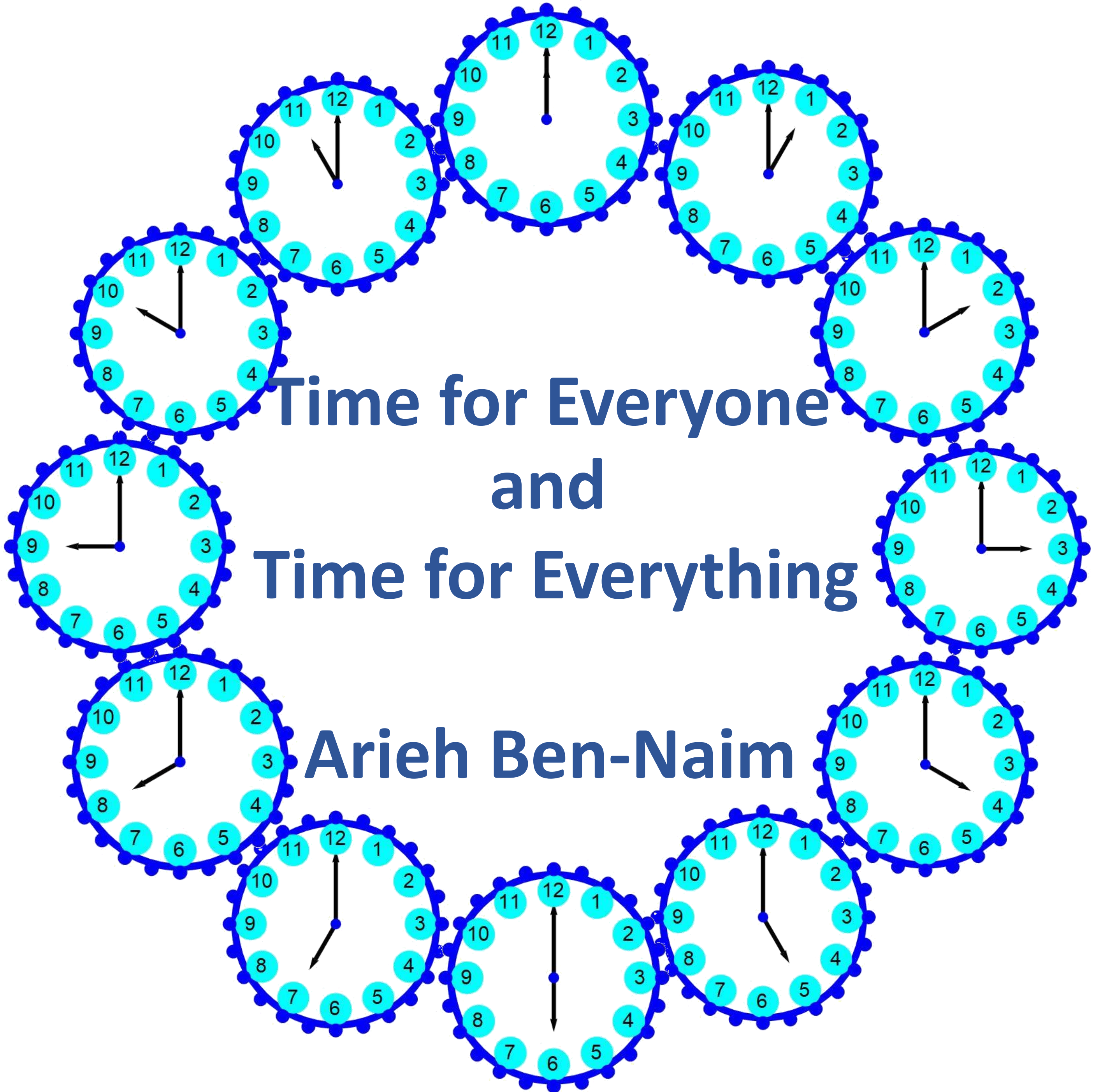


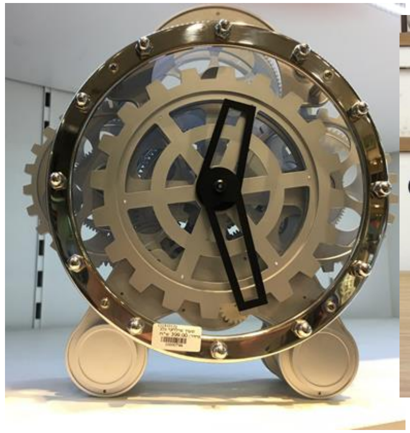
Time for Everyone and Time for Everything

