UNIVERSITY OF CAMBRIDGE

ECONOMICS ADMISSIONS ASSESSMENT

D563/11

Wednesday 31 October 2018

80 minutes

SECTION 1

4097862250

INSTRUCTIONS TO CANDIDATES

Please read these instructions carefully, but do not open this question paper until you are told that you may do so. This paper is Section 1 of 2.

A separate answer sheet is provided for this paper. Please check you have one. You also require a soft pencil and an eraser.

Please complete the answer sheet with your candidate number, centre number, date of birth, and name.

At the end of 80 minutes, your supervisor will collect this question paper and answer sheet before giving out Section 2.

This paper contains two parts, **A** and **B**.

Part A Problem Solving (20 questions)
Part B Advanced Mathematics (16 questions)

You should attempt **both** parts and you are **strongly** advised to divide your time equally between the two parts: 40 minutes on **Part A** and 40 minutes on **Part B**.

This paper contains 36 multiple-choice questions. There are no penalties for incorrect responses, only marks for correct answers, so you should attempt **all** 36 questions. Each question is worth one mark.

For each question, choose the **one** option you consider correct and record your choice on the separate answer sheet. If you make a mistake, erase thoroughly and try again.

You **must** complete the answer sheet within the time limit.

You can use the question paper for rough working, but **no extra paper** is allowed. Only your responses on the answer sheet will be marked.

Dictionaries and calculators may NOT be used.

Please wait to be told you may begin before turning this page.

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PART A Problem Solving

1 I am redecorating my house and need to buy wallpaper for one of the rooms. I need to buy 54 m of wallpaper in total and want to pay the lowest price. The table below shows the details of the five types of wallpaper I want to choose between.

wallpaper type	*roll length*	*cost per roll*	*special offers*
woodchip	2 m	£25	every fifth roll is free
vymura	3 m	£35	10% discount for orders over £500
anaglypta	3 m	£40	20% discount for orders over £500
embossed	4 m	£50	25% discount on all orders
fabric effect	5 m	£100	buy one, get one free

Which type of wallpaper should I choose?

A woodchip

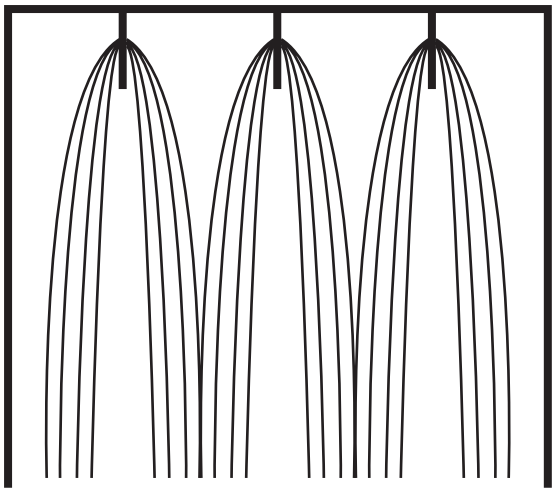
B vymura

C anaglypta

D embossed

E fabric effect

2 The diagram below shows the method of construction of a book with four folded sheets in each block, and three blocks in total. Page one is the first page of the first block of four sheets. At the centre of each block, you can see the stitching that binds the book together.



A book is to be made using the same technique but with eight sheets of paper in each of the three blocks.

Which of the following pairs of pages could be in the centre of a block (that is, if opened there, the stitching would be visible)?

A 46 and 47

B 47 and 48

C 48 and 49

D 63 and 64

E 64 and 65

3 Jake has a 500 ml bottle of orange squash that he has made according to the instructions on the bottle of concentrate. The instructions dictate that he should add 4 parts water to 1 part concentrate. He accidentally spills his squash, and now there is only 400 ml in the bottle. He then tops up the remainder with concentrate.

What percentage of the squash in his 500 ml bottle is now concentrate?

A 18%

B 20%

C 28%

D 36%

E 40%

4 Below is a table showing the value of Lucy's shares. They started at £3.00 in 2011 and in 2016 they were worth £22.68.

year	*share value*
2011	£3.00
2012	£4.20
2013	£6.30
2014	£9.45
2015	£15.12
2016	£22.68

When did Lucy's shares have the biggest percentage increase?

