immediately scrapped.
d) if the number of defects in a sample do not exceed the acceptance number, the entire lot is accepted.

142. All of the following are characteristics of continuous sampling except

a) it is only used where product flow is discrete.
b) the clearing number must be specified.
c) the amount of product checked may vary.
d) the product is not able to be formed into lots.

143. The following parameters are required for sampling plan construction using the Binomial Nomograph except

a) AQL.
b) RQL.
c) α.
d) Sample size.

CONTROL CHARTS

144. The primary use of a control chart is to

    a) detect assignable causes of variation in the process.
    b) detect non-conforming product.
    c) measure the performance of all quality characteristics of a process.
    d) detect the presence of random variation in the process.

145. np charts are based on which distribution?

    a) Poisson
    b) Binomial
    c) Shewhart
    d) Exponential

146. c and u charts are based on which distribution?

    a) Poisson
    b) Binomial
    c) Shewhart
    d) Exponential

147. Why do $\bar{x}$ charts always follow a normal distribution?

    a) Variance
    b) The Law of Large Numbers
    c) The Central Limit Theorem
    d) The Addition Theorem

148. When used together for variables data, which of the following pair of quantities is the most useful in preparing control charts?

    a) AQL, p
    b) P, n
    c) $\bar{x}$, R
    d) R, σ

149. A process is in control at $\bar{x}$ = 100, $\bar{R}$ = 7.3 with n = 4. If the process level shifts to 101.5, with the same $\bar{R}$, what is the probability that the next $\bar{x}$ point will fall outside the old control limits?

    a) .016
    b) .029
    c) .122
    d) .360

150. A process is checked by inspection at random samples of 4 shafts after a polishing operation, $\bar{x}$ and R charts are maintained. A person making a spot check picks out 2 shafts, measures them accurately, and plots the value of each on the $\bar{x}$ chart. Both points fall just outside the control limits. He advises the department foreman to stop the process. This decision indicates that

    a) the process level is out of control.
    b) both the level and dispersion are out of control.
    c) the process level is out of control but not the dispersion.
    d) the person is not using the chart correctly.

151. The hardness of rivets is normally distributed with $\mu = 60.0$ and standard deviation $\sigma = 1.2$. What are the 3 sigma control limits for the $\bar{x}$ chart using samples of size 5?

    a) 57.95,   62.15
    b) 58.0,   62.0
    c) 58.38,   61.62
    d) 56.50,   63.5

152. A possible cause of a cycle pattern in a control chart include all of the following except

    a) seasonal effects.
    b) differences between suppliers.
    c) different inspectors.
    d) new supplier.

Use the following information to answer problems 153 - 158. The following data are obtained from measuring the length of a metal bracket.

Sample #1	Sample #2	Sample #3	Sample #4
$\bar{x}$ = 1.51"	$\bar{x}$ = 1.50"	$\bar{x}$ = 1.52"	$\bar{x}$ = 1.53"
R = .03"	R = .02"	R = .04"	R = .03"
n = 5	n = 5	n = 5	n = 5

153. What are the values of $\bar{\bar{x}}$, $UCL_{\bar{x}}$ and $LCL_{\bar{x}}$ for an $\bar{x}$ chart?

    a) 1.500", 1.517", 1.443"
    b) 1.515", 1.532", 1.498"
    c) 1.515", 1.491", 1.336"
    d) 1.525", 1.532", 1.498"

154. What are the values of $\bar{R}$, UCL_R, LCL_R for an R chart?

    a) .020", .9970", .012"
    b) .025", .0634", -.012"
    c) .030", .0634", 0
    d) .030", 0,   -.062

155. What are the values of the sample size and number of samples?

    a) 5, 5
    b) 4, 5
    c) 5, 4
    d) 4, 4

156. What is the standard error?

    a) .0012"
    b) .0058"
    c) .0632"
    d) .0729"

157. What is the standard deviation of the individual data points?

    a) .013"
    b) .030"
    c) .010"
    d) 1.52"

158. What is the process capability for the individual data points?

    a) 1.498" to 1.532"
    b) 1.500" to 1.530"
    c) 0.020" to 0.040"
    d) 1.476" to 1.554"

Use the following information to answer questions (problems) 159 - 162. The following data are the result of inspecting aircraft seat belt buckles.