Arieh Ben-Naim

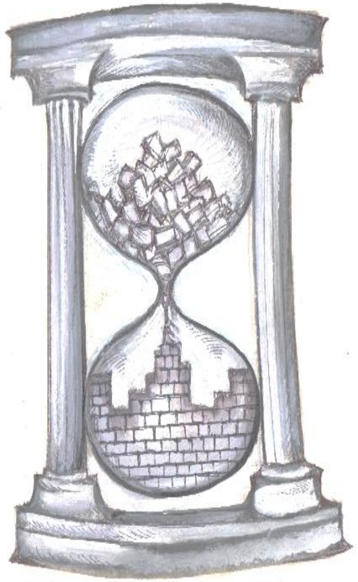
Prehistoric: Stonehenge and Newgrange

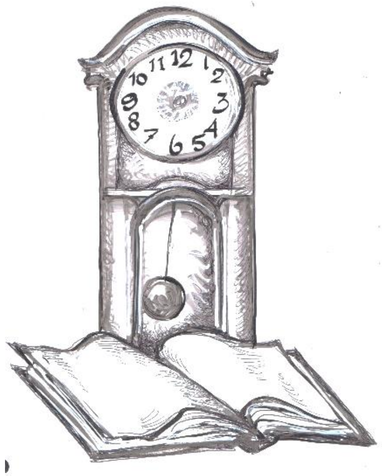
Antique

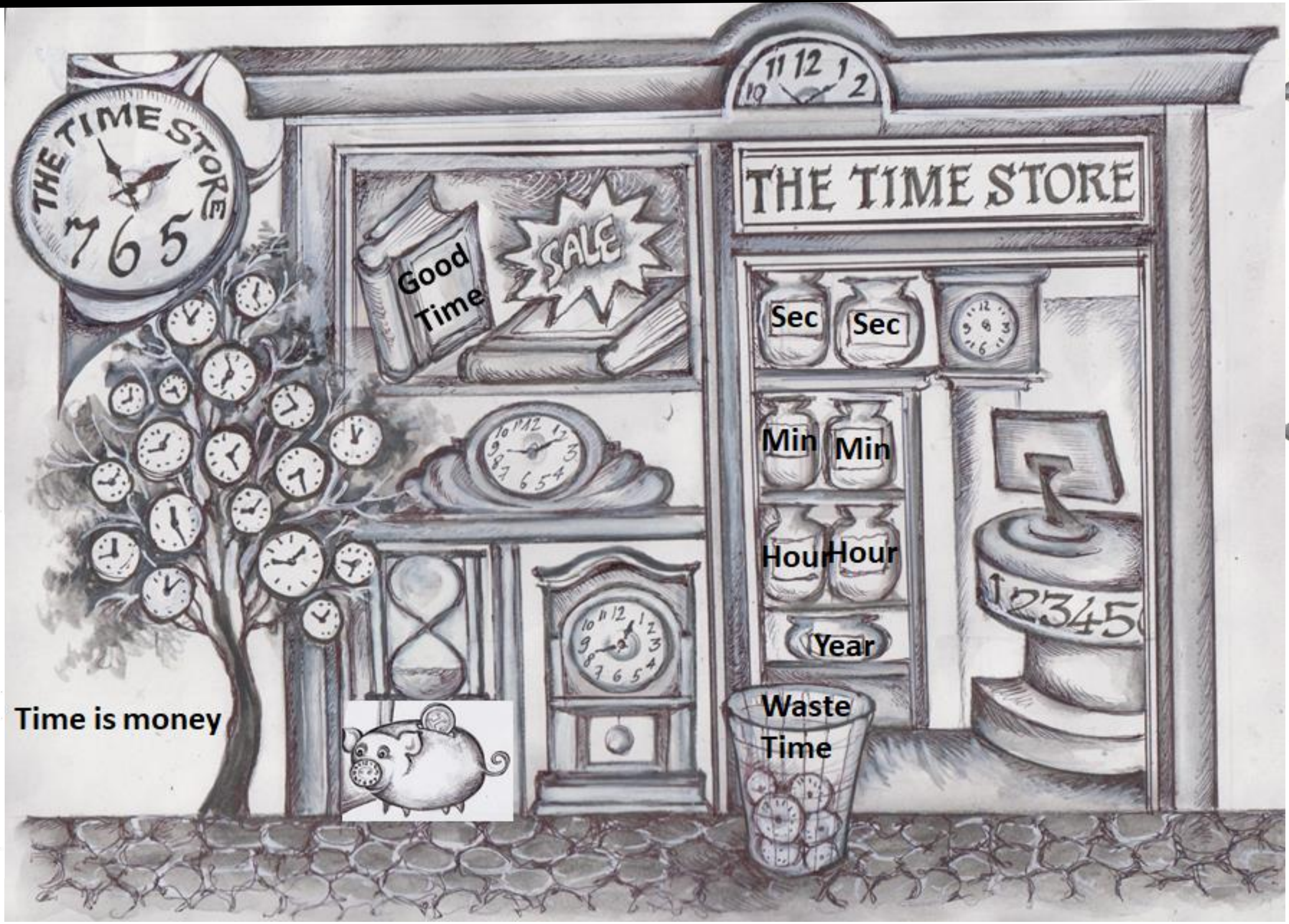
Modern

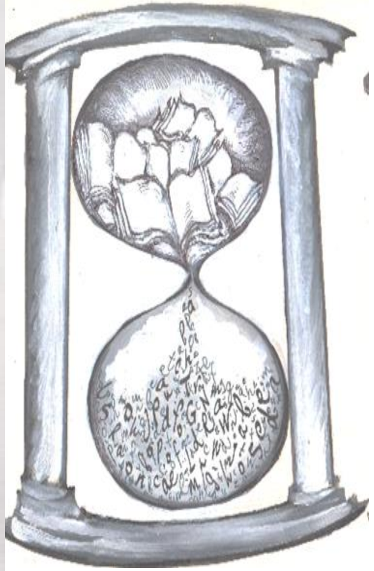


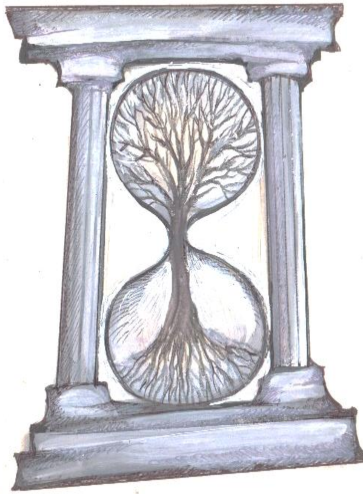
Artistic and humor






THE TIME STORE
THE TIME STORE
Good Time
SALE
Sec
Sec
Min
Min
Hour
Hour
Year
Waste Time
Time is money