A 2011–2012

B 2012–2013

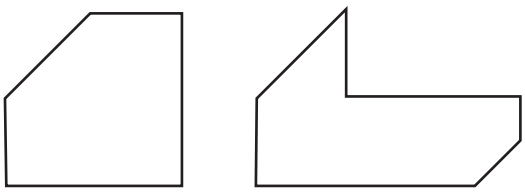
C 2013–2014

D 2014–2015

E 2015–2016

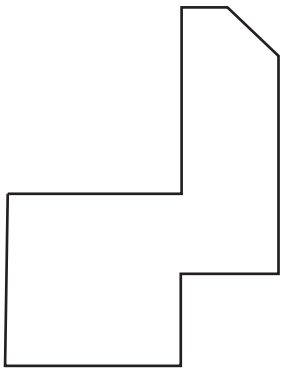
5 Connem Ltd. has recently adopted a new company logo.

A large plastic version of the logo has just been delivered to the office, to be attached to the outside of the building. Unfortunately, in transit, the plastic has broken into two pieces, as shown below:



Which one of the following could **not** be Connem's new logo?

A



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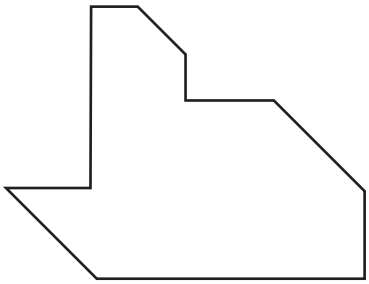

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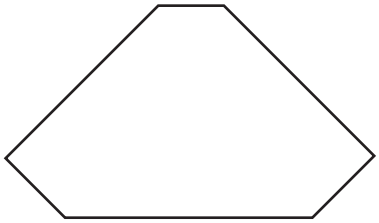

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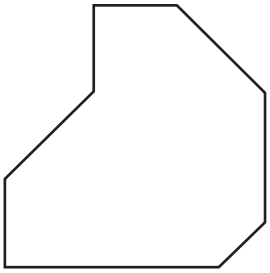

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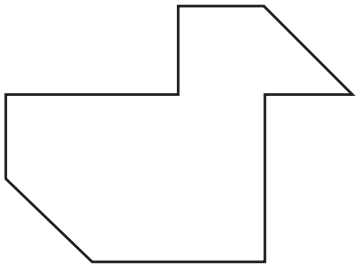


6 A Youth Centre runs a number of football teams for boys of different ages. Each season, one prize is awarded to the player who has given the best all-round performance. Five players have been nominated as possible recipients of this year's prize. The manager has decided not to reward any player who has missed two consecutive training sessions more than twice, and the manager will also exclude anyone who has failed to score a goal from a penalty kick more than twice. After these criteria have been applied, the prize will go to the player who has scored the highest number of goals.

player	*no. of years in a team*	*no. of times late for training*	*no. of times missed two consecutive training sessions*	*no. of penalty kicks taken*	*no. of penalties scoring a goal*	*total no. of goals scored*
David	2	3	2	16	13	32
John	3	2	1	10	9	26
Colin	2	4	1	13	9	30
Mike	1	2	2	12	10	29
Graham	2	0	3	8	7	36

Which player will receive the best all-round performance prize?

A David

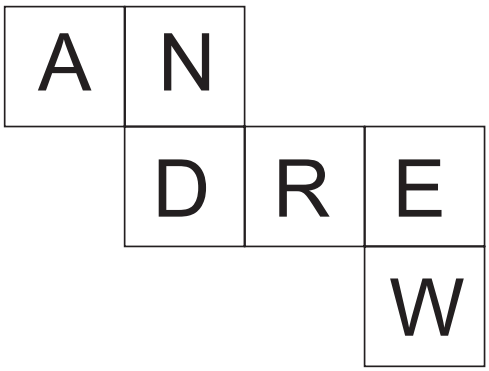
B John

C Colin

D Mike

E Graham

7 The diagram below shows the net of a cube.



The following diagrams show five suggested views of the cube once it has been assembled.

1 2 3 4 5

Which two of the above are possible views of the cube?