Number of buckles in the sample	Number of defective buckles
50	2
60	3
40	1
50	2
55	0
55	1
50	0
60	1

159. What is the average percent defective ($\bar{p}$)?

    a) .833
    b) .024
    c) .009
    d) .997

160. What are the upper and lower control limits?

    a) .087,   -.024
    b) .024,   0
    c) 1.50,   .013
    d) .087,   0

161. What is the appropriate type of control chart for these data?

    a) u chart
    b) p chart
    c) c chart
    d) np chart

162. An additional sample of 75 buckles contains 4 defectives. Is this sample within the control limits?

    a) Yes, p = .053
    b) Yes, p = .024
   c) No, p = .053
    d) No, p = .024

RELIABILITY

163. A reliability data system usually implies collecting data on

    a) process machine downtime.
    b) product failures and operating time.
    c) maintenance costs.
    d) repair times.

164. Which of the following best describes the failure rate in the wear out phase of the bathtub curve?

    a) Constant
    b) Random
    c) Improves
    d) Gets Worse

165. The greatest contribution of a reliability effort is made in the

    a) design area.
    b) manufacturing area.
    c) shipping area.
    d) field service area.

166. Reliability prediction is

    a) the process of estimating performance.
    b) the process of estimating the probability that a product will perform its intended function for a stated time.
    c) the process of telling "how you can get there from here."
    d) All of the above.

167. Maintainability is

    a) the probability of a system being restored to functional operation within a given period of time.
    b) performing adequate maintenance on a system.
    c) probability of survival of a system for a given period of time.
    d) maintaining a machine in satisfactory working condition.

168. A set of components has a MTBF of 1000 hours. What percentage will fail if the components are tested for 500 hours?

    a) 25%
    b) 39%
    c) 61%
    d) 50%

169. What is the reliability of a system at 850 hours, if the average usage on the system was 400 hours for 1650 items and the total number of failures was 145? Assume an exponential distribution.

    a) 0%
    b) 36%
    c) 18%
    d) 83%

Use the following information to answer problems 170, 171 and 172.

$$\lambda_A = .001, \quad \lambda_B = .002, \quad \lambda_C = .003, \quad \lambda_D = .0025, \quad t = 100 \text{ hours}$$
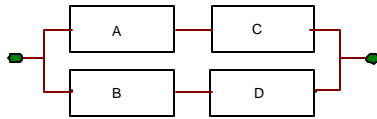
170. What is the reliability of the system?

    a) .9302
    b) .4000
    c) .8805
    d) .4403

171. What is the MTBF for components A, B, C and D respectively?

    a) 500, 400, 333, 999
    b) 1000, 750, 333, 500
    c) 700, 500, 333, 500
    d) 1000, 500, 333, 400

172. What is the probability that component C will fail before 100 hours.

    a) .5184
    b) .2592
    c) .3460
    d) .1296

173. The MTBF of a complex piece of repairable radar equipment is determined to be 950 hours. The equipment has been in continuous operation for 150 hours. What is the probability that the equipment will continue to operate without failure for at least another 375 hours?

    a) 0.5754
    b) 0.6376
    c) 0.6739
    d) 0.8521

REGRESSION AND CORRELATION

174. All of the following about multiple regression are true except

   a) extrapolation beyond the region of observations can lead to erroneous predictions.
   b) that it always involves at least 3 variables.
   c) that it involves one independent and two or more dependant variables.
   d) that it may be linear in the coefficients.

175. All of the following statements are true about a correlation coefficient except

   a) it is a mathematical measure of the degree of correlation.
   b) negative correlation will result in a negative correlation coefficient.
   c) a correlation coefficient of 0 indicates no correlation.
   d) a correlation coefficient of ±1 indicates a cause and effect relationship.

176. A study was conducted on the relationship between the speed of different cars and their gasoline mileage. The correlation coefficient was found to be 0.35 from the study. Later, it was discovered that there was a defect in the speedometers and they had all been set 5 miles per hour too fast. The correlation coefficient was computed using the correct scores. What is the new correlation coefficient?

   a) 0.30
   b) 0.35
   c) 0.40
   d) 0.45

Use the following information to answer problems 177 - 182.

