Name: _____ Group: _____

THE PROJECT

A magic contest!

The company, Abracadabra, has announced its annual magic contest. For this year's edition, participants must design and construct a magic box that will allow amateur magicians to create optical illusions using plane (flat) mirrors and a deck of cards.

Contest rules:

1. Prepare a design plan containing the following information:
   - the positions of the playing card and the observer
   - the positions of the mirrors
   - the path of the light waves
   - the normal, the angle of incidence and the angle of reflection for each of the mirrors
2. Submit technical drawings of the magic box and its lid.
3. Build a prototype of the magic box that respects the project specifications.

Specifications available upon request.

Abracadabra: now it's your turn!

In this LES, you will play the role of a participant in the magic contest.

Name: _____ Group: _____

THE PROJECT *(continued)*

Specifications

Overall function of the object

This magic box is intended to create the illusion that a playing card moves or disappears—by magic—inside the box. The magician asks an observer to insert a card into the box. When the observer looks inside the box, an optical illusion gives the impression that the card is no longer there.

Material constraints

- Each side of the box must be no longer than 200 mm.
- The box must contain at least two plane (flat) mirrors (each 40 mm X 60 mm).
- The box lid must be removable.
- The box must have some system to hold a card in position.
- There must be a hole to allow an observer to look inside the box and see that the card appears to have moved.
- The box must also have a number of small holes to allow light inside. The holes, however, should not allow the observer to see the card.
- The interior of the box must be light-coloured.
- Only materials approved by the teacher can be used to make the box.

Physical constraints

- The box must be solid.
- The box must be easy to transport.
- The box must be safe to carry; that is, it should have no sharp edges or splinters.

Presentation constraints

The magic box must be attractive to look at.

Name: _____ Group: _____

CREATING THE CONTEXT

I ask myself

1. What happens when light hits the surface of a mirror?

2. What are the laws of reflection?

3. What is the difference between a cross section and a section?

4. What is the difference between dimensioning and tolerance?

5. In terms of the dimensioning of an object, what unit of measure is generally used?

6. What is a design plan used for?

7. What is a technical diagram used for?

8. What information is generally found on a technical diagram? Give some examples.

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CREATING THE CONTEXT *(continued)*

9. What are some of the principal rules to follow when producing a diagram?

10. Draw the following symbols.

a) A complete link.

b) The surface of a mirror.

c) A light ray.

d) A translational guide.

I must

11. What is the goal for this project?

Name: _____ Group: _____

CREATING THE CONTEXT *(continued)*

I think

12. In your opinion, what is the most appropriate design solution for the magic box? Make a design plan using a cross-sectional view of the inside of the magic box. Show the path that the light rays will take.

Reflection

	Yes	No
Does my design plan respect the specifications?	☐	☐
Do I have a good understanding of:		
• deviation of light waves?	☐	☐
• cross sections and sections?	☐	☐
• dimensioning and tolerance?	☐	☐
• diagrams and symbols?	☐	☐
• electromagnetic spectrum?	☐	☐

Name: _____ Group: _____

PLANNING THE PROJECT

I plan

Develop your plan of action.

1. Draw a technical diagram of a cross section of the magic box. Show your chosen design solutions for the inside of the magic box.

Name: _____ Group: _____

PLANNING THE PROJECT *(continued)*

2. Draw a technical diagram of a lid for the magic box. Show your chosen design solution for the construction of the lid.

Name: _____ Group: _____

PLANNING THE PROJECT *(continued)*

3. List the materials needed to build the magic box.

Reflection

	Yes	No
Have I thought of any other ways to construct my magic box?	☐	☐

Have the plan of action approved by the teacher before you construct your magic box.

Teacher's approval

Name: _____ Group: _____

INITIATING THE PROJECT

I design

1. Put your magic box together, respecting your technical diagrams.
2. If you make changes to your prototype, note them on the technical diagrams as well as on your list of materials. Make sure you write down any changes.
3. Which safety rules did you observe when making your box?

Reflection

	Yes	No
Did I record and explain all of the changes I made to my plan of action?	☐	☐

Name: _____ Group: _____

THE FINAL TEST

I verify

Answer the following questions to test your magic box.

1. Does your magic box work as it is supposed to? Explain your answer.

2. Did you respect all of the specifications? If not, explain your answer.

3. Did you make any changes to your plan of action? Why? Justify any changes.

4. Did you experience any difficulties when you designed or constructed your magic box? If yes, what were they?

5. Make some suggestions for improving the design and construction of your magic box.

Name: _____ Group: _____

MY EVALUATION

Use the evaluation grid on the following page to do a self-evaluation. Write A, B, C, D or E in the appropriate place in the table.

SSC1 Seeks answers or solutions to scientific or technological problems				
Criteria*	**Observable indicators**	**Me**	**Teacher**	**Comments**
1	**Creating the context** Definition of the goal and production of a design plan		☐ With help	
2	**Planning the project** Execution of the plan of action: suitability of materials and completion of technical diagrams		☐ With help	
3	**Initiating the project** Respect for the technical diagrams and safety rules during construction of a magic box		☐ With help	
4	**The final test** Verification of the magic box operation		☐ With help	

*** Evaluation criteria**

1 Appropriate representation of the situation
2 Development of a suitable plan of action for the situation
3 Appropriate implementation of the plan of action
4 Development of relevant conclusions, explanations or solutions

EVALUATION GRID

Name: _____ Group: _____

SSC 1 Seeks answers or solutions to scientific or technological problems

Criteria*	Observable indicators	A	B	C	D	E
1	**CREATING THE CONTEXT** Definition of the goal and production of a design plan	The goal is defined very clearly and relates to the project. The design plan is complete.	The goal is defined clearly and relates to the project. The design plan has a few minor errors.	The goal is defined more or less clearly, or does not relate to the project OR the design plan has many errors.	The goal is defined more or less clearly, or does not relate to the project AND the design plan has major errors.	The work needs to be redone.
2	**PLANNING THE PROJECT** Execution of the plan of action: suitability of materials and completion of technical diagrams	All materials are appropriate and the technical diagrams are complete.	The materials are appropriate, but the technical diagrams contain a few minor errors.	The materials are more or less appropriate OR the technical diagrams contain many errors.	Most of the materials are more or less appropriate AND the technical diagrams contain many errors.	The work needs to be redone.
3	**INITIATING THE PROJECT** Respect for the technical diagrams and safety rules during construction of a magic box	The magic box corresponds to the technical diagrams. The work was performed safely.	Some elements of the magic box do not correspond to the technical diagrams. The work was performed safely.	Many elements of the magic box do not correspond to the technical diagrams. The work was performed safely.	The magic box doesn't correspond to the technical diagrams OR the work was not performed safely.	The work needs to be redone.
4	**THE FINAL TEST** Verification of the magic box operation	The magic box works and respects all of the specifications. The proposed improvements are relevant.	The magic box respects most of the specifications. Most of the proposed improvements are relevant.	The magic box respects most of the specifications, and the proposed improvements are more or less relevant.	The magic box doesn't respect most of the specifications.	The work needs to be redone.

* Evaluation criteria

1 Appropriate representation of the situation
2 Development of a suitable plan of action for the situation
3 Appropriate implementation of the plan of action
4 Development of relevant conclusions, explanations or solutions

Observatory/Guide 11160-A