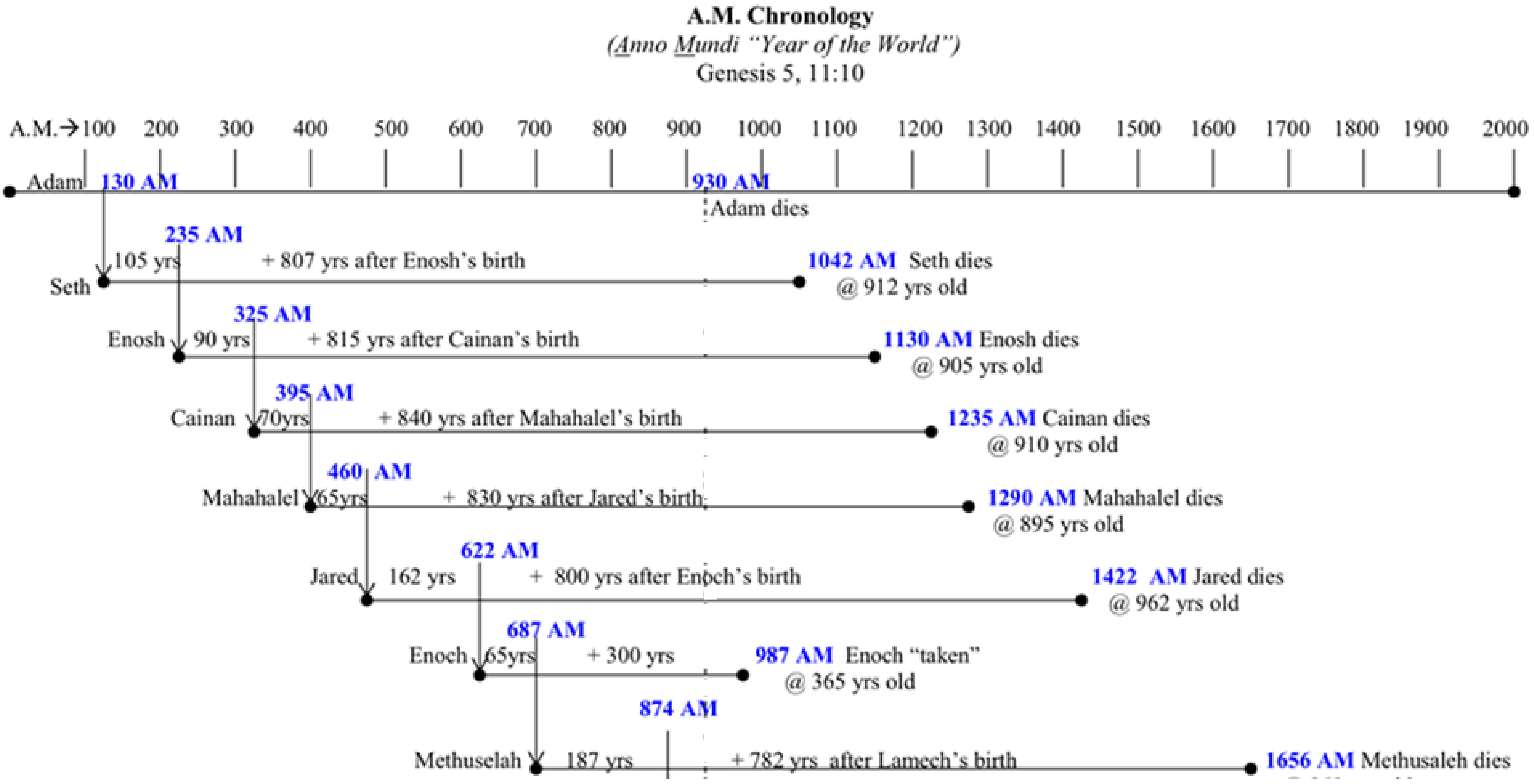
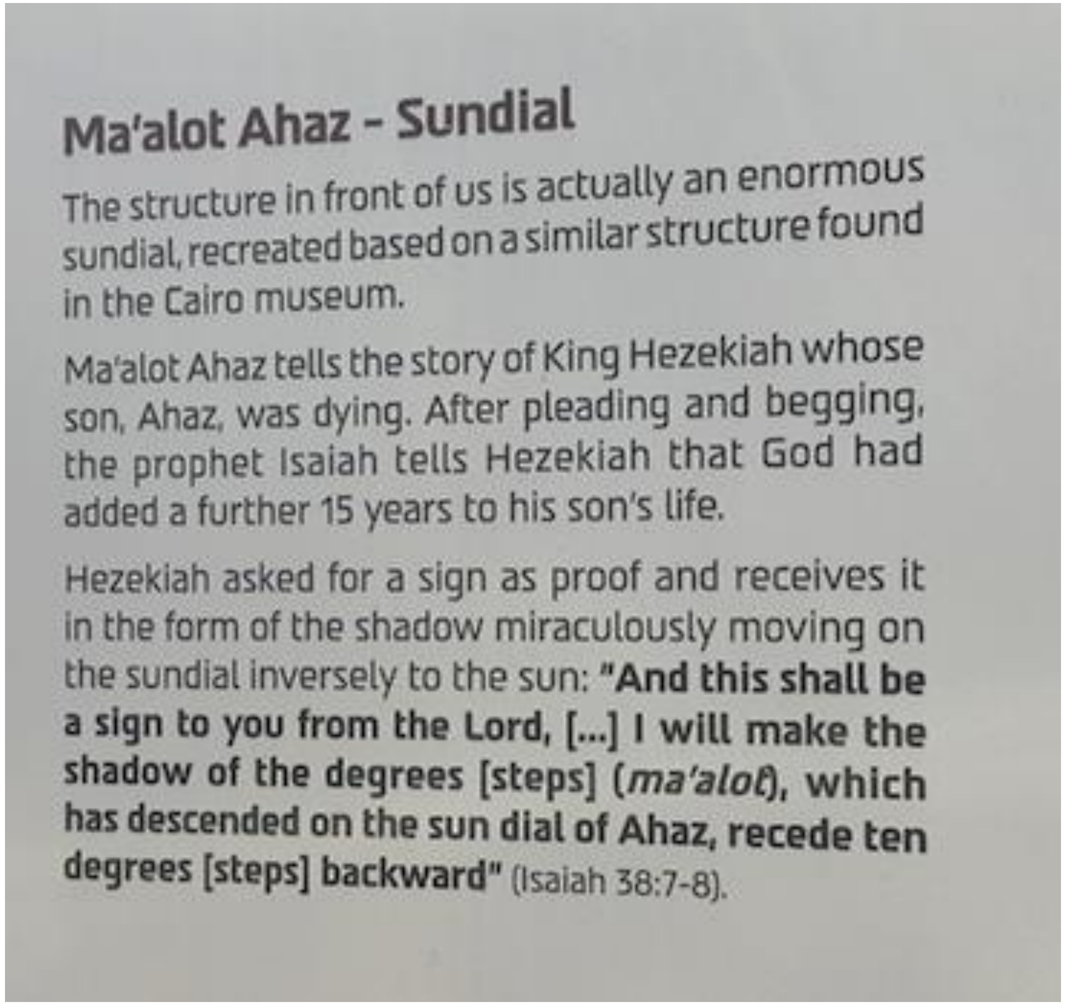


