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EXAMINATION FOR TWO-YEAR SCHOLARSHIP 1967-68

AUSTRALIAN GOVERNMENT

FREEDOM OF INFORMATION ACT

QUANTITATIVE THINKING

Morning Session,
Thursday, 28th July

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REMEMBER
All answers on this paper
are letters of the
alphabet

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COMMONWEALTH SECONDARY AND TECHNICAL SCHOLARSHIPS

EXAMINATION FOR TWO-YEAR SCHOLARSHIP 1967-68

QUANTITATIVE THINKING

Morning Session, Thursday, 28th July, 1966

Time allowed : Two hours

TEST BOOKLET. TO BE HANDED IN WITH YOUR ANSWER SHEET.

INSTRUCTIONS TO CANDIDATES

This is a test of your ability to use basic mathematical principles and ideas.

If a question involves terms or principles which you might not have met before, these will be explained in sufficient detail to enable you to answer the questions concerned.

In addition, a selected list of symbols and simple formulae is printed on page 1 of this booklet.

You are strongly advised to observe the following points :

1. Work carefully through the questions in the order in which they are given.
2. Do not waste too much time on any one question ; if necessary, go on to the next question and come back to the difficult ones later.
3. If you think that you know an answer, write it down even if you are not certain that it is correct.
4. Make sure that you print each answer in the correct space on the answer sheet.

ANSWERING

In all questions you are required to select one answer from several choices and to indicate your answer by printing the appropriate letter (A, B, C, D, etc.) on your Answer Sheet.

Now look through this examination paper but do not start writing until the supervisor tells you to do so.

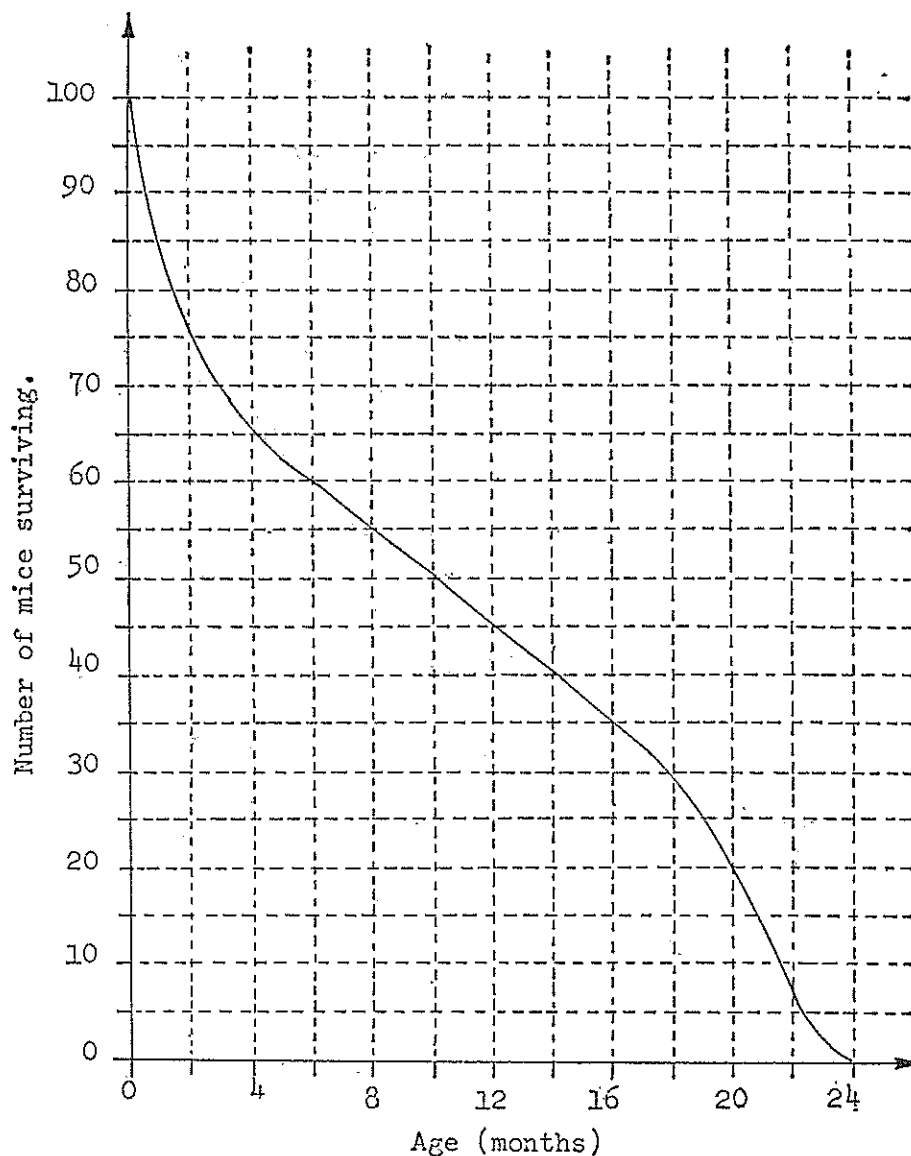
SYMBOLS :

- = means 'is equal to'.
 \neq means 'is not equal to'.
 $>$ means 'is greater than'.
 $<$ means 'is less than'.
 \perp indicates that the angle between the two lines is a right-angle.
 $\angle ABC$ means 'angle ABC'.

