

Senior Challenge '26 Solutions

1	2	3	4	5	6	7
4	8	5	4	6	8	5

<p>1. Phyllis' Flight Number</p> <p>3 digits, last digit is odd Difference between digits must be 1, 2, 3 or 4 If 2 or 4 then we have either 3 odd digits which won't add to 12 or 3 evens which won't make an odd number. If 1 then 3,4,5 is the only set that adds to 12, but $3+4>5$ so it's no good If 3 then 0,3,6 or 1,4,7 or 2,5,8 or 3,6,9 Add up to 12 1,4,7 First digit $> 2^{\text{nd}}$ and 3^{rd}, so 7 is 1^{st}. Must be odd for last digit so: <u>741</u></p>	<p>4 marks: (2 marks for 741, 2 marks for reasoning)</p>
<p>2. Trip Tickets</p> <p>Chris: $0.9 \times 24C + (4-2)A \Rightarrow 21.6C + 2A = 153.60$ ① Jo & Beth: $6P + 2A = 72$ ② Michael & Katie: $2A + 2C + P = 44$ ③ ③ $\Rightarrow P = 44 - 2A - 2C$ substitute into ② ④ $= 6(44 - 2A - 2C) + 2A = 72 \Rightarrow 264 - 12A - 12C + 2A = 72 \Rightarrow 192 = 10A + 12C$ ⑤ $= 5 \times ① \Rightarrow 108C + 10A = 768$ ⑥ $= ⑤ - ④ \Rightarrow 108C - 12C + 10A - 10A = 768 - 192 \Rightarrow 96C = 576 \Rightarrow C = 6$ Substitute into ① $21.6 \times 6 + 2A = 153.60 \Rightarrow 2A = 153.6 - 129.6 = 24 \Rightarrow A = 12$ Substitute into ② $6P + 2 \times 12 = 72 \Rightarrow 6P = 48 \Rightarrow P = 8$</p> <p><u>P = £8, A = £12, and C = £6</u> so <u>P+A+C = £26</u></p>	<p>8 marks: (3 marks for equations, 3 marks for P, A and C, 1 mark for P+A+C, 1 mark for calculations)</p>

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3. Shuffling Seats

With four people, there are 24 possible arrangements, of which 9 are derangements (no one in the correct seat)

A	E	M	P	P	M	E	M	P	E
E	A	A	A	M	P	M	P	M	P
P	M	E	M	A	A	A	E	E	M
M	P	P	E	E	E	P	A	A	A

A = Anouk, E = Ethan, P = Polly, M = Maks.

The left-most column shows the booked seats.

There are 9 possible derangements of this seating plan. But why?

Let's say, for example, that A takes E's seat.

Case 1: E takes A's seat. We are now left with a derangement of two guests (M and P here), for which there is only one possibility. See column 2.

Case 2: E does not take A's seat. Therefore, we now have a derangement of three guests. E can take either P's or M's seat (see columns 3 and 4), leaving a derangement of two, which is a forced choice. So we have two possibilities.

As A can choose from three different seats to begin with (E's, P's or M's), the total number of derangements possible is $3 \times (1 + 2) = 9$.

Red denotes A's choice of 'wrong' seat, blue the possible 'wrong' choices for the character whose seat she occupied, and yellow the forced choices.

5 marks:
(1 for 24 arrangements,
1 for 9 derangements,
3 for reasoning)

Allow full marks for shows 24 arrangements and removes 15 to leave 9 derangements.

4. Clean Up on Aisle...

Machine	Cost	Hours	Joel	Percent	Income	Profit
Robbie	1299	1	16	87	20,880	19,565
Vinnie	1649	2	32	94	22,560	20,879
Callum	1999	8	128	99	23,760	21,633

Callum the Cleaner is the most profitable.

4 marks:
(1 for calculating cost of Joel,
1 for calculating incomes,
1 for calculating profits,
1 for correct conclusion)

Special case: if they have erroneously calculated income as £60 per % point overall, not per plane, then Vinnie is the most profitable. Award 3 marks for this if calculations are correct.

