



Canadian Space Agency  
Agence spatiale  
canadienne

Educational Product

Student's Edition

Grades 9-12

# ***NEUROLAB FOR CLASSROOMS***

***CANADIAN SPACE AGENCY  
EDUCATIONAL MATERIALS  
FOR STS-90 NEUROLAB***

Canada



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# GRASPING EXPERIMENT

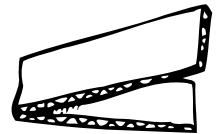
# 1

## Materials

- 2 strips of single corrugated cardboard (20 cm by 3 cm)
- 4 pieces of sandpaper (3 cm by 3 cm)
- 1 piece of foam rubber (3 x 4 x 4 cm)
- 1 one-metre stick
- glue

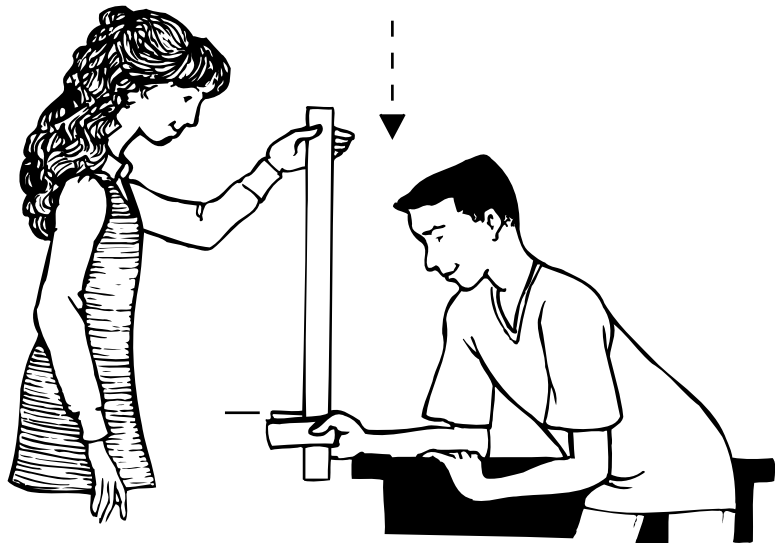
## Assembling the Grasping Devices

1. Fold one strip of the cardboard in half.
2. Glue one piece of sandpaper to each end of the inside ends of the cardboard.
3. Glue the foam midway between the fold and the open ends.
4. Assemble another grasping device without the foam.



## What to Do

- Use the grasping device without the foam. Grab the device between your index finger and thumb, in the centre of the cardboard strip as if grasping tweezers. Set the grasping device so that the ends are 3 cm apart.
- Rest your grasping hand over the edge of a desk or table.
- Have your partner position the metre stick as shown in the diagram. Align the top of the grasping device with the 10 cm mark. Keep your eyes on the 10 cm mark. Do not move your arm.
- Catch the meter stick in the grasping device. Record the measurement at the place where you held the grasping device.
- Repeat ten times. Record measurements and calculate the average.
- Repeat steps 1-5 using the grasping device with the foam. Record the measurements.
- Repeat steps 1-5 using the grasping device without a foam.
- Compare the results.



# 1

# GRASPING EXPERIMENT

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## **Try it again!**

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- Repeat the activity with your non-dominant hand and compare the results.
- Repeat the activity when you are tired or fatigued, possibly after a period of physical exercise.

## **For Discussion**

- Were the results of your hypotheses what you expected?
- What signals is your brain transmitting between the time the metre stick is dropped and the time you catch it?
- How were your reactions different when you made the transition between the two different tools? Compare the results.
- How might these findings apply to astronauts adapting to microgravity?
- How might this apply to training our astronauts?

# POINTING EXERCISE

# 2

## Materials

Each group needs:

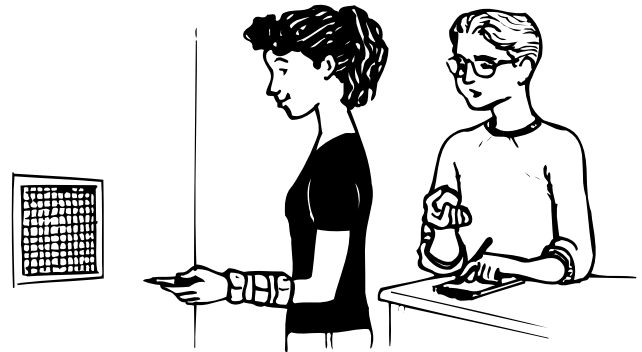
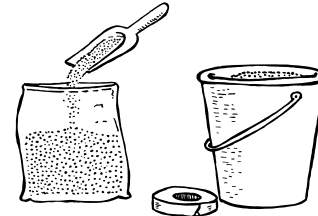
- Target Board, 3
- markers
- 2 g Simulator
- stopwatch or timer
- Pointing Exercise Record Sheet, 4