FORMULAE :

- Circumference of a circle = $2\pi \times$ radius ($2\pi r$).
Area of a circle = $\pi \times$ square of radius (πr^2).
Area of a rectangle = length \times breadth ($l \times b$).
Area of a triangle = $\frac{1}{2} \times$ base \times height ($\frac{1}{2} b \times h$).
Volume of a cuboid = length \times breadth \times height ($l \times b \times h$).

Questions 1-4.



An experiment was conducted on the life span of white mice. 100 newly-born mice were isolated and not allowed to breed. The smoothed graph above shows the number surviving (vertical axis) at various ages (horizontal axis).

Use the graph to answer the questions below :

- Which one of the following is the closest to the time that elapsed from the beginning of the experiment before exactly half of the original population had died ?

A. 2 months	D. 14 months
B. 6 months	E. 18 months
C. 10 months	
- Which one of the following is the best approximation to the number of mice that died within the first two months ?

N. 75	S. 30
P. 60	T. 25
Q. 35	V. 20
- Which one of the following is the best approximation to the percentage of the original mice that died between 6 months and 12 months after the start of the experiment ?

A. 5 per cent.	D. 30 per cent.
B. 15 per cent.	E. 45 per cent.
C. 20 per cent.	H. 50 per cent.
- Consider those mice that survived for the first 6 months. Which one of the following is the closest to the time that elapsed from the beginning of the experiment before exactly half of these had died ?

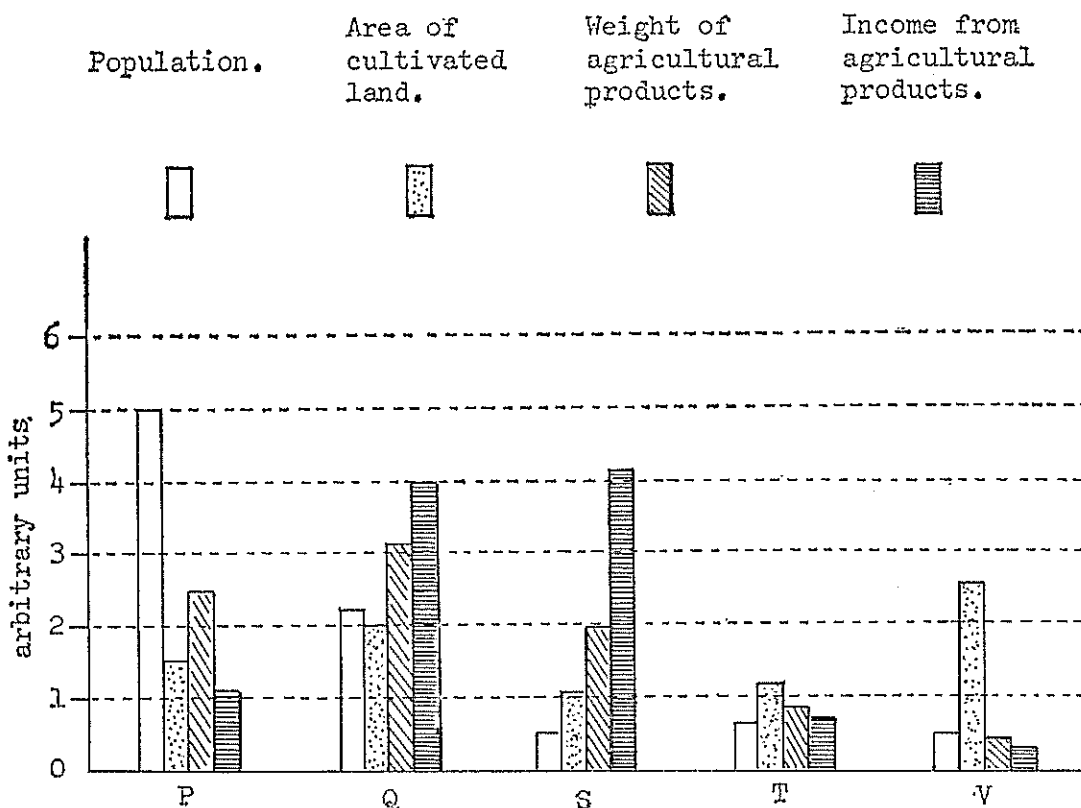
N. 6 months	S. 24 months
P. 12 months	T. 30 months
Q. 18 months	

5. Using the approximate relationship 1 inch = 2.54 cm, select from the following the one which is closest in volume to 1 cubic centimetre.

