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2019 Canadian Intermediate Mathematics Contest

Wednesday, November 20, 2019
(in North America and South America)

Thursday, November 21, 2019
(outside of North America and South America)

Solutions

Part A

1. Since $\triangle ABC$ is equilateral, then $\angle ABC = 60^\circ$. ($\triangle ABC$ has three equal angles whose measures add to 180°.)
   Since $\triangle BDC$ is right-angled at D and has $DB = DC$, then $\triangle BDC$ is a right-angled isosceles triangle, which makes $\angle DBC = 45^\circ$. (Here, $\angle DBC = \angle DCB$ since $DB = DC$ and the measures of the two angles add to 90°, which makes each 45°.)
   Therefore, $x^\circ = \angle ABD = \angle ABC - \angle DBC = 60^\circ - 45^\circ = 15^\circ$.
   Thus, $x = 15$.

   ANSWER: $x = 15$

2. *Solution 1*
   Binh's 20 quarters are worth $20 \times 25 = 500$ cents.
   Abdul's 20 dimes are worth $20 \times 10 = 200$ cents.
   Since Binh's and Abdul's coins have the same total value, then the value of Abdul's quarters is $500 - 200 = 300$ cents.
   Since each quarter is worth 25 cents, then Abdul has $300 \div 25 = 12$ quarters.

   Solution 2
   Binh's 20 quarters are worth $20 \times 25 = 500$ cents.
   Abdul's 20 dimes are worth $20 \times 10 = 200$ cents.
   Suppose that Abdul has x quarters. These are worth $25x$ cents.
   Since Binh's and Abdul's coins have the same total value, then $500 = 200 + 25x$ and so $25x = 500 - 200 = 300$ and so $x = \dfrac{300}{25} = 12$.

   ANSWER: 12 quarters

3. We note that
   $$36\,000 = 36 \times 1000 = 6^2 \times 10^3 = (2 \times 3)^2 \times (2 \times 5)^3 = 2^2 \times 3^2 \times 2^3 \times 5^3 = 2^5 \times 3^2 \times 5^3$$
   This is called the *prime factorization* of 36 000. There are many different ways of getting to this factorization, although the final answer will always be the same.
   Since $36\,000 = 2^5 \times 3^2 \times 5^3$ and we want $36\,000 = 2^a 3^b 5^c$, then $a = 5$ and $b = 2$ and $c = 3$.
   Thus, $3a + 4b + 6c = 3 \times 5 + 4 \times 2 + 6 \times 3 = 15 + 8 + 18 = 41$.

   ANSWER: 41

4. Ali earns a total of 12 points for her 12 correct answers. To determine her possible total scores, we need to determine her possible numbers of bonus points.
   Since Ali answers 3 questions incorrectly, these could all be in 1 category, split over 2 categories (2 from 1 category and 1 from another), or split over 3 categories (1 from each).
   In the first case, she answers all of the questions in 4 of the 5 categories correctly, and so earns 4 bonus points. In this case, her total score would be $12 + 4 = 16$.
   In the second case, she answers all of the questions in 3 of the 5 categories correctly, and so earns 3 bonus points. In this case, her total score would be $12 + 3 = 15$.
   In the third case, she answers all of the questions in 2 of the 5 categories correctly, and so earns 2 bonus points. In this case, her total score would be $12 + 2 = 14$.
   These are all of the possibilities.
   Therefore, Ali's possible total scores are 14, 15 and 16.

   ANSWER: 14, 15, 16

5. Since $|a|$ is at least 0 and $|b|$ is at least 0 and $|a| + |b| \leq 10$, then $|a|$ is at most 10 and $|b|$ is at most 10.
We count the number of possible pairs (a, b) by working through the possible values of $|a|$ from 0 to 10.