## What to Do

- Work in a team of four – a prompter, a timer, a recorder and a pointer. Timing begins when the prompter gives the first of the series of numbers and ends when the pointer's hand returns to the starting position after the last number is touched.
- The recorder keeps track of the numbers that were actually touched when each number was called.
- At the starting position, the pointer holds the forearm parallel to the floor with the elbow alongside the body.
- The prompter calls out a series of numbers stopping after each one until the pointer touches the Target Board and returns his/her arm to the starting position.  
**TRIAL #1**      **125, 82, 142, 65, 113, 96, 172, 143, 160, 72**
- Repeat the activity with the 2 g simulator attached to the forearm.  
**TRIAL #2**      **65, 143, 113, 82, 160, 125, 172, 142, 96, 72**
- Remove the 2 g Simulator and IMMEDIATELY repeat the activity.  
**TRIAL #3**      **72, 113, 160, 96, 125, 65, 143, 82, 142, 172**
- Work as a group to analyze the record sheet and to prepare conclusions.

### How to Make 2 g Simulator

- Fill a self-seal bag with 2-3 kg of damp sand.
- Seal the bag removing as much air as possible.
- Spread the sand equally throughout the bag.



## Discussion

- What effect did adding and removing the mass on your arm have on your pointing accuracy?
- Were the results of Trial 3 the same as Trial 1? Why or why not?
- Relate the adaptations that you experienced to those faced by astronauts in microgravity on the space shuttle.

# 3

## TARGET BOARD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224	225

# POINTING EXERCISE RECORD SHEET

# 4

The group recorder fills in the chart to track the numbers that the pointer touched in each trial.

*Trial # 1 - Without the 2 g Simulator*

Numbers Called	Numbers Pointed to
125	
82	
142	
65	
113	
96	
172	
143	
160	
72	

*Trial # 2 - With the 2 g Simulator*

Numbers Called	Numbers Pointed to
65	
143	
113	
82	
160	
125	
172	
142	
96	
72	

*Trial # 3 - Without the 2 g Simulator*

Numbers Called	Numbers Pointed to
72	
113	
160	
96	
125	
65	
143	
82	
142	
172	

# 5

## DRAWING CIRCLES

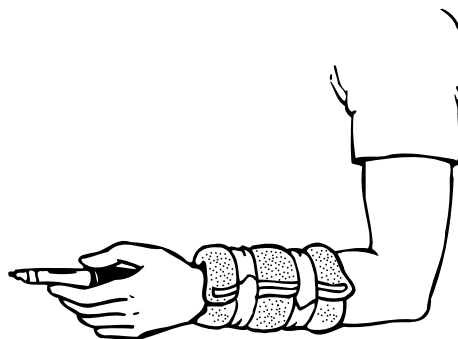
### Materials

Each team member needs:

- 3 blank papers
  - 2 markers
  - masking tape
  - 2 g simulators
- Conduct this experiment in 3 parts:
- a) On the first paper, draw and trace a circle ten times with your eyes open and ten times with your eyes closed.
  - b) Repeat part a) on the second paper with a 2 g Simulator taped to your forearm.
  - c) Remove the 2 g Simulator and immediately repeat the procedure on the third paper.
- Compare your drawings of the circles on your 3 papers.
- Compare your ability to retrace the circles in each of the drawings.
  - Compare your ability to draw circles before using the 2 g Simulator and after you removed it.
  - Were they the same?
  - Why or why not?
- Compare and discuss the results with other team members.
- Were each member's findings the same?
  - What conclusions can you draw?
- Together, discuss how you could relate this to what the astronauts experience. Do you think the shuttle astronauts would experience the same effects if they were asked to perform the tasks before, during and after their mission?

### **Hint:**

Move quickly to complete the experiment after removing the Simulator from your forearm.





