UNIVERSITY OF CAMBRIDGE

Admissions Testing Service

ECONOMICS ADMISSIONS ASSESSMENT   D563/11

Wednesday 2 November 2016   80 minutes

SECTION 1

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 (22 questions)
Part B	Advanced Mathematics (15 questions)

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

This paper contains 37 multiple choice questions. There are no penalties for incorrect responses, only marks for correct answers, so you should attempt all 37 questions. Each question is worth one mark.

Questions ask you to show your choice between options. 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 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.

This question paper consists of 33 printed pages and 3 blank pages.

PV6

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PART A Problem Solving

1 I have booked a flight from London to Auckland, which is in a time zone 12 hours ahead of GMT. I am due to leave London at 17:30 GMT on 19 August and will arrive in Auckland at 06:15 on 21 August (local time). My journey includes a 1-hour stop in Los Angeles and a 1.5-hour stop in Hawaii.

How many hours am I due to spend in the air?

A 12¾

B 22¼

C 23¼

D 24¾

E 34¼

2 Anton wants to ride one of the top 8 roller coasters in the world to celebrate his 13th birthday. The top 8 roller coasters are spread around the world. Anton has to decide which roller coaster to visit, taking into consideration:

- Anton's height: 143 cm

- $400 maximum for two one-way flights

- The roller coaster must reach at least 90mph

- Queue time is no longer than 40 minutes

Roller coaster location	Min height requirement (cm)	Speed (mph)	Highest drop (ft)	Flight cost (one way) ($)	Average queue time (mins)
Ring Racer, Rheinland-Pfalz	140	135	123	688	13
Dodonpa, Yamanashi	121	107	170	400	25
Goliath, California	155	85	235	267	50
Superman, California	122	100	415	267	33
Intimidator 305, Virginia	145	90	305	188	24
Top Thrill Dragster, Ohio	150	120	420	99	27
Voyage, Indiana	138	67	154	102	10
Kingda Ka, New Jersey	122	128	456	56	39

Which roller coaster will Anton choose to ride?
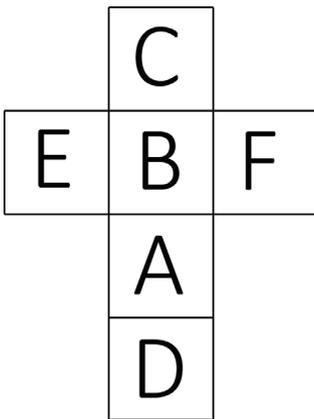
A   Intimidator 305

B   Dodonpa

C   Kingda Ka

D   Superman

E   Voyage

3   A cube is labelled with six letters and, when viewed in two positions, looks like this:
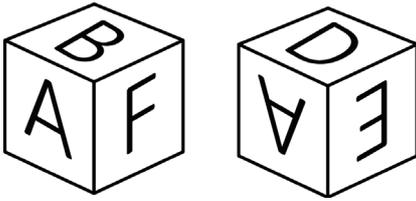
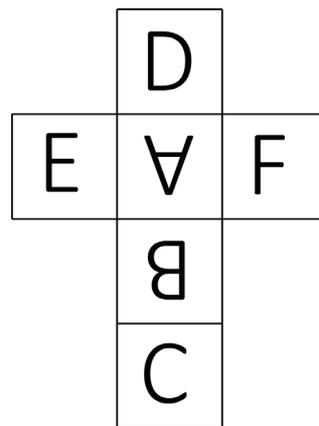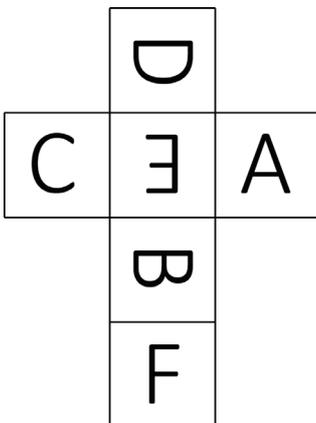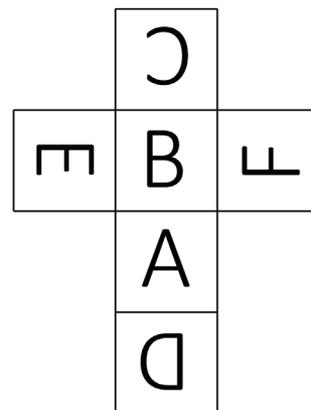Which one of the following nets could be folded to make the above cube?
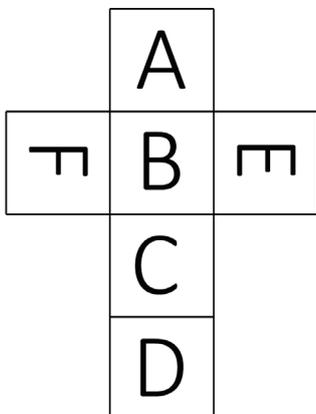
A

B

C

D

E

4 Three night security guards, Robert, Sheila and Tom, are assigned to guard a factory for five consecutive nights, Monday night to Friday night inclusive.

Two of the guards are to be on duty each night. Tom must be on duty for four nights and Robert and Sheila are on duty for three nights each. Regulations do not allow any guard to work for more than two consecutive nights.