Suppose that $|a| = 0$. This means that $a = 0$. There is 1 possible value of a in this case.
Since $|a| = 0$ and $|a| + |b| \leq 10$, then $|b| \leq 10$ which means that the possible values for b are $-10, -9, -8, \ldots, -1, 0, 1, \ldots, 8, 9$, or 10. There are 21 possible values of b in this case.
Since there is 1 possible value for a and there are 21 possible values for b, then overall there are $1 \times 21 = 21$ pairs (a, b) when $|a| = 0$.

Suppose that $|a| = 1$. This means that $a = 1$ or $a = -1$. There are 2 possible values of a in this case.
Since $|a| = 1$ and $|a| + |b| \leq 10$, then $|b| \leq 9$ which means that the possible values of b are $-9, -8, -7, \ldots, -1, 0, 1, \ldots, 7, 8$, or 9. There are 19 possible values of b in this case.
Since there are 2 possible values for a and 19 possible values for b, then overall there are $2 \times 19 = 38$ pairs (a, b) when $|a| = 1$.

Suppose that $|a| = 2$. This means that $a = 2$ or $a = -2$. There are 2 possible values of a in this case.
Here, $|b| \leq 8$ which means that b could equal $-8, -7, -6, \ldots, -1, 0, 1, \ldots, 6, 7$, or 8. There are 17 possible values of b in this case.
Overall, there are $2 \times 17 = 34$ pairs (a, b) when $|a| = 2$.

As $|a|$ increases from 2 to 9, at each step, the largest possible value of $|b|$ will decrease by 1, which means that there will be 2 fewer possible values of b from each step to the next. Since there are 2 possible values for a at each step, this means that there will be $2 \times 2 = 4$ fewer pairs (a, b) at each step.

We check the final case $|a| = 10$ to verify that nothing different happens in the last case.
Suppose that $|a| = 10$. This means that $a = 10$ or $a = -10$. There are 2 possible values of a in this case.
Here, $|b| \leq 0$ which means that b can only equal 0. There is 1 possible value of b in this case.
Overall, there are $2 \times 1 = 2$ pairs (a, b) when $|a| = 10$.

In total, this means that there are

$$21 + 38 + 34 + 30 + 26 + 22 + 18 + 14 + 10 + 6 + 2$$

pairs (a, b) with $|a| + |b| \leq 10$.
Grouping the last 10 numbers in pairs from the outside towards the middle we obtain

$$21 + (38 + 2) + (34 + 6) + (30 + 10) + (26 + 14) + (22 + 18)$$

which equals $21 + 5 \times 40$ or 221.
Thus, there are 221 pairs.

(This problem can also be solved using a neat result called Pick's Theorem. We encourage you to look this up and think about how you might apply it here.)

Answer: 221

6. Suppose that the original circle has radius R.
Thus, the circumference of this circle is $2\pi R$.
When this circle is cut into two pieces and each piece is curled to make a cone, the ratio of the lateral surface areas of these cones is $2:1$.
This means that the ratio of the areas of the two pieces into which the circle is cut is $2:1$ since it is these pieces that become the lateral surfaces of the cones.
In other words, the sector cut out is $\frac{1}{3}$ of the area of the circle, which means that its central angle is $\frac{1}{3}$ of the total angle around the centre, or $\frac{1}{3}\times 360^\circ = 120^\circ$.
Since the central angles of the two pieces are 240° and 120°, which are in the ratio $2:1$, then the circumference is split in the ratio $2:1$ when the circle is cut.
Since the circumference of the original circle is $2\pi R$, then the lengths of the pieces of the circumference are $\frac{4}{3}\pi R$ and $\frac{2}{3}\pi R$.
These pieces become the circumferences of the circular bases of the two cones.
Since the ratio of the circumference to the radius of a circle is $2\pi : 1$, then the radii of the bases of the two cones are $\dfrac{\frac{4}{3}\pi R}{2\pi} = \frac{2}{3}R$ and $\dfrac{\frac{2}{3}\pi R}{2\pi} = \frac{1}{3}R$.
Since the radius of the original circle becomes the slant height of each cone, then the slant height in each cone is R.
In a cone, the radius and the height are perpendicular forming a right-angled triangle with the slant height as its hypotenuse.
Therefore, the height of a cone with slant height R and radius $\frac{2}{3}R$ is

$$\sqrt{R^2 - \left(\tfrac{2}{3}R\right)^2} = \sqrt{R^2 - \tfrac{4}{9}R^2} = \sqrt{\tfrac{5}{9}R^2} = \tfrac{\sqrt{5}}{3}R$$