# SPINNING AROUND

# 6

- Join hands with your partner and focus on one another's face as you turn quickly in circles for 10 seconds.
- Describe below how you felt:
  - when you looked at your partner as you spun around
  - when you and your partner stopped spinning
- Spin around by yourself for 10 seconds
- Describe how you felt when you stopped
- If you felt differently after this exercise, how long did it take for this feeling to disappear?
- Why might the effects you experienced be less if you had focused on one point during each rotation activity?



**Materials:**  
*swivel chair  
or piano stool*

## **1 – SPIN YOUR PARTNER**

Work in a group of 4 students – 1 subject, 1 recorder, 2 spotters.

The subject sits in a swivel chair (with sufficient room for rotation) surrounded by the spotters.

Gently spin the chair at a constant speed.

Ask the subject to describe how he or she feels when his/her eyes are open and when they are closed.

Now have the subject tip his or her head to one side and describe his/her reaction.

Have another team member try the activity. Record any additional reactions.

### **Safety tip**

*Identify students to act as spotters. If the subject feels uncomfortable, perhaps dizzy or disoriented, the spotters should stop the chair.*

**Materials:**  
*Inside the Ear  
and Eye, 7;  
Erlenmeyer  
flask - half  
full of water*

## **2 – HUSH! I THINK I SEE SOMETHING!**

Work individually or with a partner.

- a) Use the models and/or reference materials to write a brief description about the functions of the parts of the eye and ear that are on the labelled diagram.
- b) Swirl the water around and place the flask on the table. Note the motion of the liquid. Does it stop immediately?

Apply your observation of the water's motion to the movement of the fluid within the inner ear after you have spun around and to the cessation of movement when you stop. How are they similar?

Describe the way in which messages from the inner ear link with messages from the eye.

# 3 – CATCH A FALLING RULER

*Materials:*  
30 cm ruler,  
chair

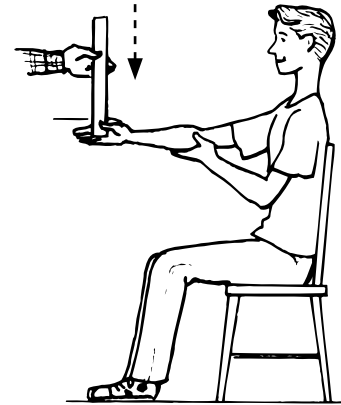
Work in a group of three. Choose a subject, a recorder and a team leader.

## Trial # 1

The subject sits in a chair, extends her/his arm forward and supports the elbow with the opposite hand.

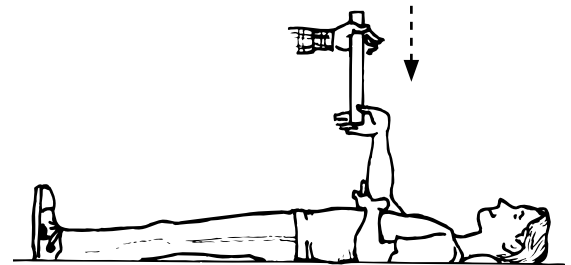
The team leader places a 30 cm ruler upright between the subject's thumb and index finger so that the 0 mark on the ruler is at the upper edge of the subject's thumb.

Release the ruler. The subject catches it. The recorder records the measurement at the subject's thumb.



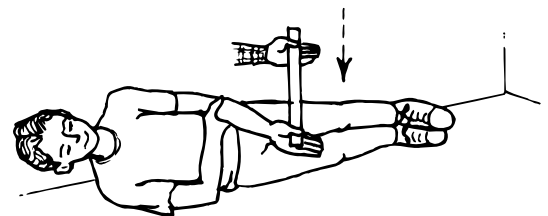
## Trial # 2

Repeat the procedure with the subject lying on his/her back. Hold the dominant arm upright and extend the opposite arm across the body and support the elbow.



## Trial # 3

Repeat the procedure with the subject lying on his/her side with the dominant side up and the arm bent at the elbow and extended outward. Support the arm with the opposite hand.



As a team, compare the results of the three trials.

- Which position felt most comfortable?
- Does the response time vary from one position to another?
- What explanation can you suggest for the variance?

Since an astronaut does not have the opportunity to conduct all of his/her work in typical body positions, how might this affect productivity?

What training solutions can you suggest?

Materials:  
*Apparatus as  
shown*

## 4 – SPINNING SPOTS

Work with a partner.

