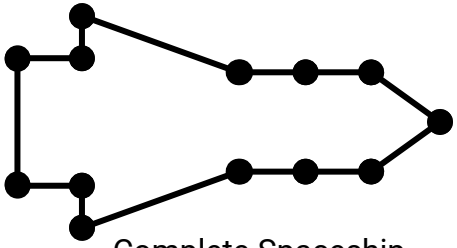
Meeting 12 Student's Booklet

CHANGE IN PLANET ARA PART 1

February 3 2016 @ UCI

Contents

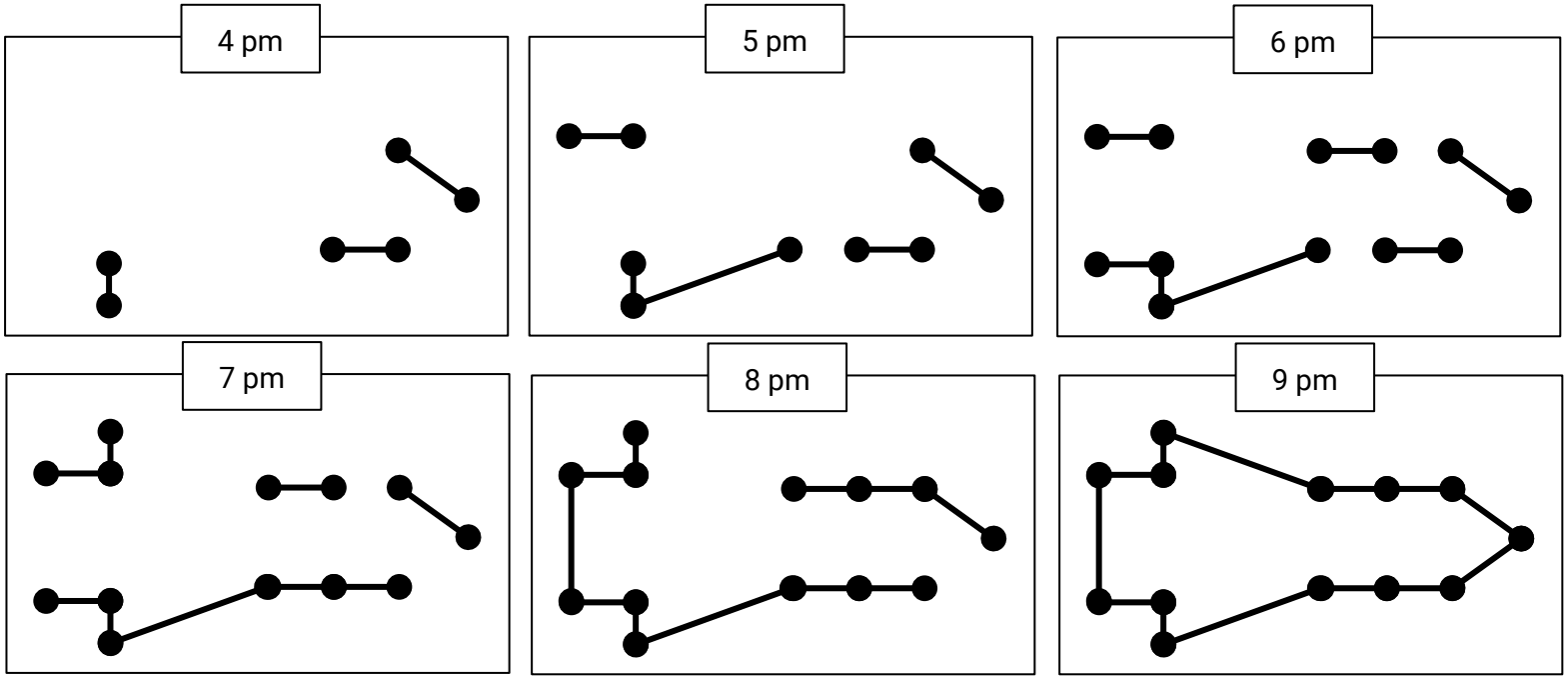
1 Assemble & Dismantle

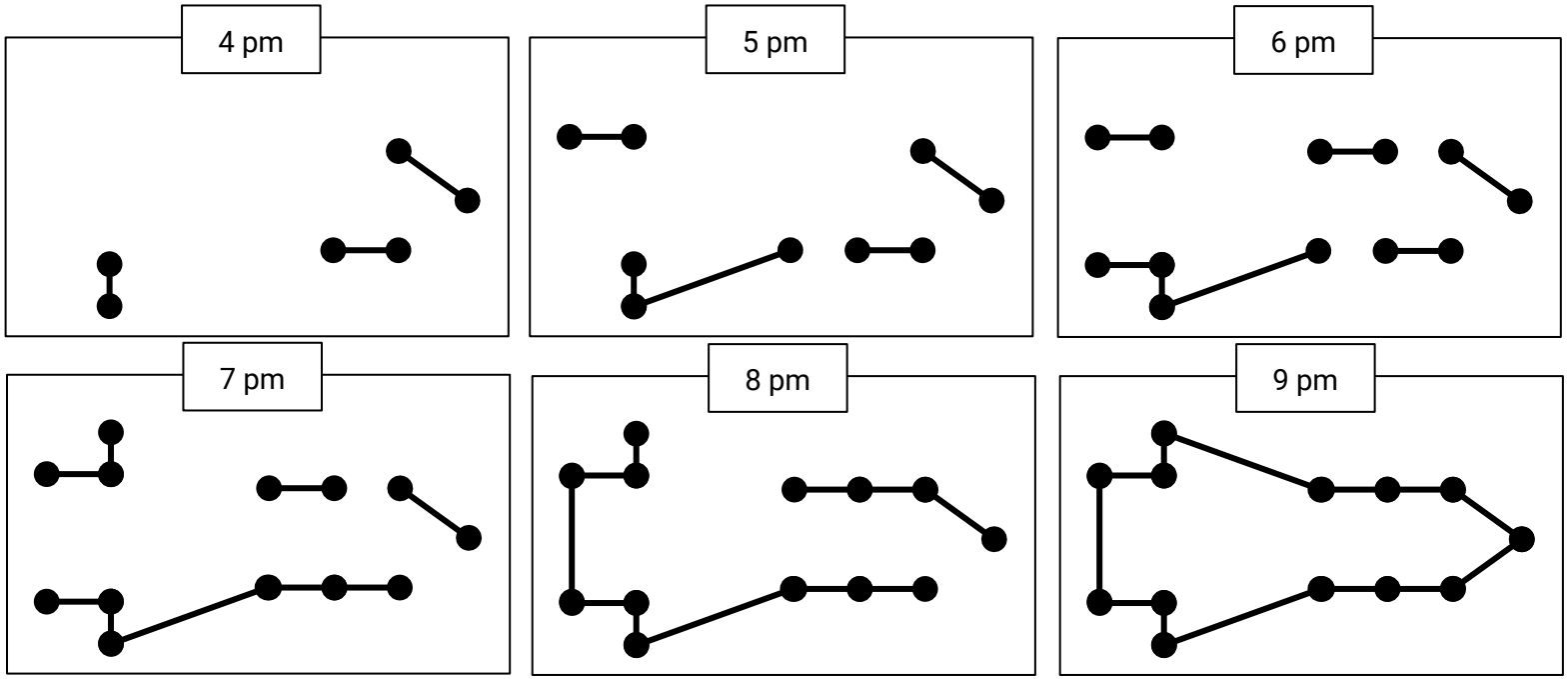


Complete Spaceship

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: "<u>The work was done at constant pace</u>".





Step change

a 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.*

Total change

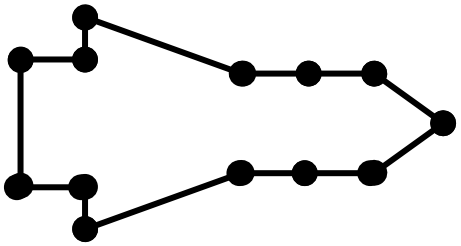
b How many segments were put from 4 to 9 pm? ____

*We call this number the **total change**. It measures the change from the first to the last frame.*

