**2020**

**VCE**

**Mathematical Methods**

**Trial Examination 2**

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**Victorian Certificate of Education**

**2020**

###### STUDENT NUMBER

Letter

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| Figures  Words |  |  |  |  |  |  |  |  |  |  |  |
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###### MATHEMATICAL METHODS

**Trial Written Examination 2**

Reading time: 15 minutes

Total writing time: 2 hours

**QUESTION AND ANSWER BOOK**

**Structure of book**

|  |
| --- |
| *Section Number of Number of questions Number of*  *questions to be answered marks* |
| A 20 20 20  B 5 5 60  Total 80 |

* Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, a protractor, set squares, aids for curve sketching, one bound reference, one approved technology (calculator or software) and, if desired, one scientific calculator. Calculator memory DOES NOT need to be cleared. For approved computer-based CAS, their full functionality may be used.
* Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

**Materials supplied**

* Question and answer booklet of 30 pages.
* Detachable sheet of miscellaneous formulas at the end of this booklet.
* Answer sheet for multiple-choice questions.

**Instructions**

* Detach the formula sheet from the end of this book during reading time.
* Write your **student number** in the space provided above on this page.
  + Write your **name** and **student number** on your answer sheet for multiple-choice questions, and sign your name in the space provided to verify this.
  + Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.
* All written responses must be in English.

**At the end of the examination**

* Place the answer sheet for multiple-choice questions inside the front cover of this book.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.**

**SECTION A – Multiple -choice questions**

**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1; an incorrect answer scores 0.

Mark will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

# Question 1

The maximal domain of the function  where  is given by

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 2**

Consider the polynomial , where , then which of the

following is **false**?

**A.** when is divided by  the remainder is 

**B.** when is divided by  the remainder is 

**C.**  has  as a factor.

**D.**  has  as a factor.

**E.**  has  as a factor.

**Question 3**

The graph of the function *f* is obtained from the graph of the function with rule

, where  by a reflection in the *y*-axis, followed by a translation of one

unit to the right parallel to the *x*-axis, followed by a dilation of *a* units away from the *y*-axis.

Which of the following is a possible rule for the function *f* ?

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 4**

The graphs of  and  where  intersect at two distinct points when

**A.** 

**B.** 

**C.** 

**D.**  and 

**E.** 

**Question 5**

The function *f* has the property  for  and 

Which of the following is a possible rule for the function *f* ?

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 6**

Several students were considering the function  where 

Allan stated that the maximal domain  and that the function has no turning points,

as it is a one-to-one function.

Ben stated that the graph crosses the *x*-axis at  and the graph crosses the *y*-axis at .

Colin stated that the graph has a vertical asymptote at  and a horizontal asymptote at 

Then

**A.** Only Allan is correct.

**B.** Only Ben is correct.

**C.** Only Colin is correct.

**D.** Only Ben and Colin are correct.

**E.** All of Allan, Ben and Colin are all correct.

**Question 7**

The graph of  has a stationary point at , then

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 8**

Given that  then  is equal to

**A.** 

**B.** 

**C.** 

**D.** 2

**E.** 3

**Question 9**

Part of the graph of  is shown below. The area of the region bounded by the graph of *f* and the co-ordinate axis is *A*. This area *A* can be approximated by four left rectangles equal to *L*, or four rectangles equal to *R*. Which of the following is **false?**

****

**A.** 

**B.** *L* overestimates *A* by 11.27%.

**C.** *R* underestimates *A* by 11.27%.

**D.** 

**E.** 

**Question 10**

The tangent to the graph of  is parallel to the line with the equation ,

when *x* is equal to

**A.**  and 

**B.**  and 

**C.**  and  where 

**D.**  and  where 

**E.**  where 

**Question 11**

Given that , then  is equal to

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 12**

The random variable *Z*  has the standard normal distribution, with  and , where . Then  is equal to

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 13**

It is found that 25% of students have some sort of mental health problems.

In a class of 30 students the probability that less than 40% have some sort of mental health problems, given that at least 10% have some sort of mental health problems, is closest to

**A.** 0.9388

**B.** 0.9488

**C.** 0.9678

**D.** 0.9753

**E.** 0.9782

**Question 14**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |

The table above shows a value of *x* and values of the differentiable function *f* and *g* and their derivatives. Let *h* be the function defined by , then is equal to

**A.** 36

**B.** 32

**C.** 30

**D.** 18

**E.** 

**Question 15**

Let *R* be the region bounded by the graph of , the vertical line  and the horizontal lines ,  and  Which of the following gives the area of the *R*.

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 16**

The period and range of a function *f* are respectively given by  and  where *p* , *b*

and *c* are all positive constants. Which of the following could be a possible rule for the function *f* ?