A. a marble
 B. a golf ball
 C. a tennis ball
 D. a basket-ball

Questions 6-9.

The column graph below shows the population, area of cultivated land, weight of agricultural products, and income from agricultural products for 5 country regions in a given financial year.



6. If the population of Region Q is approximately 50,000 which one of the following is the best approximation for the total population of the five areas ?
- A. 100,000
 B. 250,000
 C. 500,000
 D. 1 million
 E. 5 million
7. Which one of the regions P, Q, S, T, V, has the greatest *total* land area ? Write N if you think that there is not sufficient information in the graph to answer the question.
8. For which one of the regions P, Q, S, T, V, will the income from agricultural products per cultivated acre be greatest ? Write N if you think that there is not sufficient information in the graph to answer the question.
9. For which one of the regions P, Q, S, T, V, is the average income from each ton of agricultural products the least ? Write N if you think that there is not sufficient information in the graph to answer the question.

Questions 10-12.

A man who wishes to give up smoking enlists the aid of a friend who agrees to sell him cigarettes charging 1c each on the first day, 2c each on the second day, 4c each on the third day, and so on (i.e., doubling the charge in each successive day). The smoker buys cigarettes only from his friend, and is unable to spend more than \$1 on any one day for cigarettes.

10. Which one of the following is the first day on which he is unable to buy a cigarette ? (He may not buy fractions of a cigarette.)
- A. The 50th day
 B. The 21st day
 C. The 15th day
 D. The 8th day
 E. The 6th day

11. How many cigarettes can he buy on the 5th day ?

- N. 1
P. 6
Q. 7

- S. 10
T. 16
V. More than 16

12. If he buys all the cigarettes he can afford for the first 3 days, what is the average price, in cents, that he pays per cigarette over these 3 days ?

- A. Less than 2
B. Exactly 2
C. Between 2 and $2\frac{1}{2}$

- D. Exactly $2\frac{1}{2}$
E. More than $2\frac{1}{2}$

13. Which one of the following events occurred closest to 30 million seconds ago ?

- N. Sunset one week ago today.
P. High tide one month ago today.
Q. The birth of a baby who is now 12 months old.
S. The opening ceremony of the 1956 Olympic Games.
T. Captain Cook's first landing in Australia.

14. Poultry food costs \$60 per short ton (1 short ton = 2,000 lb). Which one of the following is the average cost per day of food for 160 hens if each hen eats an average of 5 oz of poultry food per day ?

- A. \$1.50
B. \$2
C. \$5

- D. \$10
E. \$15

Questions 15–17.

The table gives numerical ratings of 10 ten articles on three characteristics.

<i>Article</i>	<i>Characteristic (i)</i>	<i>Characteristic (ii)</i>	<i>Characteristic (iii)</i>
A ..	5	16	9
B ..	12	8	3
C ..	3	7	16
D ..	2	14	5
E ..	17	5	7
F ..	9	15	18
G ..	6	9	10
H ..	11	7	4
I ..	20	12	6
J ..	7	10	15

It is possible to make an ordered selection from the articles for a given purpose by applying a fixed rule to the numerical information. For example, if we selected according to the rating on characteristic (ii) we would take the articles in the following order A, F, D, I, J, etc.

In each of the questions the order of selection for the first four articles, using a fixed rule, is shown. In each case you are to find the next article that would be chosen.

15. D, C, A, G, .. (Hint : based on a single characteristic.)

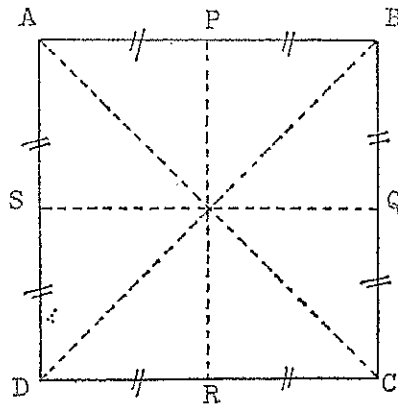
16. F, C, J, G, .. (Hint : based on a single characteristic.)

17. F, I, J, A, .. (Hint : based on all three characteristics.)

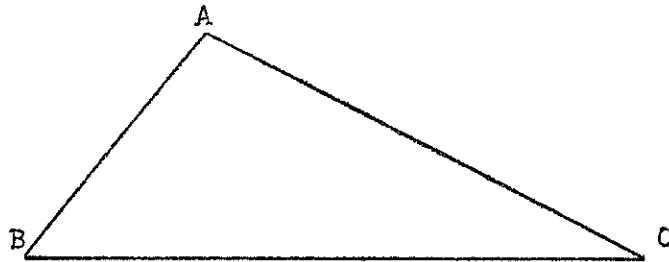
Questions 18-22.

