

Secret spy message

Overview:

Create a secret spy message that can only be seen underwater.

What you need:

- Small, watertight plastic bag
- Permanent marker
- Piece of paper about 10cm x 10cm
- Clear/glass container, deep enough to submerge the bag
- Water
- Newspaper or paper

Instructions:

1. Fill a clear container with water. The container needs to be big enough to fit your piece of paper inside, without it bending.
2. Colour in the piece of paper completely with the permanent marker. Use a layer of newspaper or paper underneath it to avoid marking.
3. Place the coloured in paper in the plastic bag and seal it.
4. Write your secret message on the outside of the plastic bag **with the same coloured permanent marker**.
5. Immerse the plastic bag inside the deep container of water.
6. Look down onto the bag from above to see your secret message revealed!



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How it works:

When you look through water does it change the appearance of objects within it? YES it does! This involves some hardcore science: light rays, reflection and refraction! Refraction is the bending of light as it moves from one clear/transparent substance to another. As we submerge the paper in the water it disappears if we look from above, due to two effects: refraction and total internal reflection. 'Total internal reflection'(TIR) is the complete reflection of light rays at the boundary of two substances with different light conducting properties (e.g. water and plastic or air). TIR can happen if the angle of incidence is greater than the critical angle. When we look at the message from above, total internal reflection will occur with the light from the coloured paper inside the bag, preventing that light from reaching our eyes. Therefore we only see the writing on the outside of the bag, which has not been totally internally reflected.

Credit to [Mrs B](#) for the idea for this fun activity.