Quality Training (Costs per employee per year)	Quality Cost Savings per employee per year
$500	$2700
800	3500
1000	4600
1200	7000
1400	9500
2000	11500

177. What is the intercept of the regression line?

      a) 42.3
      b) -100.7
      c) -1027.4
      d) 567.52

178. What is the slope of the regression line?

      a) 6.52
      b) 3.21
      c) 24.4
      d) 79.3

179. What is the correlation coefficient?

      a) .52
      b) .23
      c) .48
      d) .97

180. What is the formula for the regression line?

      a) $Y = 6.52 - 1027.42x$
      b) $Y = 79.3 + 42.3x$
      c) $Y = -100.7 + 24.4x$
      d) $Y = -1027.42 + 6.52x$

181. What will the projected quality costs savings be when $1700 per employee is invested in quality training?

      a) $97,000.00
      b) $10,056.58
      c) $152,231.50
      d) $212,520.63

182. If the cost savings were $8000 per employee, what are the probable training costs per employee?

      a) $1,000.00
      b) $1,523.33
      c) $1,384.57
      d) $682.80

COST OF QUALITY

183. The basic objective of a quality cost program is to

    a) identify the source of quality failures.
    b) interface with the accounting department.
    c) improve the profit of your company.
    d) identify quality control department costs.

184. Analysis of quality costs consists of

    a) reviewing manpower utilization against standards.
    b) evaluating seasonal productivity.
    c) establishing management tools to determine net worth.
    d) examining each cost element in relation to other elements and the total.

185. In selecting a base for measuring quality costs, which of the following should be considered?

    a) Sensitivity to increases and decreases in production schedule.
    b) Affects by seasonal product sales.
    c) Sensitivity to material price fluctuations.
    d) All of the above.

186. Which of the following quality cost indices is likely to have the greatest appeal to top management as an indicator of relative cost?

    a) Quality cost per unit of product
    b) Quality cost per hour of direct production labor
    c) Quality cost per unit of processing cost
    d) Quality cost per unit of sales

187. If prevention costs are increased to pay for engineering work in quality control, and this results in a reduction in the number of product defects, this yields a reduction in

    a) appraisal costs.
    b) quality costs.
    c) failure costs.
    d) manufacturing costs.

188. A process that sorts good product from defective product falls into which of the following quality cost categories?

    a) Prevention
    b) Appraisal
    c) Internal failure
    d) External failure

189. Cost of calibrating test and inspection equipment would be included in

    a) prevention costs.
    b) appraisal costs.
    c) failure costs.
    d) material-procurement cost.

190. The cost of writing instructions and operating procedures for inspection and testing should be charged to

    a) prevention costs.
    b) appraisal costs.
    c) internal failure costs.
    d) external failure costs.

191. Failure costs include costs due to

    a) quality control engineering.
    b) inspection set-up for tests.
    c) certification of special process suppliers.
    d) supplier analysis of non-conforming hardware.

192. Which of the following is least likely to be reported as a failure related cost?

    a) Sorting lots rejected by a sampling procedure.
    b) Downtime caused by late delivery of a purchased part rejected by the supplier's final inspection.
    c) Repair of field failures.
    d) Re-testing of a repaired product.

193. Which of the following activities is not normally charged as a preventive cost?

    a) Quality Training
    b) Design and Development of Quality Measurement Equipment
    c) Quality Planning
    d) Laboratory Acceptance Testing

194. In deciding whether sampling inspection of parts would be more economical than 100% inspection, you need to determine all of the following except

   a) cost of inspecting the parts.
   b) cost of correcting defective parts.
   c) cost of not finding defective parts.
   d) cost of improving the production process.

195. Quality cost trend analysis is facilitated by comparing quality costs to

   a) manufacturing costs over the same time period.
   b) cash flow reports.
   c) appropriate measurement bases.
   d) QC department budget.

196. For a typical month, the 3D Manufacturing Company identified and reported the following quality costs:

Inspection wages………………………………………..	$2,000
Quality planning……………………………………………	$4,000
Source inspection……………………………………………..	$2,000
In-plant scrap and rework……………………………..…	$88,000
Final product test…………………………….…..…………	$110,000
Retest and troubleshooting………………………………..	$39,000
Field warranty cost………………………….……………	$205,000
Evaluation and processing of deviation requests…………	$6,000

What is the total failure cost from this data?

   a) $244,000
   b) $261,000
   c) $205,000
   d) $332,000

197. Which of the following is a typical external failure cost?

   a) Material Repair
   b) Material Scrap
   c) Customer Appraisal
   d) Training

Use the following information to answer problems 198 - 201. A manufacturer produces an electronic memory device. The following costs are incurred on a yearly basis.