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 17**

The random variable *X*  has a binomial distribution with *n* independent trials and a probability of *p* of a success on any one trial, where , and  then  is equal to

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 18**

A box contains *r* red marbles and *b* blue marbles. Jack draws two marbles from the box

without replacement. Jack realizes that the probability that both marbles are the same colour,

is equal to the probability that both marbles are different colours. Which of the following is

**not a** possible set of values for *r* and *b*.

**A.** 

**B.** 

**C.** 

**D.** 

**E.** 

**Question 19**

In a certain forest it is known that heights of the trees follows a normal distribution.

The mean heights of the trees is *H* metres, with a known variance of *V* in square metres.

It is also known that 60% of the trees have heights greater than *D* metres. Then

**A.** 

**B.** 

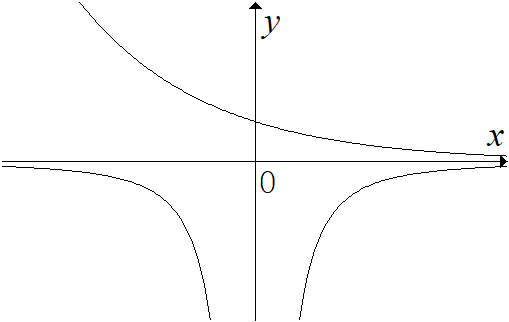
**C.** 

**D.** 

**E.** 

**Question 20**

Parts of the graphs of  and  are shown below.







The corresponding graph of  is best represented as

|  |  |
| --- | --- |
| **A.** | **B.** |
| **C.** | **D.** |
| **E.** |  |

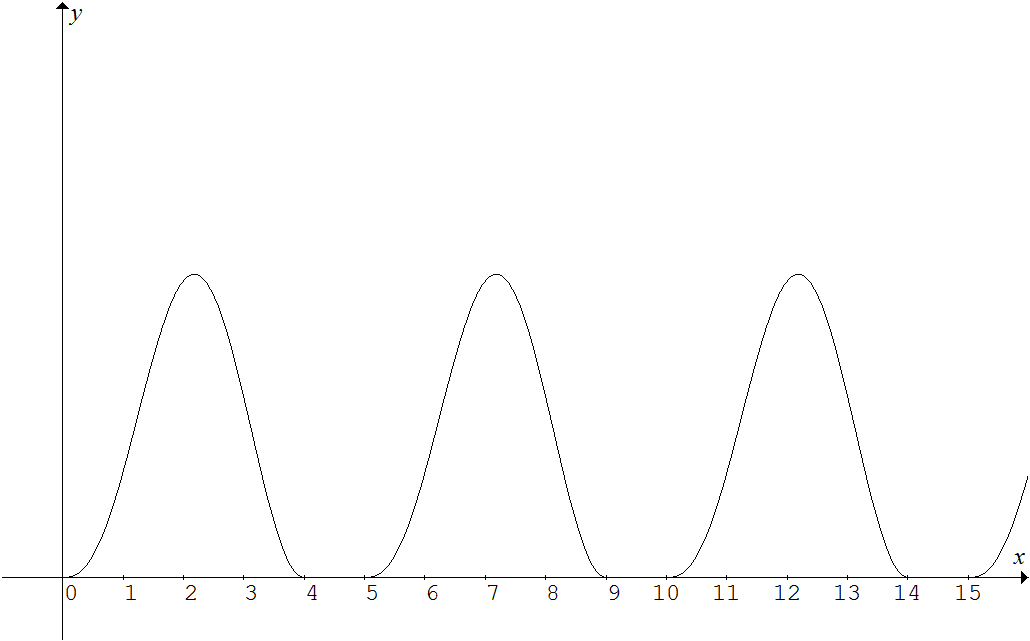
**END OF SECTION A**

**SECTION B**

**Question 1**  (11 marks)

The diagram below shows part of the design of a long symmetric roof structure. Let *x* be the horizontal distance in metres, from the left side of the roof and *y* be the height in metres, above the base of the roof line. The **total** horizontal distance of the roof is 100 metres.

*y*



The first section  is modelled by the function .

The second section  is modelled by the function , with each next section being a further translation of 5 units to the right ( in the positive ) direction parallel to the *x*-axis.

**a.** Find the functions  and  and hence determine ( in terms of *n* ) a function that describes

the *n*th section , for , and state the value of *N*.

3 marks

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**b.** Let *H* metres be the maximum height of the roof.

Find the value of *H*, giving your answer correct to three decimal places.

2 marks

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**c.** Find the average height of the roof, giving your answer in metres correct to three

decimal places.

1 mark

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**d.** Find the total cross-sectional area enclosed by the roof.

Give your answer correct to three decimal places in square metres.

1 mark

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**e.** Find the obtuse angle, that the minimum slope makes with the positive *x*-axis.