If Robert is on duty on Friday night, then the nights when Sheila is on duty are

    A   Monday, Tuesday, Thursday.

    B   Monday, Tuesday, Friday.

    C   Monday, Wednesday, Thursday.

    D   Monday, Wednesday, Friday.

    E   Tuesday, Wednesday, Friday.

5 As a treat for my sixth birthday I am going swimming with my family next Saturday afternoon. My mum is a nurse and my dad is unemployed. My sister is three years younger than me and my brother is two years older but they will both enjoy the treat too. Grandma is coming but she will watch rather than swim. Grandpa loves swimming even though he is nearly 72 years old, so he will be in the pool enjoying the swim.

The charges at the local swimming centre are shown below:

| Admission for:	Peak Times	Off-Peak Times
Adult	£3.80	£2.90
Unemployed Adult	£2.10	£1.50
Child/Senior Citizen (over 65 years)	£1.90	£1.50
Family ticket (2 adults and 2 children)	£9.50	£7.10
*Concession family ticket (2 adults and 2 children)	£4.80	£3.60
Family ticket (1 adult and 2 children)	£5.70	£4.30
*Concession family ticket (1 adult and 2 children)	£3.60	£2.85
Spectators	£0.70	£0.50
Under 4s	free	free

*Adults must be Unemployed or Senior Citizens
Off-peak – Monday to Friday 9 am to 5 pm
Peak – all other times and school holidays

What is the lowest price that we could pay for our tickets?

A £7.00

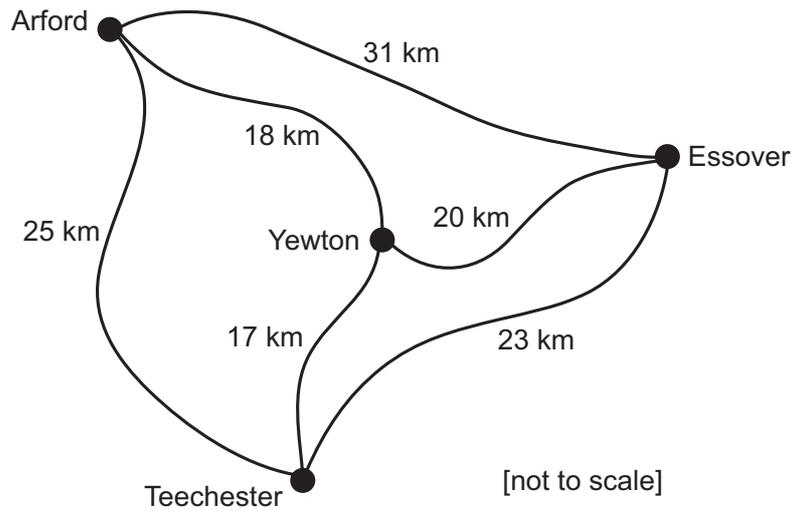**B** £9.10

C £9.30

D £12.10

E £12.30

6 The floor of the reception area of the head office of Stott and Walsh is tiled as shown below:
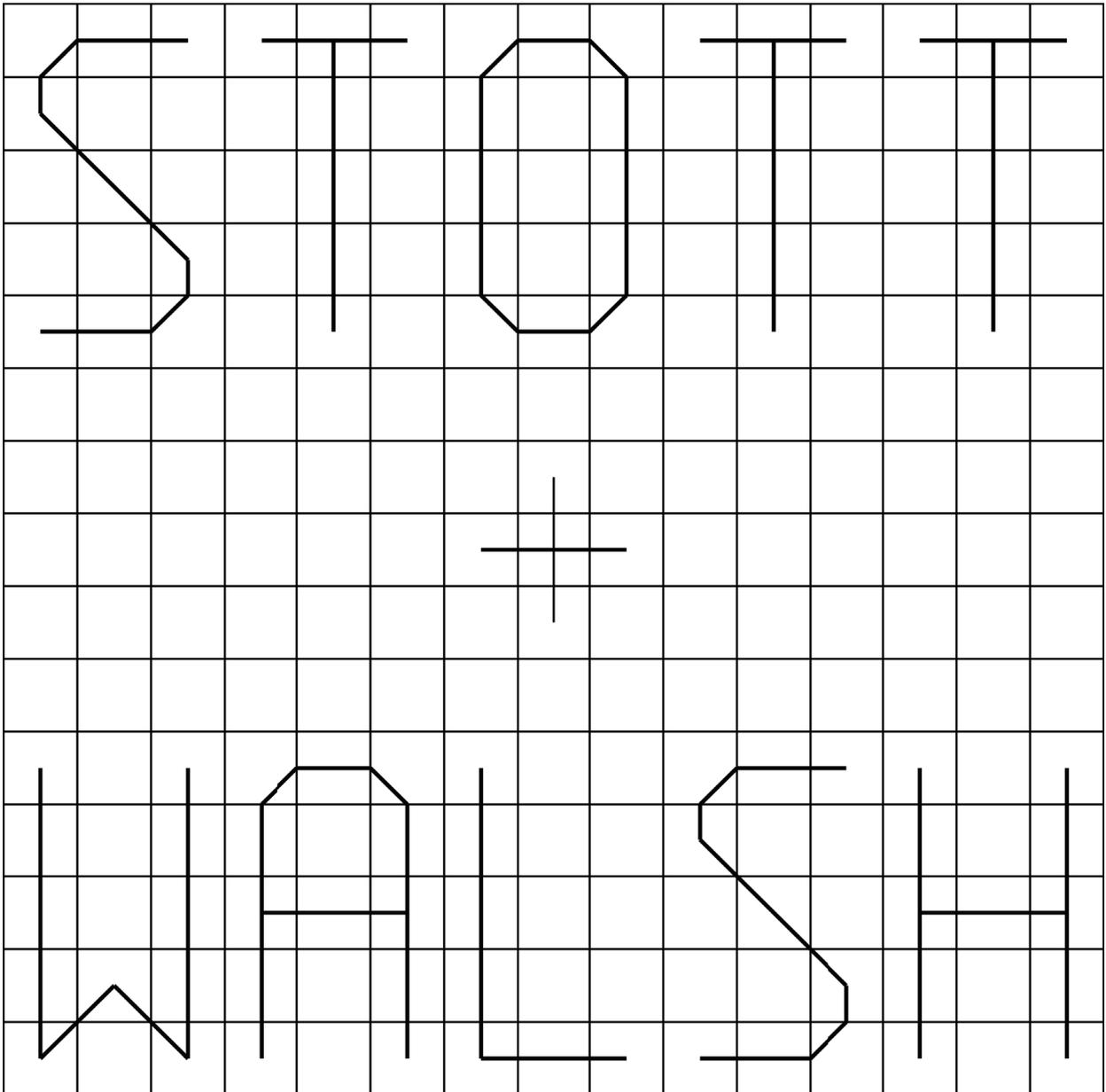
Which one of these tiles could **not** be used to replace a damaged tile on this floor?