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5. Sue Sips Serendipitously

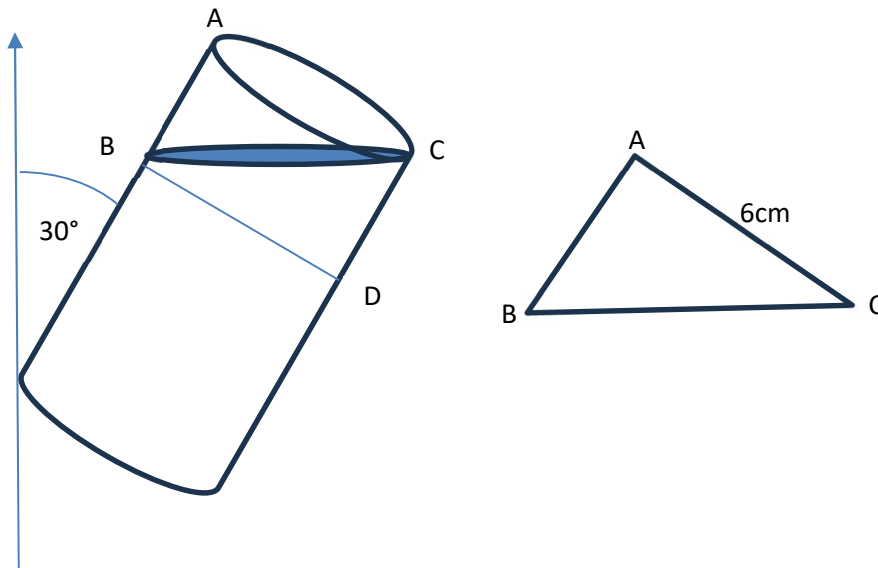
When the glass tilts, the top of the lemonade just reaches the rim at point C. This means the triangle formed from ABC is a right-angled triangle with $\angle BAC$ being the 90° angle and $\angle ACB$ being 30° . The length of AC is the diameter of the glass, so 6cm.

The length of AB is therefore $6 \tan(30) = \frac{6}{\sqrt{3}} = 2\sqrt{3} \approx 3.46\text{cm}$

The empty space in the glass is half of the volume of the cylinder ABCD.

$$V = \frac{1}{2} \times \frac{6}{\sqrt{3}} \times 9\pi = 9\sqrt{3}\pi \approx 48.97\text{cm}^3$$

So, Sue has drunk 49ml.



6 marks:
 (1 mark for labelled diagram
 1 mark for $AC = 6$
 1 mark for $AB = 2\sqrt{3}$
 1 mark for empty volume = 48.97
 1 mark for 49
 1 mark for ml or cm^3)

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6. Parachute Plummet																															
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Starting altitude</td> <td style="text-align: right;">40000</td> </tr> <tr> <td>Falls</td> <td style="text-align: right;">480</td> </tr> <tr> <td>Altitude at terminal velocity</td> <td style="text-align: right; background-color: yellow;">39520</td> </tr> <tr> <td>Terminal velocity</td> <td style="text-align: right;">176</td> </tr> <tr> <td>Time spent falling</td> <td style="text-align: right; background-color: yellow;">208</td> </tr> <tr> <td>Distance fallen</td> <td style="text-align: right; background-color: yellow;">36608</td> </tr> <tr> <td>Altitude now</td> <td style="text-align: right; background-color: yellow;">2912</td> </tr> <tr> <td>Time for parachute to deploy</td> <td style="text-align: right;">5.5</td> </tr> <tr> <td>Altitude after deployment</td> <td style="text-align: right; background-color: yellow;">1944</td> </tr> <tr> <td>Landing altitude</td> <td style="text-align: right;">40</td> </tr> <tr> <td>s</td> <td style="text-align: right; background-color: yellow;">1904</td> </tr> <tr> <td>u</td> <td style="text-align: right;">176</td> </tr> <tr> <td>a</td> <td style="text-align: right;">-8</td> </tr> <tr> <td>v²</td> <td style="text-align: right; background-color: yellow;">512</td> </tr> <tr> <td>v</td> <td style="text-align: right; background-color: yellow;">22.63ft/s</td> </tr> </table> <p style="margin-top: 10px;"><u>16√2 = 22.63ft/s</u></p>	Starting altitude	40000	Falls	480	Altitude at terminal velocity	39520	Terminal velocity	176	Time spent falling	208	Distance fallen	36608	Altitude now	2912	Time for parachute to deploy	5.5	Altitude after deployment	1944	Landing altitude	40	s	1904	u	176	a	-8	v ²	512	v	22.63ft/s	<p>8 marks: (1 mark for 39,520 feet 1 mark for 208 seconds 1 mark for fallen 36,608 feet 1 mark for altitude of 2,912 1 mark for altitude of 1,944 1 mark for 1,904 still to go 1 mark for v² = 512 1 mark for 22.63ft/s or 16√2)</p>
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<p>It cannot be 10xx or 11xx, because of Ellie's certainty that Amy doesn't know the arrival time, and both those hours contain a minute that occurs only in that hour (1043 and 1146), which would otherwise give Amy a chance of knowing already. That leaves us with 12xx and 13xx. The fact that Amy now knows the time tells us that it's not 1219 or 1319, as having been told xx19 would be insufficient information for her.</p> <p>Since this gives Ellie what she needs, then it can only be 12xx that she was told, because she'd still have a choice of two 13xx times and then would not know which of those it was.</p> <p>Therefore, <u>Davina is arriving at 1232.</u></p>	<p>5 marks: (2 for elimination 06xx and 07xx, 1 for eliminating xx19, 1 for eliminating the remaining 09xx, 1 for stating 0832)</p>																														