Also, the height of a cone with slant height R and radius $\frac{1}{3}R$ is

$$\sqrt{R^2 - \left(\tfrac{1}{3}R\right)^2} = \sqrt{R^2 - \tfrac{1}{9}R^2} = \sqrt{\tfrac{8}{9}R^2} = \tfrac{\sqrt{8}}{3}R$$

The volume of a cone with radius $\frac{2}{3}R$ and height $\frac{\sqrt{5}}{3}R$ is $\frac{1}{3}\pi\left(\frac{2}{3}R\right)^2\left(\frac{\sqrt{5}}{3}R\right)$ which equals $\frac{4\sqrt{5}}{81}\pi R^3$.
The volume of a cone with radius $\frac{1}{3}R$ and height $\frac{\sqrt{8}}{3}R$ is $\frac{1}{3}\pi\left(\frac{1}{3}R\right)^2\left(\frac{\sqrt{8}}{3}R\right)$ which equals $\frac{\sqrt{8}}{81}\pi R^3$.
Dividing the first volume by the second, we obtain

$$\frac{\frac{4\sqrt{5}}{81}\pi R^3}{\frac{\sqrt{8}}{81}\pi R^3} = \frac{4\sqrt{5}}{\sqrt{8}} = \frac{4\sqrt{5}}{2\sqrt{2}} = \frac{4\sqrt{5}\sqrt{2}}{4} = \sqrt{5}\sqrt{2} = \sqrt{10}$$

Therefore, the ratio of the larger volume to the smaller volume is $\sqrt{10}:1$.

ANSWER: $\sqrt{10}:1$

Part B

1. (a) In the diagram, AC is the hypotenuse of a right-angled triangle with legs of length 9 and 12.
By the Pythagorean Theorem, $AC^2 = 9^2 + 12^2 = 81 + 144 = 225$.
Since $AC > 0$, then $AC = \sqrt{225} = 15$.
In the diagram, CB is the hypotenuse of a right-angled triangle with legs of length 3 and 4.
By the Pythagorean Theorem, $CB^2 = 3^2 + 4^2 = 9 + 16 = 25$.
Since $BC > 0$, then $CB = \sqrt{25} = 5$.
(Note that $AC : CB = 15 : 5 = 3 : 1$.)

(b) Using the given fact, we can compute the ratio by computing the ratio of the differences of x-coordinates. We see that $\dfrac{11-5}{5-1} = \dfrac{6}{4} = \dfrac{3}{2}$.
We could also have this with y-coordinates: $\dfrac{2-5}{5-7} = \dfrac{-3}{-2} = \dfrac{3}{2}$.
Therefore, the ratio of lengths $GJ : JH$ equals $3 : 2$.

(c) *Solution 1*
The difference between the x-coordinates of $D(1,6)$ and $E(7,9)$ is $7 - 1 = 6$.
This difference is split in the ratio $1 : 2$ when it is written as $2 + 4$.
The difference between the y-coordinates of $D(1,6)$ and $E(7,9)$ is $9 - 6 = 3$.
This difference is split in the ratio $1 : 2$ when it is written as $1 + 2$.
Since D has coordinates $(1,6)$ and the x- and y-coordinates of E are larger than those of F, then F should have coordinates $(1 + 2, 6 + 1)$ or $(3,7)$.
Verifying, using the points $D(1,6)$, $F(3,7)$, $E(7,9)$, we see that

$$\frac{3-1}{7-3} = \frac{2}{4} = \frac{1}{2} \quad \text{and} \quad \frac{7-6}{9-7} = \frac{1}{2}$$

Thus, $F(3,7)$ splits the line segment joining $D(1,6)$ and $E(7,9)$ in the ratio $1 : 2$.