A 1 and 2

B 2 and 3

C 3 and 4

D 1 and 4

E 4 and 5

8 Five girls are collecting shells on a beach. They are putting them in buckets that each hold 24 shells. At the end of the collecting time, they are going to ensure that they all have the same number of shells. Four of them are only two short of filling their bucket, but the youngest one is lagging behind with her total. Each of the others give her three shells from their buckets in order to equalise the numbers collected.

How many shells did the youngest girl collect for herself?

A 4

B 7

C 10

D 12

E 19

9 I have a digital clock that works in 24-hour format (that is, after 23:59, it goes to 00:00). The patterns for each number are made up of segments, as shown below:

What is the maximum number of segments that can be displayed at once, while still showing a valid time?

A 20

B 23

C 24

D 26

E 28

10 There is an automatic photograph booth in my local shopping centre. It takes exactly 2 minutes from the time that the money is inserted for the photographs to be taken, then the developed photographs appear 4 minutes later.

Money may only be inserted when the green light is on. This light goes out immediately after money is inserted, and comes back on again exactly 3 minutes later.

This morning, I arrived at the booth just as it was being switched on, and I was sixth in the queue. The first person inserted their money immediately, and the rest of us all inserted our money as soon as we were allowed to.

How long after I arrived at the booth did I insert my money?

A 15 minutes

B 18 minutes

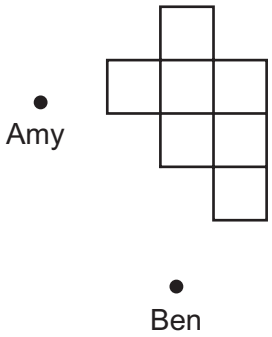
C 21 minutes

D 25 minutes

E 30 minutes

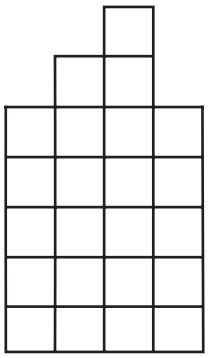
11 A number of identical boxes are piled up, waiting to be loaded into a delivery van. Amy and Ben are about to load them into the van.

The appearance of the pile of boxes and the positions of Amy and Ben at present are shown below:



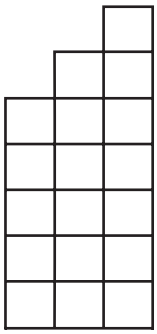
[view from above]

Amy's view of the pile is:

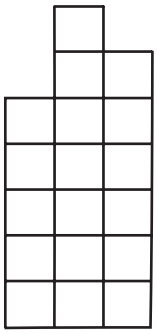


Which one of the following could **not** be Ben's view of the pile?

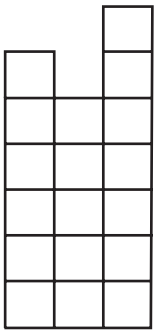
A



B



C



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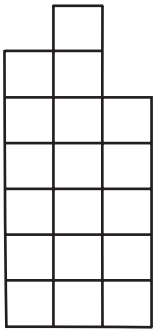
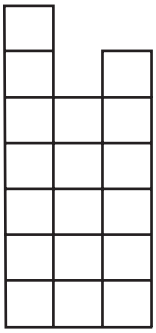


E



12 Recently, packets of Amblers crisps have had 'money-off' coupons inside them. Some coupons are worth 9p, some are worth 14p and some are worth 20p.

George has been collecting these coupons. He has more 14p coupons than 9p coupons, and more 9p coupons than 20p coupons. The total value of all of his coupons is exactly £1.50.

How many coupons has George collected?

A 9

B 10

C 11

D 12

E 13

13 Joanne is studying the period 1900–1950 and has decided to buy a new book to help with her studies. There are five different books available at her local bookshop, the details of which are summarised below:

title	*period covered*	*hardback?*	*illustrated?*	*price*
History of the 20th Century	1900–2000	yes	no	£45
The Illustrated Guide to History	1750–2000	no	yes	£50
Beginner's Guide to History	1700–1850	no	no	£40
History for All	1750–1950	yes	yes	£60
All About History	1800–1900	yes	no	£55

On Tuesday, Joanne chose to buy the cheapest book that would satisfy her requirements, and went away to get the exact amount of money needed to buy it. When she returned the following day to buy her chosen book she found that there was a sale and all of the books had been reduced by 20%. She then decided instead to buy the most expensive book that she could with the money she had, and which still satisfied her requirements.

