

FLASHMOTION TIPS & TRICKS

SETUP

1. Find a room which can be turned pitch-black.
2. Get stands and tripods for camera, magnet and flash.
3. Arrange camera, phone, electronics, object, requisites, etc.
4. Optimize field of view, focus, etc.
5. When you found the best arrangement, fix everything properly.
6. Choose proper camera settings. Best range for exposure time is between one and two seconds.

RECORDING STEPS

1. Connect electronics to your battery or power supply.
2. Choose a wav file from the playlist.
3. Mount your object to the magnet.
4. Switch off the light.
5. Trigger camera and audio player at about the same time.
6. Switch light back on and check the recorded picture. Be careful not to move the tripod.
7. Repeat from step 2.

FURTHER HINTS

> **Use long lasting batteries** for camera and pulse amplifier/flash.

> **Use a remote control.** With a remote control at your camera, you avoid touching and accidentally moving it.

> If the **LED flash glows constantly** when connected, you need to reduce the value of the resistor R3. You may also replace R3 by an adjustable resistor (similar to potentiometer P1) with a 0..5kΩ range. Turn the potentiometer until the LEDs just cease to glow.

> Phone / wav player

You may have to adjust the loudness of your phone to maximum level. Don't forget to reduce again, before you plug in your earphones! Try a tablet or another wav player, if your phone doesn't do the job.

> Positioning

Fixing the object at the same position in each repetition is crucial for smooth movies but almost impossible to achieve by eye. Think about a solution. We used sharp tips of magnetizable metal both at the magnet and the object.



> Motion types

Motions more complex than free fall can be tricky to record. The simpler the motion, the smoother your movie. But maybe you're more into chaos ...

> Camera

Exposure time: Choose a camera exposure time between one and two seconds. If it's too short, you might miss the flash. If it's too long you might capture more than one flash.

ISO, f-stop: Keep ISO as low as possible for sharpness in the grains and adjust the f-stop (aperture) for crispness at the object. Depending on your object, this will be probably between 2.8 and 5.6. We used ISO 3200 and f-stop 5.6.

Check focus: Is your object sharp in every position of the motion, especially at start and end? The focus plane might be tilted against the plane wherein motion happens. Also, the focus might be accidentally altered during recording. Check in between and adjust if necessary.

> When does it start moving?

If you record with a very small delay, say using the file delay001.wav or delay005.wav, the object might still be hold by the magnet. So first, search for the delay when the magnet releases and the object starts moving downwards. In our experiment this happened with the file

delay014.wav, meaning the astronaut began falling about 14 milliseconds after the magnet was triggered. Note the found number if you want to use your camera as a measuring device (> Documentation). The offset occurs because the electromagnet also has a reaction time depending on local parameters. When the first beat arrives, the magnet's holding force decays gradually until the gravitational force prevails and pulls the object down.

The wav-filenames just indicate the delay between the two trigger beats in milliseconds.

> Documentation

While recording, note which picture (picture file name) corresponds to which delay (wav file name). Also document if you notice mistakes or something awkward. This documentation can help you in postproduction.

On top you can turn your camera into a measuring device that even lets you do analytical research. Use the picture-delay-relation to tag each picture with the corresponding time stamp. With this you're armed to investigate your system's temporal evolution quantitatively: Measure how other magnitudes change with respect to time, for example position or orientation as seen in the pictures. You can verify or falsify laws of nature, e.g. Galilei's fall equations, Newton's law of gravity. Analyze chaotic processes or try hunting gravitational waves;