Solution 2
Suppose that F has coordinates (a,b).
Since $F(a,b)$ splits $D(1,6)$ and $E(7,9)$ in the ratio $1 : 2$, then $\dfrac{a-1}{7-a} = \dfrac{1}{2}$ and $\dfrac{b-6}{9-b} = \dfrac{1}{2}$.
From $\dfrac{a-1}{7-a} = \dfrac{1}{2}$, we obtain $2a - 2 = 7 - a$ and so $3a = 9$ or $a = 3$.
From $\dfrac{b-6}{9-b} = \dfrac{1}{2}$, we obtain $2b - 12 = 9 - b$ and so $3b = 21$ or $b = 7$.
Thus, $F(3,7)$ splits the line segment joining $D(1,6)$ and $E(7,9)$ in the ratio $1 : 2$.

(d) For $M(7,5)$ to divide $K(1,q)$ and $L(p,9)$ in the ratio $3 : 4$, we need

$$\frac{7-1}{p-7} = \frac{3}{4} \quad \text{and} \quad \frac{5-q}{9-5} = \frac{3}{4}$$

Since $\dfrac{7-1}{p-7} = \dfrac{6}{p-7}$ and $\dfrac{3}{4} = \dfrac{6}{8}$, then $\dfrac{6}{p-7} = \dfrac{6}{8}$ gives $p - 7 = 8$ and so $p = 15$.
Since $\dfrac{5-q}{9-5} = \dfrac{5-q}{4}$, then $\dfrac{5-q}{4} = \dfrac{3}{4}$ gives $5 - q = 3$ and so $q = 2$.
Therefore, the point $M(7,5)$ divides the line segment joining $K(1,2)$ and $L(15,9)$ in the ratio $3 : 4$.

2. (a) By definition, $\left\langle \begin{array}{|c|c|}\hline 7 & 3 \\ \hline 2 & 7 \\ \hline \end{array} \right\rangle = 73 + 27 + 72 + 37 = 209$.

   (b) We first note that a two-digit number "mn" is equal to $10m + n$.
   This means that

$$\left\langle \begin{array}{|c|c|}\hline a & b \\ \hline c & d \\ \hline \end{array} \right\rangle = \text{“}ab\text{”} + \text{“}cd\text{”} + \text{“}ac\text{”} + \text{“}bd\text{”}$$
$$= (10a + b) + (10c + d) + (10a + c) + (10b + d)$$
$$= 20a + 11b + 11c + 2d$$

   Therefore,

$$\left\langle \begin{array}{|c|c|}\hline 5 & b \\ \hline c & 7 \\ \hline \end{array} \right\rangle = 20 \times 5 + 11b + 11c + 2 \times 7 = 11b + 11c + 114$$

   and

$$\left\langle \begin{array}{|c|c|}\hline x & b+1 \\ \hline c-3 & y \\ \hline \end{array} \right\rangle = 20x + 11(b + 1) + 11(c - 3) + 2y = 20x + 11b + 11c + 2y - 22$$

   For these to be equal, we need $20x + 2y - 22 = 114$ and so $20x + 2y = 136$ which means that $10x + y = 68$.
   Since x and y are digits, then it must be the case that $x = 6$ and $y = 8$. (There are no other possibilities, since x cannot be 7 or greater (since y is at least 0) and x cannot be 5 or smaller (since y is at most 9).)