Dismantling the ship

c 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.

2 am



3 am

4 am

5 am

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

STEP CHANGE = ____

e The total change is: ____

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.

f Represent what you did in part d by filling the following table:

Time				
# of Segments				

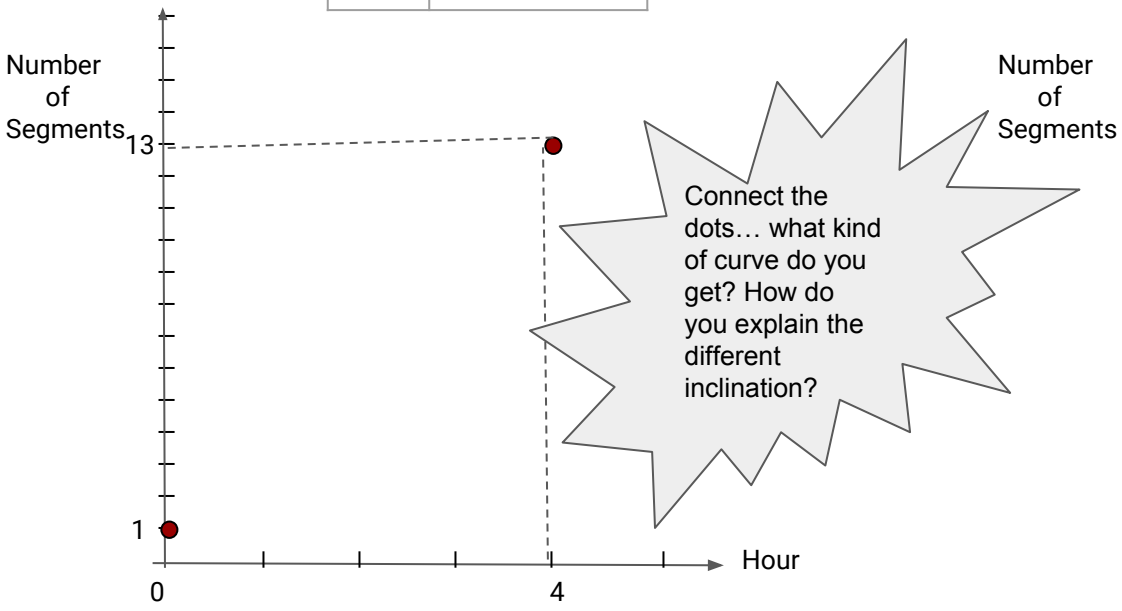
e Fill in the blanks in these two tables, then plot the points below...

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

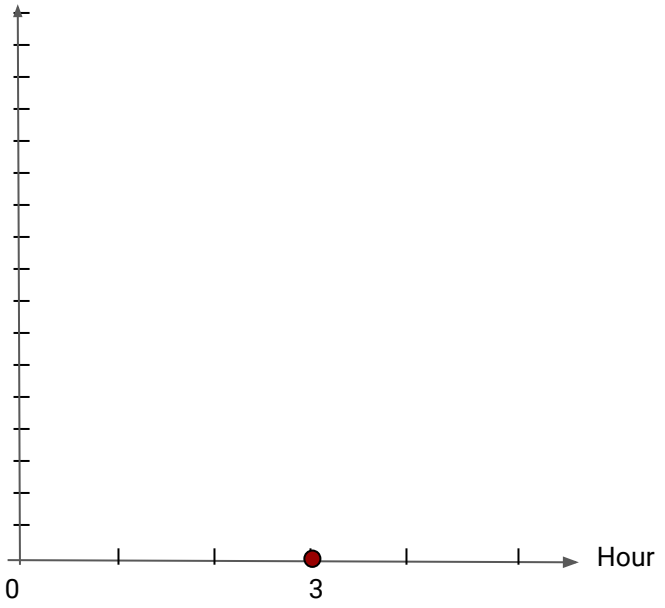
Hour	Number of Segments	STEP CHANGE =
0	1	
1		+3
2		+3
3		+3
4	13	

