CURIOUS MINDS, SERIOUS MATH

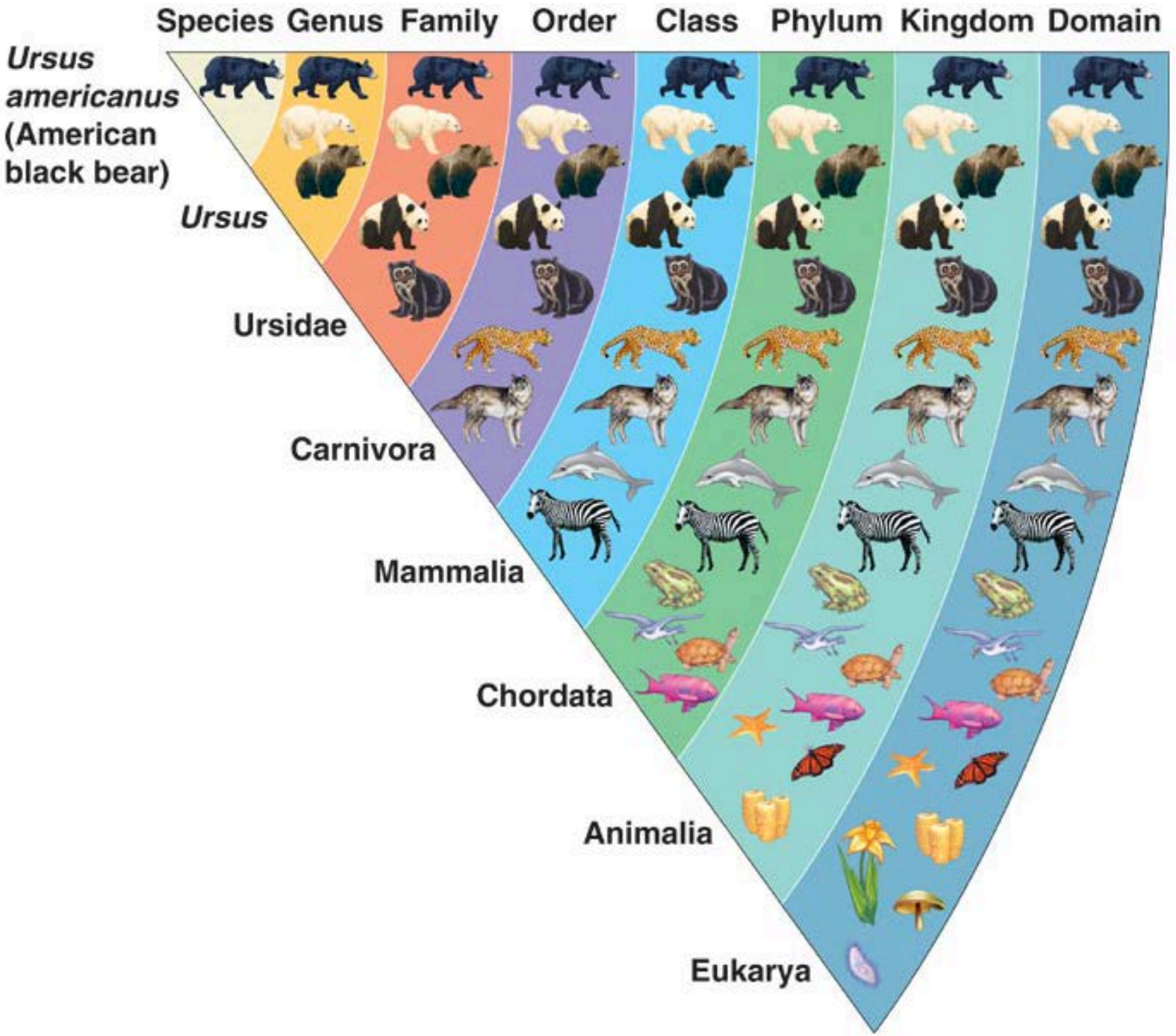
Prof. Dr. Jan de Lange

ANIMALS

- Do you know any of these animals
- Are there more than 1 of a kind
- Are there more….than……
- Which animals belong to each other
- Can you put them in order

- Science and Math behind the animals

CAROLI LINNÆI
REGNUM ANIMALE.
I QUADRUPEDIA
II AVES
III AMPHIBIA
IV PISCES
V. INSECTA
VI VERMES
PARADOXA


Species
Genus
Family
Order
Class
Phylum
Kingdom
Domain
Ursus americanus (American black bear)
Ursus
Ursidae
Carnivora
Mammalia
Chordata
Animalia
Eukarya

CAROLI LINNAEI

EQVITIS DE STELLA POLARI,

ARCHIATRI REGII, MED. ET BOTAN. PROFESS. VPSAL. ACAD. VPSAL. HOLMENS. PETROPOL. REGIAE IMPER. LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATVRAE

PER

REGNA TRIA NATVRAE,

SECVNDVM

CLASSES, ORDINES, GENERA, SPECIES,

CVM

CHARACTERIBVS, DIFFERENTIIS, SYNONYMIS, LOCIS.

TOMVS I.