   (c) Using our work so far,

$$\left\langle \begin{array}{|c|c|}\hline a & b \\ \hline c & d \\ \hline \end{array} \right\rangle - \left\langle \begin{array}{|c|c|}\hline a+1 & b-2 \\ \hline c-1 & d+1 \\ \hline \end{array} \right\rangle$$
$$= (20a + 11b + 11c + 2d) - (20(a + 1) + 11(b - 2) + 11(c - 1) + 2(d + 1))$$
$$= (20a + 11b + 11c + 2d) - (20a + 11b + 11c + 2d + 20 - 22 - 11 + 2)$$
$$= -20 + 22 + 11 - 2$$
$$= 11$$

   Therefore, the only possible value for the difference is 11.

   (d) From our earlier work, $\left\langle \begin{array}{|c|c|}\hline a & b \\ \hline c & d \\ \hline \end{array} \right\rangle = 20a + 11b + 11c + 2d$.
   This means that we want to find all non-zero digits a, b, c, d for which

$$20a + 11b + 11c + 2d = 104$$

   Since each of b, c and d is at least 1, then $11b + 11c + 2d$ is at least 24, which means that $20a = 104 - (11b + 11c + 2d)$ is at most 80.
   Since $20a$ is at most 80, then a is at most 4.
   Since a is at least 1, then a could equal 1, 2, 3, or 4.

<u>Case 1: $a = 1$</u>
Here, $11b + 11c + 2d = 104 - 20 \times 1 = 84$.
Note that $11(b + c) = 11b + 11c = 84 - 2d$ which is even since $82 - 2d = 2(42 - d)$.
Since $11(b + c)$ is even, then $b + c$ is even.
Since $2d$ is positive, then $11(b + c)$ is less than 84.
This means that $b + c$ is less than 8.
Since d is at most 9, then $2d$ is at most 18, which means that $11(b + c) = 84 - 2d$ is at least $84 - 18 = 66$.
This means that $b + c$ is at least 6.
Since $b + c$ is even, at least 6, and less than 8, then the only possibility is $b + c = 6$.
If $b + c = 6$, then $11(b + c) = 66$ and so $2d = 84 - 11(b + c) = 18$ which means that $d = 9$.
Also, if $b + c = 6$, then since b and c are non-zero digits, we could have b and c equal to 1 and 5, or 2 and 4, or 3 and 3, or 4 and 2, or 5 and 1.
There are thus 5 grids in this case:

$$\begin{array}{|c|c|}\hline 1 & 1 \\ \hline 5 & 9 \\ \hline \end{array}\,,\quad \begin{array}{|c|c|}\hline 1 & 2 \\ \hline 4 & 9 \\ \hline \end{array}\,,\quad \begin{array}{|c|c|}\hline 1 & 3 \\ \hline 3 & 9 \\ \hline \end{array}\,,\quad \begin{array}{|c|c|}\hline 1 & 4 \\ \hline 2 & 9 \\ \hline \end{array}\,,\quad \begin{array}{|c|c|}\hline 1 & 5 \\ \hline 1 & 9 \\ \hline \end{array}$$

<u>Case 2: $a = 2$</u>
Here, $11b + 11c + 2d = 104 - 20 \times 2 = 64$.
As in Case 1, $b + c$ is even.
Since $2d$ is positive, then $11(b + c)$ is less than 64.
This means that $b + c$ is less than 6.
Since d is at most 9, then $2d$ is at most 18, which means that $11(b + c) = 64 - 2d$ is at least $64 - 18 = 46$.
This means that $b + c$ is greater than 4.
Therefore, $b + c$ must be an even integer, must be less than 6, and must be greater than 4.
No such integer exists, and so there are no solutions in this case.