Activity	Cost
Research and Development	$50,000
Manufacturing Engineering	40,000
Quality Engineering	5,000
Plant Facilities	60,000
Training	1,000
Direct Labor	80,000
Process Control (Labor)	5,000
Supervision	30,000
Materials	90,000
Inspection	13,000
Scrap Costs	21,000
Rework Costs	12,000

198. What are the annual Prevention costs?

    a) $10,000
    b) $6,000
    c) $4,000
    d) $18,000

199. What are the annual Appraisal costs?

    a) $18,000
    b) $22,000
    c) $12,000
    d) $33,000

200. What are the annual Failure costs?

    a) $18,000
    b) $66,000
    c) $33,000
    d) $27,000

201. What is the percentage of quality costs to total costs

    a) 47%
    b) 8%
    c) 10%
    d) 14%

DESIGN OF EXPERIMENTS

202. In performing an Analysis of Variance for a single factor experiment, a fundamental assumption which is made is that the factor

    a) means are equal.
    b) means are unequal.
    c) variances are equal.
    d) variances are unequal.

203. To state that a model in an experimental design is fixed indicates that

    a) the levels used for each factor are the only ones of interest.
    b) the levels were chosen from a fixed population.
    c) the equipment from which the data are collected must not be moved.
    d) the factors under consideration are qualitative.

204. An experiment with two factors, in which all levels of one variable are run at each level of the second variable, is called a

    a) One-way experiment.
    b) Latin square experiment.
    c) factorial experiment.
    d) fractional factorial experiment.

205. A two-way Analysis of Variance has r levels for the first variable and c levels for the second variable with 2 observations per cell. The degrees of freedom for interaction is

    a) $2(r \times c)$
    b) $(r - 1)(c - 1)$
    c) $rc - 1$
    d) $2(r - 1)(c - 1)$

206. An analysis of variance results in a calculated F value of $F(10, 12) = 2.75$. What is the level of significance?

    a) $p < 0.01$
    b) $p = .01$
    c) $p = .05$
    d) $p > .05$

207. A 3^2 experiment means that we are considering

a) two levels of three factors.
b) two dependent variables and three independent variables.
c) two go/no-go variables and three continuous variables.
d) three levels of two factors.

208. Which of the following distributions is needed to evaluate the results of analysis of variance (ANOVA)?

a) binomial distribution
b) Chi Square distribution
c) F distribution
d) Z distribution

209. The primary advantage of the Latin Square design compared to the factorial design, is that

a) it requires less data.
b) it eliminates the need for interaction analysis.
c) it allows higher significance levels.
d) it does not require homogeneity of variance.

210. Consider the SS and MS columns of an Analysis of Variance table for a single factor design. The appropriate ratio for testing the null hypothesis of no treatment effect is

a) SS treatments divided by SS residual.
b) MS treatments divided by MS residual.
c) SS treatments divided by MS residual.
d) MS treatments divided by SS residual.

211. A completely randomized design is best described as

a) a design in which the linear equation coefficients are sorted randomly.
b) a design in which each factor is selected randomly.
c) a design in which all treatments are assigned to the experimental units in a completely random manner.
d) a design in which certain factors are randomly selected for analysis.

Use the following information to answer problems 212 - 216. The following factorial experiment was conducted to determine the effect of *study time* and *study material used* on

test scores. The numbers in the box represent the test scores. You will need to construct the ANOVA table to complete all of the questions.

		Hours of Study	
		4	6
Study Material Used	1	60, 85	77, 92
	2	55, 65	60, 80

212. How many factors are used in this experiment?

   a) 2
   b) 4
   c) 6
   d) 8

213. How many levels are being examined for each factor?

   a) 2
   b) 4
   c) 6
   d) 8

214. What is the sum of squares for the residual?

   a) 675.0
   b) 242.0
   c) 364.5
   d) 1283.5

215. Which factor has the greatest impact on the outcome?

   a) Study Hours
   b) Study Material Used
   c) Interaction
   d) Residual

216. Which of the following factors are significant?

   a) Study Hours and Interaction
   b) Study Material Used
   c) Interaction
   d) None of the above

METROLOGY AND CALIBRATION

217. The key to designing an effective calibration program is to balance

   a) reliability and performance metrics.
   b) cost and quality considerations.
   c) test and result considerations.
   d) cost and variance metrics.

