AC
EA
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AP

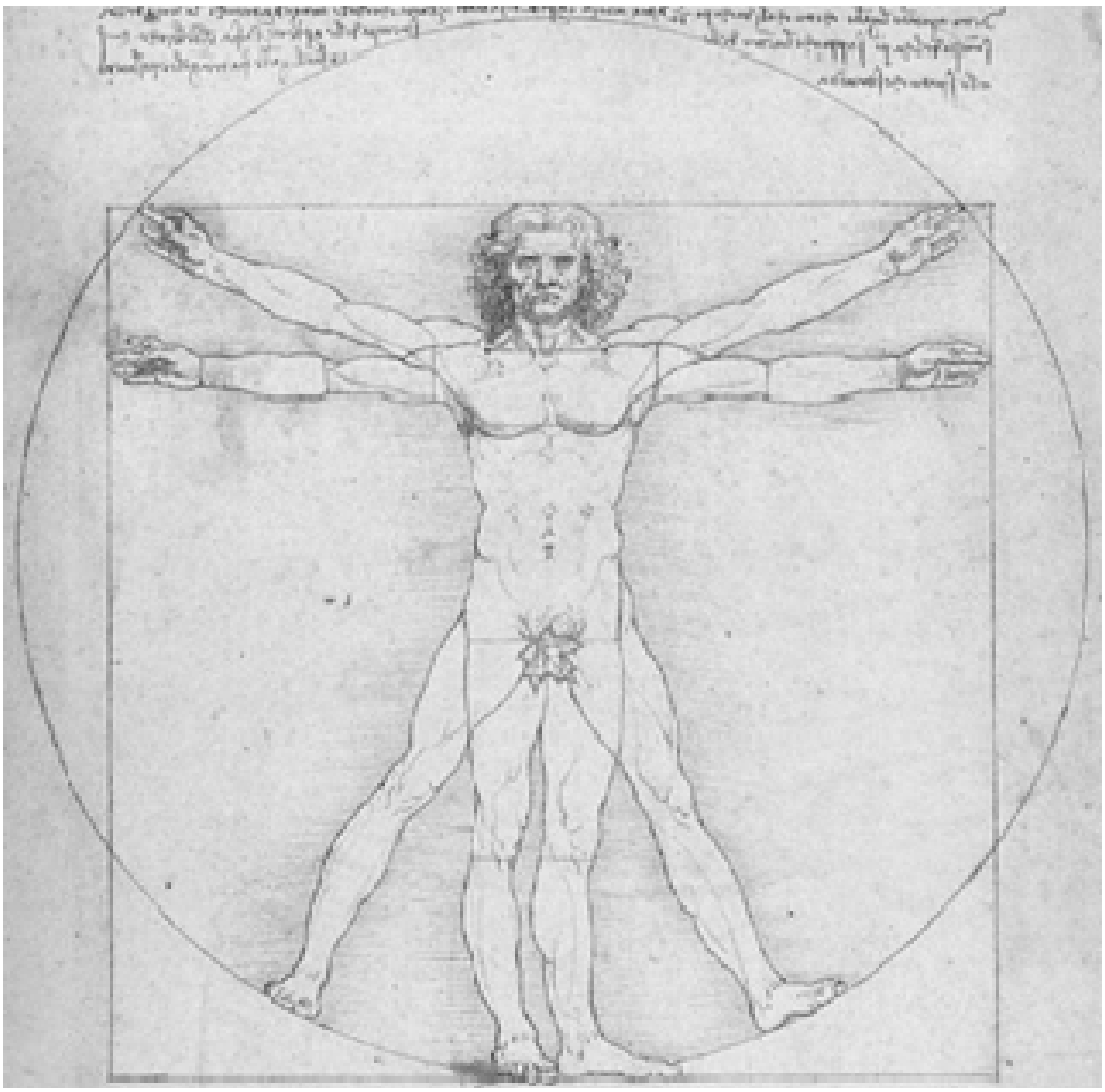
Body Ratios

We are investigating proportional relationships between measurements of various body parts.

Task 1: Vitruvian Man

In groups

- Below is a picture of Vitruvian Man:



Explore:
What mathematical relationships can you find in this diagram?