A   B   C

D   E

[Turn over

7   This diagram shows the roads that connect four towns and the distances involved.

I live in Essover. This afternoon I have to visit clients in Arford, Teechester and Yewton before returning to Essover. It does not matter in which order I visit the clients.

What is the minimum distance I could travel this afternoon?

A   78 km

B   83 km

C   86 km

D   89 km

E   93 km

**8**   The following is from a report on road accidents in Scotland in 1998:

A total of 13,828 car users were injured in road accidents, representing 62% of all casualties. Of these people, a total of 2,386 were either fatally or seriously injured, 223 of whom died. Roads in built-up areas accounted for a little over half of all car-user casualties (53%: 7,389 out of 13,828). Presumably because average speeds are higher in non-built-up areas, they accounted for much higher percentages of the total numbers of car users who were fatally injured (84%: 187 out of 223) or were fatally or seriously injured (72%: 1,724 out of 2,386).

How many car users suffered serious, but not fatal, injuries in accidents on roads in Scotland in non-built-up areas in 1998?

A   1,537

B   1,724

C   2,199

D   6,439

E   7,389

9 One of the exhibits in the Interactive Art Exhibition at the Hanson Gallery consists of 16 identical free-standing cubes. Visitors to the exhibition are invited to handle these cubes and rearrange them to create their own work of art.

This is the arrangement that I have made:
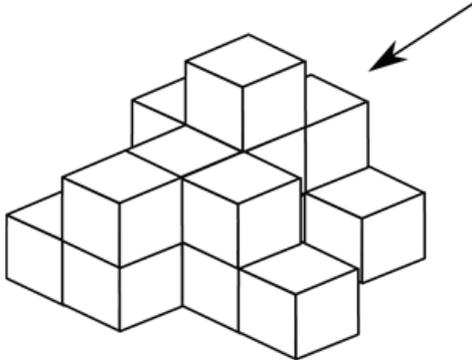
What is the side view of my arrangement from the direction indicated by the arrow?

A

B

C

D

E
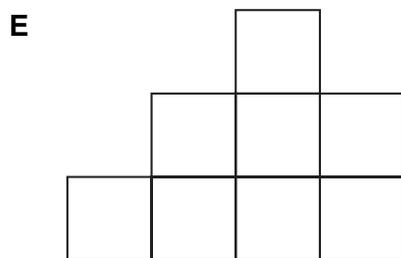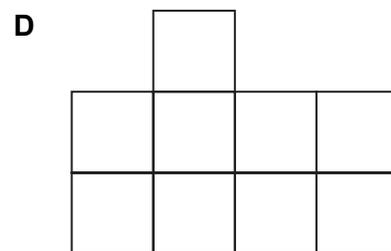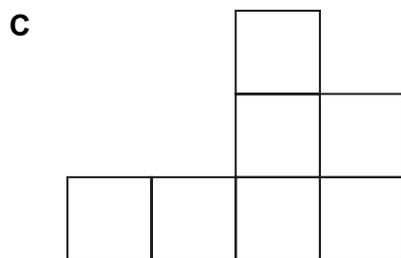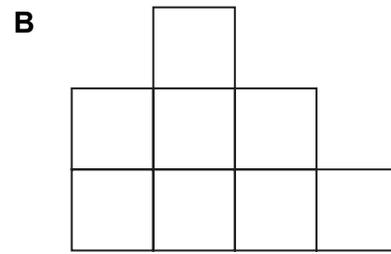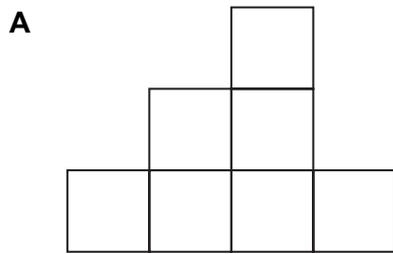
10 Last night I took part in a quiz night, and my team won first prize.