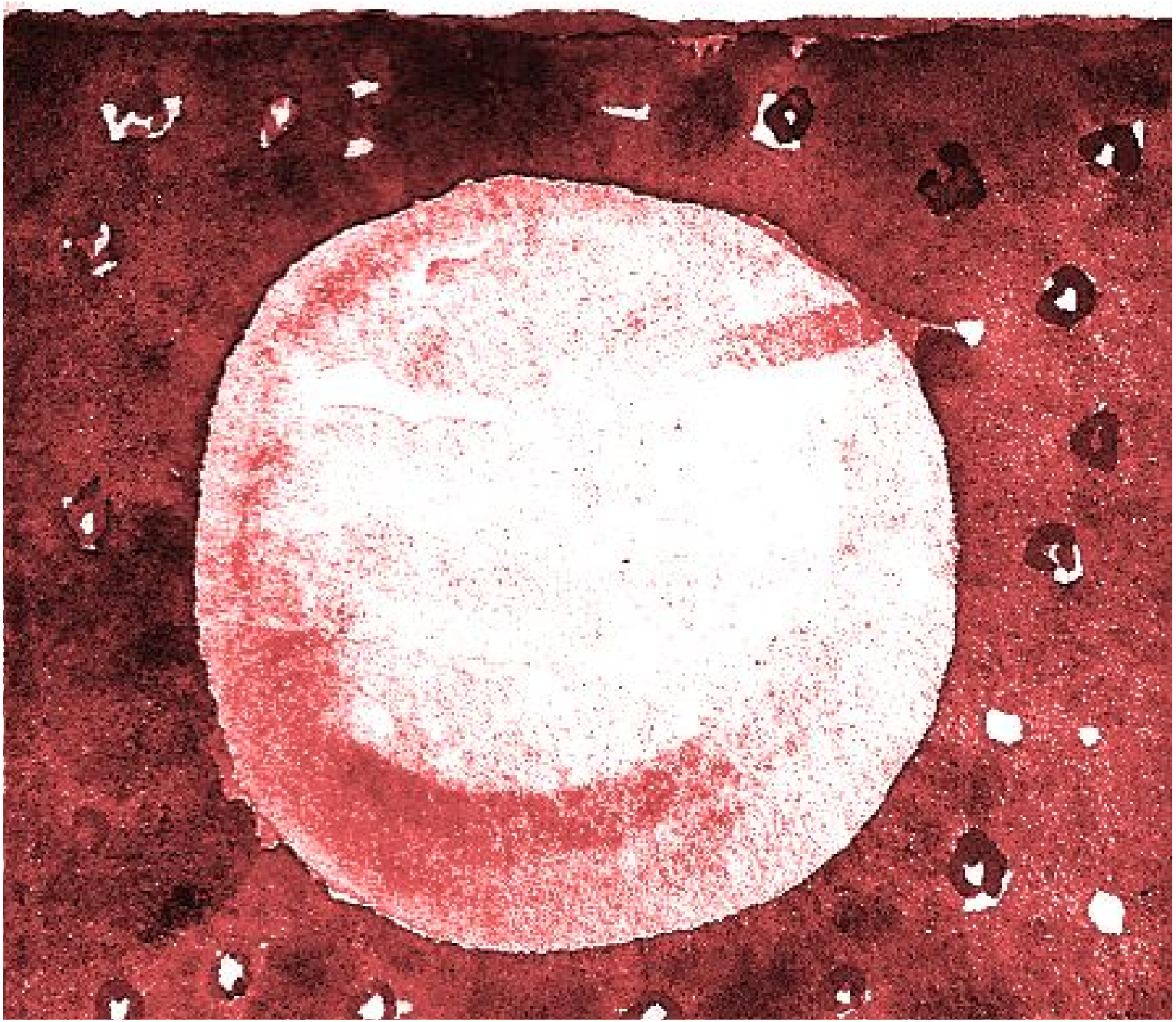
Dismantling the ship, 4 pieces at the time, starting with ? pieces

Hour	Number of Segments	STEP CHANGE =
0		
1		-4
2		-4
3	0	-4



Connect the dots… what kind of curve do you get? How do you explain the different inclination?





2 The Ships Arrive

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

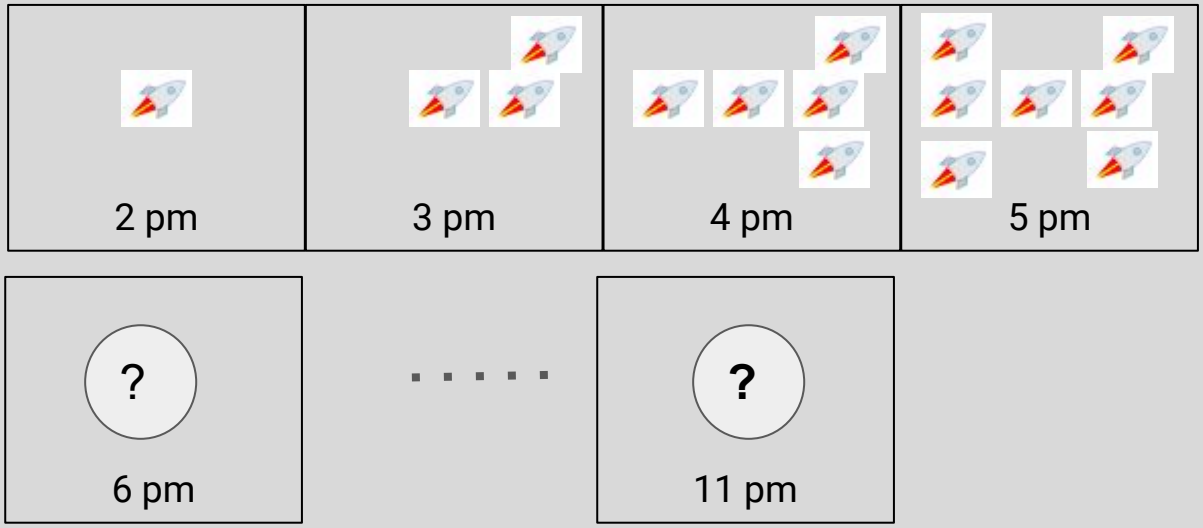
The *step change is*

[**x**] Constant [ ] Not constant

make a prediction

# of ships at 6 pm: _____

# of ships at 11 pm: _____



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

Time	2	3	4	5	6	....	11
# of Segments	1	3	5	7	9	....	?