<u>Case 3: $a = 3$</u>
Here, $11b + 11c + 2d = 104 - 20 \times 3 = 44$.
As in Case 1, $b + c$ is even.
Since $2d$ is positive, then $11(b + c)$ is less than 44.
This means that $b + c$ is less than 4.
Since d is at most 9, then $2d$ is at most 18, which means that $11(b + c) = 44 - 2d$ is at least $44 - 18 = 26$.
This means that $b + c$ is greater than 2.
Therefore, $b + c$ must be an even integer, must be less than 4, and must be greater than 2.
No such integer exists, and so there are no solutions in this case.

<u>Case 4: $a = 4$</u>
Here, $11b + 11c + 2d = 104 - 20 \times 4 = 24$.
Since $b \geq 1$ and $c \geq 1$ and $d \geq 1$, then $11b + 11c + 2d \geq 24$.
To have $11b + 11c + 2d$, we must have $b = c = d = 1$.
There is thus 1 grid in this case: $\begin{array}{|c|c|}\hline 4 & 1 \\ \hline 1 & 1 \\ \hline \end{array}$.

In summary, the grids that satisfy $\left\langle \begin{array}{|c|c|}\hline a & b \\ \hline c & d \\ \hline \end{array} \right\rangle = 104$ are

$$\begin{array}{|c|c|}\hline a & b \\ \hline c & d \\ \hline \end{array} = \begin{array}{|c|c|}\hline 1 & 1 \\ \hline 5 & 9 \\ \hline \end{array}, \begin{array}{|c|c|}\hline 1 & 2 \\ \hline 4 & 9 \\ \hline \end{array}, \begin{array}{|c|c|}\hline 1 & 3 \\ \hline 3 & 9 \\ \hline \end{array}, \begin{array}{|c|c|}\hline 1 & 4 \\ \hline 2 & 9 \\ \hline \end{array}, \begin{array}{|c|c|}\hline 1 & 5 \\ \hline 1 & 9 \\ \hline \end{array}, \begin{array}{|c|c|}\hline 4 & 1 \\ \hline 1 & 1 \\ \hline \end{array}$$

3. (a) After 4 people, there is 1 person at the Left table, 1 person at the Centre table, and 2 people at the Right table.
Continuing the table, we obtain

Left		Middle		Right	
5		3		6	P1
5	P2	3		3	
$\frac{5}{2}$		3	P3	3	
$\frac{5}{2}$		$\frac{3}{2}$		3	P4
$\frac{5}{2}$	P5	$\frac{3}{2}$		2	
$\frac{5}{3}$		$\frac{3}{2}$		2	P6
$\frac{5}{3}$	P7	$\frac{3}{2}$		$\frac{3}{2}$	

Person 5 sits at the Left table because $\frac{5}{2} = 2.5$ is greater than $\frac{3}{2} = 1.5$.

Person 6 sits at the Right table because $\frac{5}{3} \approx 1.67$ and $\frac{3}{2} = 1.5$ are both less than 2.

Person 7 sits at the Left table because $\frac{5}{3} \approx 1.67$ is greater than $\frac{3}{2} = 1.5$.

Therefore, Person 5 sits at the Left table, Person 6 at the Right table, and Person 7 at the Left table.

(b) Suppose that there are integers L, M, R for which the first 6 people sit as described.
We construct a similar chart from the given information, using the information about where the previous people have sat to calculate the shares in each row:

Left		Middle		Right	
L	P1	M		R	
$\frac{1}{2}L$		M	P2	R	
$\frac{1}{2}L$		$\frac{1}{2}M$		R	P3
$\frac{1}{2}L$	P4	$\frac{1}{2}M$		$\frac{1}{2}R$	
$\frac{1}{3}L$	P5	$\frac{1}{2}M$		$\frac{1}{2}R$	
$\frac{1}{4}L$	P6	$\frac{1}{2}M$		$\frac{1}{2}R$	