Give your answer to the nearest degree.

2 marks

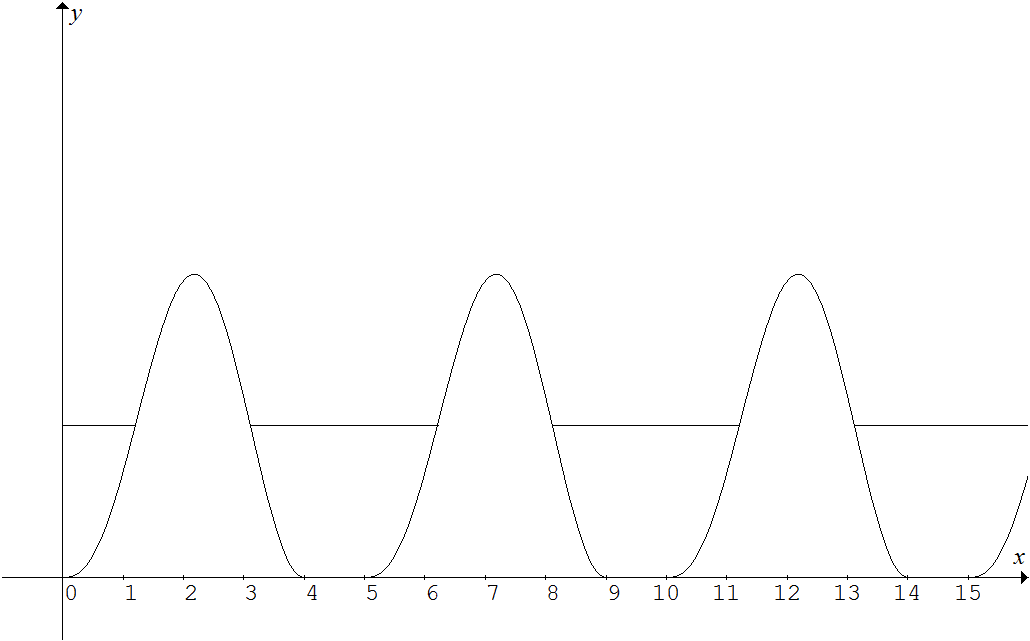
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**f.** To add further support and structure to the roof, supporting horizontal beams as shown

are installed at heights of  as shown in the diagram below.

*y*



*H*



Determine the **total** length in metres of all the supporting beams.

Give your answer correct to one decimal place.

2 marks

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**Question 2**  (8 marks)

The diagram shows the graph of the function , along with a

tangent drawn at the point  where .



**a.** Find in terms of *v*, the equation of the tangent to the graph of  at the point Q.

1 mark

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**b.** This tangent crosses the *x*-axis at the point R and the *y*-axis at the point S.

Find the coordinates of the points R and S.

2 marks

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**c.**  The line segment QN is parallel to the *x*-axis and the line segment QM is parallel to

the *y*-axis. Show that the area *A* of the shaded region is given by.

2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**d.** Find the value of *v* which gives the minimum shaded area and find the minimum shaded area.

3 marks

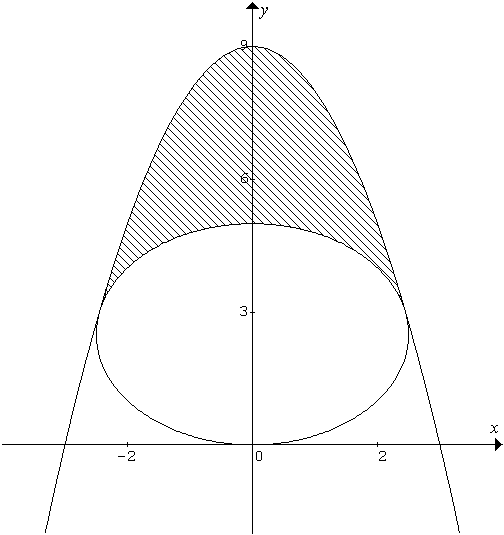
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**Question 3** (13 marks)

The graph of the function  is shown, along with the circle with centre at  and radius *a*, where  with the equation . The circle and the parabola touch at the point , where.



**a.** Find in terms of *u*, the equation of the tangent to the graph of the function *f* at the point *P*.

1 mark

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**b.** Find the gradient of the line segment joining the points *C* and *P*, in terms of *a* and *u*.

1 mark

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**c.** Write down two independent simultaneous equations involving *u* and *a*.

2 marks

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**d.** Hence show that  and 

2 marks

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**e. i.** Write down a definite integral which gives the area of the shaded region.

1 mark

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**ii.** Determine the value of the shaded area giving your answer correct to three decimal

places.