How much money did Joanne have left over once she had bought the book?

A £0

B £1

C £2

D £3

E £5

14 At the start of the school year, a village shop stocks and sells a range of stationery items. The table below shows details of the wholesale costs and retail prices for a number of the items sold.

items	*wholesale cost per pack of 12*	*retail selling price per 1 item*	*number sold in one week*
crayons	48p	10p	180
felt tips	72p	12p	150
pencils	24p	6p	200
pens	36p	15p	150
rulers	60p	30p	40

Of the five items sold, which two together made the most profit for the shop owner?

A crayons and pencils

B crayons and pens

C felt tips and pencils

D felt tips and rulers

E pens and rulers

15 In the main draw of a lottery, six of the balls (which are numbered from 1 to 49) are selected at random, then the numbers chosen are rearranged and displayed in ascending numerical order.

For instance: 3 17 20 29 34 45

In one draw recently, I noticed that the six numbers were made up of a total of ten digits, all different. The lowest number on this occasion was 1 and the highest number was 49, so the range of the six numbers was 48, the greatest possible range for the lottery main draw.

What is the smallest possible range when the six numbers in the main draw of the lottery have a total of ten digits, all different?

A 21

B 23

C 27

D 31

E 32

16 Car parking charges are shown in the table below. Brian wants to park his car for a period of 7.5 hours, whilst he is at work. He buys a ticket in the morning when he arrives at the car park. Due to the close proximity of the car park to his place of work, he is able to return to his car to buy a new ticket as many times as needed.

up to	*car parking charges*
1 hour	£0.80
2 hours	£1.20
3 hours	£1.70
4 hours	£2.40
5 hours	£3.50
6 hours	£4.20
7 hours	£5.20
8 hours	£6.20
over 8 hours	£8.20

What is the most Brian can save by returning to the car to buy new tickets compared to buying one 8-hour ticket?

A £1.10

B £1.40

C £1.60

D £2.10

E £3.60

17 A car journey begins with a 15 km drive at an average speed of 60 km / hour, then 5 hours on the motorway, including two 15-minute rest stops, travelling at an average driving speed of 80 km / hour, and finally a 20 km drive at an average speed of 40 km / hour from the motorway to the destination.

If the destination is reached at 12:00 midday, at what time did the journey begin?

A 5:18 am

B 5:25 am

C 5:45 am

D 6:15 am

E 6:45 am

18 Fiona is going to put some shelves up in her living room. The shelves must each be 1.80 m long and have a depth of at least 40 cm. There will be five shelves in total. The different prices for wood are shown in the table below.

	depth		
length	*30 cm*	*45 cm*	*60 cm*
0.50 m	$0.90	$1.35	$1.50
1.00 m	$1.70	$2.55	$2.80
1.50 m	$2.50	$3.75	$4.20
2.00 m	$3.30	$4.95	$5.50
3.00 m	$4.80	$7.20	$8.00
4.00 m	$6.20	$9.30	$10.00

Fiona can cut pieces of wood to make more than one piece of the correct size, but she wants each of the shelves to be made of one complete piece of wood.

What is the cheapest total cost for which Fiona can make her shelves?

A $21.15

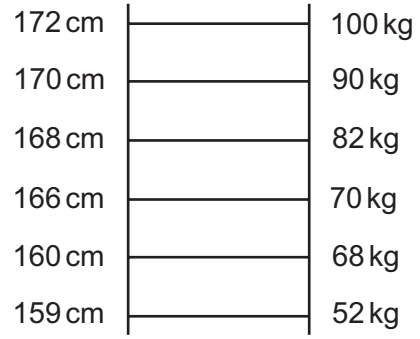
B $23.25

C $23.55

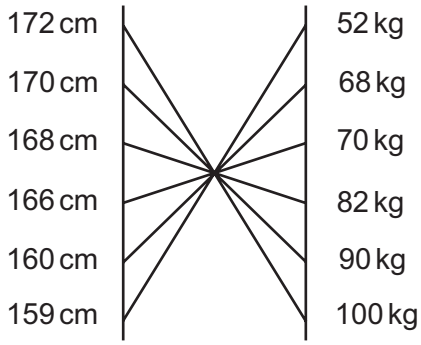
D $24.75

E $25.50

19 Keith likes to draw 'bump charts' to look at relationships. For instance, if 6 individuals were ordered by height, and it happened that the order was the same by weight, the bump chart would look like this:

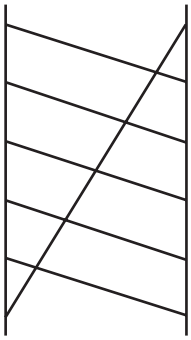


Or if height was maintained for order on the left hand but lightness rather than heaviness on the right hand, the bump chart would be this:

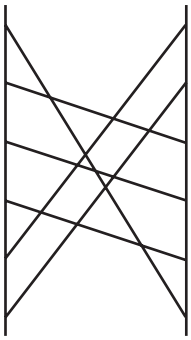


If one axis is reversed in order (as in heaviness goes to lightness), which one of the following bump charts would **not** be symmetrical about a vertical line midway between the axes?

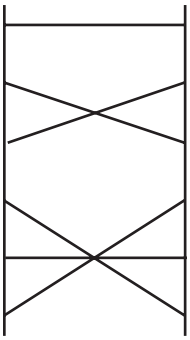
A



B



C



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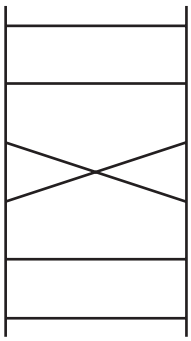
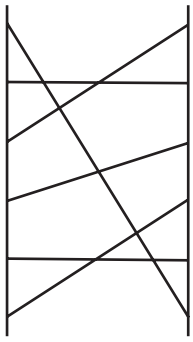


E

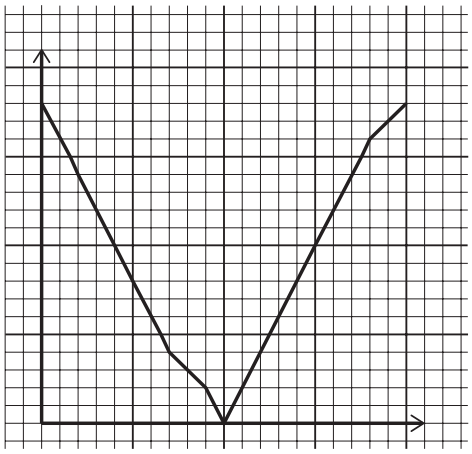


20 A frequent train service runs between Weskham and Eashon, a distance of 18 miles. Most trains stop once during the journey, for 2 minutes at Orthorp, 7 miles from Eashon. When in motion, all trains travel the route at a steady speed of 60 mph.

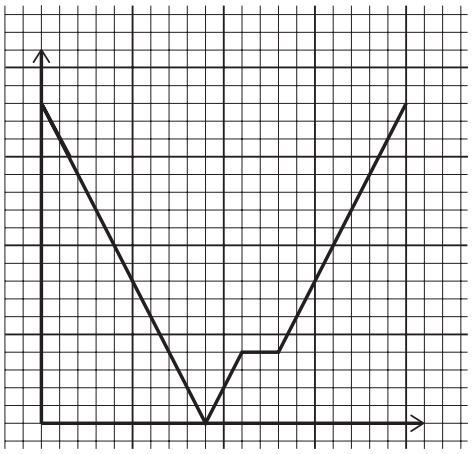
At 2:45 pm, trains leave Weskham and Eashon simultaneously. The train from Weskham stops at Orthorp, but the train from Eashon does not.

Which one of the following graphs, suitably labelled, shows how far apart the two trains are from each other, beginning with the time of departure and ending when they have both reached their final destination?