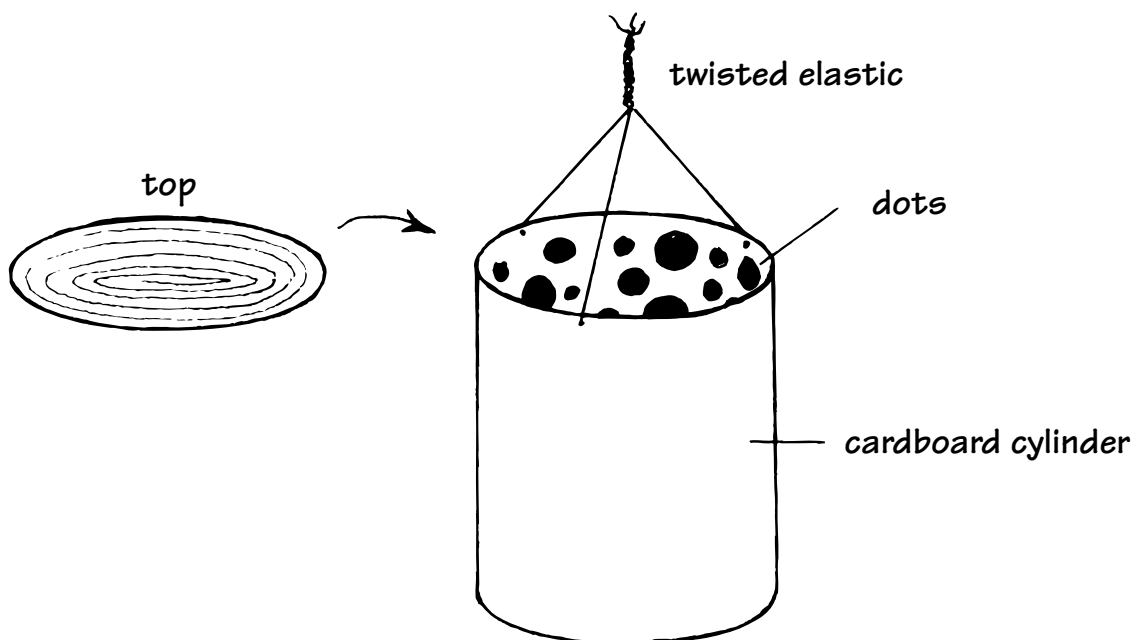
The subject lies on the floor. The partner holds a “wound up” apparatus directly above the subject’s face.

Allow the apparatus to unwind as the subject looks up and describes the sensations he/she feels.

Repeat the trial with the partner being the subject.

Compare the two responses.

Even though you knew that you were stationary, why did your mind perceive motion?



# 5 – CATCH THE BALL IF YOU CAN...

*Materials:*  
Tennis ball

Work with a partner.

## Trial # 1

The subject sits on the floor facing forward. The partner drops a tennis ball from 2 metres directly above the subject's head. The subject tries to catch the ball in one hand.



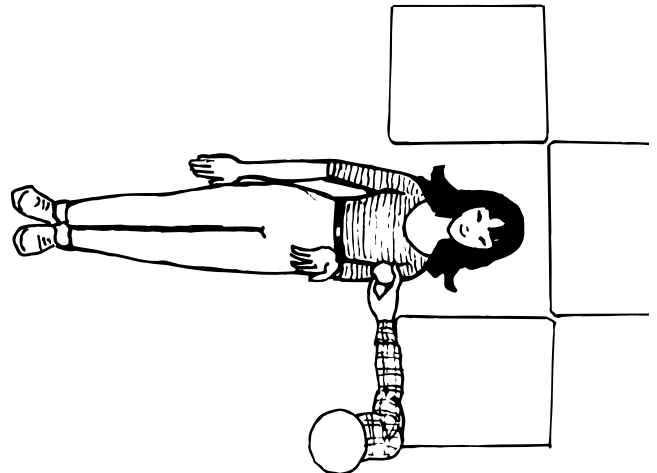
## Trial # 2

Repeat the procedure with the subject lying on his/her back.



## Trial # 3

The subject remains lying down. Place three desks on their sides to frame the subject's head. Repeat the procedure.



Describe what happened in each trial.

Did the subject's reaction time and dexterity change while lying down?

Why do you think this happened?

What effect did the desks have on the subject's reaction time and dexterity?

Materials:  
Four boxes

## 6 – NO PEEKING!

Shake each box gently.