PRAEFATVS EST

IOANNES IOACHIMVS LANGIVS

HALAE MAGDEBVRGICAE

SCIENCE & MATH

- Classification
- Seriation

½ 4 √2 −5

−3/4 0.34 34

1,33333 7/8

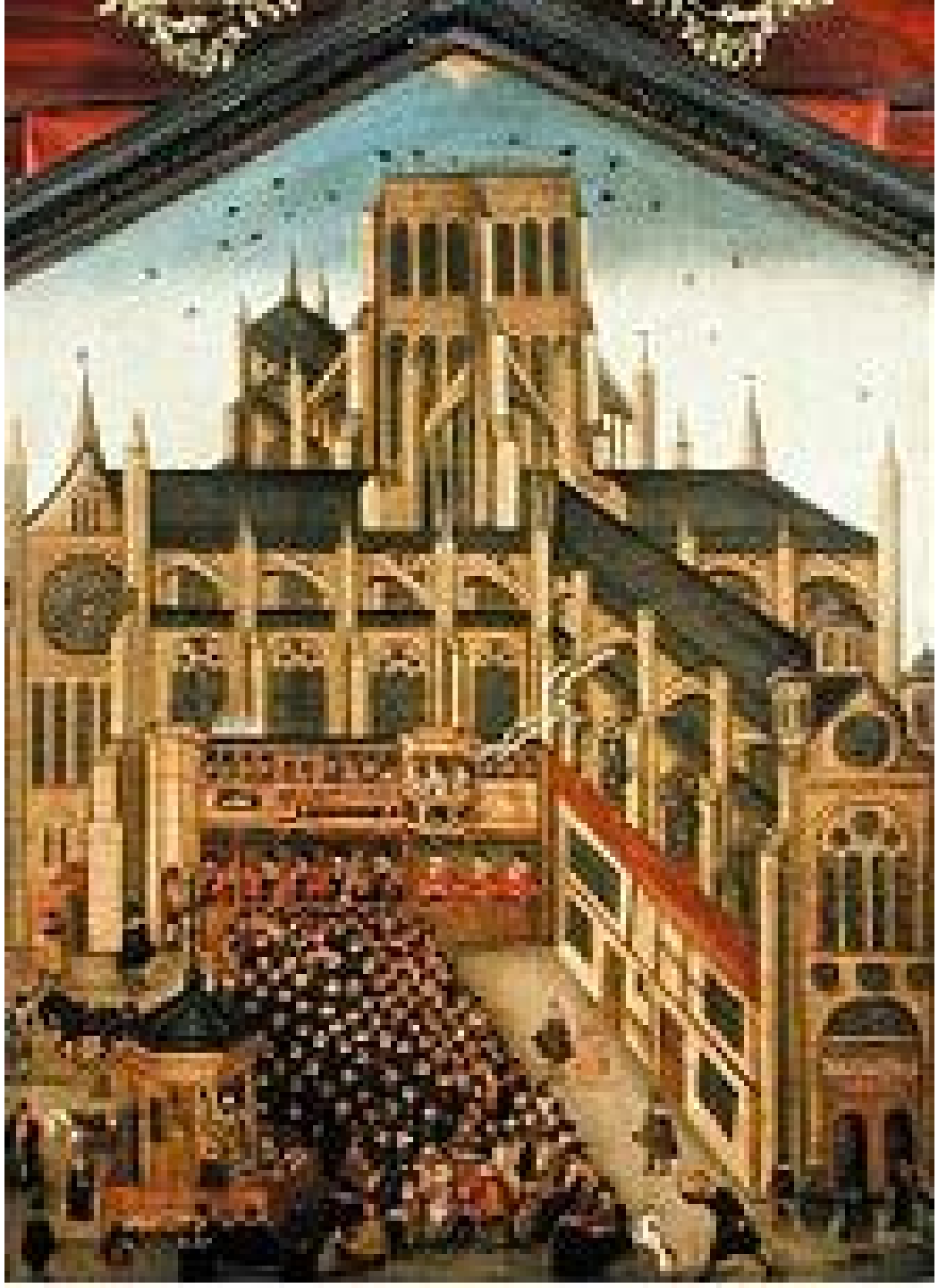
−1/22 0.66 123

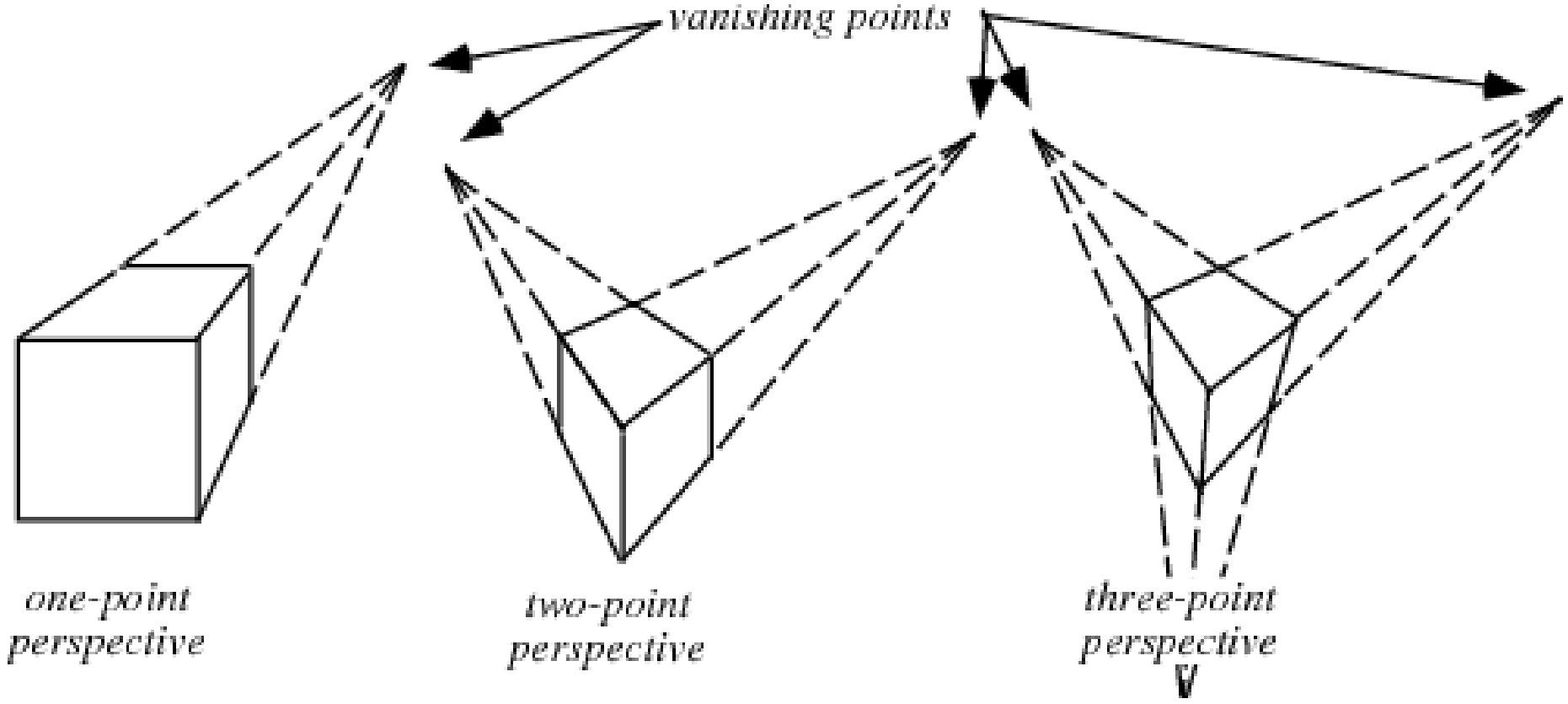
−11/12 .−26 22.22 √4

PHOTO

VRAGEN FOTO'S

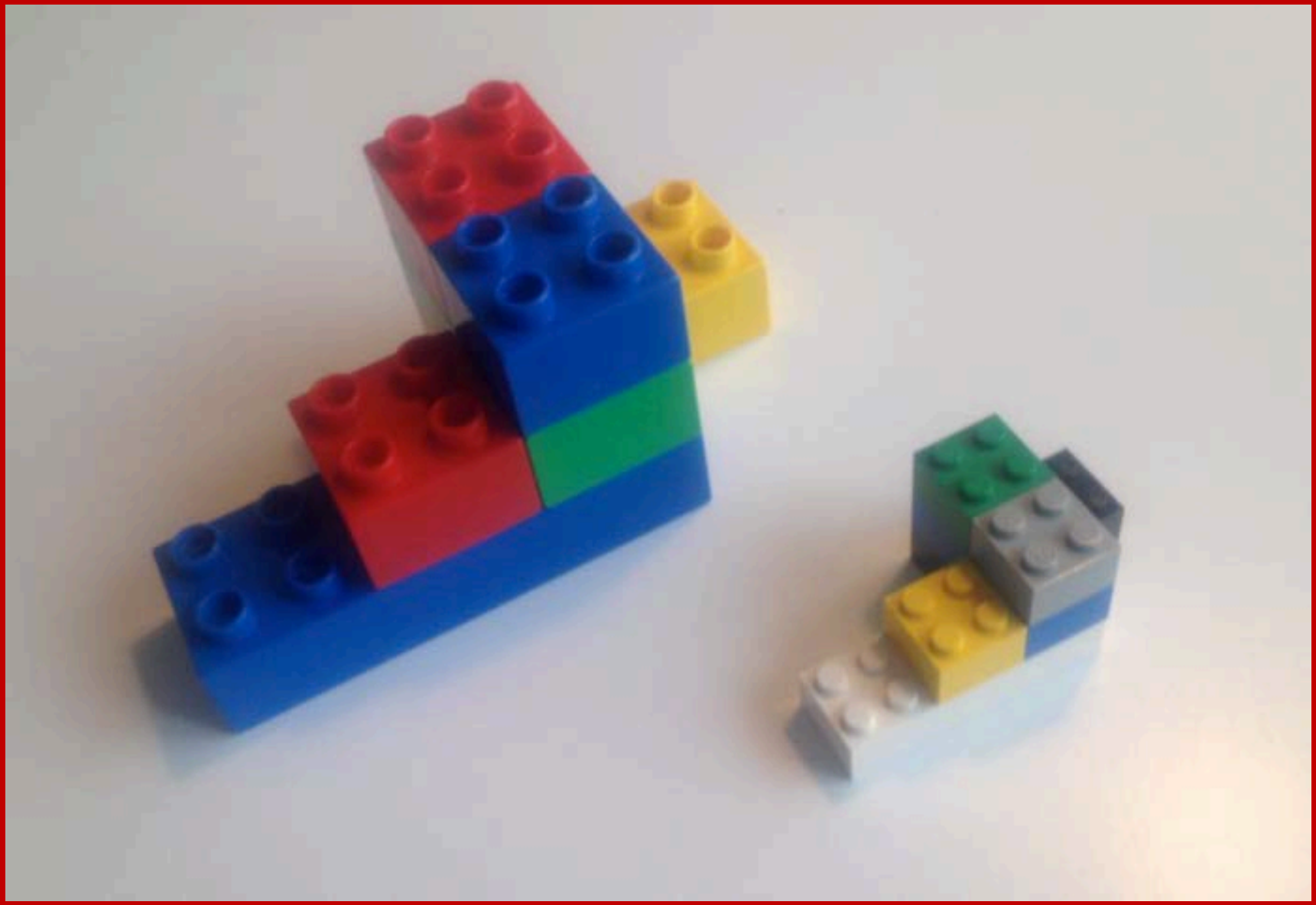
- Are the cars (animals) the same
- What is the same, what is different
- Can you take photos top view
- Can you take a photo where the cars have the same size




vanishing points
one-point perspective
two-point perspective
three-point perspective

SCIENCE & MATH

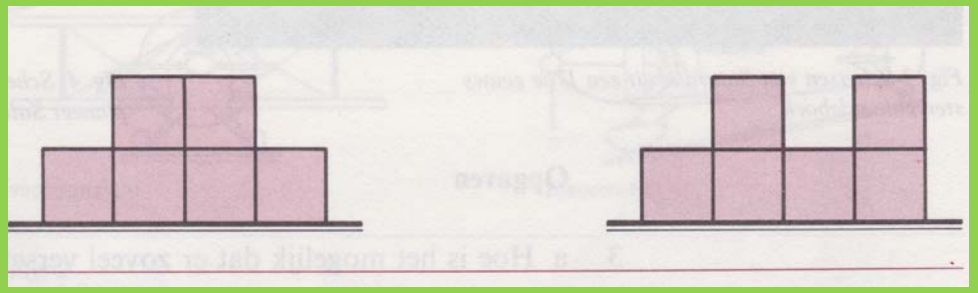
- SIMILAR
- CONGRUENT
- PERSPECTIVE
- LINES OF SIGHT