Task 2: Body Conjectures

Exercise 1:

Take measurements individually to find out if the following conjectures are true or false for your body.

- the length of a person's outspread arms is equal to his / her height
- the length of the hand is one-tenth of a person's height
- the length of the face is one-eighth of a person's height
- the width of the shoulders is one-quarter of a person's height
- the distance from the elbow to the tip of the hand is one-fifth of a person's height
- the distance from the elbow to the armpit is one-eighth of a person's height
- the length of the ear is one-third of the length of the face
- the distance from the nose to the bottom of the chin is one-third of the length of the face
- the distance from the hairline to the eyebrows is one-third of the length of the face

Compare your answers with those of another member of your group.

Exercise 2: Using ratios

Write each of the conjectures from Exercise 1 in ratio form.

e.g. If your finger length is one half of your hand length, the ratio of finger length to hand length would be 1:2.

Exercise 3:

Assume that the conjectures in Exercise 1 are correct. Use the measurements given below to find the height of the following people:

1) hand length of 12 cm
2) arm span of 1.6 m
3) elbow to armpit of 23 cm
4) shoulder width of 375 mm
5) elbow to hand tip of 35 cm
6) elbow to hand tip of 19 cm
7) length of face of 19.4 cm
8) arm span of 1645 mm
9) hand length of 0.17 m
10) elbow to armpit of 13.7 cm

Two step problems:

11) length of ear of 6 cm
12) distance from nose to bottom of chin 47 mm
13) length of ear of 0.08 m
14) distance from hairline to eyebrows 3.9 cm
15) distance from nose to bottom of chin 55 mm

Exercise 4:

Use the height measurements given below to find the body measurements given in brackets.

1) 1.76 m (elbow to armpit)
2) 145 cm (arm span)
3) 1.89 m (elbow to armpit)
4) 89 cm (hand length)
5) 1440 mm (arm span)
6) 210 cm (elbow to hand tip)
7) 1.59 m (length of face)
8) 60 cm (shoulder width)
9) 1800 mm (elbow to hand tip)
10) 1.81 m (hand length)

Two step problems:
11) 195 cm (length of ear)
12) 1.21 m (distance from nose to bottom of chin)
13) 1080 mm (length of ear)
14) 133 cm (distance from hairline to eyebrows)
15) 1730 mm (distance from nose to bottom of chin)

Exercise 5:

If we know that the ratio of hand length to height is 1:10 and the ratio of face length to height 1:8 what can we say about the ratio of hand length : face length?

What other ratios can you find using the above strategy?

The final three conjectures from Exercise 1 all compare facial features to face length. What can you deduce from these three statements?

Exercise 6:

Make one conjecture of your own and test it on the members of your group.

Exercise 7:

Design a spreadsheet that enables a person to enter their height and gives estimates of their other body part measurements.

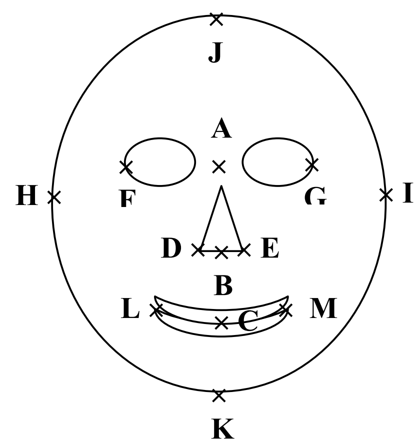
Task 3: Perfect faces?

Let's investigate facial measurements a bit more closely.

Exercise 1:

Take the following measurements for members of your group and present your information in a table

- pupil height to nose-tip AB
- nose-tip to lip BC
- width of nose DE
- outside distance between eyes FG
- width of head HI
- hairline to pupil JA
- nosetip to chin BK
- lips to chin CK
- length of lips LM
- nosetip to lips BC



Find the following ratios:

BK:CK	BK:AB
DE:BC	FG:JA
LM:DE	JK:HI

If each of these were in the form a:1. What can you say about a?

Exercise 2: Golden Ratio

The golden ratio is a special number that is approximately equal to 1.618033988749. We use the greek letter Phi (Φ) to refer to this ratio. Like pi the digits of the golden ratio go on foever without repeating. This number appears in many different circumstances such as architecture, the environment, art and body proportions.