What did you think was in each box?

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_

Open the boxes and check your answers.

How accurate were they?

How does your body compensate when you can't see something?

When you are in a car, why is it an unsafe practice to listen to music wearing earphones?

Why is listening to the car radio considered safer?

Research to find out how the senses of hearing and sight are affected in space.

Materials:  
Box and  
cards

## 7 – GOING MY WAY?

Work with a partner.

Place the box over the subject's head and rest it on the person's shoulders.

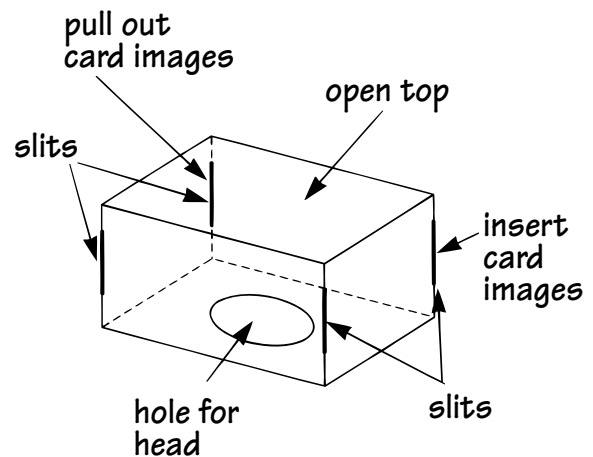
Insert the first card into the slits on the side of the box and gently but smoothly pull the image through.

Repeat with other cards.

Record the sensations the subject experienced each time –

- Card with lines:
- Card with spots:
- Card with landscape:
- Card with faces:

What caused the subject to experience these sensations?



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## **8 – BRAIN MESSAGES**

*Materials:  
Optical Illusions,  
8-9  
Impossible  
Shapes, 10-11*

Work with a partner.

Consider each illusion on your own first and then discuss your reactions with your partner.

Discuss the sensory conflicts you feel while viewing these optical illusions.

Use your knowledge of how vision works to draw some conclusions about what caused the illusions.