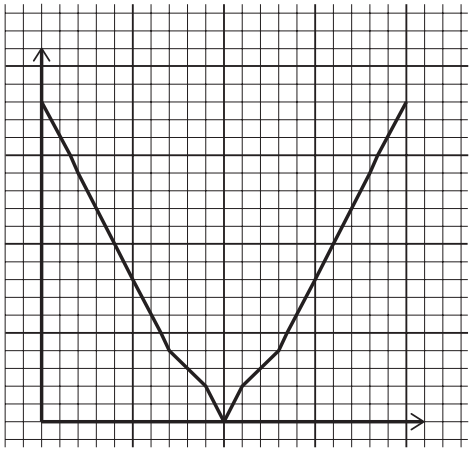
A



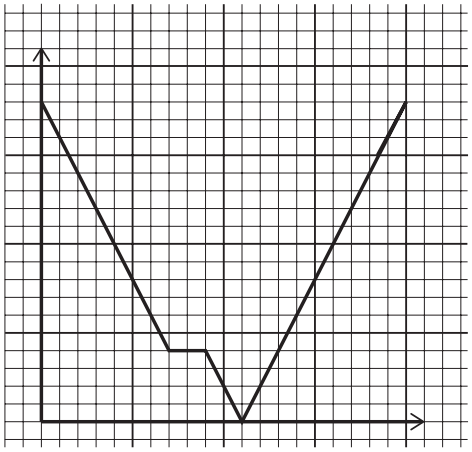
B



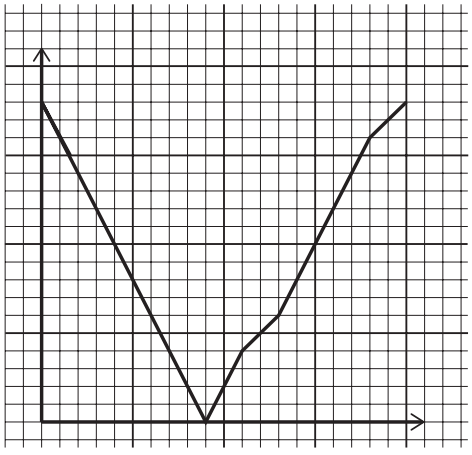
C



D



E



PART B Advanced Mathematics

21 Given that

$$5^{x+1} \times 25^{3x} = 125^{19}$$

what is the value of x?

A 3

B $\frac{9}{2}$

C 8

D 9

E $\frac{19}{4}$

22 The 1st term of an arithmetic progression is non-zero.

The 5th term of this arithmetic progression is the square of the 1st term.

The 33rd term of this arithmetic progression is 10 times the 3rd term.

What is the 10th term?

A 31

B 34

C 39

D 248

E 496

23 In the binomial expansion of $(a + 2x)^6$, where a is positive, the coefficient of x^4 is 1200

What is the value of a?

A $\frac{\sqrt{2}}{2}$

B $\frac{\sqrt{10}}{2}$

C $\frac{\sqrt{15}}{2}$

D $\sqrt{5}$

E $2\sqrt{10}$

24 $ax - 1$ is a factor of $3ax^3 + (6a + 1)x^2 - 4$

a is a non-zero real number.

What are the possible values of a?

A -1 or $-\frac{1}{2}$

B $+\frac{1}{2}$ or $+1$

C -2 or $+\frac{1}{2}$

D $-\frac{1}{2}$ or $+2$

E $-\frac{1}{3}-\frac{\sqrt{7}}{3}$ or $-\frac{1}{3}+\frac{\sqrt{7}}{3}$

F $+\frac{1}{3}-\frac{\sqrt{7}}{3}$ or $+\frac{1}{3}+\frac{\sqrt{7}}{3}$

25 Two fair six-sided dice are identical except for their colour.

Each of the dice has its faces numbered from 1 to 6, with one number on each face.

One of the dice is red and the other is blue.

The two dice are rolled.

The number shown on the red dice is divided by the number shown on the blue dice to give the score.

What is the probability of a score of 0.5?

A 0

B $\frac{1}{36}$

C $\frac{1}{18}$

D $\frac{1}{12}$

E $\frac{1}{6}$

26 The positive real numbers a and b satisfy the simultaneous equations:

$$\log_2 4a - \log_2 b = 4$$

$$\log_2 a + \log_2 2b = 3$$

What is the value of $a - 2b$?

A 0

B $\frac{8}{9}$

C 2

D $\frac{8}{3}$

E 4

F 6

27 A train arriving at Edinburgh has 12 passengers.

The passengers got on the train at three different stations:

5 at Peterborough

4 at Newark

3 at York

The passengers leave the train one at a time in a random order.