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*

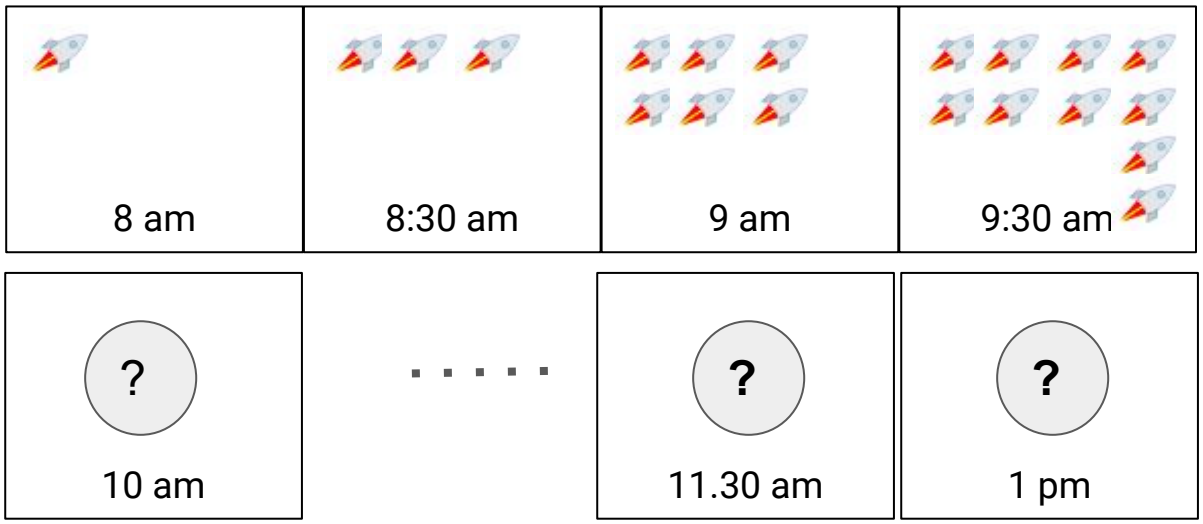
[ ] Constant [ ] Not constant

Predict:

# of ships at 10 am: _____

# of ships at 11.30 am: _____

# of ships at 1 pm: _____



Situation O

The *step change is*

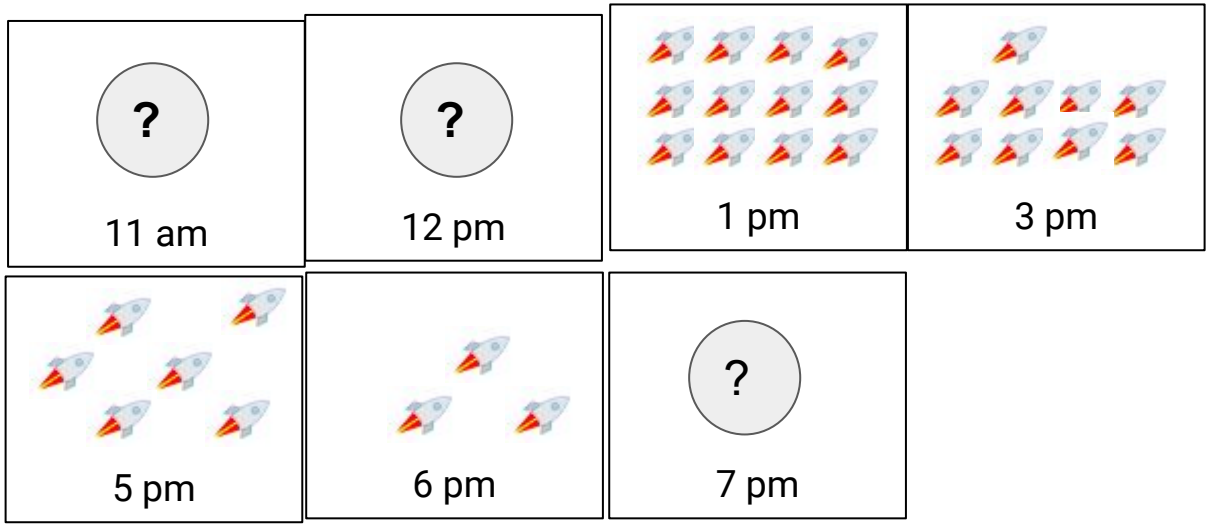
[ ] Constant [ ] Not constant

Predict:

# of ships at 11 am: _____

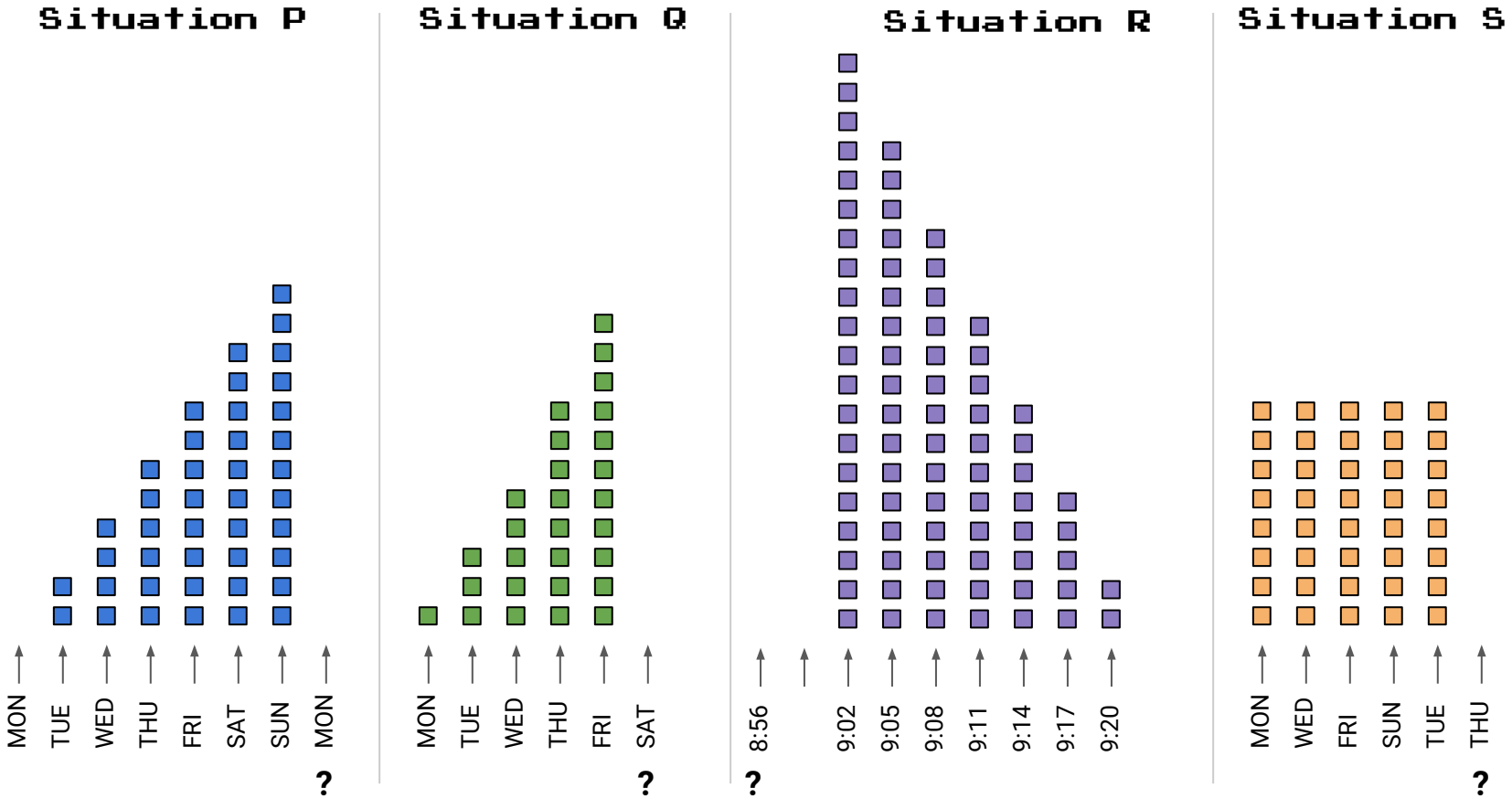
# of ships at 6 pm: _____

# of ships at 7pm 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.



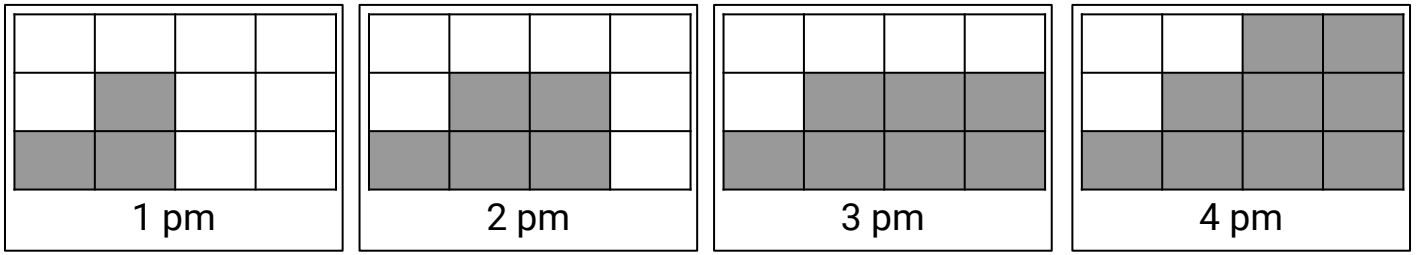
More situations

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: _____

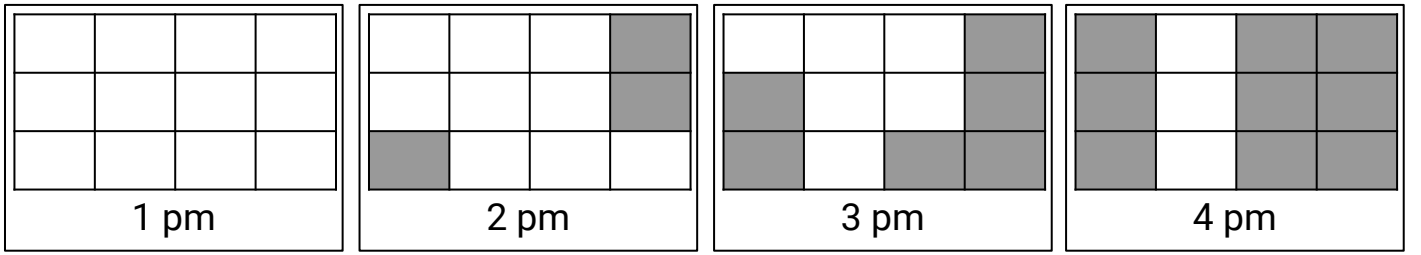
Step change: _____



Situation U

Initial value: _____

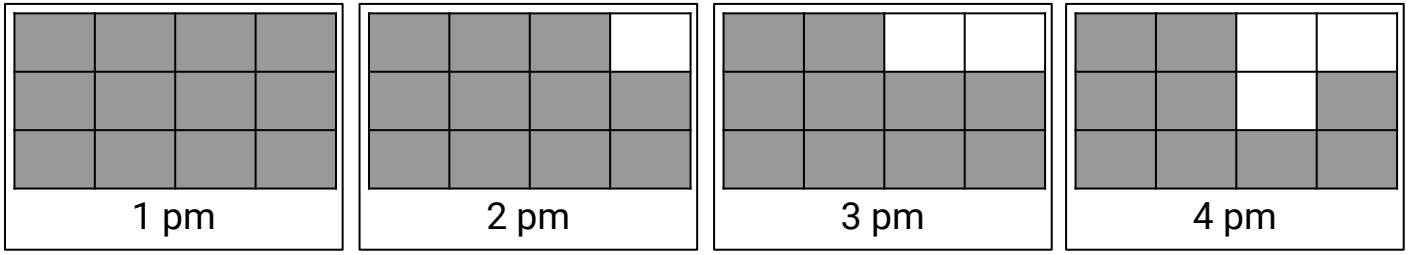
Step change: _____



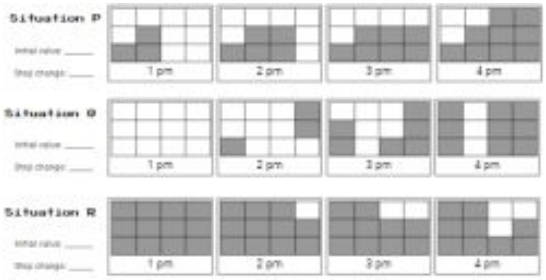
Situation V

Initial value: _____

Step change: _____



Representing the situations



Situation ☐

Start with 3 ships, add 2 each time.