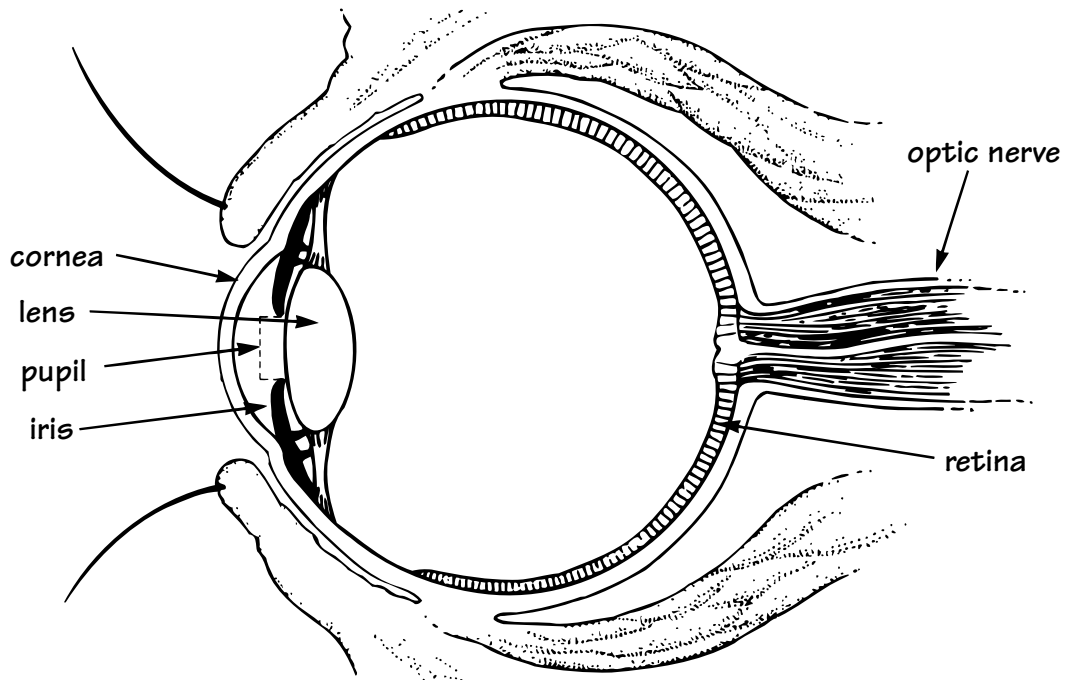
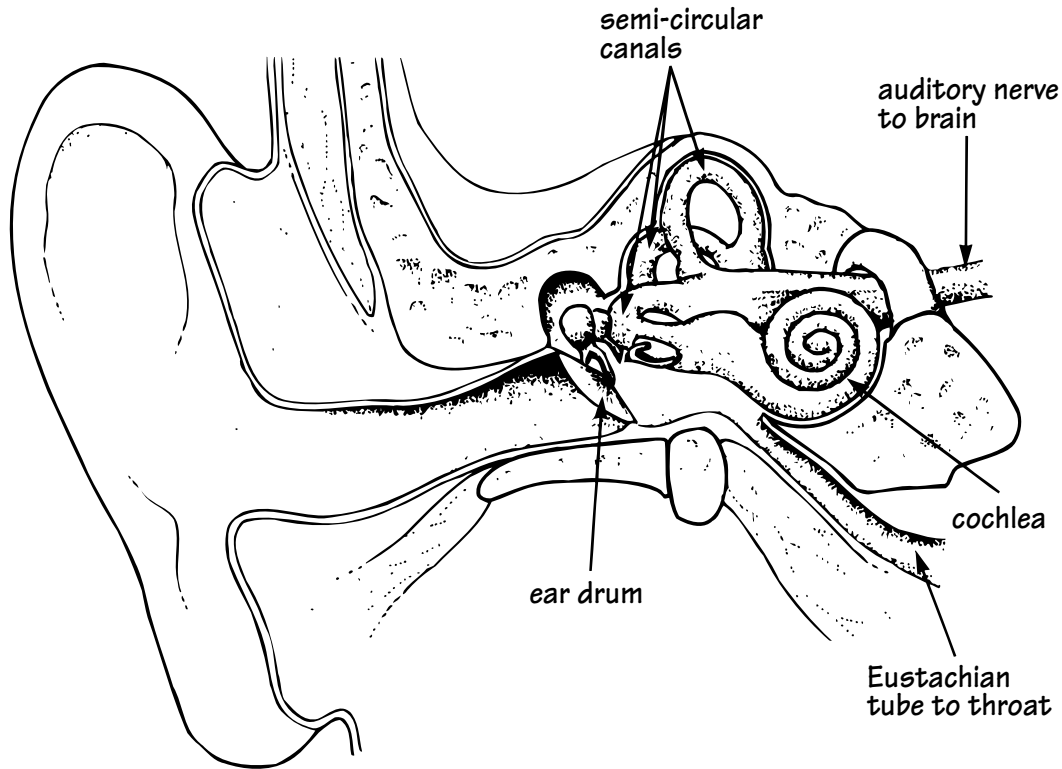
Look at the shapes on Impossible Shapes, 10-11.

Could these shapes be built?

Give reasons for your answers.