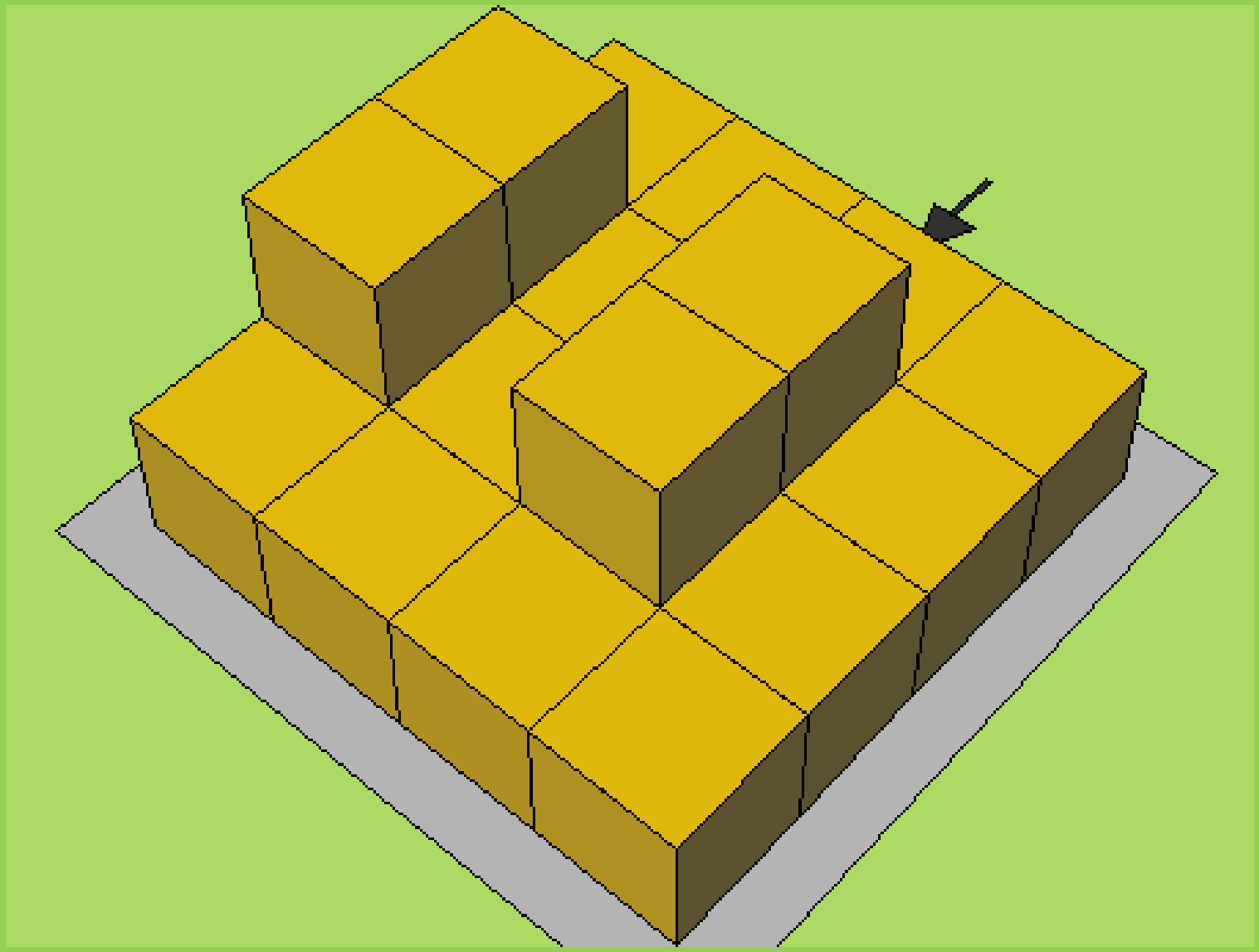
- **LEGO/DUPLO**
- Lots of opportunities
- Similar
- Differences
- Scale
- Linear
- Quadratic
- Cubic
- Top-, Side-, Frontview

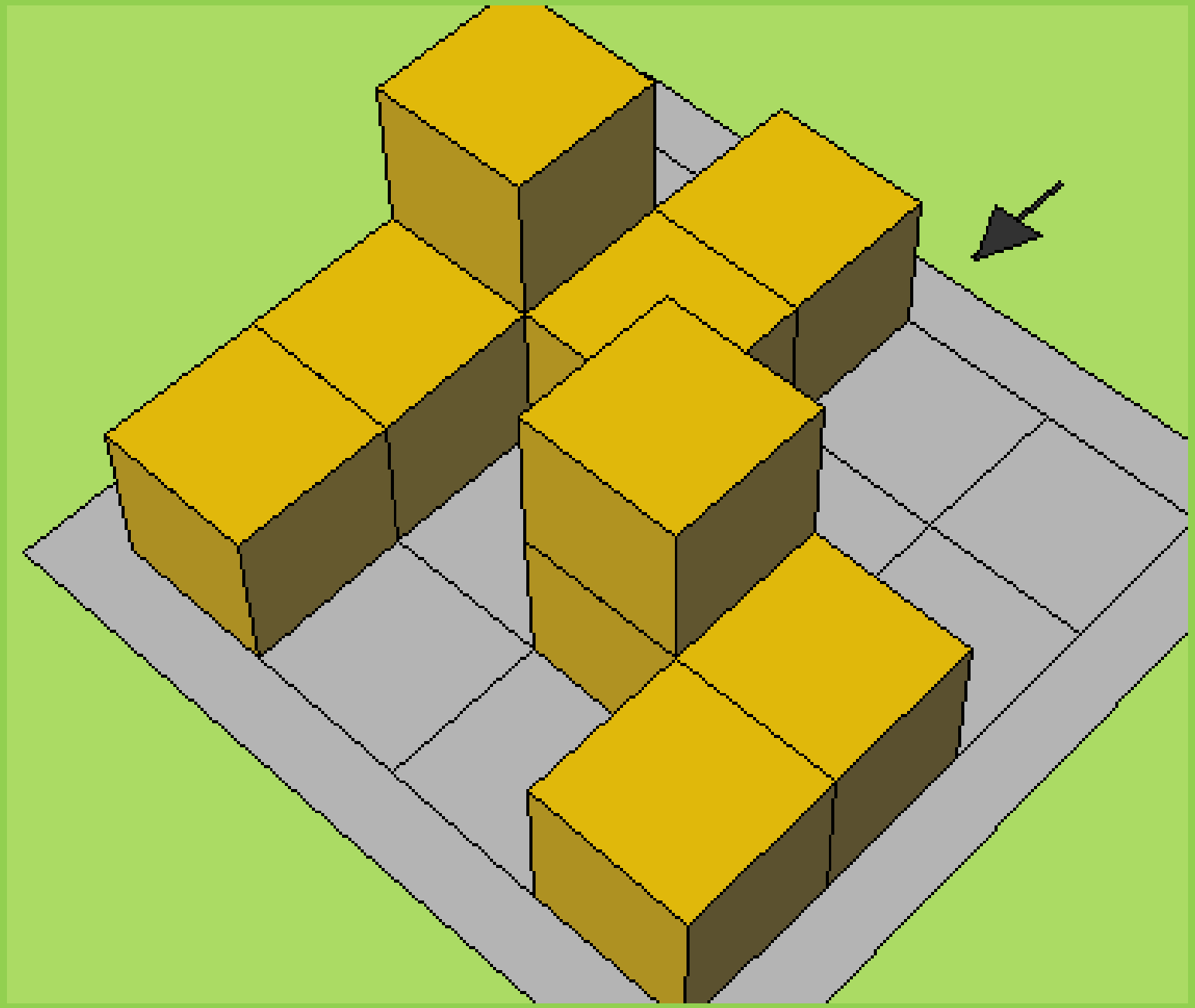
FRONT-AND SIDEVIEW

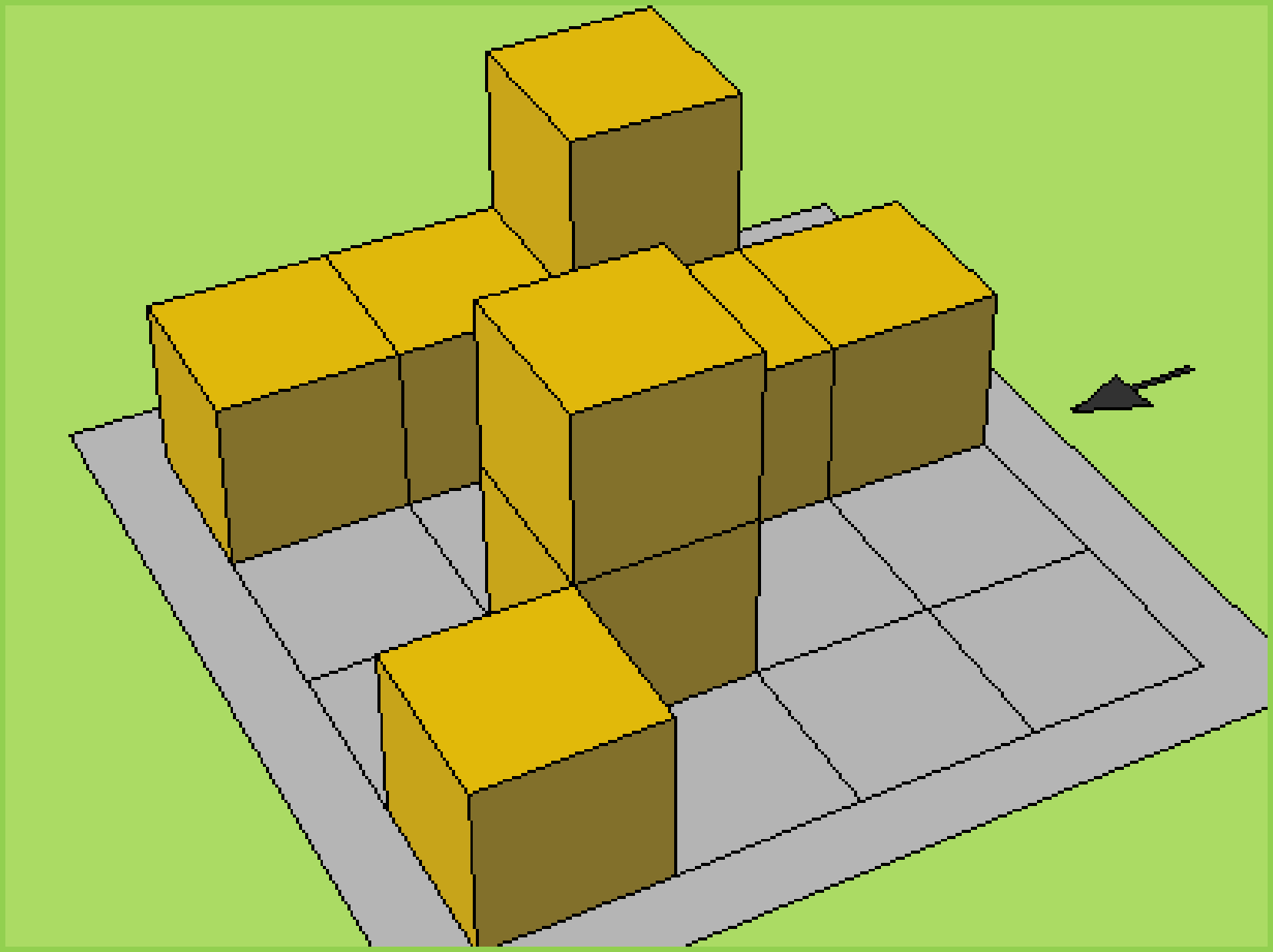
HOW MANY BLOCKS DO YOU NEED?