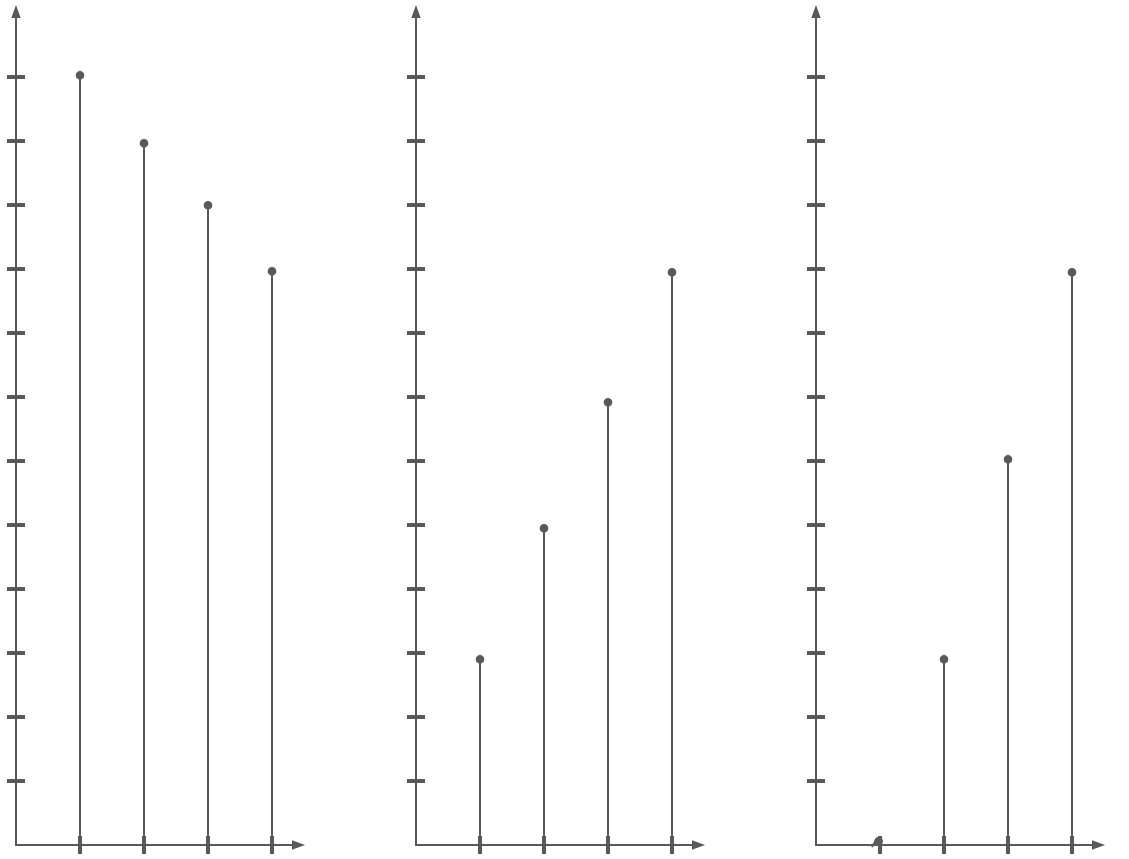
Situation ☐

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:



Situation ☐ **Situation** ☐ **Situation** ☐

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 in terms of n, where n is the time?

C1

Time	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
# of ships	15 + 1	15+ 3	15+5	15+7	15+9	15+11

C2

Time	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
# of ships	100	97	94	91	88	85

C3

Time	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
# of ships	1	2	4	8	16	32

C4

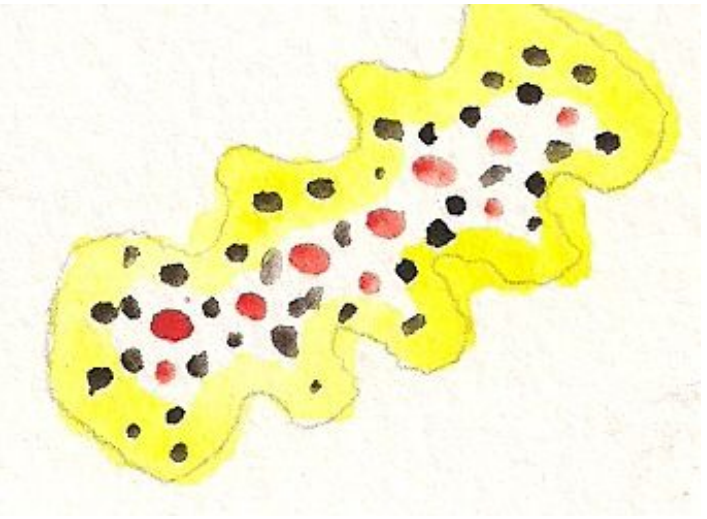
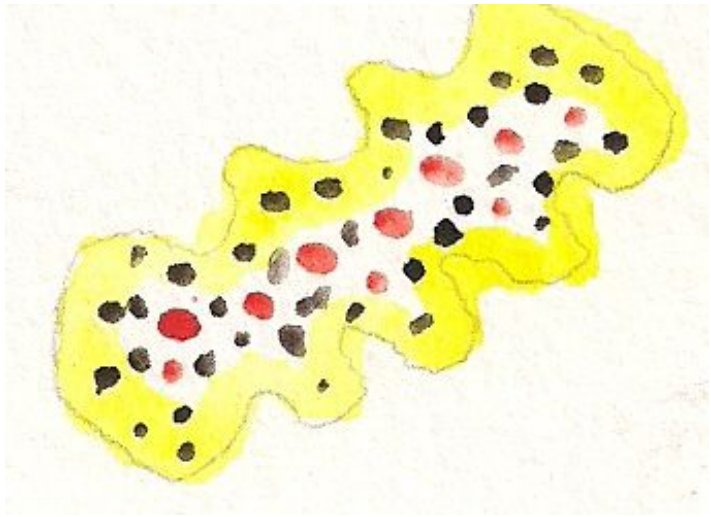
Time	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
# of ships	3+1	3+4	3+9	3+16	3+25	3+36

C5

Time	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
# of ships	3	30	300	3000	30000	300000

Situation	Is change constant?	Value at 7 pm	Value at 8pm	Formula for # of ships in terms of *n* (where *n* represents the time)
C1				
C2				
C3				
C4				
C5				

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

There are many possible answers, find them all.

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.

Number of fruit in 1 pocket	Number of fruit in 1 bag	TOTAL number of fruits (1 pocket + 4 bags)
		22
		22
		22
		22
		22
		22