The quiz consisted of three rounds:

Round 1 was 20 easy questions worth 1 point each;

Round 2 was 20 medium questions worth 2 points each;

Round 3 was 20 hard questions worth 5 points each.

Our winning score was 138 points, having answered just nine questions incorrectly.

The runners-up were annoyed because they had fewer incorrect answers, but fortunately for us (although a little embarrassing) we had more incorrect answers in Round 1 (the easy questions) than in either of the other two rounds.

How many questions did we answer incorrectly in Round 1?

A 4

B 5

C 6

D 7

E 8

11 I need to buy new printer paper for my fax machine. The paper comes in rolls. My machine needs paper 210 mm wide and will take a roll up to 25.4 mm in diameter.

I do not really care how long the paper in the roll is and will buy rolls in bulk if they are cheaper. I will just buy the most economical paper to use. I cannot, however, afford to spend more than £30.00.

The prices in the catalogue are as follows:

Width (mm)	Length (m)	Diameter (mm)	Single rolls			Packs of 6 rolls		
			RRP	Price	Saving	RRP	Price	Saving
216	100	25.4	£12.84	£7.99	38%	£77.04	£39.54	49%
210	25	12.7	£4.16	£2.49	40%	£24.96	£13.14	47%
210	100	25.4	£12.13	£7.49	38%	£72.78	£38.10	48%
210	100	50.8	£12.24	£7.59	38%	£73.44	£38.94	47%
210	50	25.4	£6.62	£4.19	37%	£39.72	£20.94	47%

(RRP=Recommended Retail Price)

How much will the transaction cost me?

A £2.49

B £4.16

C £7.49

D £20.94

E £24.96

12 After having some carpets fitted recently I was left with these five remnants.

V   W   X   Y   Z
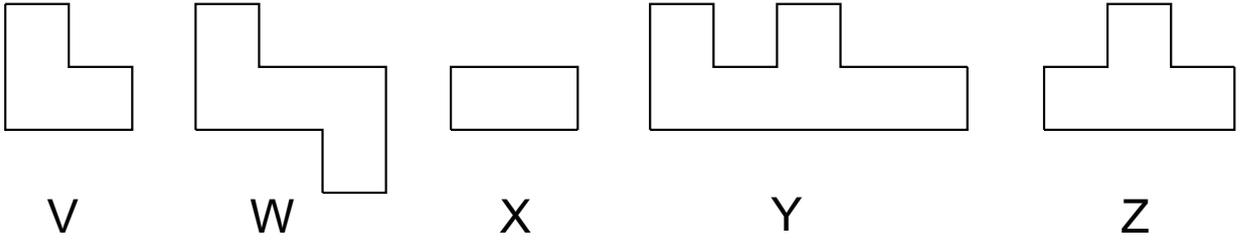
I have stitched four of these pieces together to create a rectangular 'patchwork' mat whose length is twice its width.

Which one of the pieces is **not** part of my mat?

A   V

B   W

C   X

D   Y

E   Z

13 A company is producing a one-page flysheet 24 cm high by 18 cm wide. It will have a text area in the centre which has a margin of the same width all the way around. The text must occupy exactly half of the total area:
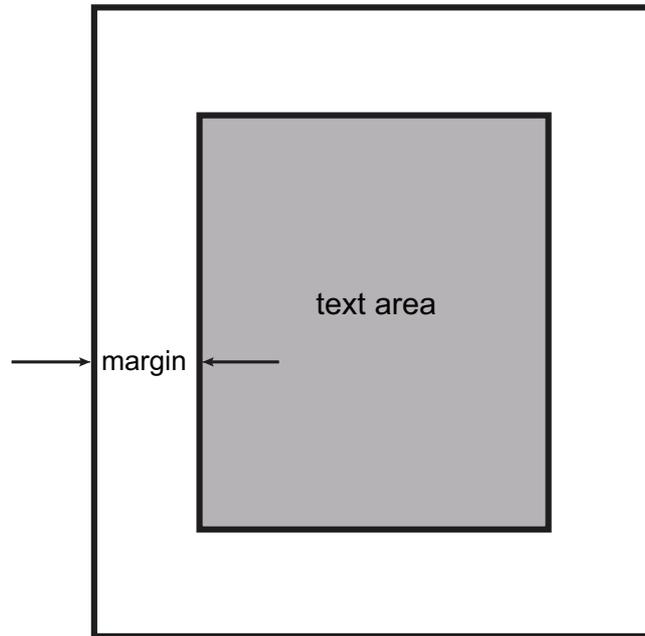
What is the width of the margin?