# 7

## INSIDE THE EAR AND EYE

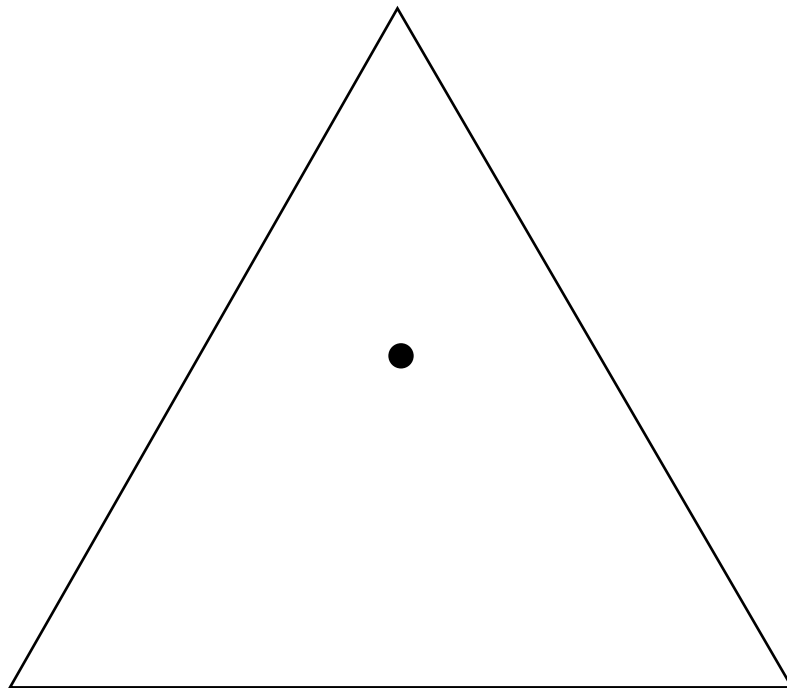
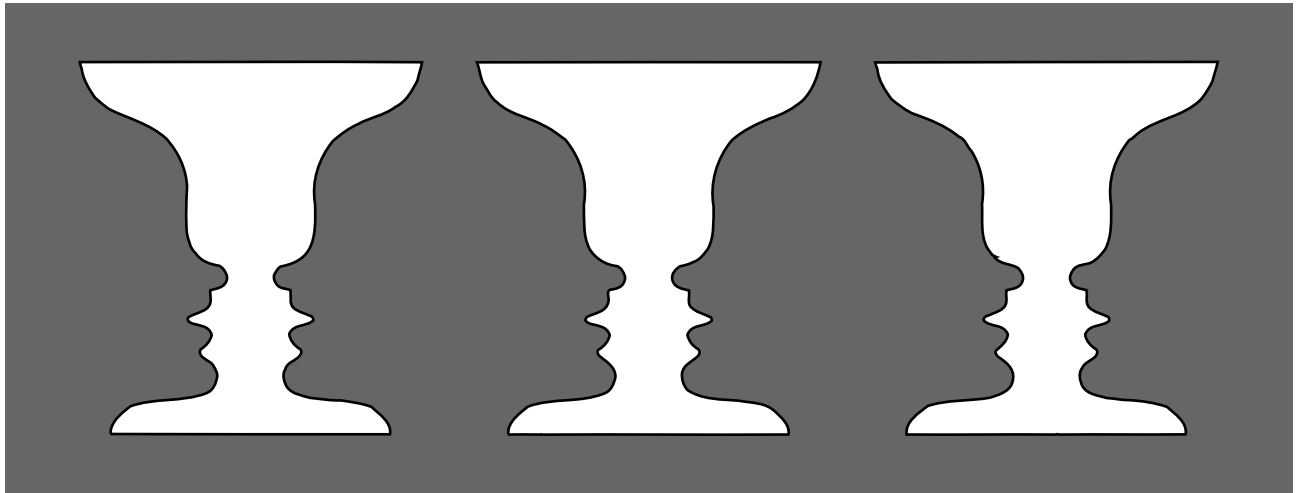