Figure 1.1. The life spans of Adam and his descendants until Methuselah. The "years" are counted from the creation of the world; A.M. = Anno Mundi.



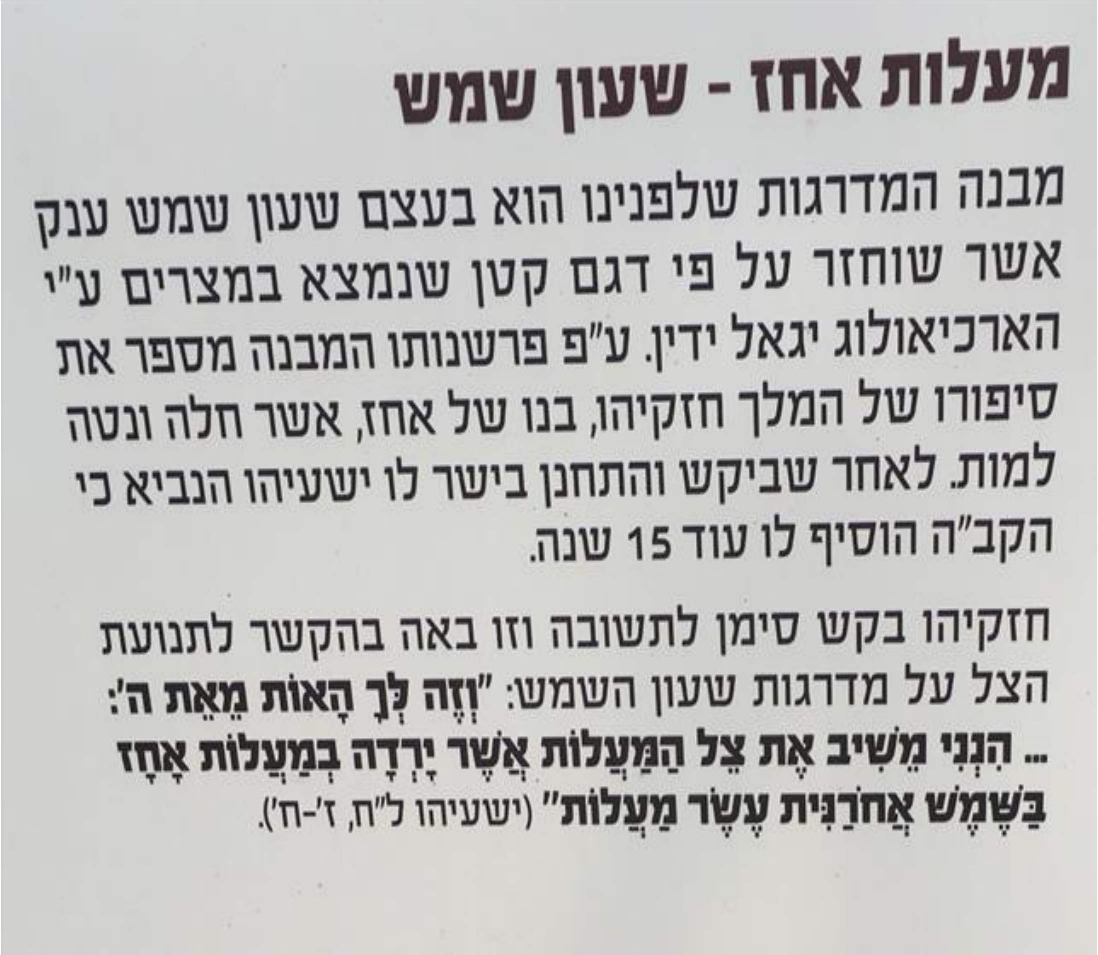


Figure 1.2. The biblical story related to Ma'alot Ahaz.

Figure 1.3. The sign in Ma'alot Ahaz citing a quotation from Isaiah.