A 3.00 cm

B 4.50 cm

C 5.25 cm

D 6.00 cm

E 12.00 cm

14 Daria and her three friends are planning a trip to London to see a musical in the West End. Ticket prices vary according to the location of seats in the theatre. Monday to Friday, Balcony seats are £78.20 per person; seats in the Dress Circle cost £95.50 per person; seats in the Grand Circle £88.99 per person; and seats in the Orchestra Stalls £82.00 per person.

At the weekend (Saturday and Sunday), Balcony seats are £81.35 per person, seats in the Dress Circle cost £99.99 per person; seats in the Grand Circle £93.20 per person; and seats in the Orchestra Stalls £86.00 per person.

The theatre also sells Boxes which seat four people and cost £320.00 in total. A special offer of 15% off group booking for four or more people is available on seats in the Dress Circle.

Daria and her friends decide that they want to sit together in the same part of the theatre. What is their cheapest option?

A Balcony

B Box

C Dress Circle

D Grand Circle

E Orchestra Stalls

15 Bob, Eve, Nan, Pip and Viv took part in a 6-hour sponsored bowling marathon to raise money for charity. They were all sponsored per complete 100 points scored.

Bob was sponsored for a total of £63 per 100 points.

Eve was sponsored for a total of £56 per 100 points.

Nan was sponsored for a total of £72 per 100 points.

Pip was sponsored for a total of £54 per 100 points.

Viv was sponsored for a total of £68 per 100 points.

During the 6-hour marathon:

Pip scored 2,835 points.

Eve scored 2,782 points.

Bob scored 2,407 points.

Viv scored 2,293 points.

Nan scored 2,169 points.

Remarkably, four of them raised exactly the same amount. Who raised a different amount to the other four?

A Bob

B Eve

C Nan

D Pip

E Viv

16 The payment systems which use pre-paid magnetic swipe cards are not all that wonderful. We had one put into the office last week to operate the tea and coffee dispensing machine. I was somewhat surprised to find, after having five coffees, that I had spent 121 p, and my colleague, after four teas, had spent 82 p. We were assured that there had been no changes in the prices; the problem appears to be that if you ask the machine how much you have left, it deducts a 'service' charge for this 'service'. We both enquired once. Charges for tea, coffee and service are whole numbers.

What is the minimum that the service charge could be?

A 1 p

B 2 p

C 4 p

D 6 p

E 14 p

[Turn over

17 I have a square field which is exactly one hectare (100 m × 100 m). On Monday I was surprised to find 4 mushrooms growing in a 1 m square formation, in the centre of my field. On Tuesday the group of mushrooms had expanded to 16, which were all 1 m apart.
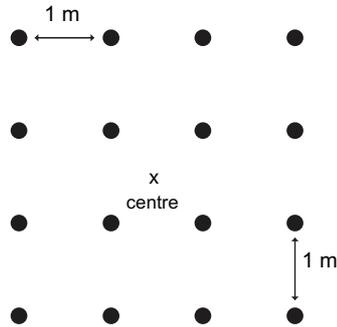
When I looked at the group of mushrooms today (Wednesday), it had expanded to 36.
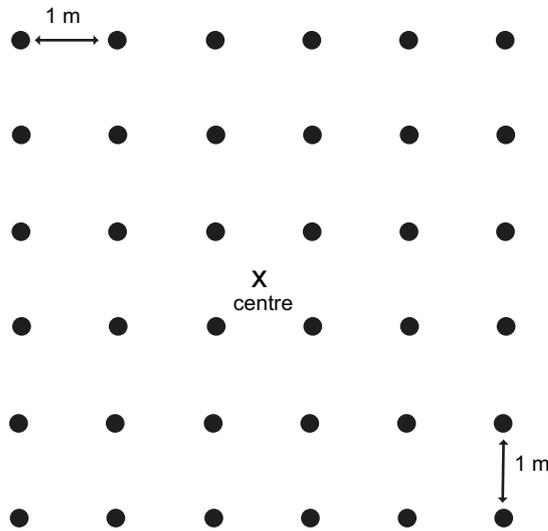
If the area covered by mushrooms continues to expand at this rate, how many days (including today) will it be until my field is covered in mushrooms?

A 48

B 50

C 96

D 100

E 192

18 Water was poured into five containers at a steady rate until each was full. A graph of the depth of water (h) in the container against time (t) was sketched for each container. One of the graphs has been lost.
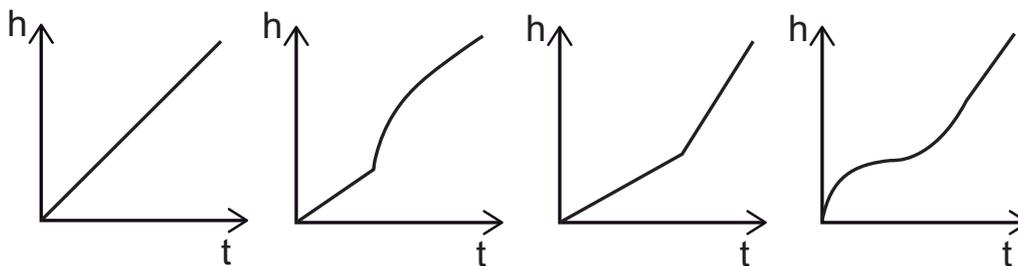
Which one of the following containers is **not** represented by any of the above graphs?