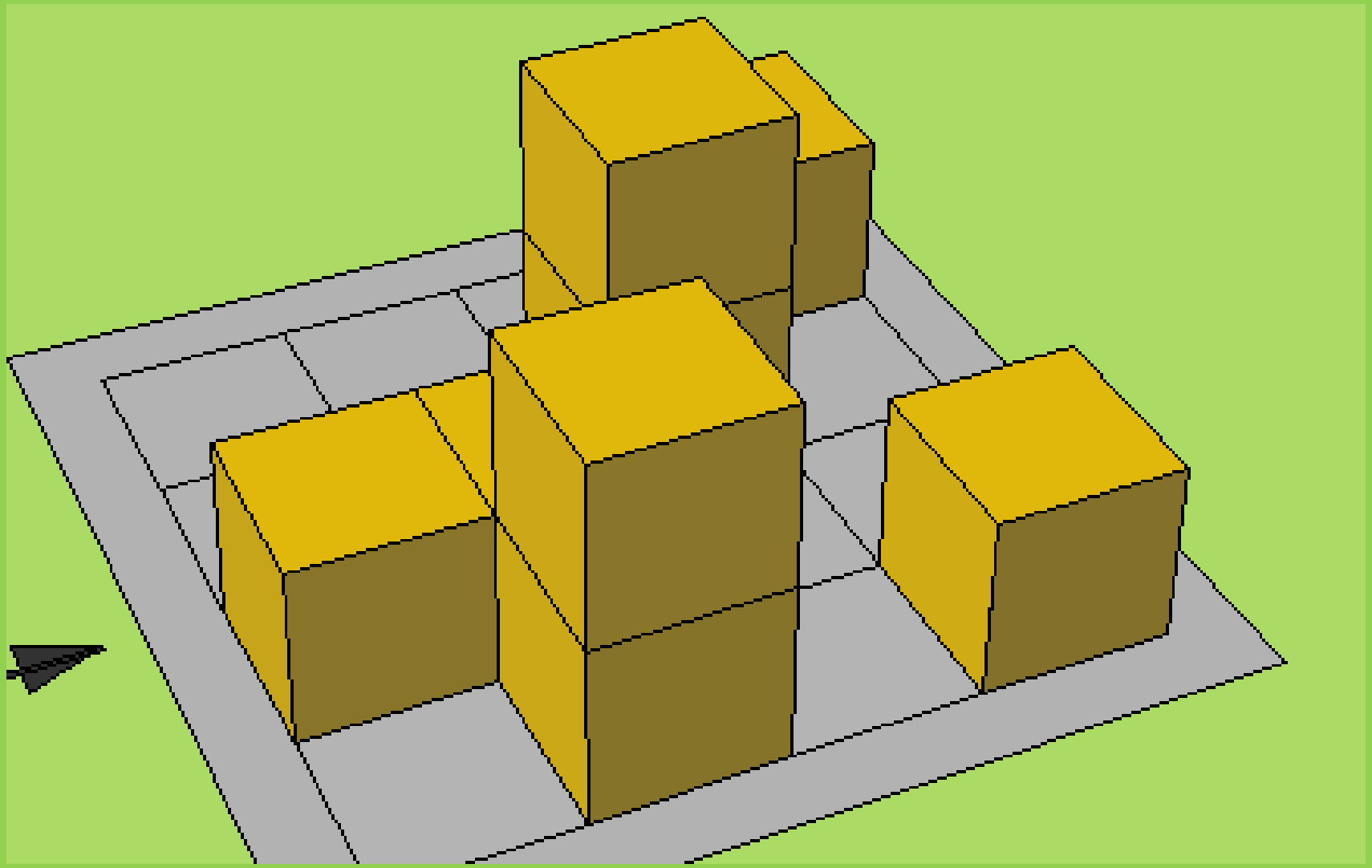


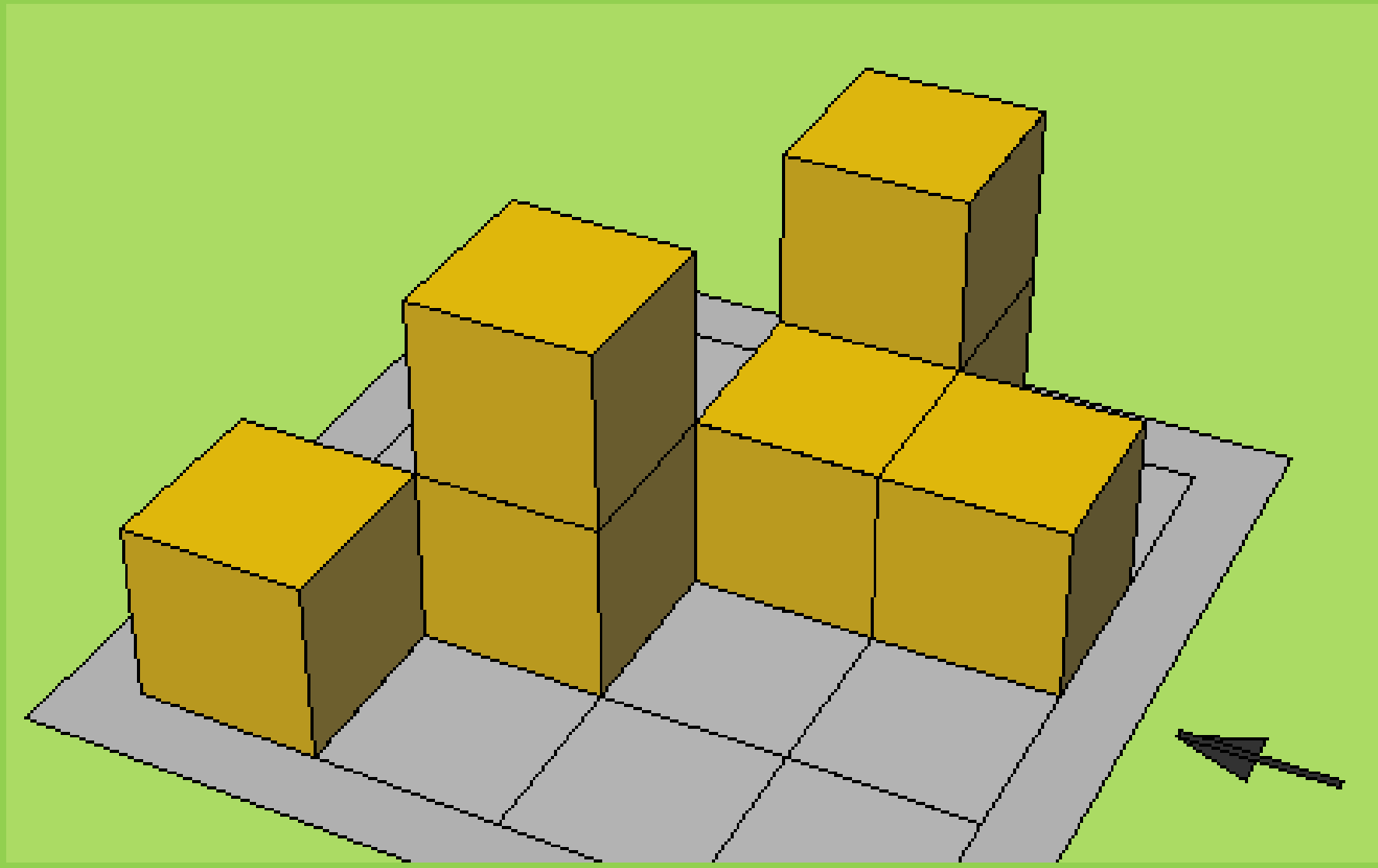
Hoeveel blokjes heb je nodig?