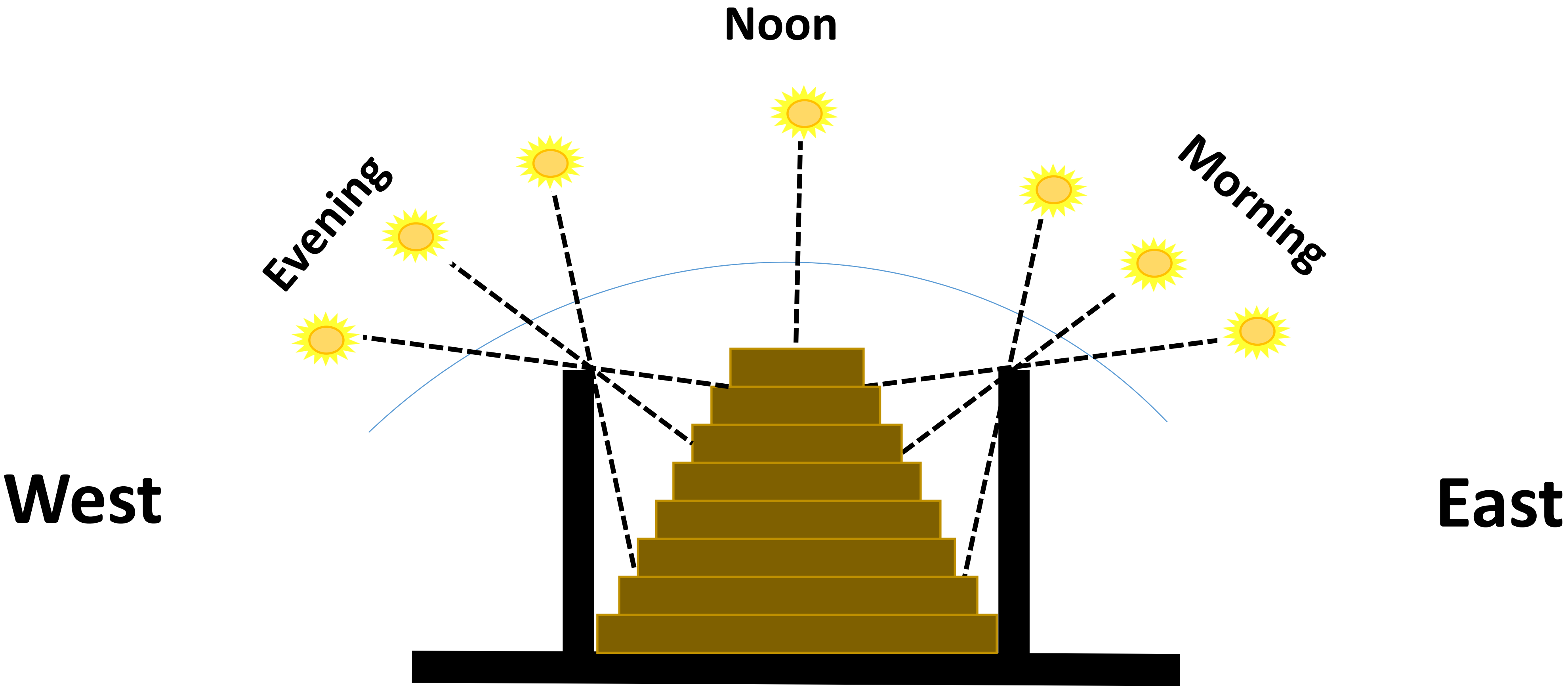


Figure 1.4. A model of the sundial in Ma'alot Ahaz.
The paths of the sun's rays are shown by dashed lines.

Figure 1.5. A few pictures taken at different hours during the morning in Ma’alot Ahaz.

Figure 1.6. Two pictures taken at different hours during the afternoon, at about 2:00 and 4:00 PM in Ma’alot Ahaz.

Figure 1.6. A few pictures taken at different hours during the afternoon in Ma’alot Ahaz.

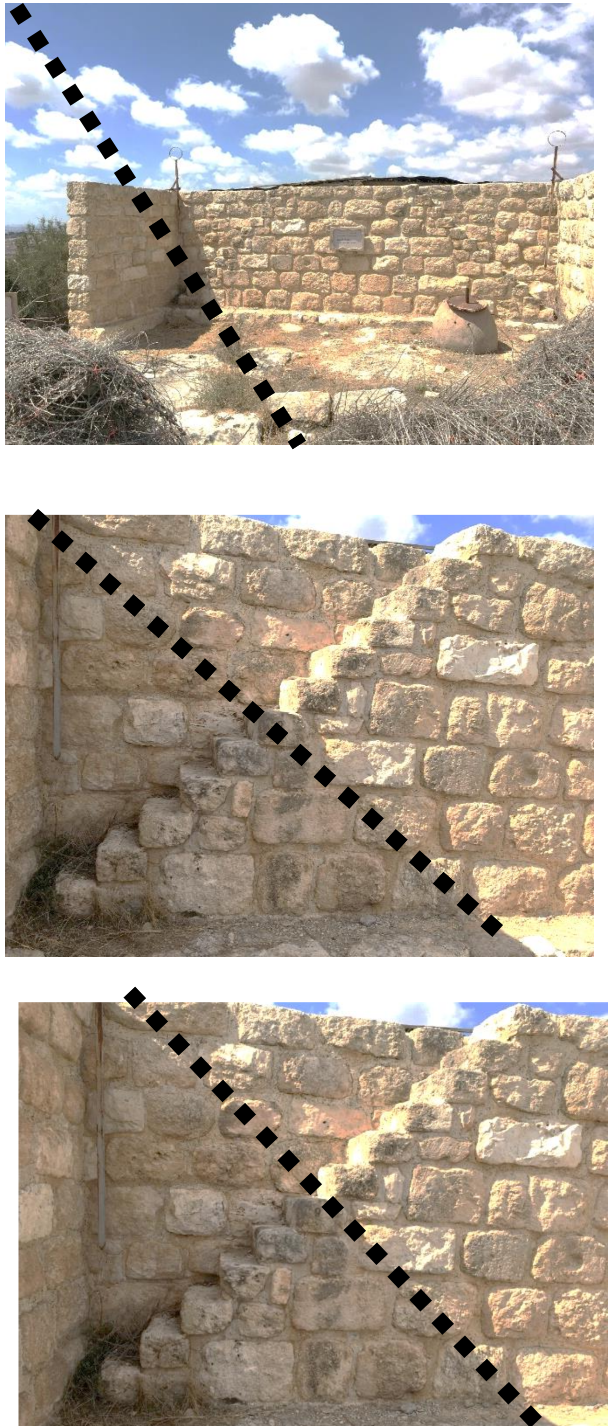


Figure 1.7. The tower clock the Chatrapati Shivaji Terminus (CST) railway station in Mumbai, India.