1 mark

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****Consider now the graph of the function , where , along with the circle with centre at  and radius *b*, where  with the equation . The circle and the parabola touch at the point , where.



**f.** Show that  and 

3 marks

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**g. i.** Write down a definite integral in terms of *k* which gives the area of the shaded

region.

1 mark

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**ii.** Determine the value of the *k* for which the area of the shaded region is a minimum.

1 mark

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**Question 4** (18 marks)

The weights of basketballs are normally distributed, with a mean mass of 0.625 kg,

with a standard deviation of 0.02 kg.

**a. i.** Find the probability that a basketball has a weight more than 0.65 kg.

Give your answer correct to three decimal places.

1 mark

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**ii.** What is the probability that a box containing 10 basketballs, more than two have masses

more than 0.65 kg. Give your answer correct to four decimal places.

1 mark

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**iii.** If 60% of basketballs have masses of more than *w* kg. Find the value of *w*, giving your

answer correct to two decimal places.

1 mark

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**b.** The distance that Betty can throw a basketball is known to be normally distributed.

She throws a basketball more than 28 metres on 35% of her throws, and less than 25 metres

on 25% of her throws. Find the mean distance and standard deviation in metres that Betty

can throw a basketball. Give both answers correct to two decimal places.

3 marks

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When shooting for a basket from the three-point line, Colin shoots a basket on 65% of the

time. In a basketball game, Colin has ten shots from the three-point line **c. i.** Find the probability that Colin scores more than six baskets, if it is known he has scored at

least two baskets. Give your answer correct to four decimal places.

2 marks

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**ii.** Find the probability that Colin scores more than six baskets, if it is known that his first two

attempts were baskets. Give your answer correct to four decimal places.

2 marks

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**d.** In a basketball match Dan has *n* shots at shooting a basket. He knows from past experience

that he only scores on 35% of the time. If the probability that he scores at least two baskets

exceeds 85% find the minimum value of *n*.

1 mark

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**e.** Two machines are used to produce basketballs. Machine A produces 60% of the

basketballs and it is found that 8% are defective. A basketball is selected at random and

is found to be defective. The probability that it was produced by machine B is 0.25.

Find the percentage of defective basketballs produced from machine B.

3 marks

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Let *p* be the probability that on any one shot at a basket, Fred scores a basket, where 

In a game Fred has 8 shots at shooting a basket. Let *q* be the probability that Fred scores three or four baskets.

**f. i.** Express *q* as a polynomial in terms of *p*.

2 marks

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**ii.**  Find the maximum value of *q* and the value of *p*, for which this maximum occurs, giving

both answers correct to four decimal places.

2 marks

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**Question 5**  (10 marks)

Consider the function  where *k* is a non-zero real number.

**a.** The function  can be obtained from the graph of  under a transformation,

 ,  Find the values of *a*, *b*, *m* and *n*.

2 marks

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**b.** Find  the inverse **function** *g*.

2 marks

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The point with co-ordinates  lies on the graphs of  and .

**c.** Express *c* in terms of *k*, stating conditions on *k*, given that 

3 marks

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**d.** Let  be the tangent to the curve  at the point  and let  be the tangent

to the curve at the point where , and  If these two tangents  and 

in the first quadrant intersect at an acute angle of  find the value(s) of *k*.

3 marks

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**END OF SECTION B**

**EXTRA WORKING SPACE**

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##### End of question and answer book for the

##### 2020 Kilbaha VCE Mathematical Methods Trial Examination 2

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**MATHEMATICAL METHODS**

**Written examination 2**

FORMULA SHEET

Directions to students

Detach this formula sheet during reading time.

This formula sheet is provided for your reference.

## Mathematical Methods formulas

## Mensuration

|  |  |  |  |
| --- | --- | --- | --- |
| area of a trapezium |  | volume of a pyramid |  |
| curved surface area  of a cylinder |  | volume of a sphere |  |
| volume of a cylinder |  | area of triangle |  |
| volume of a cone |  |  |  |

## Calculus

|  |  |  |  |
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|  | |  | |
|  | |  | |
| product rule |  | quotient rule |  |
| chain rule |  |  | |

## Probability

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|  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Probability distribution** | | **Mean** | **Variance** |
| Bernoulli |  |  |  |
| Binomial |  |  |  |
| normal |  |  |  |

## 

**END OF FORMULA SHEET**

**ANSWER SHEET**

###### STUDENT NUMBER

Letter

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| Figures  Words |  |  |  |  |  |  |  |  |  |  |  |
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###### SIGNATURE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**SECTION A**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **1** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
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| **3** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **4** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **5** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **6** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
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| **11** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **12** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **13** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **14** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **15** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
| **16** | |  | **A** |  | **B** |  | **C** |  | | **D** |  | **E** |  |
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