A
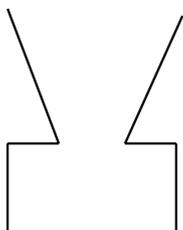
B
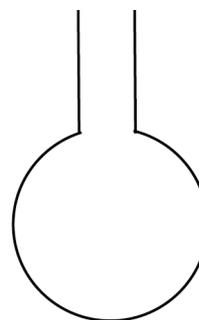
C

D
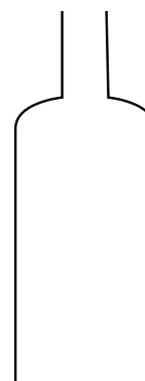
E
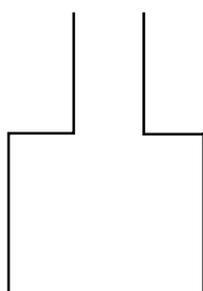
19 Anna buys potatoes in the local market. She has noticed that the price on Saturday morning is 5 p per kilo more than the normal weekday price. However, an hour before the stall closes on a Saturday afternoon, the price drops to 5 p per kilo below the weekday price. She spends £3.00 a week on potatoes. This will buy her 3 kilos less in weight on a Saturday morning than on a weekday, but 5 kilos more in weight at the low Saturday afternoon price than on a weekday.

What is the weekday price of potatoes per kilo?

A 12 p

B 15 p

C 20 p

D 25 p

E 30 p

20 Mike wants to buy a second-hand car that offers the lowest depreciation per mile. He is not worried about the model. His family insist that the car has 4 or 5 doors and an engine of at least 1.6 litres so that it can tow a caravan. Mike plans to keep the car until it has covered 100 000 miles and then sell it for £1,000. He scans the following price list from his local garage:

Make	Model	Engine	Mileage	Price
Ford	Escort 3 door	1.6 litre	70 000	£2,500
Rover	214 SLi 3 door	1.4 litre	30 000	£4,500
Rover	414 Si 4 door	1.4 litre	40 000	£4,500
VW	Golf CL 3 door	1.6 litre	95 000	£1,200
Rover	820 4 door	1.6 litre	30 000	£7,000
Vauxhall	Vectra 3 door	1.8 litre	10 000	£8,000
Vauxhall	Astra 3 door	1.4 litre	50 000	£3,500
Ford	Escort 5 door	1.4 litre	40 000	£4,000
Renault	Clio 3 door	1.6 litre	80 000	£2,000
Renault	Laguna 5 door	1.8 litre	20 000	£7,000
Rover	825 4 door	2.5 litre	90 000	£1,500
Ford	Sierra 4 door	2.0 litre	70 000	£2,000

Which make of car does Mike buy?

A Ford

B Rover

C VW

D Vauxhall

E Renault

21 The population pyramid below shows the age and gender distribution of the residents in England and Wales in 2010.

England and Wales Population 2010

	Male	Age	Female	
	417900	85+	856400	
	545800	80-84	786900	
	797200	75-79	977800	
	1031200	70-74	1153800	
	1253700	65-69	1343700	
	1635200	60-64	1707800	
	1551600	55-59	1605100	
	1731600	50-54	1770000	
	1994500	45-49	2041700	
	2043200	40-44	2069800	
	1862900	35-39	1882100	
	1745000	30-34	1718100	
	1926300	25-29	1844800	
	1963300	20-24	1855700	
	1784500	15-19	1680500	
	1615100	10-14	1542900	
	1565800	05-09	1497900	
	1399400	01-04	1330700	
	364400	<1	346200	

Which one of the following statements is not true?

A Over the age of 34, the number of women is higher than that of men for every age group.

B Below the age of 35, the number of men is higher than that of women in every age group.

C There are more than twice as many women as men in the 85+ age group.

D Not taking children below the age of 1 into consideration, the least numerous age group is that of people aged 80 to 84.

E The most numerous age group consists of people aged between 40 and 44.