Since Person 1 sits at the Left table, then their potential share at the Left table is at least as large as it is at the Middle and Right tables.
Therefore, $L \geq M$ and $L \geq R$.
Since Person 2 sits at the Middle table, then their potential share at the Middle table is larger than that at the Left table (if they were equal, they would choose Left) and at least as large as it is at the Right table.
Therefore, $M > \frac{1}{2}L$ and $M \geq R$.
Since Person 6 sits at the Left table, then their potential share at the Left table is at least as large as it is at the Middle and Right tables.
Therefore, $\frac{1}{4}L \geq \frac{1}{2}M$ and $\frac{1}{4}L \geq \frac{1}{2}R$.
The inequality $\frac{1}{4}L \geq \frac{1}{2}M$ is equivalent to saying $\frac{1}{2}L \geq M$.
But this gives $M > \frac{1}{2}L$ and $\frac{1}{2}L \geq M$.
These two inequalities cannot both be true.
This means that we have a contradiction and so there are no values of L, M, R that would give the seating pattern shown.

(c) Since $L = 9$, the 9th person to sit at the Left table would be getting a share of 1 kg.
Since $M = 19$, the 19th person to sit at the Middle table would be getting a share of 1 kg.
Since $R = 25$, the 25th person to sit at the Right table would be getting a share of 1 kg.
We note also that each additional person who sits at a table causes the share per person at that table to decrease.
Since each person sits at the table that maximizes their current share of chocolate, then there cannot be 10 people at the Left table before there are 19 people at the Middle table and 25 people at the Right table, because the 10th person at the Left table would get a larger share by sitting at the Middle or Right table.
Similarly, there cannot be 20 people at the Middle table before there are 9 people at the Left table and 25 people at the Right table, and there cannot be 26 at the Right table before there are 9 people at the Left table and 19 people at the Middle table.
In other words, we must have 9 people at the Left table, 19 people at the Middle table, and 25 people at the Right table before there are more than 9, 19 and 25 people at the Left, Middle and Right tables, respectively.
At this point, there are $9 + 19 + 25 = 53$ people in total that have been seated.
The largest multiple of 53 less than 2019 is $38 \times 53 = 2014$.
We note also that $38 \times 9 = 342$ and $38 \times 19 = 722$ and $38 \times 25 = 950$.
The 342nd person to sit at the Left table would be getting a share of $\frac{9}{342}$ kg $= \frac{1}{38}$ kg.
The 722nd person to sit at the Middle table would be getting a share of $\frac{19}{722}$ kg $= \frac{1}{38}$ kg.
The 950th person to sit at the Right table would be getting a share of $\frac{25}{950}$ kg $= \frac{1}{38}$ kg.
Using a similar argument to that above, we cannot have more than 342 people at the Left table before there are 722 people and 950 people at the Middle and Right tables. Similarly, we cannot have more than 722 people at the Middle table before there are 342 people and 950 people at the Left and Right tables, or more than 950 people at the Right table before there are 342 people and 722 people at the Left and Middle tables.
In other words, once 2014 people have been seated, there are 342 people at the Left table, 722 people at the Middle table, and 950 people at the Right table.
To determine at which table Person 2019 sits, we first determine where Person 2015, Person 2016, Person 2017, and Person 2018 sit:

Left		Middle		Right	
$\frac{9}{343} \approx 0.026239$		$\frac{19}{723} \approx 0.026279$		$\frac{25}{951} \approx 0.026288$	P2015
$\frac{9}{343} \approx 0.026239$		$\frac{19}{723} \approx 0.026279$	P2016	$\frac{25}{952} \approx 0.026261$	
$\frac{9}{343} \approx 0.026239$		$\frac{19}{724} \approx 0.026243$		$\frac{25}{952} \approx 0.026261$	P2017
$\frac{9}{343} \approx 0.026239$		$\frac{19}{724} \approx 0.026243$	P2018	$\frac{25}{953} \approx 0.026233$	
$\frac{9}{343} \approx 0.026239$	P2019	$\frac{19}{725} \approx 0.026207$		$\frac{25}{953} \approx 0.026233$	

Therefore, Person 2019 sits at the left table.