218. Reliability metrics can be used to measure equipment

   a) availability.
   b) waste.
   c) performance.
   d) redundancies.

219. Which of the following terms is defined as the probability that measurement equipment will be found to be in tolerance after a specified period of time?

   a) Availability
   b) Activism
   c) Reproducibility
   d) Reliability

220. Suppose a test procedure is performed in order to determine the value of a product measurement. What is the order of equipment type, from lowest to highest accuracy, if NIST traceability is to be achieved?

   a) Working standards, ISO standards, transfer standards, reliability standards
   b) Primary standards, ISO standards, transfer standards
   c) Primary standards, transfer standards, working standards
   d) Working standards, transfer standards, primary standards

221. Which procedures are performed on product and test equipment in order to determine if predefined specifications have been met?

   a) Inspection
   b) Identification
   c) Labeling
   d) Traceability

222. Which of the following is used to qualify measurement instruments in reference to national or internationally recognized standards?

    a) Reliability
    b) Traceability
    c) Variability
    d) Dependability

223. A measurement standard with a stated uncertainty of 0.1 V, 95% confidence level, is used to test a device that has a nominal value of 100 V, and a tolerance of ±10 V. What is the TUR for this measurement?

    a) 10
    b) 100
    c) 9.5
    d) 95

224. A requirement of the ISO 9000 series standards is that all M&TE used for product inspection

    a) is calibrated at least annually.
    b) meets Mil-Std 45662A requirements.
    c) is identified and labeled appropriately.
    d) has passed the null test.

225. What ISO 9001 element addresses equipment calibration?

    a) 4.1
    b) 4.5
    c) 4.11
    d) 4.17

QREVIEW ANSWERS

1. b	46. b	91. a	136. c	181. b
2. d	47. a	92. b	137. b	182. c
3. b	48. b	93. d	138. d	183. c
4. c	49. a	94. a	139. c	184. d
5. b	50. c	95. d	140. d	185. d
6. b	51. d	96. b	141. c	186. d
7. a	52. d	97. a	142. a	187. c
8. c	53. a	98. c	143. d	188. c
9. c	54. b	99. b	144. a	189. a
10. a	55. a	100. a	145. b	190. a
11. b	56. c	101. b	146. a	191. d
12. d	57. c	102. c	147. c	192. b
13. a	58. b	103. d	148. c	193. d
14. c	59. c	104. a	149. a	194. d
15. d	60. a	105. b	150. d	195. c
16. b	61. d	106. c	151. c	196. d
17. b	62. c	107. a	152. d	197. a
18. b	63. a	108. d	153. b	198. b
19. c	64. b	109. b	154. c	199. a
20. c	65. d	110. b	155. c	200. c
21. c	66. b	111. b	156. b	201. d
22. c	67. a	112. a	157. a	202. c
23. c	68. d	113. c	158. d	203. a
24. d	69. a	114. a	159. b	204. c
25. d	70. d	115. c	160. d	205. b
26. c	71. b	116. b	161. b	206. c
27. d	72. c	117. c	162. a	207. d
28. c	73. d	118. b	163. b	208. c
29. d	74. b	119. b	164. d	209. a
30. c	75. c	120. d	165. a	210. b
31. c	76. b	121. c	166. b	211. c
32. a	77. b	122. b	167. a	212. a
33. b	78. b	123. d	168. b	213. a
34. d	79. b	124. c	169. d	214. a
35. c	80. b	125. a	170. c	215. b
36. d	81. a	126. d	171. d	216. d
37. b	82. d	127. b	172. b	217. b
38. c	83. c	128. d	173. a	218. c
39. b	84. c	129. b	174. c	219. d
40. c	85. b	130. c	175. d	220. d
41. a	86. c	131. a	176. b	221. a
42. c	87. a	132. d	177. c	222. b
43. d	88. c	133. a	178. a	223. b
44. b	89. b	134. a	179. d	224. c
45. b	90. d	135. d	180. d	225. c