# Materials Decathlon - Challenge n°9 - 40'

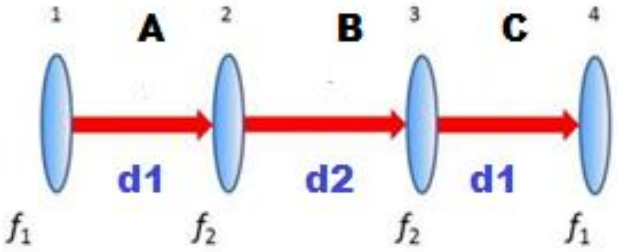
## INVISIBILITY CLOAK

On the desk you have 4 lenses: two of them with a focus length of 150 mm and the other two of 50 mm.

**Q1**. Identify the two types of lens and for each of them verify that the focus really is as mentioned above. Describe how you tested it.

From now onward we will call **L1** the lenses with focal length ***f1 = 150 mm*** and with **L2** the lenses with focal length ***f2 = 50 mm***.

1. Calculate ***d1 = f1 + f2*** and ***d2 = 2*f2*(f1+f2) / (f1-f2)*** Then use a ruler to measure the distances and put the 4 lenses as in the picture.




2. Put a screen at a certain distance from lens 4 and observe it through the four lenses. The observer should be at the opposite side of the lens system (lens 1) and at a distance between 2 and 3 metres approximately.
3. Test the lens system for perfect alignment with a laser beam. Everything will be ok if the laser beam spot on the screen is bright, focused and small! The laser beam should not spread wide as it goes across the lenses, but appear as a tiny dot on the screen.
4. ***The invisibility cloak is ready!*** Now explore the cloaked regions by slowly moving a pencil in between two lenses, perpendicularly to the optical axis. Repeat it in different areas of the three regions (A, B, C). Annotate on the picture the cloaked regions that you have found.

   Take **pictures and/or videos** [*at least one for each region A, B, C*] proving the existence of the cloaked regions and clearly showing the "disappearing" pencil in some areas.
5. Take a sheet of graph paper and using a ruler draw the lens system with extreme accuracy **(Graph 1).** Note on the optical axis the point where is positioned the ***focus*** of each lens. Finally trace the path of the light rays parallel to the optical axis ("coming from infinity") starting from the first lens and going through all the 4 lenses.

**Q2**. Can you identify on your drawing the cloaked regions? Can you explain their presence in that specific position? Do they correspond to the areas you already found in step 4.? If not, go back to the real lens system and test them (take more pictures/videos!)

**Q3.** When you move the pencil perpendicularly to the optical axis and it enters the uncloaked region is its behaviour exactly the same in all the three regions A, B, C or do you notice any difference?

**☞OUTPUT WANTED: answer to Q1-Q3 + Graph1 + Videos/Pictures**

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**Answer sheet** **GROUP N°_____**

# Ch.9 --- INVISIBILITY CLOAK

**Q1**

**Q2** [*You can answer also drawing on the to Graph 1*]

**Q3** if you move the pencil downward it will appear as it was moving upward. The reason is quite clear if you look at the scheme of the lenses ….

**PICTURES/VIDEOS** **[*Sent by Whatsapp to your group – See general instruction to share files*]**

- **Picture/Video1 description:**
- **Picture/Video2 description:**
- **Picture/Video3 description:**
- **Additional Picture/Video description:**

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