# OPTICAL ILLUSIONS

# 8

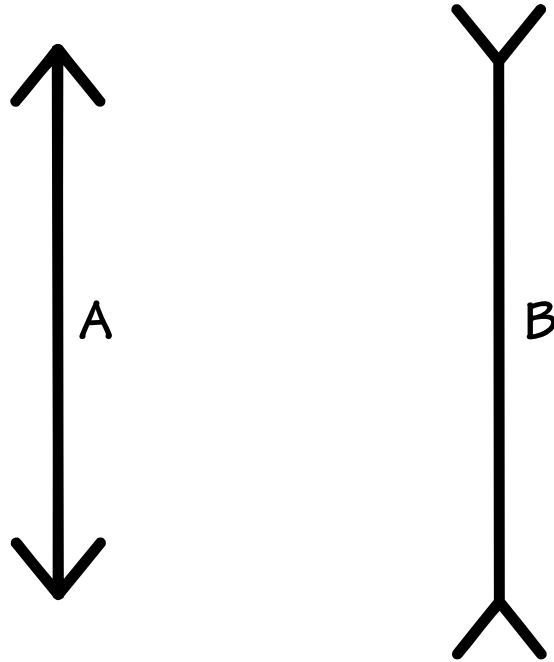
*What do you see?*



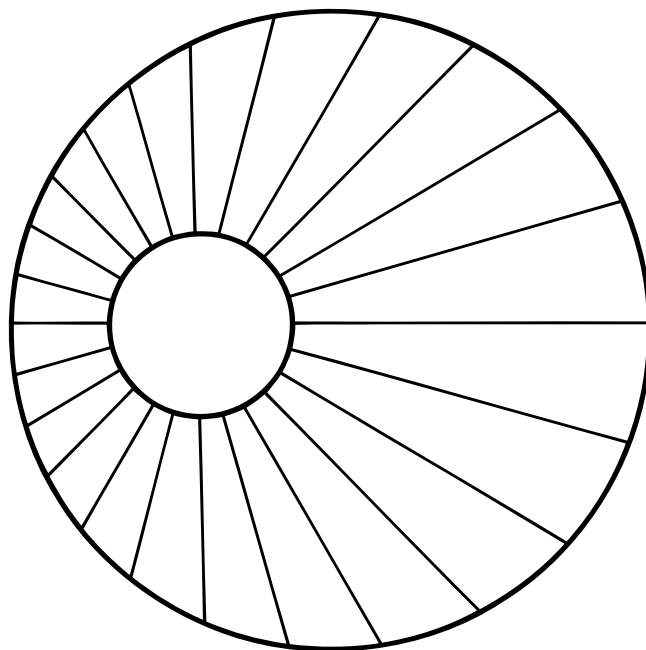
# 9

## OPTICAL ILLUSIONS

Which is longer – A or B?

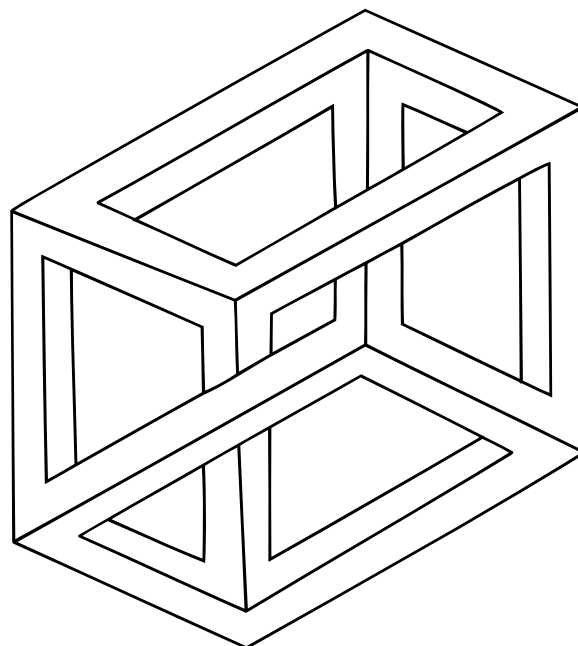
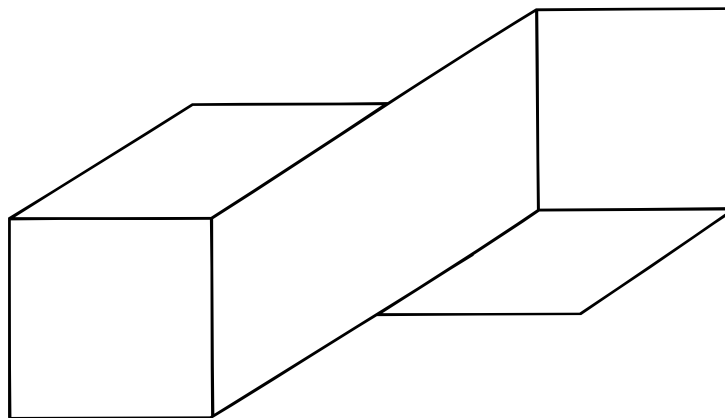
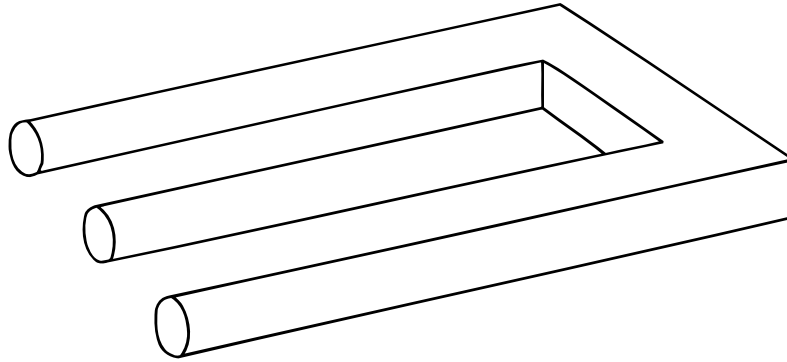


What do you see?



# IMPOSSIBLE SHAPES

10



# 11

## IMPOSSIBLE SHAPES