22 The planet Melpomene has three moons, Othello, Hamlet and Romeo, each moving at a constant speed in the same direction in circular orbits.
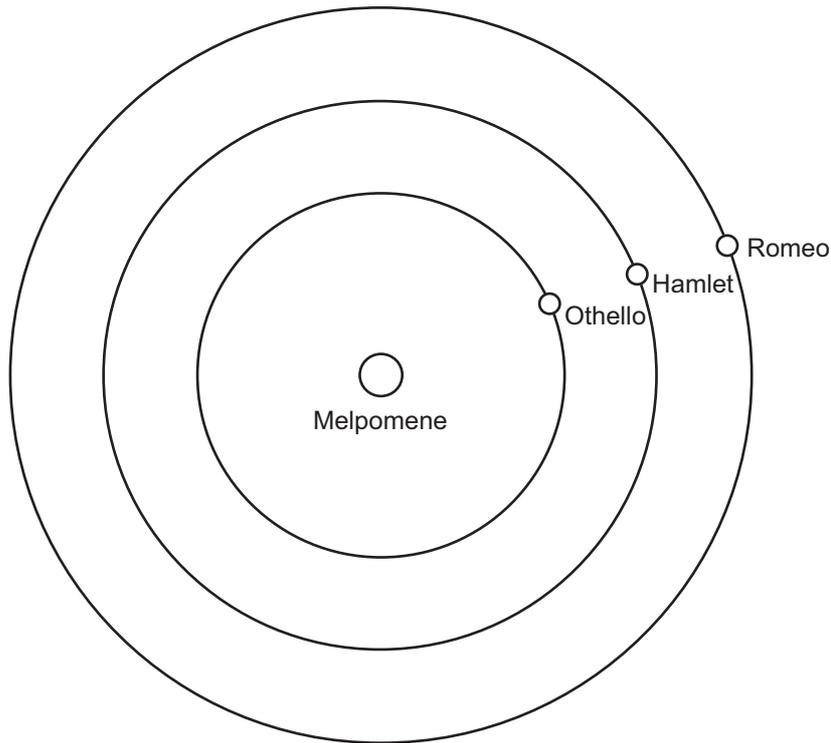
Othello takes 20 days to complete one orbit of Melpomene, whereas Hamlet takes 45 days and Romeo takes 120 days.

How often are Melpomene and all three of its moons in line with each other in the order shown in the diagram?

A   every 36 days

B   every 72 days

C   every 132 days

D   every 180 days

E   every 216 days

[Turn over

PART B Advanced Mathematics

23 The first three terms of a geometric series are equal to the first, fifth and sixth terms respectively of an arithmetic series.

Given that the terms in the geometric series are all different, find the value of the common ratio.

A -1

B $-\dfrac{4}{9}$

C $-\dfrac{1}{4}$

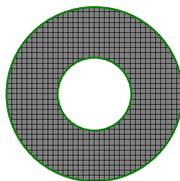**D** $\dfrac{1}{4}$

E $\dfrac{4}{9}$

F 1

24 One of the roots of the equation $2x^2 + 9x - k = 0,$ where k is a constant, is 4 more than the other root.

The value of k is

A $-\dfrac{77}{8}$

B $-\dfrac{73}{8}$

C $-\dfrac{65}{8}$

D $-\dfrac{17}{8}$

E $\dfrac{55}{8}$

F $\dfrac{175}{8}$

[Turn over

25 The diagram shows the cross section of a cylindrical roll of paper towels which are used in domestic kitchens.

[diagram not to scale]

The roll consists of 64 towels, each of which is a square of side 250 mm, and they are tightly wrapped around an inner cardboard tube of diameter 5 cm. The outer diameter of the roll is 11 cm and the length of the cylinder is 25 cm.

The thickness of an individual towel, in millimetres, is estimated from this information.

Which one of these estimates is the best?

A   0.01 mm

B   0.05 mm

C   0.1 mm

D   0.5 mm

E   1 mm

F   2 mm

26 Each of the positive real numbers a, b, c, and d is increased by 20%.

What is the resulting percentage increase in the value of the expression $\dfrac{abc}{2d} + \dfrac{3bcd}{a+b+c}$?

A   20%

B   40%

C   44%

D   88%

E   92%

F   116%

G   It depends on the values of a, b, c, and d.

27   A sector of a circle of radius x cm contains an angle of θ radians.

The perimeter of the sector is 12 cm.

What is the maximum possible value of the area of the sector, in square centimetres, as x varies?

[The area of a sector of radius r containing an angle of θ radians is $\dfrac{1}{2}r^2\theta$

The length of an arc subtended by an angle θ radians is $r\theta$, where r is the radius.]

A   3

B   6

C   9

D   18

E   27

[Turn over

28   The diagram shows a partial **sketch** of the curve $y = 2x^3 - 9x^2 + 12x + p$ where p is constant.

[diagram not to scale]
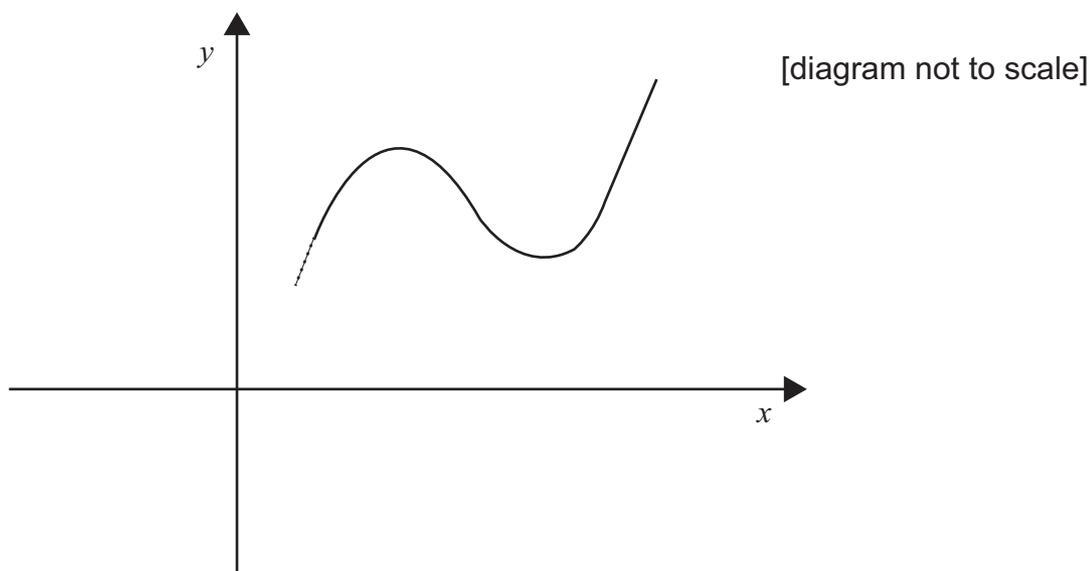
The curve cuts the x-axis at one point only and does not touch the x-axis at any other point.