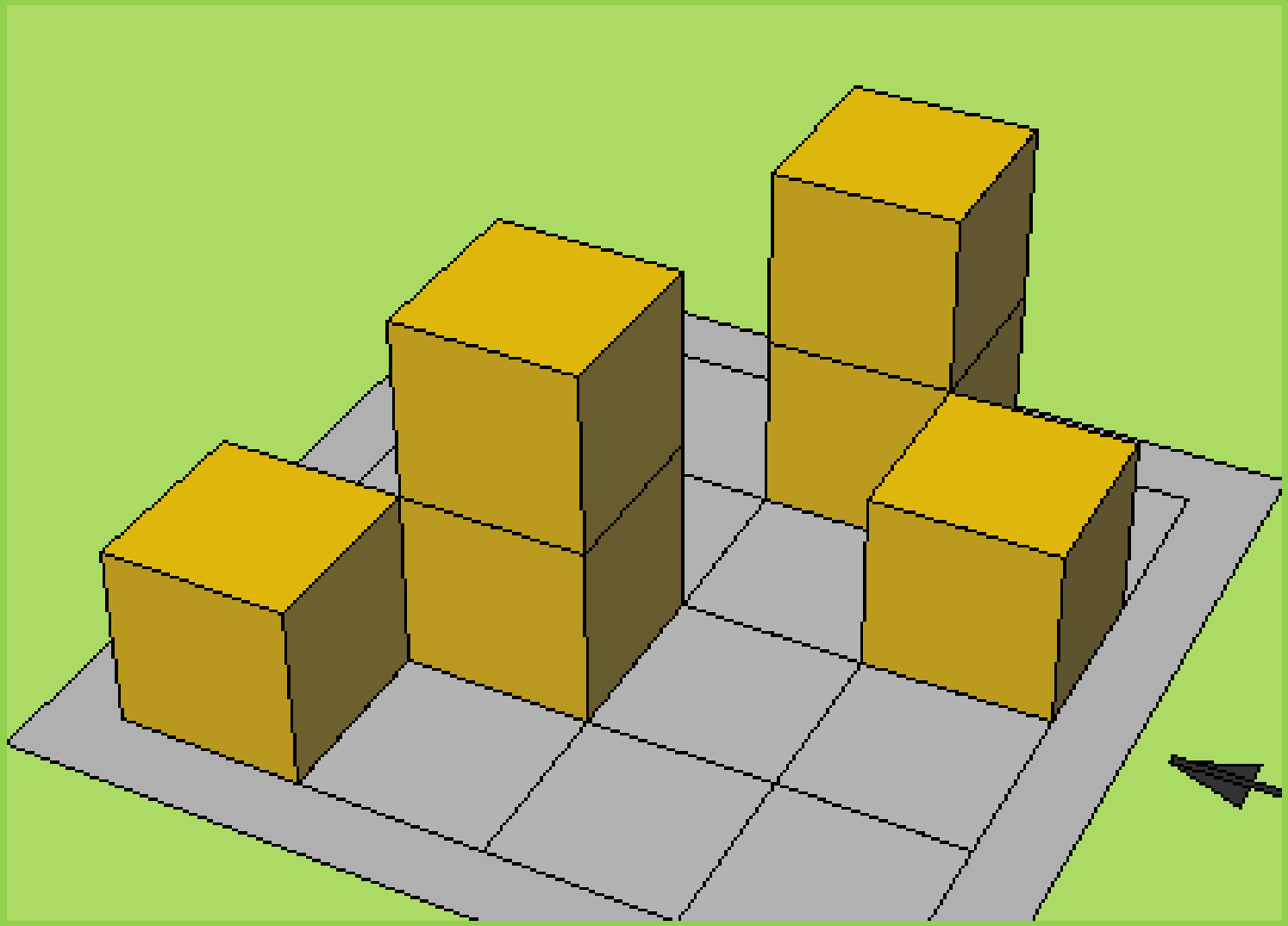




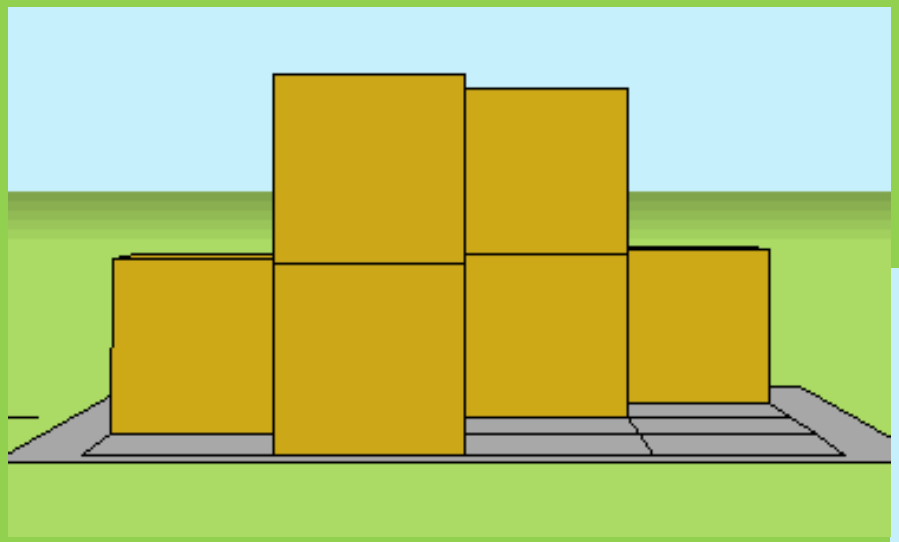


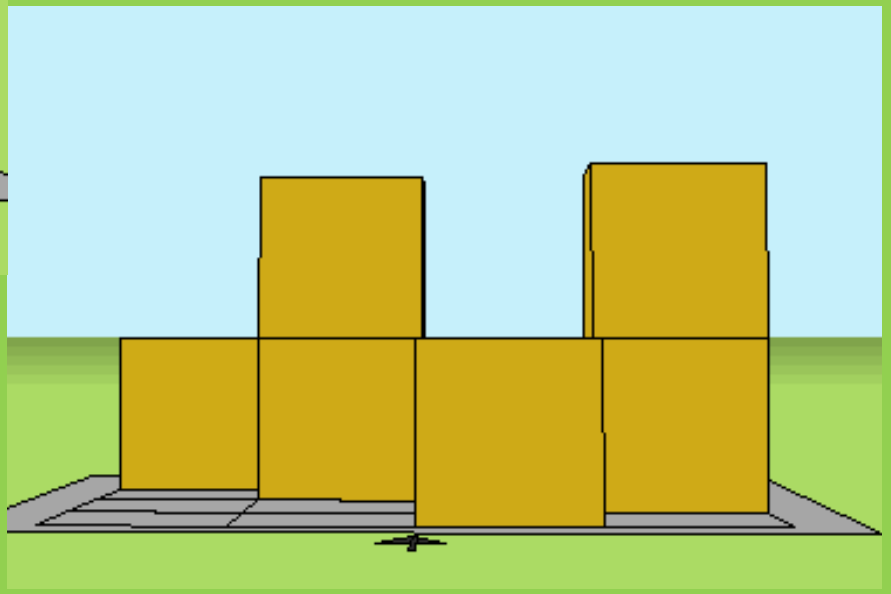


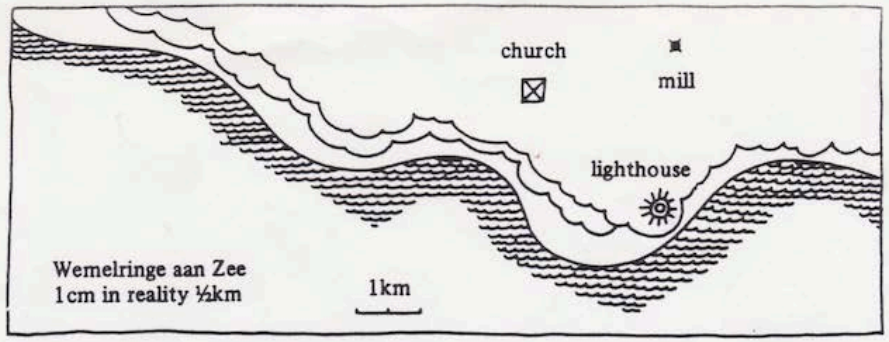


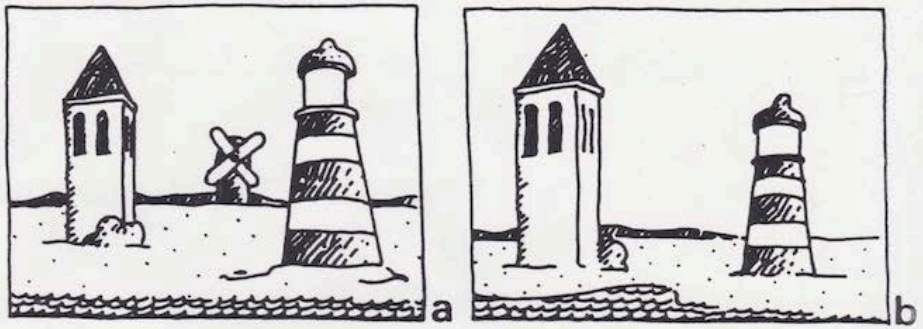


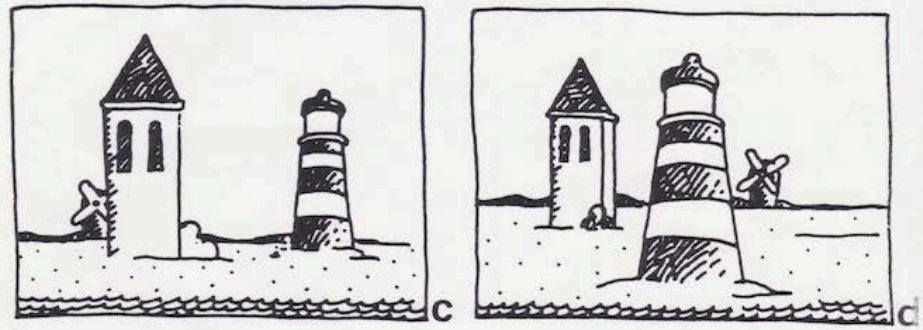
FRONT & SIDE VIEW

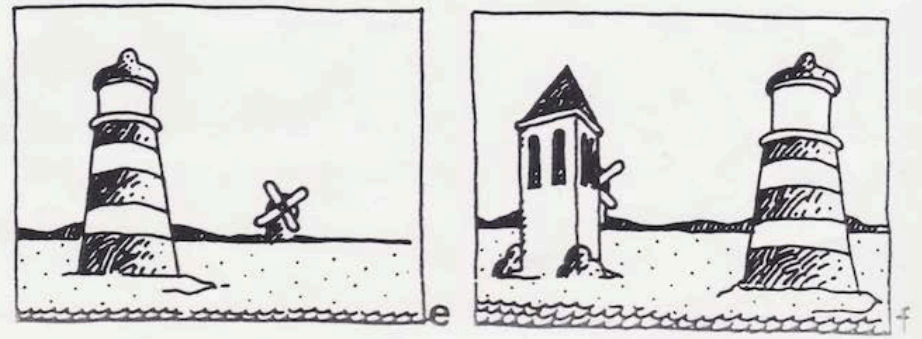





church
mill
lighthouse
Wemelringe aan Zee
1cm in reality ½km
1km

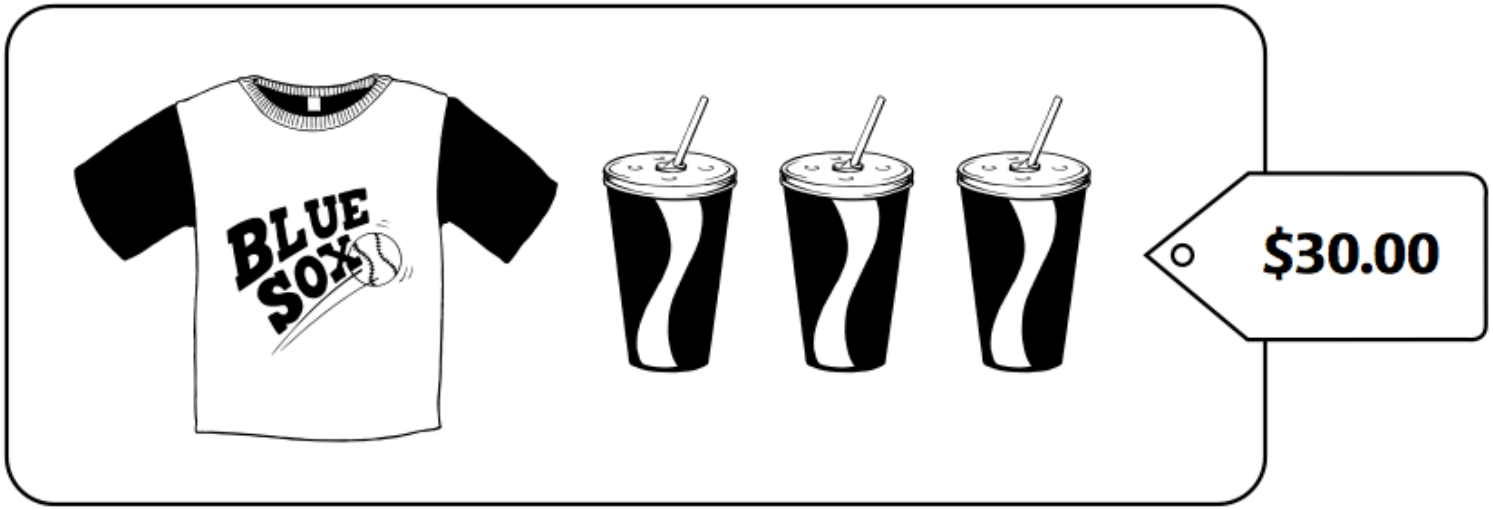

a
b


c
d


e
f

FROM INFORMAL
TO FORMAL
FROM CONCRETE
TO ABSTRACT
FROM REAL WORLD
TO CONCEPT

- FROM SPATIAL REASONING
- TO ALGEBRAIC REASONONG



1. How much does a T-shirt cost?

How much is a drink?

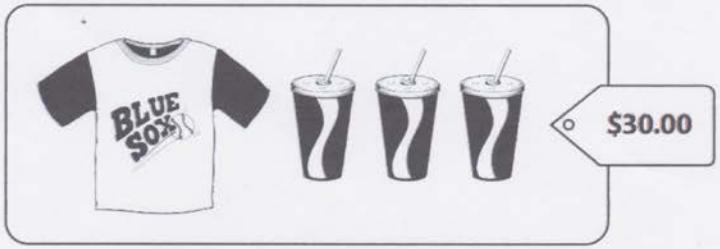
Explain how you got your answers.

1. How much does a T-shirt cost?

   How much is a drink?

   Explain how you got your answers.

one t-shirt costs $18.00
because 1 t-shirt and 1 soda
are $22.00, this leaves
2 sodas in the lower picture
and $8.00 so 1 soda is $4.00
and 22-4=18 so 1 t-shirts
costs $18.00



1. How much does a T-shirt cost?

How much is a drink?

Explain how you got your answers.

counting on:

2 shirts and 2 cups then:
1 shirt and 3 cups then:
0 shirt and 4 cups -
almost ready

Price was 44.- less 1 t-shirt
30.- less 1 t-shirt

left 16 ÷ 4 = 4

1. How much does a T-shirt cost?

   How much is a drink?

   Explain how you got your answers.

cups 30 - 22 = 8 for 2

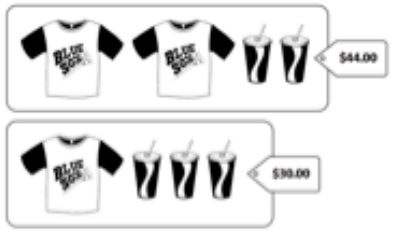
so

44 - 8 = 36 for 2 t-shirts

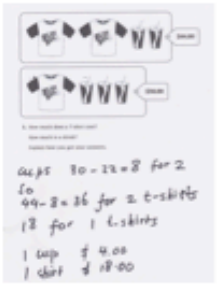
18 for 1 t-shirts

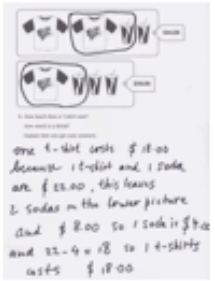
1 cup $ 4.00

1 shirt $ 18.00



CONCEPTUAL MATHEMATIZATION





INTERACTION SCHEMATIZATION FORMALIZATION

2x + 2y = 44

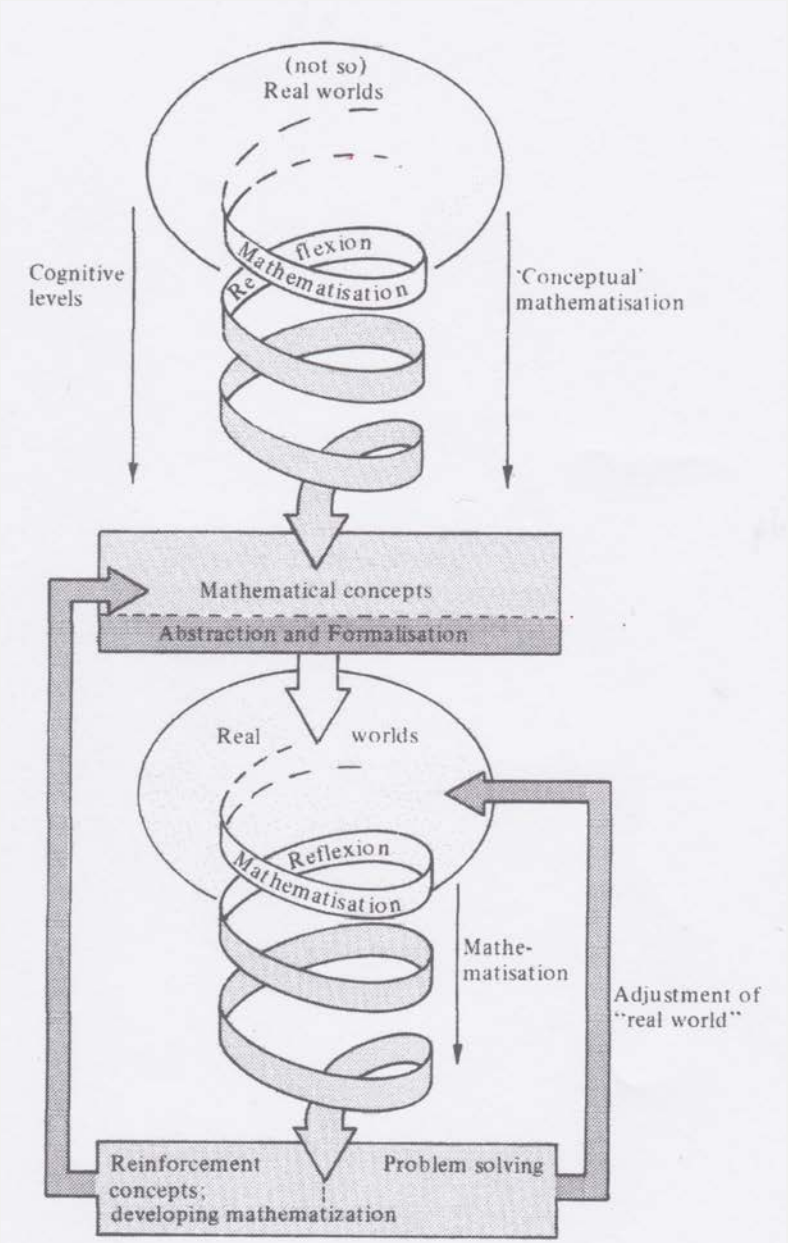
x + 3y = 30

CONCEPTS

VARIABLE EQUATION

APPLIED MATHEMATIZATION

REINFORCORCING CONCEPTS

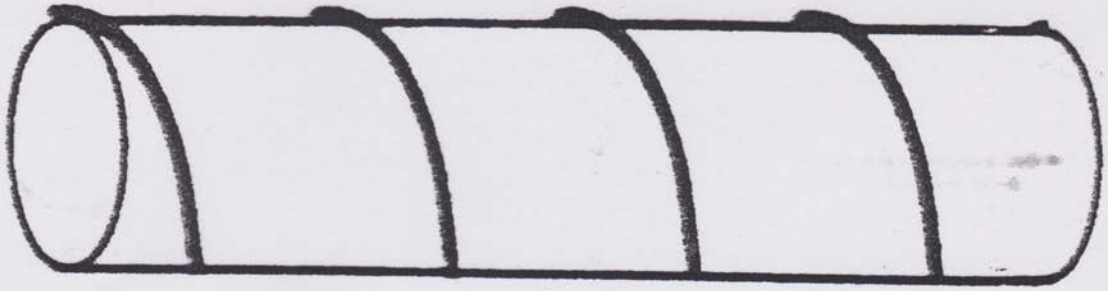


Global schema of the activities of the experimental math a curriculum

fig. II.

The Problem

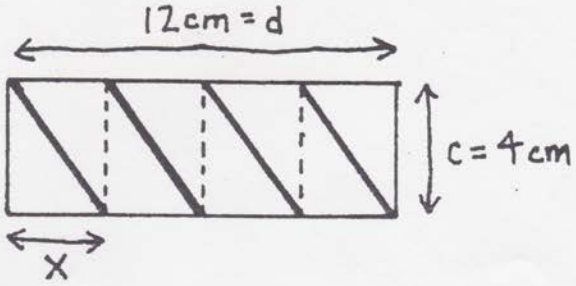
A string is wound symmetrically around a circular rod. The string goes exactly four times around the rod. The circumference of the rod is 4 cm. and its length is 12 cm.



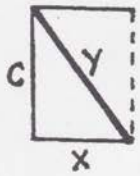
Find the length of the string.
Show all your work.