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

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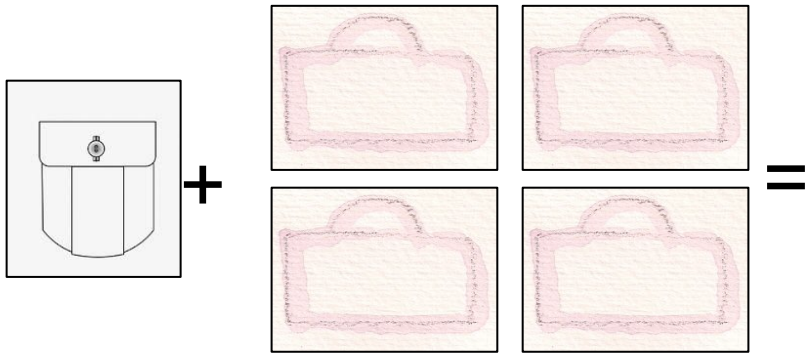
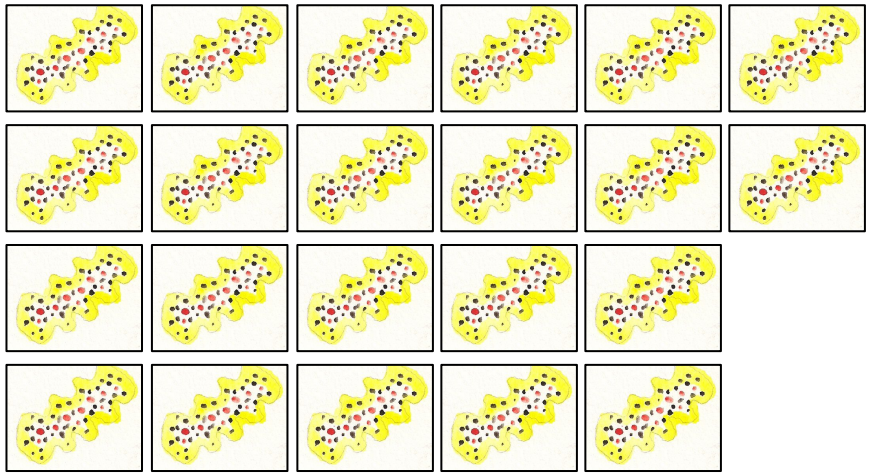
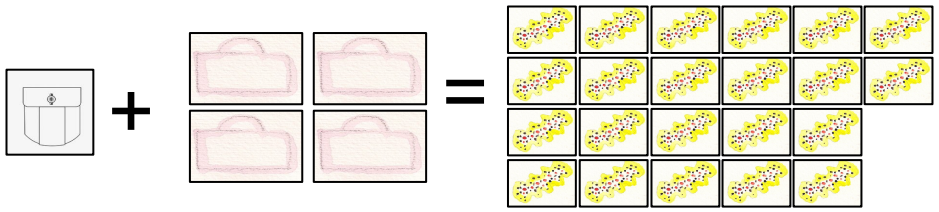




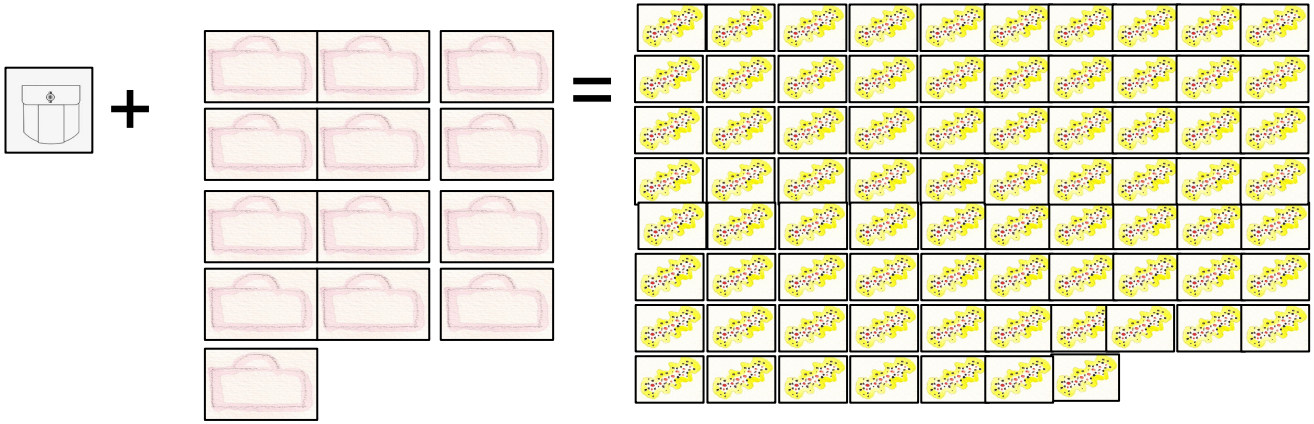
Every day he puts the same number of fruits in his pocket and in each bag, but uses a different number of bags.

Monday:
1 pocket
+ 4 bags



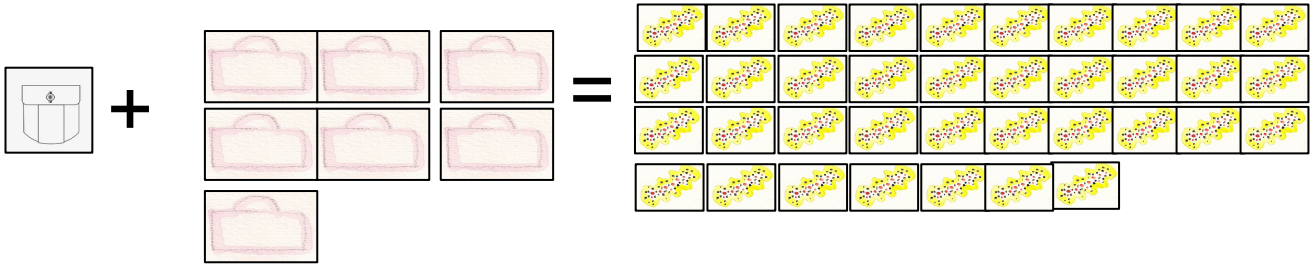
22 fruits

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?

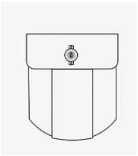
e On Friday, he uses his pocket and some bags. He picks 192 fruits. How many bags did he use?

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.

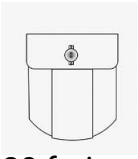
The astronauts compete in contests: whoever collects more fruits wins. Remember that all astronauts will carry the same number of bags.