For a plane figure, an axis of symmetry is a line drawn on the figure, dividing it into two parts such that folding the plane figure along this line will result in the two parts of the figure becoming coincident, i.e., one will exactly cover the other.

Example (i) The square $ABCD$ has four axes of symmetry, PR , BD , QS , AC .



Example (ii) The scalene triangle ABC has no axis of symmetry.



In each of the following questions a plane figure is given. For each question you are to write the letter, from the KEY, which corresponds to the number of axes of symmetry of the given figure.

KEY

N. 0

P. 1

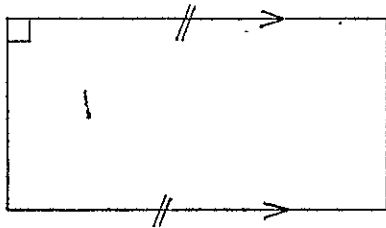
Q. 2

S. 3

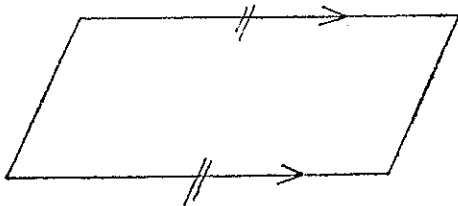
T. 4

V. More than 4

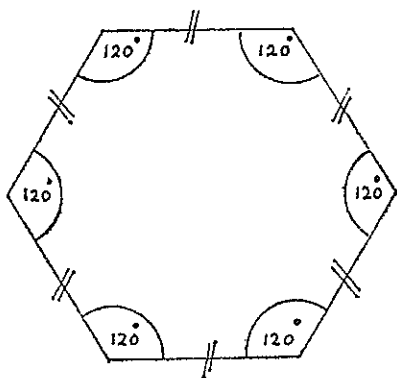
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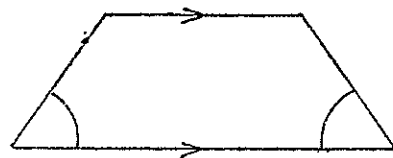
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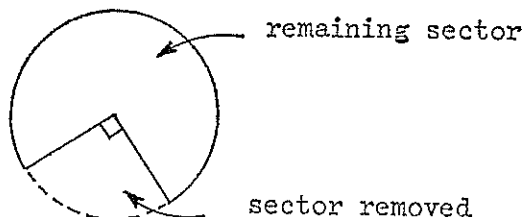


22.



Two circular arcs

23.



A circular piece of paper has a sector of angle 90° cut from it. The two straight edges of the remaining sector are joined without overlap so that a cone is formed. Which one of the following correctly gives the area of the curved surface of the cone as a fraction of the original area of the circle?

- A. $\frac{1}{4}$
- B. $\frac{1}{3}$
- C. $\frac{1}{2}$
- D. $\frac{2}{3}$
- E. $\frac{3}{4}$

24. The pilot of a jet fighter must be conscious of the time his eyes can be closed when he blinks quite normally, as it amounts to a short blackout period. On an average this time is 0.3 seconds.

State which of the following is *closest* to the distance that he would have moved during one of these normal “blackouts” when he is travelling at 1,200 miles per hour. N.B.—15 miles per hour is the same speed as 22 ft per second.

- A. 8.4 ft
- B. 50 ft
- C. 500 ft
- D. 1 mile
- E. 6 miles

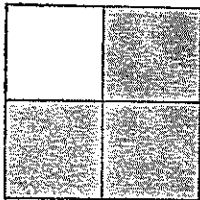
Questions 25–28.

In this set of questions $a \wedge b$ means “the greatest common factor of a and b ” and $a \vee b$ means “the lowest common multiple of a and b ”. For example $12 \wedge 8 = 4$ and $12 \vee 8 = 24$.

25. $(5 \vee 10) \times (3 \wedge 6)$ is equal to
- N. 15
 - P. 20
 - Q. 30
 - S. 40
 - T. 60
 - V. 150
26. If $a \vee b = c$ then the value of $2a \vee 2b$ is
- A. c
 - B. $2c$
 - C. $4c$
 - D. c^2
 - E. $4c^2$
27. If a and b are even numbers then
- N. both $a \wedge b$ and $a \vee b$ must be even.
 - P. only $a \wedge b$ must be even.
 - Q. only $a \vee b$ must be even.
 - S. neither $a \wedge b$ nor $a \vee b$ must be even.
28. If $a \wedge b = k$ then the value of $a^2 \wedge b^2$ is
- A. k
 - B. $2k$
 - C. $4k$
 - D. k^2
 - E. k^4

Questions 29, 30.