The Solution

Imagine that you unwrap the cylinder and flatten it.



$$x = \frac{d}{4} = \frac{12\,cm}{4} = 3\,cm$$



$$y^2 = c^2 + x^2$$

$$y^2 = 16 + 9 = 25\,cm^2$$

$$y = 5\,cm$$

n = number of times string is wrapped around = 4

Length of string = $y \cdot n = 5\,cm \cdot 4$

$= \underline{\underline{20\,cm}}$

Source: I.E.A. Third International Mathematics and Science Study, 1995-96

New York Times

Mathematics is Thinking

LEAKING SRB

RUBBER O-RINGS

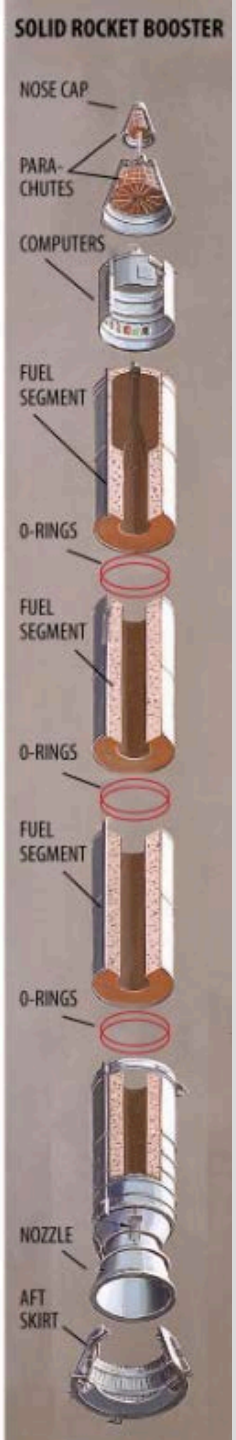
To make each solid-rocket booster, the Morton Thiokol factory built four hull segments filled with powdered aluminum (fuel) and ammonium perchlorate (oxidizer).

At the launch site, the fuel segments were assembled vertically. Field joints containing rubber O-ring seals were installed between each fuel segment.

The O-rings were never tested in extreme cold. On the morning of the launch, the cold rubber became stiff, failing to fully seal the joint.

RUPTURED FUEL TANK

As the shuttle ascended, one of the seals on a booster rocket opened enough to allow a plume of exhaust to leak out. Hot gases bathed the hull of the cold external tank full of liquid oxygen and hydrogen until the tank ruptured.



TEMPERATURE CONCERN ON

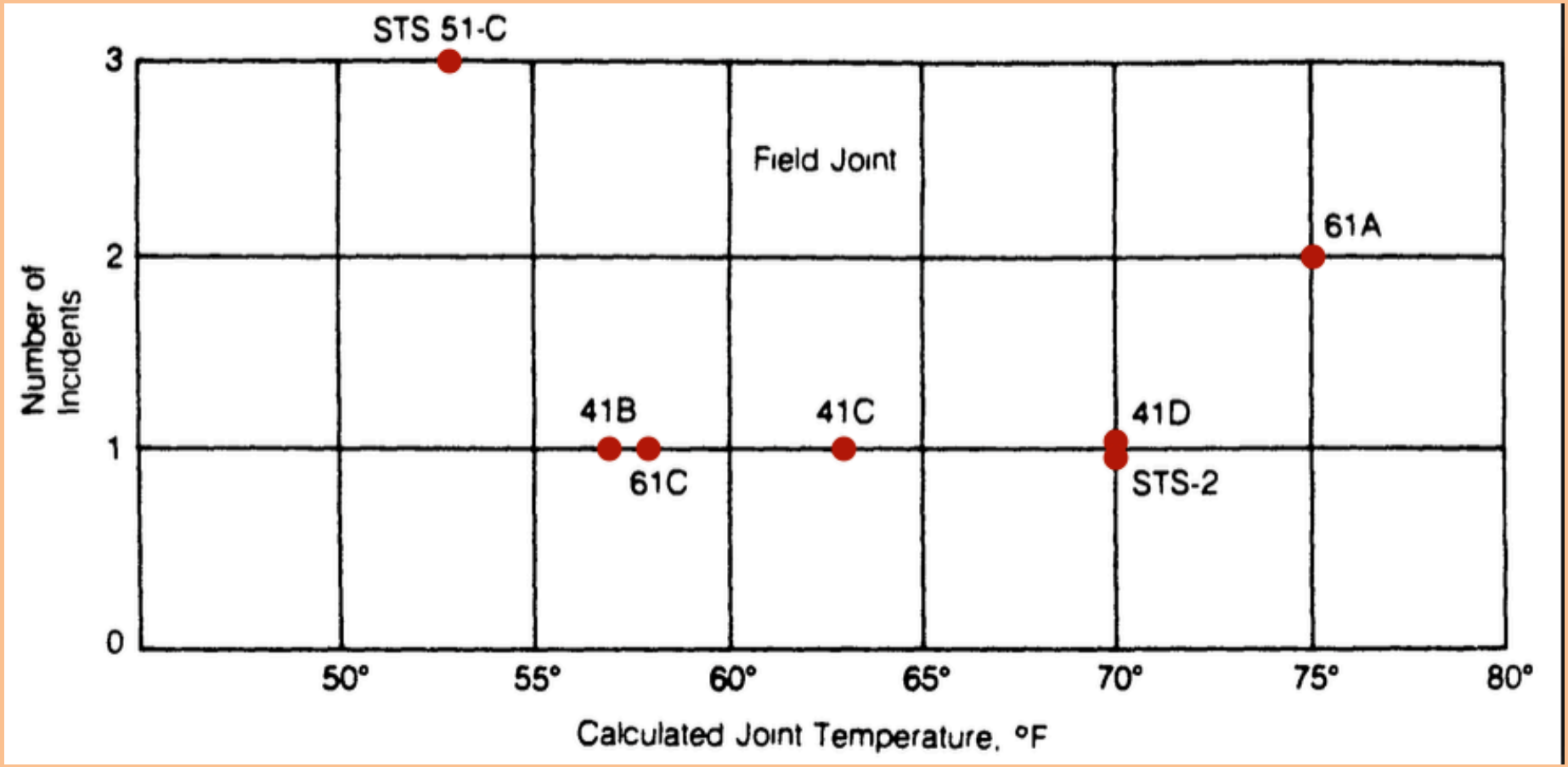
SRM JOINTS

27 JAN 1986

HISTORY OF O-RING TEMPERATURES (DEGREES - F)

MOTOR	MBT	AMB	O-RING	WIND
DM-1	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29	10 MPH
			27	25 MPH

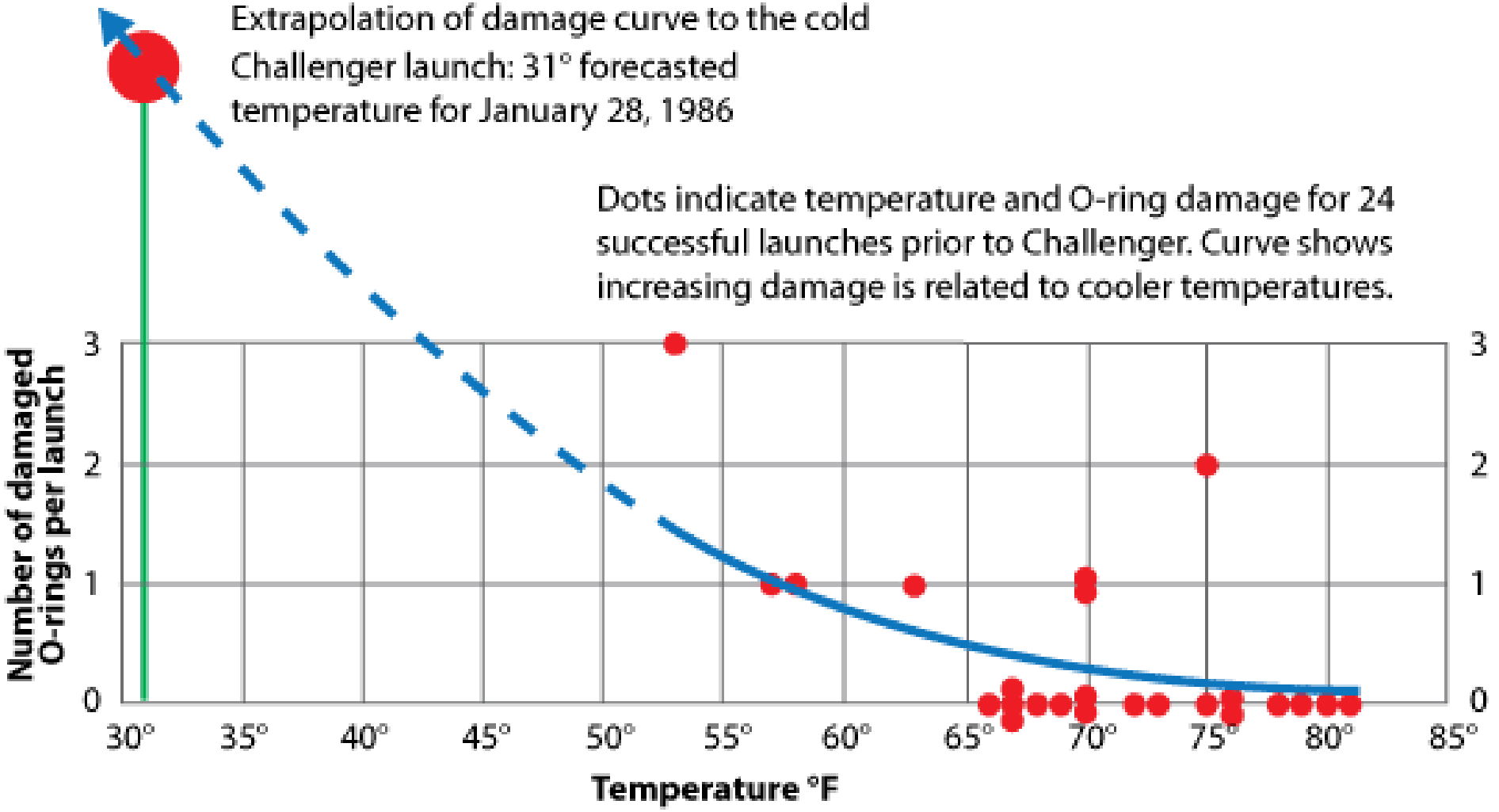
Graph: Damage & Temperature



Data by Edward Tufte

Flight	Date	Temperature °F	Erosion incidents	Blow-by incidents	Damage index
51-C	01.24.85	53°	3	2	11
41-B	02.03.84	57°	1		4
61-C	01.12.86	58°	1		4
41-C	04.06.84	63°	1		2
1	04.12.81	66°			0
6	04.04.83	67°			0
51-A	11.08.84	67°			0
51-D	04.12.85	67°			0
5	11.11.82	68°			0
3	03.22.82	69°			0
2	11.12.81	70°	1		4
9	11.28.83	70°			0
41-D	08.30.84	70°	1		4
51-G	06.17.85	70°			0
7	06.18.83	72°			0
8	08.30.83	73°			0
51-B	04.29.85	75°			0
61-A	10.30.85	75°		2	4
51-I	08.27.85	76°			0
61-B	11.26.85	76°			0
41-G	10.05.84	78°			0
51-J	10.03.85	79°			0
4	06.27.82	80°			?
51-F	07.29.85	81°			0