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


0 fruits

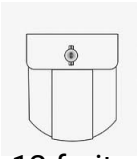

7 fruits

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


20 fruits


3 fruits

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

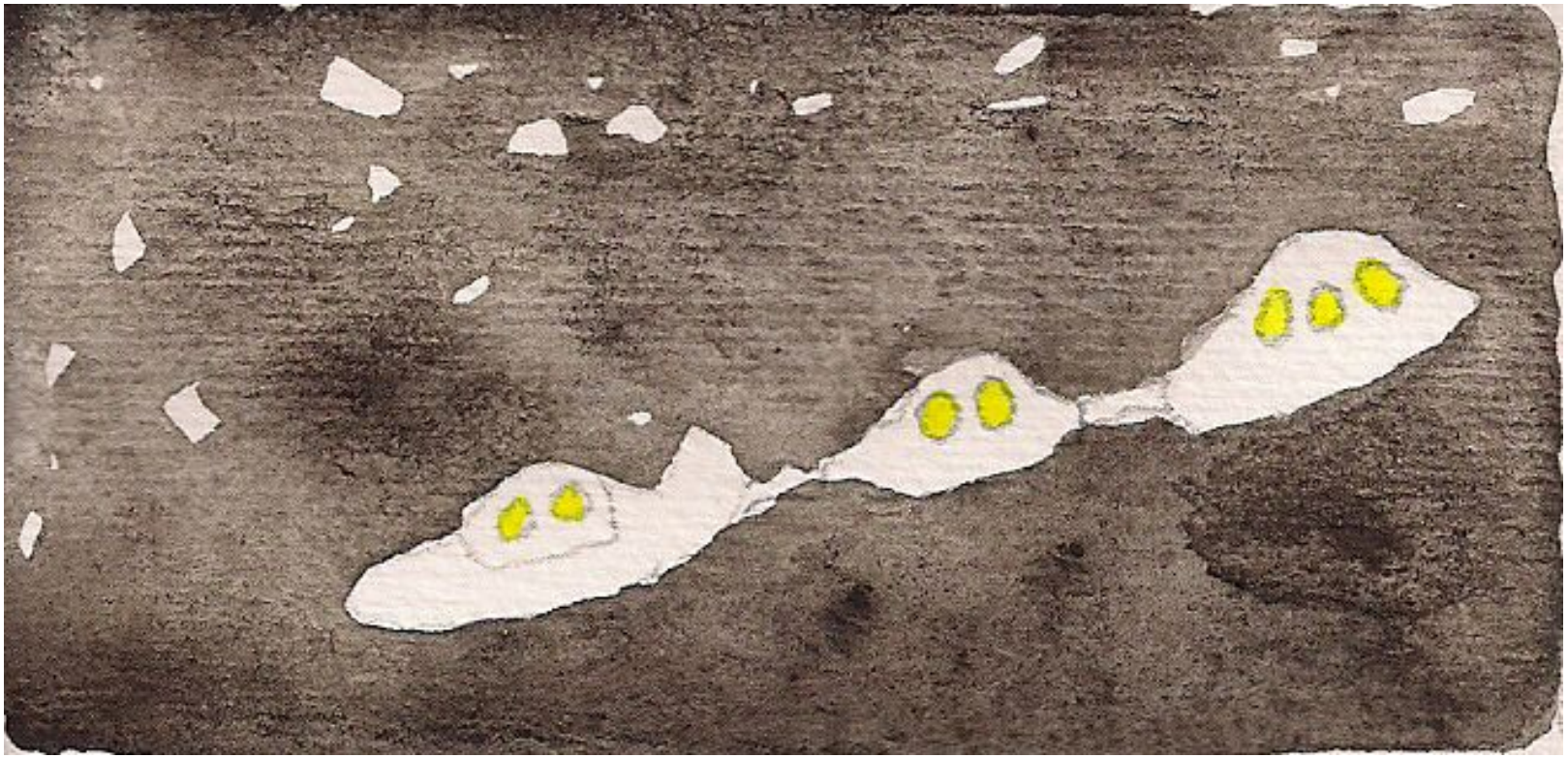

12 fruits


5 fruits

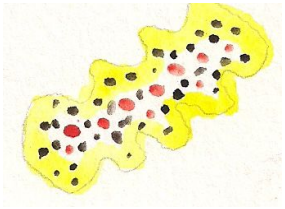
f Who wins the contest if each astronaut takes 2 bags?

g 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*.

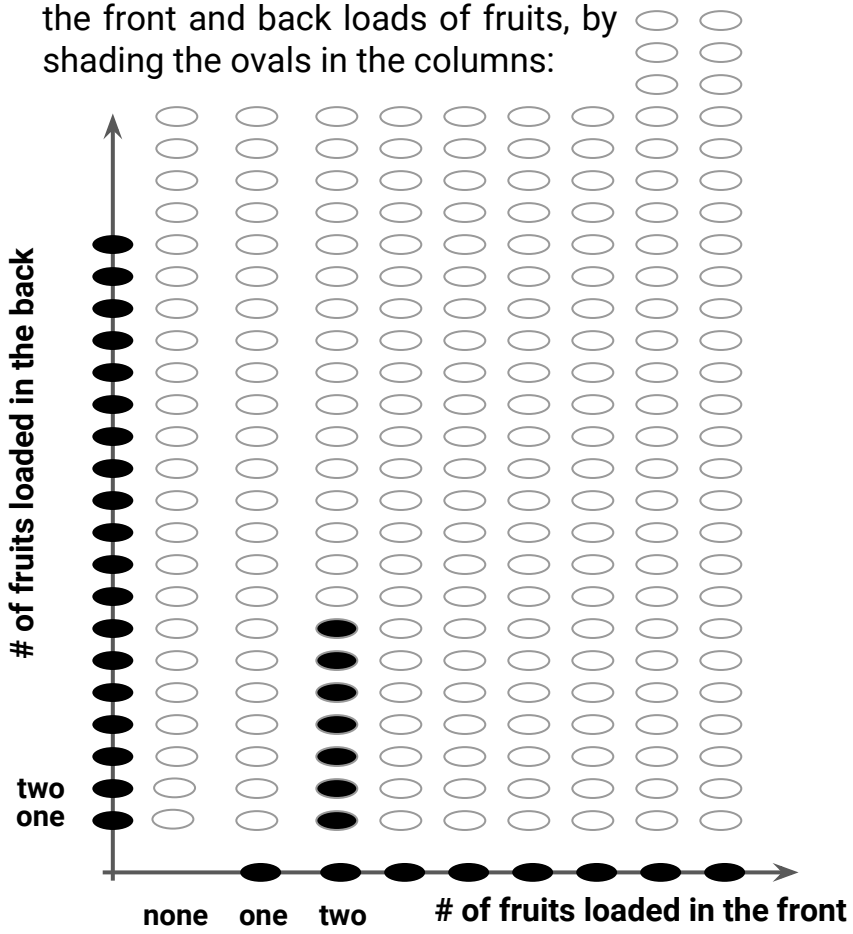
The loading rules are simple:
(I) Put 1 fruit in the back (do not put any fruits in the front yet).
*(II) Now put several fruits in the front, one by one, and for each fruit that you put in the front container, put **3 fruits** in the back.*

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?