

Fri: Read

Mond: 49-54

Barrett: p 27-32

Mon: HW 3 by 5pm

Brief History of Sundials

Devices that use moving shadows to tell time have been found as early as ancient Egyptian civilization (3000BC → 500BC) although these were likely used to give information about the day of year rather than time of the day. Such sundials were also later encountered in

- ancient Greek civilization 800BC - 200BC
- ancient Roman " 500BC → 476AD

Initially these would have been used to tell days of the year (solstices, equinoxes) but by around 300BC there were references to single hours. The earliest datable sundials are Greek and date to the 3rd century B.C.

Greek sundial technology was eventually introduced into the Roman empire, and were widespread there.

Sundials were used throughout the middle ages in Europe (476AD - 1500AD) particularly in churches + public areas.

Fundamental issues with sundials

There are various fundamental issues with sundials.

Q. What possible issues are there for using sundials (particularly in the ancient world)?

These are:

- 1) they cannot work when it is cloudy (overcast)
- 2) they cannot work at night.
- 3) they were seldom calibrated more accurately than one hour (ancient Greece).
- 4) they were calibrated using temporal hours which varied during the seasons.

Such sundials were not useful for measuring small units of time or to serve as timers for units of time smaller than one hour.

~~Q. What simple objects could be used.~~

Q. What might have been tasks where timing was required in the ancient world?

Q. What ways could such time have been timed?

Various possibilities are:

- 1) burning candles / lamps ...
- 2) sandclocks / sandglasses / hourglasses.

Wikipedia hourglass page

- 3) waterclocks

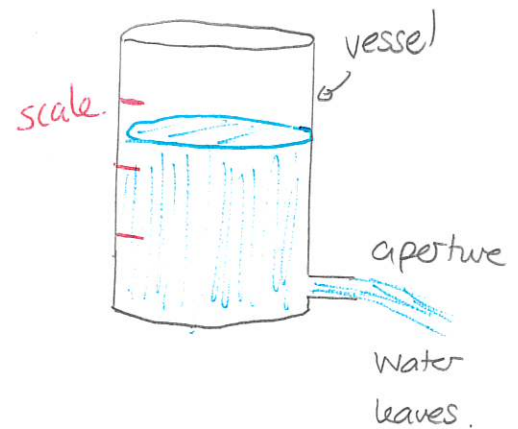
Water Clocks

A water clock is a mechanism that is engineered to produce a steady flow of water. The rate at which water flows is quantified by some means and this is converted into a measurement of time. There are generally two basic types of water clocks:

- 1) outflow water clock
- 2) inflow water clock.

Outflow clocks

In an outflow clock, water leaves a vessel via a small aperture. As it does so, the level in the vessel drops. One could calibrate/graduate the vessel so that the level corresponds to the passage of time.



Demo: [Wikimedia Image, Ancient Agora Museum, Athens.](#)

We can now consider how this might have been used.

1 Outflow water clocks

Imagine constructing a water clock using a bucket with a small outflow hole.

- a) Would this device function best as a "clock," a "timer" or as a "stopwatch?"

It works most like a timer - can tell a fixed duration of time.

- b) Suppose that the bucket would take 20 minutes to drain from completely full. Could you calibrate the bucket to count off 5 minute intervals by dividing its height into four equal segments? Explain your answer.

No, the rate of outflow decreases as the level drops.

- c) What issues arise in trying to calibrate the water clock?

One would have to account for the diminishing rate of outflow

- d) In terms of timekeeping what is the basic difference between a water clock and a sundial?

The sundial can tell when it is noon - can tell time of day.
Waterclock cannot - it can measure a duration of time.

- e) What advantages does such a water clock have over a sundial? What disadvantages does it have?

advantages - works at night and when cloudy

disadvantages - cannot tell time of day

- calibration must account for varying outflow rate.

- need to refill

Demo: me 3340 video - different outflow rates up to 1min

Demo: Ancient Mechanical Clocks video - roughly 1min \rightarrow 4min

Such outflow water clocks were used in:

- 1) ancient Egypt
- 2) ancient Greece
- 3) ancient Rome
- 4) Islamic world.

The records from ancient Greece and ancient Rome show that these were used in:

- 1) legal and politic proceedings - to time speeches
- 2) military activities - to time night watches
- 3) scientific investigations -

In other parts of the world, particularly the Islamic world water clocks would have been used for regulating allotments of irrigation water.

Demo: Agora water clock (Armstrong article)