Figure 1.8. Three clocks the author bought from a book store in IIT Bombay.

Figure 1.9. A waterproof watch bought in Madurai, India.
Proof: The watch works while immersed in water.

Figure 1.10. The clock behind the reception desk of our hotel in Madurai.

Figure 1.11. A few beautiful clocks not bought in Madurai.

Figure 1.12. A few clocks bought in Madurai.

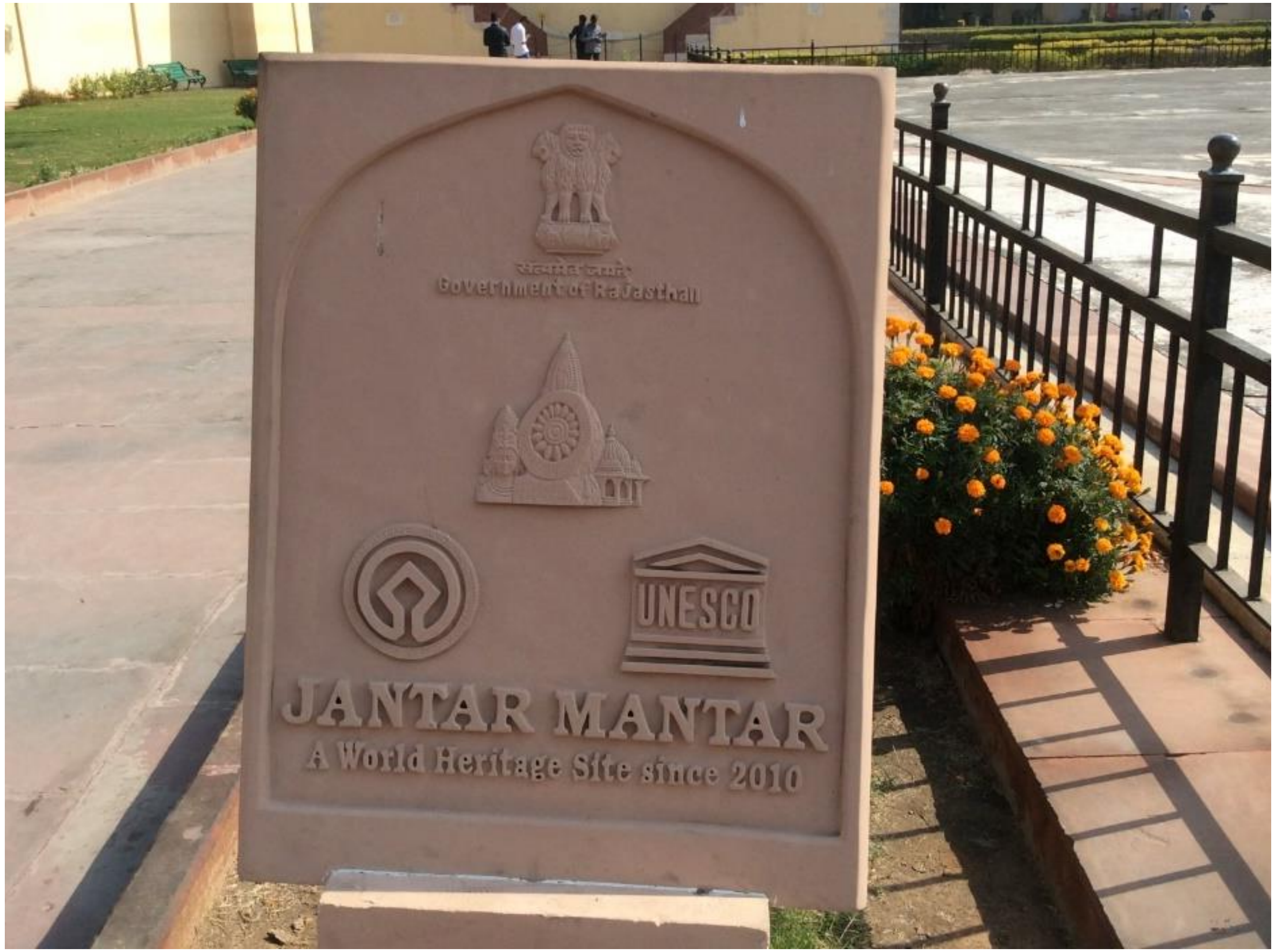


Figure 1.13. At the entrance to Jantar Mantar, Jaipur, India.

Figure 1.14. Some interesting structures in Jantar Mantar, Jaipur, India.

Figure 1.15. A beautiful clock which I bought in Jaipur. On its face are two peacocks, India's national bird.

Figure 1.16. A beautiful clock bought from street hawkers plying their trade along pedestrian paths facing the Jal Mahal, Jaipur, India.

