Contents

1 Assemble and Dismantle
2 The Ships Arrive
3 Picking Chiouis
4 Transportation
For the mission to planet Ara, a Spaceship is made out of 13 segments, as the picture shows. The construction of the Spaceship is shown below, starting with an initial configuration of 3 segments.

The construction used constant change, meaning that the same number of segments were added each hour. So: “The work was done at constant pace.”

Complete Spaceship
The change in the number of segments each hour is:

We call this number the **step change**. It measures the change from one frame to the next one.

How many segments were put from 4 to 9 pm?

We call this number the **total change**. It measures the change from the first to the last frame.
Now we want to **dismantle** the Spaceship in 3 hours, with constant change, so that we **end up with 4 segments**. Complete the three blank frames.

Let **STEP CHANGE** be the change in the number of segments every hour.

<table>
<thead>
<tr>
<th>Time</th>
<th># of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 am</td>
<td></td>
</tr>
<tr>
<td>3 am</td>
<td></td>
</tr>
<tr>
<td>4 am</td>
<td></td>
</tr>
<tr>
<td>5 am</td>
<td></td>
</tr>
</tbody>
</table>

Remember: To find the total change, you need to look at the first and last frames only. In this situation the step and total changes are negative.
### 1 Assemble and Dismantle

#### e. Fill in the blanks in these two tables, then plot the points below...

**Mounting the ship, 3 pieces at the time, starting with 1 piece**

<table>
<thead>
<tr>
<th>Hour</th>
<th>Number of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
</tr>
</tbody>
</table>

**STEP CHANGE** = +3

**Dismantling the ship, 4 pieces at the time, starting with ? pieces**

<table>
<thead>
<tr>
<th>Hour</th>
<th>Number of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

**STEP CHANGE** = -4

#### Connect the dots... what kind of curve do you get? How do you explain the different inclination?
Ships arrive to (and sometime leave) planet Ara in different days. For each situation, determine whether the *step change* (= the change in number of ships from one frame to the next one.) is constant or not. Then predict the number of ships at the indicated time.

**Sample Situation M**

The *step change is*

- [X] Constant    [ ] Not constant

# of ships at 6 pm: ______

# of ships at 11 pm: ______

Guessing the pattern may be easier if you record the data in a table:

<table>
<thead>
<tr>
<th>Time</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>...</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Segments</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>...</td>
<td>?</td>
</tr>
</tbody>
</table>

The number of ships grows by +2 every step. Between 5pm and 11pm there are 6 steps, so it must grow by +12. So at 11pm we expect 7+12=19 ships.
Situation N

The step change is

[ ] Constant   [ ] Not constant

Predict:

# of ships at 10 am: ______
# of ships at 11:30 am: ______
# of ships at 1 pm: ______

Situation O

The step change is

[ ] Constant   [ ] Not constant

Predict:

# of ships at 11 am: ______
# of ships at 6 pm: ______
# of ships at 7 pm: ______
Predictions

Of the following 4 situations, there is exactly one that does not follow constant change. Find it. For the rest of them, predict the number of squares in the time marked with “?” by drawing those squares.
The following three situations all present constant change (each shaded cell represents a ship). For each one, find the initial value (initial number of ships) and the step change.

**Situation T**

Initial value: ______
Step change: _____

**Situation U**

Initial value: ______
Step change: _____

**Situation V**

Initial value: ______
Step change: _____
Representing the situations

Situation
Start with 3 ships, add 2 each time.

Situation
Start with 12 ships and remove 1 each time.

Situation
Start with 0 ships and add 3 each time.

Relate situations T, U and V (from the previous page) with a unique description and a unique graph from the ones presented below:
### Challenge

Situations C1 to C5 are represented by numerical tables. Fill in the chart in the next page, indicating:

- Is the change constant?
- Can you predict the value at 7pm and 8pm?
- Can you find a pattern (formula) for the number of ships in terms of n, where n is the time?