From the 60 matches in a box a boy builds a pattern thus: he forms a square with 4 matches (call this layer 1); to this he adds 3 more equal squares, as shown shaded in the diagram, to form layer 2; he continues to add layers in the same manner, so that after each layer is added the pattern is always a complete square; the boy stops when he has added as many complete layers as possible with the 60 matches.



29. How many complete layers will the pattern have?
- N. 2
 - P. 3
 - Q. 4

- S. 5
- T. 6
- V. More than 6

30. How many matches will be left over ?

- A. 0
 B. 1
 C. 2
 D. 3
 E. 4
 H. More than 4

31. Any odd number may be expressed as the sum of the two whole numbers nearest to its half. For instance

$$7 = 4 + 3$$

$$9 = 5 + 4$$

If the odd number is called " n " the general formula to express it as the sum of the whole numbers nearest to its half is :

$$N. n = \left(\frac{n}{2} + \frac{3}{2}\right) + \left(\frac{n}{2} - \frac{3}{2}\right)$$

$$Q. n = \left(\frac{n}{2} + \frac{1}{2}\right) + \left(\frac{n}{2} - \frac{1}{2}\right)$$

$$P. n = \left(\frac{n}{2} + 1\right) + \left(\frac{n}{2} - 1\right)$$

$$S. n = \left(\frac{n}{2} + \frac{1}{4}\right) + \left(\frac{n}{2} - \frac{1}{4}\right)$$

32. Another way of writing $(a + b)^2$ is $a^2 + 2ab + b^2$ which is, of course, the same as $b^2 + 2ba + a^2$.

Similarly $(a + b)^5 = a^5 + 5a^4b + 10a^3b^2 + \dots + 5ab^4 + b^5$. The \dots represents a missing term.

Which one of the following should replace the \dots ?

- A. $5ab^3$
 B. a^2b^3
 C. $15a^2b^4$
 D. $10a^2b^3$
 E. None of the above

33. A girl has n cubes, all of the same size, from which she tries to build a big cube. Nearly finished, she finds that she does not have enough cubes to complete the building of the big cube ; just one row along one edge is missing. If the big cube needs 216 small cubes to build, how many cubes has the girl ?

- N. 6
 P. 144
 Q. 162
 S. 200
 T. 210
 V. $216 - n$

Questions 34–36.

A positive integer is *prime* if it has only two factors, itself and one. (1 is not generally included as a prime.)

A *prime number pair* consists of two prime numbers which differ by two.

34. How many prime numbers lie between 10 and 40 ?

- A. 4
 B. 7
 C. 9
 D. 10
 E. 15
 H. None of the above

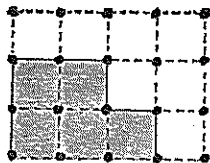
35. How many prime number pairs lie between 10 and 40 ?

- N. 2
 P. 3
 Q. 4
 S. 7
 T. 15
 V. None of the above

36. 197 and 199 form a prime number pair. When 90 is added to each of them or subtracted from each of them a prime number pair results :

- A. in both cases
 B. in neither case
 C. from the addition but not from the subtraction
 D. from the subtraction but not from the addition

37.



The grid shown is called a lattice and contains 20 lattice points. The shaded area, if every square is counted as a square unit, is 5. This area may be expressed by the lattice points in the following way :

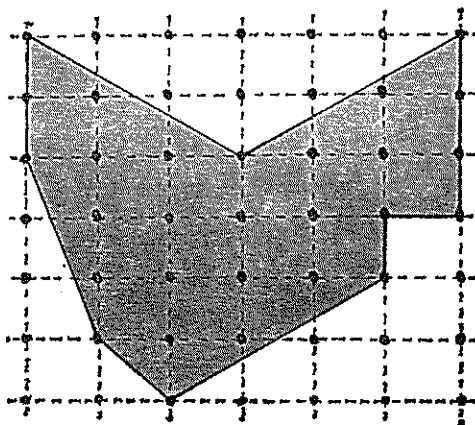
Area (in square units)

$$\begin{aligned} &= \frac{1}{2} (\text{sum of all lattice points on the perimeter}) + \text{sum of all lattice points inside the perimeter} - 1 \\ &= \frac{1}{2} (10) + 1 - 1 \\ &= 5 \end{aligned}$$

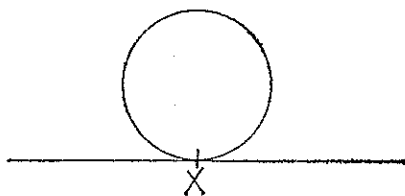
Whenever the vertices of a plane figure with straight sides are all lattice points this method may be used to calculate the area of the figure. Apply the method to find the area shaded in the diagram below.

The area shaded is :

- N. 13 square units
- P. 16 square units
- Q. 17 square units
- S. 20 square units
- T. 21 square units
- V. 36 square units



38. A white spot is painted on a bicycle wheel at X :



radius of wheel = $9\frac{5}{8}$ inches

To a person sitting on the ground and carefully watching the white spot as the wheel is rolled along a level surface, it would appear to trace out the path as shown.