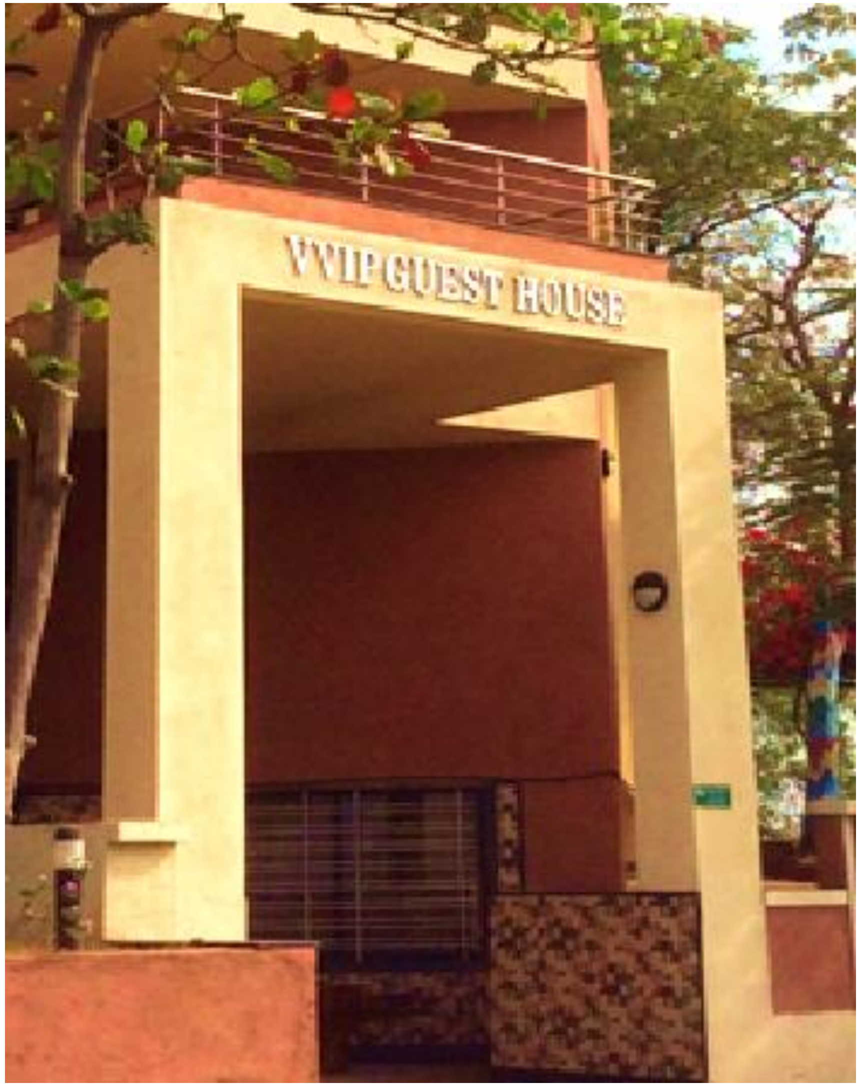


Figure 1.17. The VVIP Guest house in North Maharashtra University, Jalgaon, home to my wife and me during my visit to the university.

Figure 1.18. Left photo shows two clocks which I bought in the clock center in Jalgaon. Photo on the right is the historic clock tower of Jalgaon.

Figure 1.19. A few clocks bought in the Chandi Chowk market in Old Delhi.

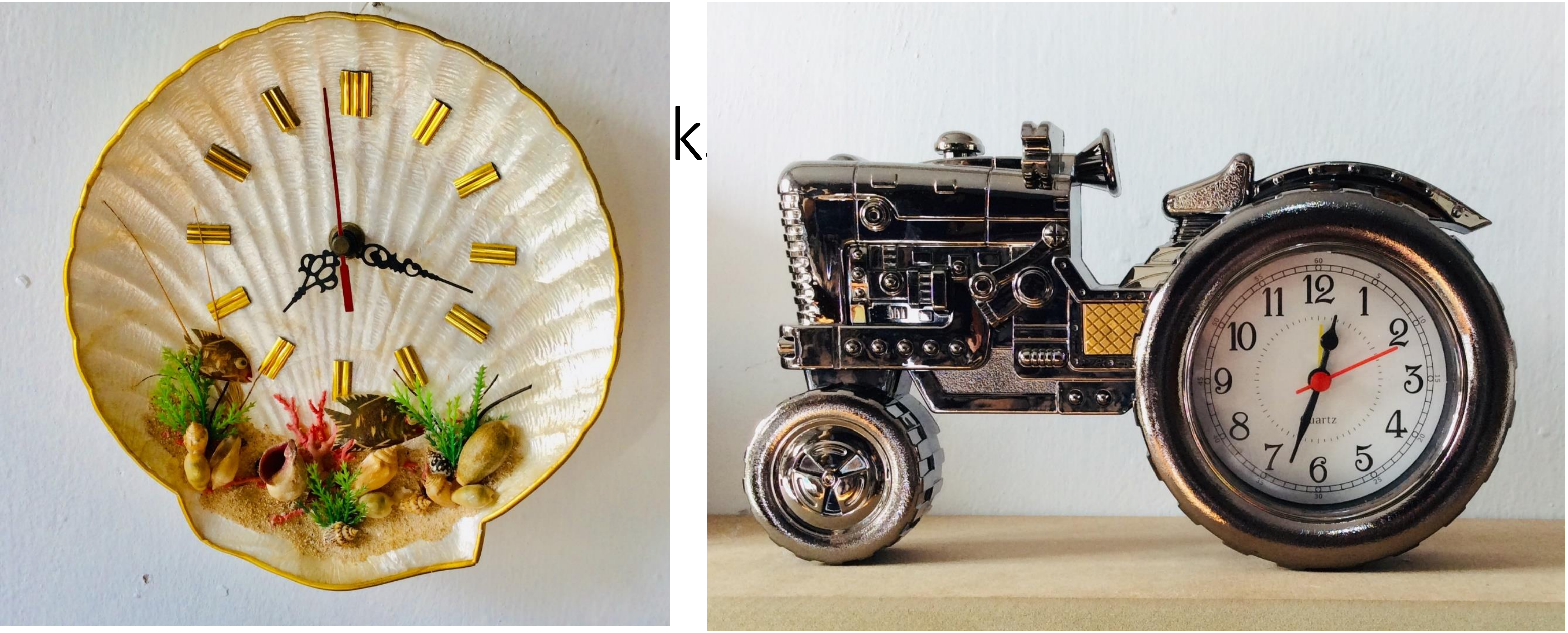


Figure 2.1. Some of the clocks in my collection

Figure 2.2. Photo on the left is a cuckoo clock from the Black Forest in Germany. The clock on the right was bought during our visit to Armenia.