#### C1

<table>
<thead>
<tr>
<th>Time</th>
<th>1 pm</th>
<th>2 pm</th>
<th>3 pm</th>
<th>4 pm</th>
<th>5 pm</th>
<th>6 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ships</td>
<td>15 + 1</td>
<td>15+ 3</td>
<td>15+5</td>
<td>15+7</td>
<td>15+9</td>
<td>15+11</td>
</tr>
</tbody>
</table>

#### C2

<table>
<thead>
<tr>
<th>Time</th>
<th>1 pm</th>
<th>2 pm</th>
<th>3 pm</th>
<th>4 pm</th>
<th>5 pm</th>
<th>6 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ships</td>
<td>100</td>
<td>97</td>
<td>94</td>
<td>91</td>
<td>88</td>
<td>85</td>
</tr>
</tbody>
</table>

#### C3

<table>
<thead>
<tr>
<th>Time</th>
<th>1 pm</th>
<th>2 pm</th>
<th>3 pm</th>
<th>4 pm</th>
<th>5 pm</th>
<th>6 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ships</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td>32</td>
</tr>
</tbody>
</table>

#### C4

<table>
<thead>
<tr>
<th>Time</th>
<th>1 pm</th>
<th>2 pm</th>
<th>3 pm</th>
<th>4 pm</th>
<th>5 pm</th>
<th>6 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ships</td>
<td>3+1</td>
<td>3+4</td>
<td>3+9</td>
<td>3+16</td>
<td>3+25</td>
<td>3+36</td>
</tr>
</tbody>
</table>

#### C5

<table>
<thead>
<tr>
<th>Time</th>
<th>1 pm</th>
<th>2 pm</th>
<th>3 pm</th>
<th>4 pm</th>
<th>5 pm</th>
<th>6 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ships</td>
<td>3</td>
<td>30</td>
<td>300</td>
<td>3000</td>
<td>30000</td>
<td>300000</td>
</tr>
</tbody>
</table>
The Ships Arrive

<table>
<thead>
<tr>
<th>Situation</th>
<th>Is change constant?</th>
<th>Value at 7 pm</th>
<th>Value at 8 pm</th>
<th>Formula for # of ships in terms of (n) (where (n) represents the time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hints for the formulas:
C1: what is the formula for the odd integers?
C2: Note that 97 = 100 - 3, 94 = 100 - 6, etc.
C3: What is the formula for the powers of 2?
C4: What is the formula for the perfect squares?
C5: 30 = 3*10, 300 = 3 * 100, etc.
3 Picking Chiouis

The chief astronaut has a very important mission. Go out to planet Ara and collect certain number of chiouis (a delicious fruit from the planet).

He can carry fruit in his pocket and in bags. (All bags hold the same number of fruits, and he cannot cut the fruit in pieces.)

On Monday, the astronaut used 4 bags and collected a total of 22 fruits.

How many fruits did he put in the his pocket? And how many fruit did he put in each bag?

<table>
<thead>
<tr>
<th>Number of fruit in 1 pocket</th>
<th>Number of fruit in 1 bag</th>
<th>TOTAL number of fruits (1 pocket + 4 bags)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>

There are many possible answers, find them all.
Every day he puts the same number of fruits in his pocket and in each bag, but uses a different number of bags.

**Monday:**
1 pocket + 4 bags = 22 fruits

**Tuesday:**
1 pocket + 13 bags = 67 fruits

**Wednesday:**
1 pocket + 7 bags = 37 fruits

**b.** How many fruits fit in the pocket?

**c.** How many fruits fit in each bag?

**d.** On Thursday, he uses his pocket, but no bags. How many fruits can he hold?

**e.** On Friday, he uses his pocket and some bags. He picks 192 fruits. How many bags did he use?
A competition

Three astronauts will go to pick Chiouis. They will all have different pocket sizes. **They will carry the same number of bags**, but each astronaut has chosen a different type of bags that determines their size.

The astronauts compete in contests: whoever collects more fruits wins. Remember that all astronauts will carry the same number of bags.

**Astronaut A**
His pocket is so small that fits no fruit. Each of his bags holds 7 fruits

**Astronaut B**
His pocket fits 20 fruits. Each of his bags holds 3 fruits

**Astronaut C**
His pocket fits 12 fruits. Each of his bags holds 5 fruits

Who wins the contest if each astronaut takes 2 bags?

Who wins the contest if each astronaut takes 10 bags?

Discuss: Which of the three astronauts would you choose to be? Explain your choice.
4 Transportation

Now is the time to transport all the fruits collected by the Chief Astronaut. He has a space car with two containers: front and back.

The loading rules are simple:
(I) Put 1 fruit in the back (do not put any fruits in the front yet).
(II) Now put several fruits in the front, one by one, and for each fruit that you put in the front container, put 3 fruits in the back.

a Explain, in few words, why it is true that if the front has 2 fruits then the back has 7 fruits.

b If the front has 5 fruits, how many fruits are in the space car?

c How many fruits should we put in the front if we want the back to have 40 fruits?

d Complete the graph below relating the front and back loads of fruits, by shading the ovals in the columns:

Discuss: Can you connect the top ovals from all columns with a single line? Why?