Explore: Some people have suggested that faces that fit the golden ratio are more beautiful than others. Can you find the golden ratio in any of the previous exercises?

Task 4: Exploring surface areas

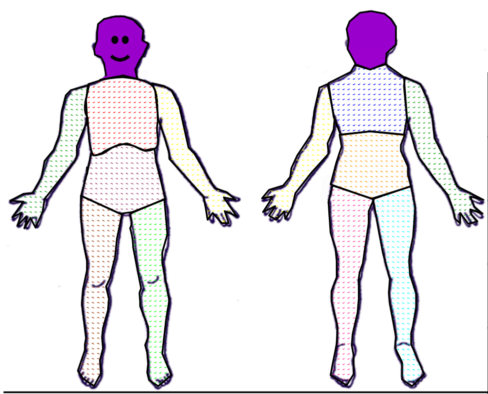
Exercise 1: Surface area

Your surface area can be estimated using the fact that the area of your hand is 1% of your total body surface area.

Find the area of your hand and use it to estimate your total body surface area.

Exercise 2: Rule of 9

Doctors use the rule of 9 to estimate the amount of the body affected in cases involving the skin, for example in burn victims. The rule divides the body into 11 different areas, each of which represents approximately 9% of the total surface area of the body. Use this rule, and the total surface area for your body (calculated in Exercise 1) to calculate the surface area of each of these areas. Design your own way of testing the accuracy of this rule.



Rule of 9			Front Left Leg
	Head and Neck		Front Right Leg
	Chest		Back Left Leg
	Stomach		Back Right Leg
	Left Arm		Lower Back
	Right Arm		Upper Back

Use these 11 areas to find another way of estimating the surface area of the body.
How does your answer compare to what you got in Exercise 1?
Which do you think is more accurate and why?

Exercise 3: Children's surface areas

Children have different proporations of surface areas than adults, as shown in the table below:

PERCENTAGE	BODY PART	6.75	Front Left Leg
18	Head and Neck	6.75	Front Right Leg
9	Chest	6.75	Back Left Leg
9	Stomach	6.75	Back Right Leg
9	Left Arm	9	Lower Back
9	Right Arm	9	Upper Back

If a child has a hand area of 12 cm^2, find the surface areas of the other parts of his body. You may assume that the 1% rule applies for children.

Exercise 4:

Find an estimate for the volume of your body.
Clearly communicate the strategy you have used to generate your answer.

What is your ratio of surface area to volume? Compare your ratio to those of the other members of your group. Who has the largest ratio? How can you tell?

In terms of children – would they have a larger or smaller ratio of surface area to volume than adults?

One major problem with children being left in cars is that they dehydrate very quickly compared to adults. Can you explain this in terms of the ratio of surface area to volume?

Body Ratios
Answers

Task 2
Exercise 2

1)	1:1	(2)	1:10	(3)	1:8	(4)	1:4
5)	1:5	(6)	1:8	(7)	1:3	(8)	1:3
(9)	1:3						

Exercise 3

1) 120 cm
2) 1.6 m
3) 184 cm
4) 150cm
5) 175 cm
6) 95 cm
7) 155.2 cm
8) 1645 mm
9) 1.7 m
10) 109.6 cm
11) 144 cm
12) 1128 mm
13) 1.92 m
14) 93.6 cm
15) 1320 mm

Exercise 4

1) 0.22 m
2) 145 cm
3) 0.24 m
4) 8.9 cm
5) 1440 mm
6) 42 cm
7) 0.2 m
8) 15 cm
9) 360 mm
10) 0.18 m
11) 8.1 cm
12) 0.05 m
13) 45 mm
14) 5.5 cm
15) 72 mm

Exercise 5

Ratio of Hand: Face is 8:10 or 4:5

Task 4
Exercise 3

SURFACE AREA/ cm^2	BODY PART	81	Front Left Leg
216	Head and Neck	81	Front Right Leg
108	Chest	81	Back Left Leg
108	Stomach	81	Back Right Leg
108	Left Arm	108	Lower Back
108	Right Arm	108	Upper Back

Exercise 4
Children have a higher ratio of surface area to volume than adults. This increased surface area is the reason why they dehydrate more quickly than adults.