What is the probability that the first three to leave did **not** all get on the train at the same station?

A $\frac{3}{11}$

B $\frac{41}{44}$

C $\frac{103}{110}$

D $\frac{19}{20}$

E $\frac{21}{22}$

F $\frac{43}{44}$

G $\frac{54}{55}$

H $\frac{219}{220}$

28 Find the set of values of x such that both $x^2 + x - 6 \geq 0$ and $4 + 3x - x^2 \leq 0$

A $2 \leq x \leq 4$

B $-3 \leq x \leq -1$

C $x \leq -3$ or $-1 \leq x \leq 4$

D $-3 \leq x \leq -1$ or $2 \leq x \leq 4$

E $x \leq -1$ or $x \geq 2$

F $x \leq -3$ or $x \geq 4$

29 The line with equation

$$\left(1+\sqrt{3}\right)y = px + 5$$

is perpendicular to the line with equation

$$y = \left(2-\sqrt{3}\right)x + 8$$

What is the value of p?

A $-5 - 3\sqrt{3}$

B $-5 + 3\sqrt{3}$

C $5 - 3\sqrt{3}$

D $5 + 3\sqrt{3}$

30 S is a geometric progression: $u_1, u_2, u_3, u_4, u_5, u_6, \ldots$

All of the terms in S are positive.

S is split to form two new geometric progressions, O and E.

The terms of O are: $u_1, u_3, u_5, \ldots$

The terms of E are: $u_2, u_4, u_6, \ldots$

The sum to infinity of O is $\frac{8}{9}$, and $u_1 = \frac{2}{3}$

What is the sum to infinity of E?

A $\frac{4}{9}$

B $\frac{5}{9}$

C $\frac{2}{3}$

D $\frac{5}{6}$

E $\frac{8}{9}$

F $\frac{4}{3}$

31 A class of 20 students took a maths test, and their mean mark was 70. The range of these marks was 18.

Five new students joined the class and took the same maths test. When their marks were included, the new mean for the 25 students was 68.

Given only this information, which of the following statements **must** be true?

1 All of the five new students scored 68 marks or less for this test.

2 The mean of the marks for just the five new students was 60.

3 When the marks for the five new students were included, the range of the marks for the class was unchanged.

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

32 The tangents to the curve $y = x^2 - 9$ are drawn at the points where the curve meets the x-axis.

What is the area of the closed region bounded by the curve and the two tangents?

A 9

B 18

C 54

D 72

E 90

33 p is the greatest solution and q is the least solution of the equation

$$y^4 - 15y^2 + 36 = 0$$

What is the value of $2p - q$?

A $3\sqrt{3}$

B $6\sqrt{3}$

C $\sqrt{6}$

D $3\sqrt{6}$

E 6

F 21

34 Consider the statement:

$f(x) > x$ for all real values of $x > 1$

Which one of the following is a negation of this statement?

A $f(x) \leq x$ for all real values of $x \leq 1$

B $f(x) \leq x$ for all real values of $x > 1$

C $f(x) \leq x$ for at least one real value of $x \leq 1$

D $f(x) \leq x$ for at least one real value of $x > 1$

E $f(x) > x$ for at least one real value of $x \leq 1$

F $f(x) > x$ for at least one real value of $x > 1$

G $f(x) > x$ for no real values of $x \leq 1$

H $f(x) \leq x$ for no real values of $x > 1$

35 A cubic polynomial is given by $f(x) = x^3 + bx^2 + cx + d$ where b, c and d are constants.

Two of its factors are $(x - 1)$ and $(x + 1)$

Which of the following statements, taken independently, is/are **necessarily** true?

1 **If** $f(0) = k$ **then** $f(k) = 0$

2 $f(x) = x^3 - x$

3 The graph of $f(x)$ is symmetrical in the y-axis.

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

36 In this question, x and y are non-zero real numbers.

Consider the three statements:

1 $x > y$ **if** $\frac{x}{y} > 1$

2 $\frac{x}{y} > 1$ **if and only if** $\frac{y}{x} < 1$

3 **If** $xy < 1$ **then** both $x < 1$ and $y < 1$

Which of these statements, taken independently, is/are true?

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

END OF TEST