Brain and Elementary Math



HEART BEAT (PISA)

HEARTBEAT

For health reasons people should limit their efforts, for instance during sports, in order not to exceed a certain heartbeat frequency.

For years the relationship between a person's recommended maximum heart rate and the person's age was described by the following formula:

Recommended maximum heart rate = 220 - *age*

Recent research showed that this formula should be modified slightly. The new formula is as follows:

Recommended max. heart rate = 208 - (0.7 × *age*)

HEARTBEAT

Question 1: HEARTBEAT *M537Q01 - 0 1 9*

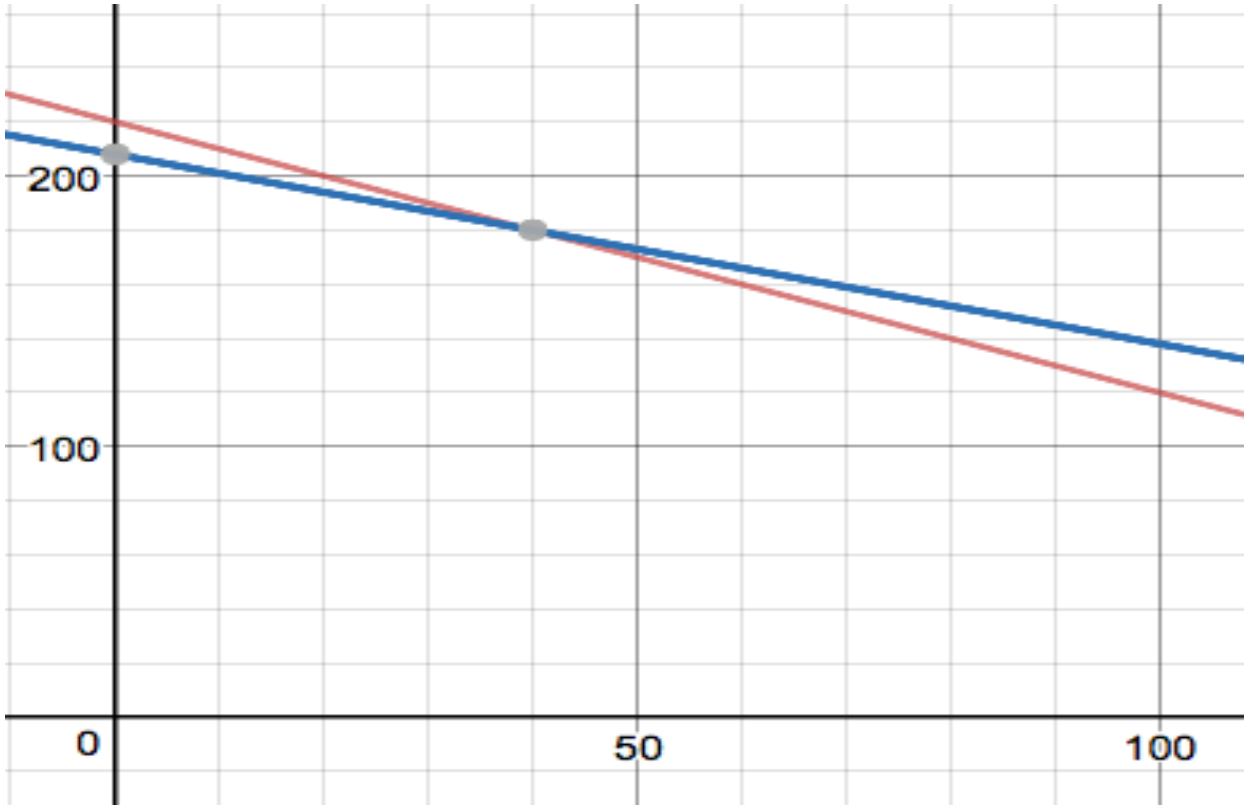
A newspaper article stated: "A result of using the new formula instead of the old one is that the recommended maximum number of heartbeats per minute for young people decreases slightly and for old people it increases slightly."

From which age onwards does the recommended maximum heart rate increase as a result of the introduction of the new formula? Show your work.

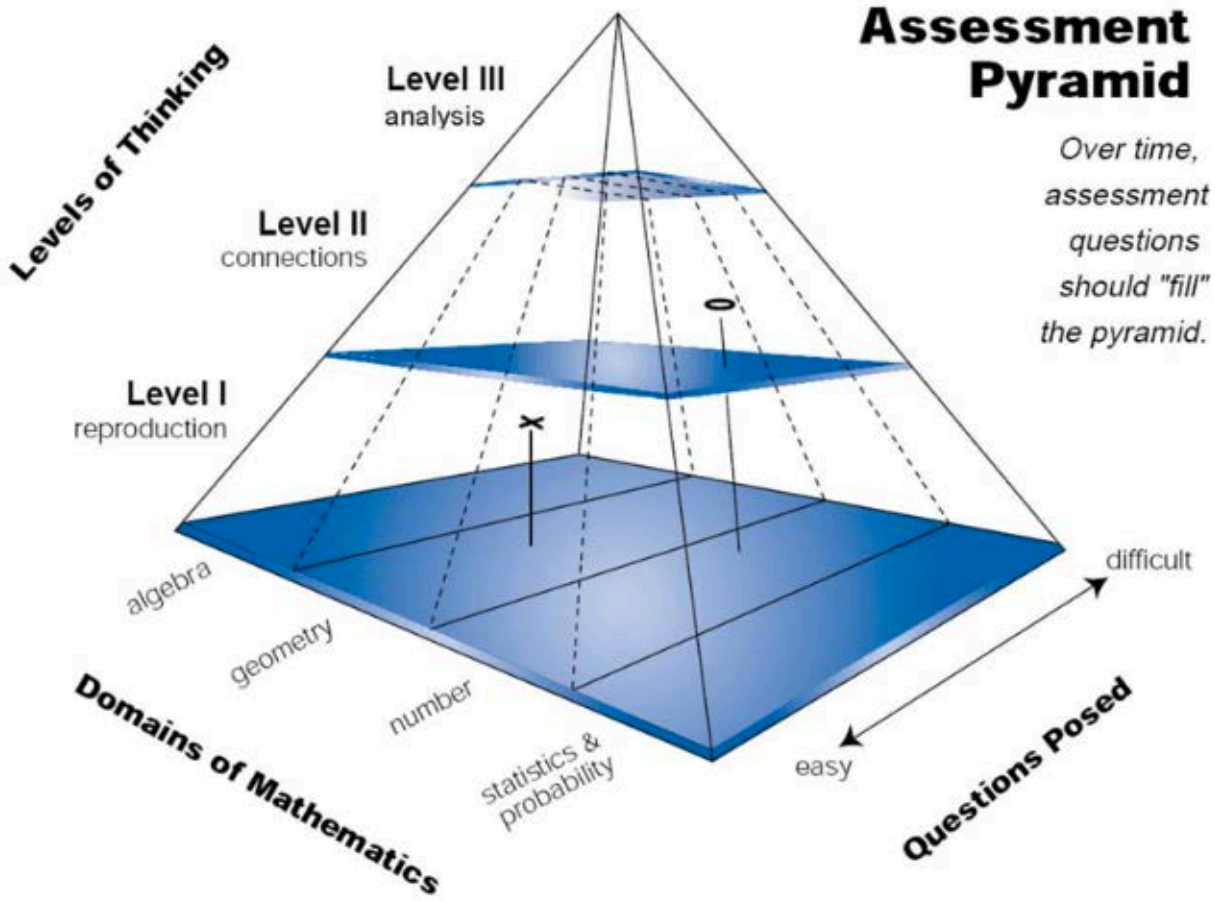
HEARTBEAT

$$y = 220 - x$$

$$y = 208 - (0.7|x)$$



ASSESSMENT


Assessment Pyramid
Over time, assessment questions should "fill" the pyramid.
Levels of Thinking
Level III
analysis
Level II
connections
Level I
reproduction
x
o
algebra
geometry
number
statistics & probability
Domains of Mathematics
difficult
easy
Questions Posed

SUMMARY

- Starting in real world
- Conceptual mathematizing
- Formalization/abstraction of concept
- Applying concept in problem solving:
- Applied mathematization
- Reinforcing concepts

SUMMARY

- More exploration
- More challenging
- Attention to context use
- Wider connections: intertwined
- Reflection
- Both reproduction and higher order thinking skills
- Aligned assessment

SUMMARY

- Group-and individual
- Useful and relevant use of IT
- More attention to brain science connection
- *Importantly, EF may be developed in learning the mathematics in the context of challenging activities, not in "exercising" the mathematics once learned.* (DOUG CLEMENTS 2016)