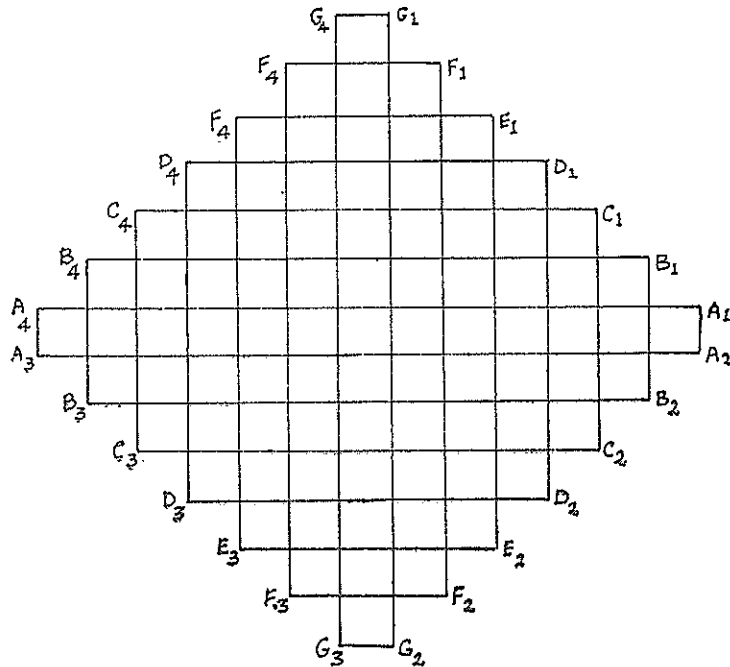


Not drawn to scale.

To the nearest whole number the value of x is

- A. 4
- B. 5
- C. 9
- D. 10
- E. 19

39. The diagram below is made up of a number of small squares each of side 1 unit. Seven rectangles $A_1A_2A_3A_4$, $B_1B_2B_3B_4$, etc., have been indicated on the diagram. Let the perimeters of these be a units, b units, &c., respectively, and let their areas be A square units, B square units, etc., respectively. For the rectangle $A_1A_2A_3A_4$, the ratio $\frac{A}{a}$ is $\frac{13}{28}$. This ratio will vary from rectangle to rectangle.



Select the rectangle for which the ratio is the greatest. What is the value of the ratio in this case ?

N. $\frac{13}{28}$

S. $\frac{49}{28}$

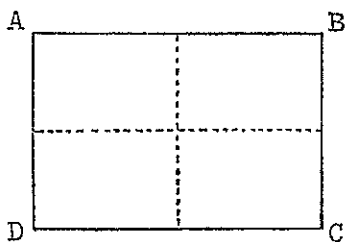
P. $\frac{33}{28}$

T. $\frac{52}{28}$

Q. $\frac{45}{28}$

V. $\frac{85}{28}$

Questions 40, 41.



$ABCD$ is a rectangular section of wall into which four tiles fit, as shown by the dotted lines.

40. You are given two white tiles and two black tiles with which to fill the rectangle. How many different patterns can you make from these four tiles ?

A. 3

E. 8

B. 4

H. 12

C. 5

K. 16

D. 6

41. If you are given four tiles, each of which is white on one side and black on the other, how many different patterns can you make ?

N. 4

T. 12

P. 6

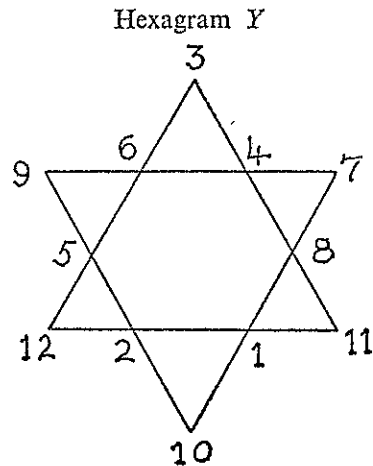
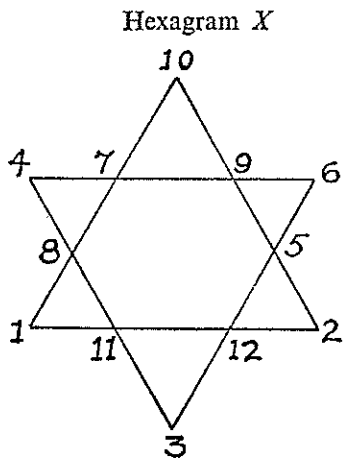
V. 14

Q. 8

X. 16

S. 10

42. The numbers along each straight line of the magic hexagram X add up to 26.
To develop from X the magic hexagram Y each number x on X is replaced by $(n + 1 - x)$.