The y-coordinates of the turning points of the curve are both positive.

Find the complete range of values of p.

A $p > -5$

B $p > -4$

C $-5 < p < -4$

D $4 < p < 5$

E $p > 4$

F $p > 5$

29   Find all possible positive values of x for which $2 + 2\log_5 x = \log_5 (24 + 10x)$ is true.

A $5 \pm 2\sqrt{6}$

B $\dfrac{6}{5}$

C $2\sqrt{6}$

D $\dfrac{4}{5}$

E   There are no values of x.

30   Last Saturday, Jez visited his friend in a neighbouring town.

He cycled the first 5 km at an average speed of 10 km/h and then immediately caught a bus which travelled the remaining 10 km at an average speed of 30 km/h.

What was Jez's average speed for the whole journey?

A   12.5 km/h

B   18 km/h

C   20 km/h

D   22 km/h

E   28 km/h

31   Find the total area enclosed between the curve $y = x(x+a)(x-2a)$, the x-axis and the lines $x = -a$ and $x = a$, where a is a positive constant.

A $\dfrac{2}{3}a^4$

B $\dfrac{5}{6}a^4$

C $\dfrac{4}{3}a^4$

D $\dfrac{3}{2}a^4$

E $\dfrac{7}{2}a^4$

[Turn over

32 A curve has equation $y = 3x^2 + 2$ and a line has equation $y = 5x - 6$

What is the shortest distance parallel to the y-axis between the curve and the line?

A $\dfrac{5}{6}$

B $\dfrac{11}{6}$

C $\dfrac{49}{12}$

D $\dfrac{71}{12}$

E $\dfrac{73}{12}$

33 A bag only contains $2n$ blue balls and n red balls. All the balls are identical apart from colour.

One ball is randomly selected and not replaced. A second ball is then randomly selected.

What is the probability that at least one of the selected balls is red?

A $\dfrac{n-1}{3(3n-1)}$

B $\dfrac{3n-1}{3(3n-1)}$

C $\dfrac{4n-2}{3(3n-1)}$

D $\dfrac{4n}{3(3n-1)}$

E $\dfrac{5n-1}{3(3n-1)}$

F $\dfrac{5n-5}{3(3n-1)}$

34 The real numbers a, b and c are non-zero and $a \le b$

Consider these three statements:

1 $\quad \dfrac{1}{a} \ge \dfrac{1}{b}$

2 $\quad 2^a \le 2^b$

3 $\quad ac \le bc$

Which of the above statements **must** be true?

A none

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

35 A curve has the equation $y = ax^3 + bx^2 + c$

The curve has a maximum stationary point at $x = 0$ and a minimum stationary point in the 4th quadrant (that is, the region where $x > 0$ and $y < 0$)

Which of the following set of conditions is **sufficient** to ensure this?

A $a < 0$, $b < 0$, $c < 0$

B $a < 0$, $b < 0$, $c > 0$

C $a < 0$, $b > 0$, $c < 0$

D $a < 0$, $b > 0$, $c > 0$

E $a > 0$, $b < 0$, $c < 0$

F $a > 0$, $b < 0$, $c > 0$

G $a > 0$, $b > 0$, $c < 0$

H $a > 0$, $b > 0$, $c > 0$

[Turn over

36 An electronic circuit contains three light bulbs, X, Y and Z, which are each either on or off at any particular time. It is known that if bulb X is off **or** bulb Y is on, then bulb Z is on.

Which one of these statements **necessarily** follows from this?

A If bulb Z is on, then bulb X is off **or** bulb Y is on.

B If bulb Z is on, then bulb X is on **and** bulb Y is off.

C If bulb Z is on, then bulb X is on **or** bulb Y is on.

D If bulb Z is off, then bulb X is off **and** bulb Y is off.

E If bulb Z is off, then bulb X is on **or** bulb Y is off.

F If bulb Z is off, then bulb X is on **and** bulb Y is on.

37 The mean mass of a group of 20 people is 84 kg. When N people leave the group, the mean mass is reduced by 3 kg.

Which one of the following is an expression, in kilograms, for the mean mass of the people who left the group?

A $\dfrac{60}{N} - 81$

B $\dfrac{3320}{N} - 81$

C $\dfrac{3420}{N} - 87$

D $87 - \dfrac{60}{N}$

E $81 + \dfrac{60}{N}$

F $87 + \dfrac{60}{N}$

G $81 + \dfrac{3320}{N}$

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