

Physics Investigation 4 Task Sheet

Observation

An object falls much faster in air than in oil as oil is more viscous.

Problem

How does the viscosity (resistive force) of a medium affect the motion of an object?

Hypothesis

Aim

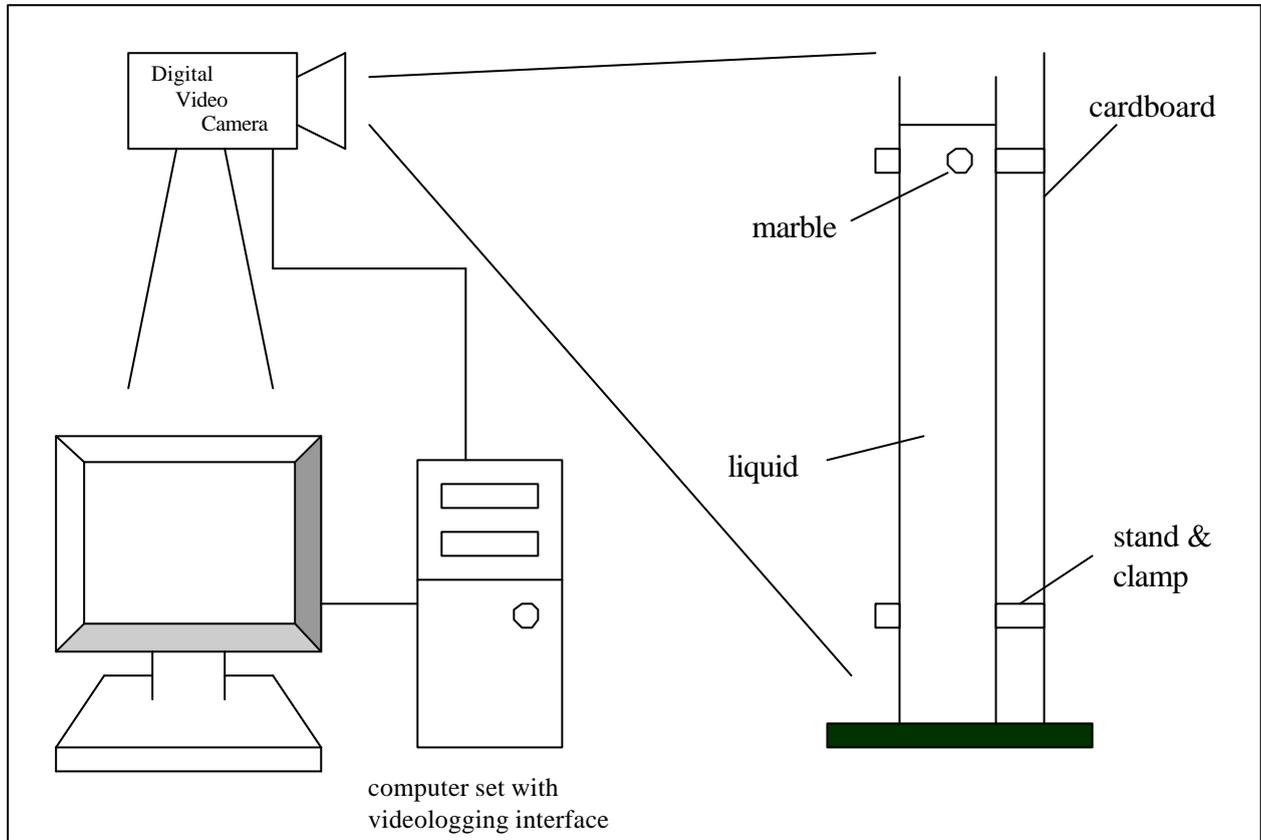
Principle

When an object falls "freely" in air, it moves with uniform acceleration (10ms^{-2}). If it falls in a fluid, there will be mainly three forces acting on it. They are its own weight, resistive force and upthrust by the fluid. Since the upthrust acting on a heavy object is much smaller than the other two, it can be assumed to be negligible and omitted for the purpose of this investigation. The equation of motion can be written as $W - f = ma$. (W - weight of object, f - resistive force, m - mass of object, a - acceleration.)

Equipment and Materials

- Visual logging interface X 1
- Desktop computer X 1
- Digital video camera X 1
- A painted marble X 1
- A black cardboard X 1
- Stand & clamp X 1
- Column of liquid X 1 (about 1m long)

Diagram of experimental set-up



Procedure

1. Connect the digital video camera to the computer;
2. Set up the apparatus as shown in the diagram above;
3. Switch on the digital video camera;
4. Choose **'Record'**, and then **'Show Capture Window'** in the visual-logging program;
5. Choose **'Record'**, and then choose **'Rapid Record'** and set the recording time limit to 2s. Set the radio button to 25 frames per second in the PAL/SECAM system;
6. Click **'Record'** in the capture window to start recording. At the same time, allow the marble to fall in air for about 50cm;
7. After the recording has stopped, choose **'Analysis'** and **'Video Object Trace'** in the menu bar;
8. Calibrate the screen by choosing the region to analyze the data, i.e. the position from where the ball starts to drop until the end of the motion. Enter the **'Y'** value, which

would be the distance the marble traveled. Leave the "X" value blank and then click "Finish";

9. Click "Fix Origin" and move the crosshair on the marble, then click "Finish";
10. Calibrate the points by positioning the crosshair on the marble frame by frame;
11. Click "Extra" and choose the radio button – "show Y value" only. Check the box of "Velocity" only and then click "Confirm". Click "OK";
12. Plot the graphs of velocity and distance against time;
13. Repeat steps 4-12 for the marble falling in oil. Choose 5s interval for time of recording instead.

Precautions

1. Make sure that the marble is dropped vertically;
2. The marble should not be too small. Otherwise, it will not be easily seen on the capture window;
3. A marble painted with a sharp colour is preferred so that it can be clearly seen on the screen;
4. Release the marble just a few mm above the oil surface to avoid the formation of bubbles on the marble or spilling oil out of the tube.

Results

Interpretation

Possible errors

Improvement

Conclusion