The value of n is

- | | |
|------|-------|
| A. 0 | D. 9 |
| B. 2 | E. 12 |
| C. 6 | H. 13 |

Questions 43, 44.

There are several temperature scales which have been used in scientific work. Two of these are the Kelvin scale and the Reaumur scale. 273° on the Kelvin scale is almost equivalent to 0° Reaumur (freezing point of water) and 373° is almost equivalent to 80° Reaumur (boiling point of water).

Between the two "fixed" points (i.e., the freezing point of water and the boiling point of water) the Reaumur temperature scale is divided into 80 equal intervals each of size 1 Reaumur degree. Similarly, the Kelvin scale is divided into equal intervals each of size 1 Kelvin degree.

43. Which one of the following changes in temperature on the Reaumur scale would correspond to a change of 10° on the Kelvin scale?
- | | |
|---------------|--------------------------|
| N. 4° | S. $12\frac{1}{2}^\circ$ |
| P. 8° | T. 16° |
| Q. 10° | V. 30° |
44. The temperature on a sunny day is 20° Reaumur. What would the temperature reading be on the Kelvin scale?
- | | |
|---------------|----------------|
| A. 24° | D. 100° |
| B. 25° | E. 293° |
| C. 40° | H. 298° |
45. In a pile of beads 30 per cent are red and the remainder blue. There are 360 beads in the pile. A second pile contains 300 beads. How many in the second pile are red if half of the two piles combined are red?
- | | |
|-------|--------|
| N. 20 | S. 210 |
| P. 60 | T. 222 |
| Q. 70 | V. 330 |

46. The equations to circles of diameters 6 inches and 10 inches may be written

$$\frac{x^2}{9} + \frac{y^2}{9} = 1 \quad \text{and} \quad \frac{x^2}{25} + \frac{y^2}{25} = 1 \quad \text{respectively.}$$

The diameter of the circle with equation

$$\frac{x^2}{64} + \frac{y^2}{64} = 1 \quad \text{is}$$

- | | |
|--------------|----------------------|
| A. 8 inches | D. 20 inches |
| B. 12 inches | E. 48 inches |
| C. 16 inches | H. None of the above |

Questions 47-50.

The following consists of the statement of a theorem, notes about the terms used and a proof of the theorem. Two lines (line X and line Y) have been omitted. Study the material given and then answer the questions below :

Theorem .. $\sqrt{2}$ is not a rational number.

Notes .. $\sqrt{2}$ stands for the number which gives 2 when multiplied by itself.

A rational number is one which can be expressed as the fraction p/q , where p, q are whole numbers ($q \neq 0$) and have no factor in common, e.g., $\frac{5}{7}, \frac{2}{1}$.

Proof .. If $\sqrt{2}$ was rational it could be written as p/q where p and q are whole numbers ($q \neq 0$) and have no common factor.

i.e., $\sqrt{2} = p/q$

squaring and rearranging leads to

.....(line X)

Thus p^2 is even and so p must be even

Let $p = 2r$

Thus $2q^2 = 4r^2$

or $q^2 = 2r^2$

Hence q must also be even

.....(line Y)

But this contradicts the original assumption in the proof.

Therefore $\sqrt{2}$ is not rational.

47. Select, from the following, the number which is not rational :

N. $\sqrt{0.81}$

P. $\sqrt{2\frac{1}{4}}$

Q. $\sqrt{16}$

S. $\sqrt{5}$

T. $\sqrt{\frac{2}{5}}$

48. Which one of the following would be the most suitable to write in line X ?

A. $2 = p/q$

B. $q^2 = 2p^2$

C. $2q = p$

D. $p^2 = 2q^2$

E. $q^2 p^2 = 2$

49. Which one of the following statements would be the most suitable to write in line Y ?

N. Hence p and q cannot be rational

P. Hence p/q is not rational

Q. Hence $p = q = 2r$

S. Hence p and q have the factor 2 in common

T. Hence p and q are both perfect squares

50. Which one of the following best summarizes the method used to establish the truth of the statement " $\sqrt{2}$ is not a rational number" ?

A. Assume that the statement is false and then show that this leads to a contradiction.

B. Assume that the statement is true and then show that this cannot be directly supported by logical means.

C. Deduce logically from a known fact that the statement cannot be contradictory.

D. Develop logically a contradiction of the statement from a known fact.

51. A party of 7 adults and 7 children travels on a bus journey for which each adult pays the full fare of \$1. A child if accompanied by its father travels free, otherwise it pays half fare. The total fare paid by the party is \$9. On the return journey the party travels by train for which the fares are the same as on the bus except that a child must be accompanied by its mother in order to travel free. If the total fare for the return journey is \$10, how many children in the party are not accompanied by a parent ?

N. None

P. 2

Q. 3

S. 4

T. There is insufficient information supplied to answer the question

52. The cube root of a number squared is 36. The number is

A. 3

B. $\sqrt[3]{6}$

C. 6

D. 12

E. 216

H. 1296

53. $12\frac{1}{2}$ per cent. of a man's gross income is exempt from taxation. The ratio of his gross income to his taxable income is

N. $\frac{8}{7}$

S. $\frac{9}{8}$

P. $\frac{7}{8}$

T. $\frac{1}{8}$

Q. $\frac{8}{9}$

Questions 54–56.

You are sales manager for a fuel refinery, making three different grades of fuel, represented by *P*, *Q*, *R*. The sulphur content and price for each grade is listed in the table.

Grade	<i>P</i>	<i>Q</i>	<i>R</i>
Percentage weight of sulphur ..	2.2	1.8	1.4
Price per ton (\$)	29	31	35

To vary the percentage weight of sulphur content you may mix two or three of the three basic grades. Any fuel, either a pure grade or a mixture is referred to as a sample.

Each statement below consists of two requirements stipulated by a customer.

You are to write

- A. if you can meet neither requirement *X* nor requirement *Y*.
 B. if you can meet requirement *X* and requirement *Y* taken separately but not together.
 C. if you can meet requirement *X* and requirement *Y* taken together with just one sample.
 D. if you can meet requirement *X* and requirement *Y* taken together with more than one sample.
 E. if a case occurs which is not covered by A, B, C, and D.

54. Requirement *X*—a fuel of not more than 1 per cent sulphur.

Requirement *Y*—a fuel costing exactly \$38 per ton.

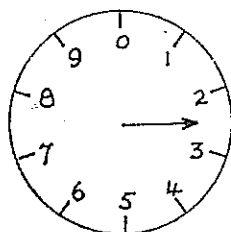
55. Requirement *X*—a fuel of not more than 2 per cent sulphur.

Requirement *Y*—a fuel costing not more than \$30 per ton.

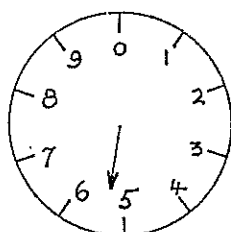
56. Requirement *X*—a fuel of exactly 2 per cent sulphur.

Requirement *Y*—a fuel costing exactly \$31 per ton.

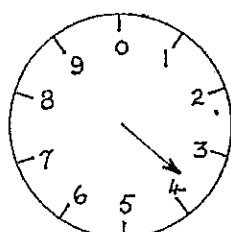
57.



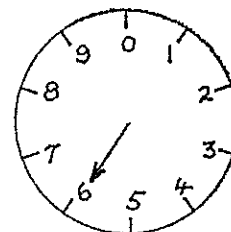
thousands



hundreds



tens



units

The diagram shows the present reading on a special electricity meter. The previous reading was 2196. For the electricity used since the previous reading the first 40 units cost \$3.40 and the remaining units cost 5 cents per unit. What is the cost, to the nearest dollar, of the electricity used since the previous reading?

- N. \$4
 P. \$18
 Q. \$21

- S. \$46
 T. \$51
 V. \$108

58. The cost of painting a cube on all faces is \$2*b* per sq ft if only one coat of paint is applied. It costs \$10 to give a cube of side length *x* ft one coat of paint.

What is the maximum number of complete cubes each of side length $\frac{x}{2}$ ft that can be painted for \$10 if only one coat of paint is given to each?

- A. 2
 B. 4
 C. 5

- D. 8
 E. 16
 H. 20

59. Following an outbreak of an epidemic in the town of Schmerz two doctors made initial and independent recommendations as to the area that should be quarantined. One week later they both decided to change their recommendation.

Doctor X—Initial recommendation—no person be allowed to move more than 10 miles from the Post Office (area 1).

Amended recommendation—no person be allowed to move more than 5 miles from the Post Office (area 2).

Doctor Y—Initial recommendation—all persons be restricted within an area of 300 square miles (area 3).

Amended recommendation—all persons be restricted within an area of 150 square miles (area 4).

With respect to the four areas it is correct to say that

N. area 1 is greater than area 3 and area 2 is greater than area 4.

P. area 1 is greater than area 3 but area 2 is less than area 4.

Q. area 1 is less than area 3 but area 2 is greater than area 4.

S. area 1 is less than area 3 and area 2 is less than area 4.

60. As an abbreviation for " $3 \times 2 \times 1$ " we write $3!$. Similarly " $5 \times 4 \times 3 \times 2 \times 1$ " is represented by $5!$

If $\frac{x!}{(x-1)!} = 8$ what is the value of $\left(\frac{x}{2}\right)!$?

A. $4/7$

B. 4

C. 6

D. 12

E. 24

H. None of these

CHECK YOUR WORK AND REMEMBER THAT YOU SHOULD HAVE WRITTEN ALL YOUR ANSWERS AS LETTERS OF THE ALPHABET