Figure 2.3. Some of the clocks in my collection

Figure 2.4. Some of the clocks in my collection

Figure 2.5. The Museum of Islamic Art in Jerusalem

My own clocks

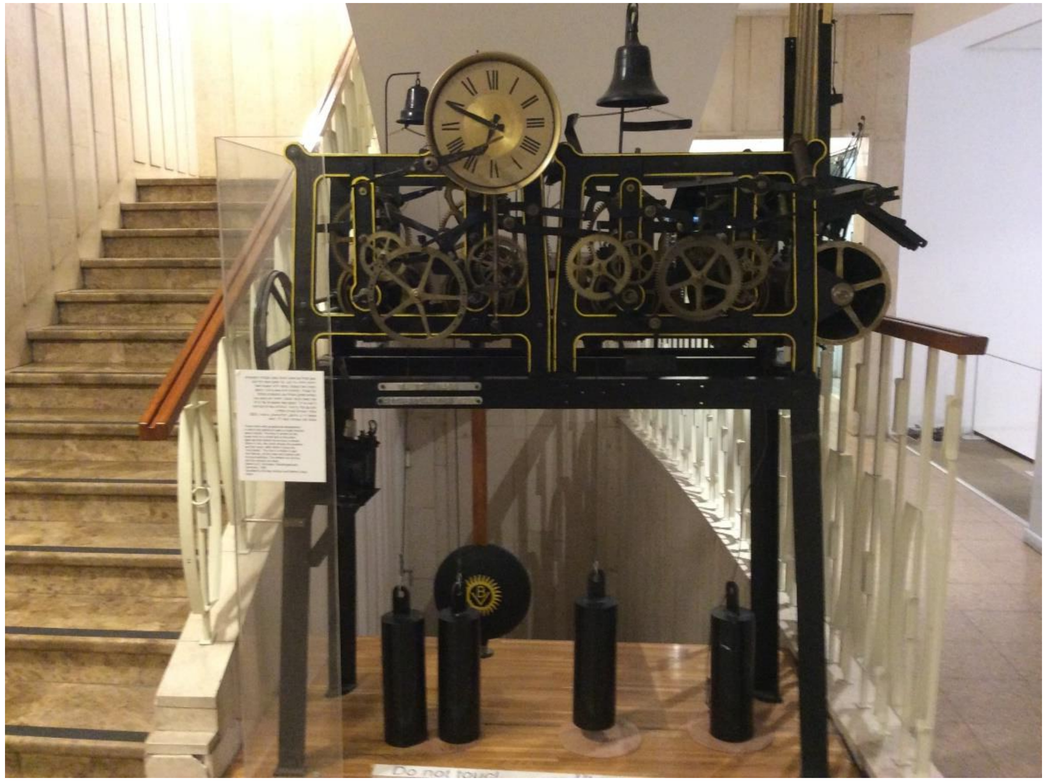

QUARTZ


THERMO

QUARTZ


Quartz


Big Ben London



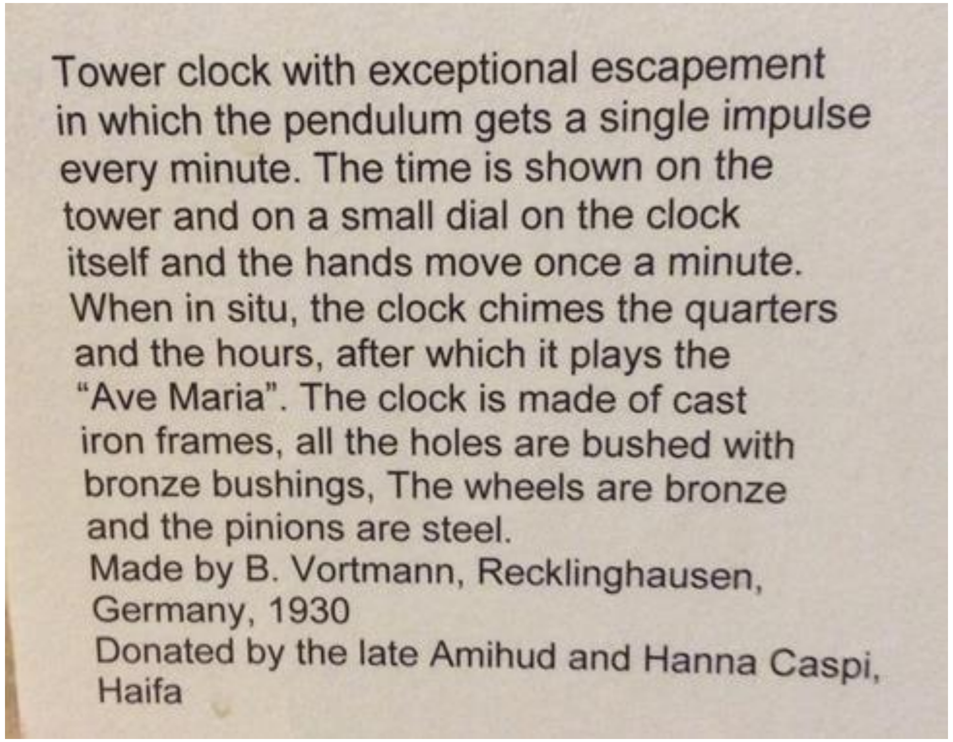


Figure 2.6. At the entrance to the clocks exhibition of the Museum of Islamic Art in Jerusalem

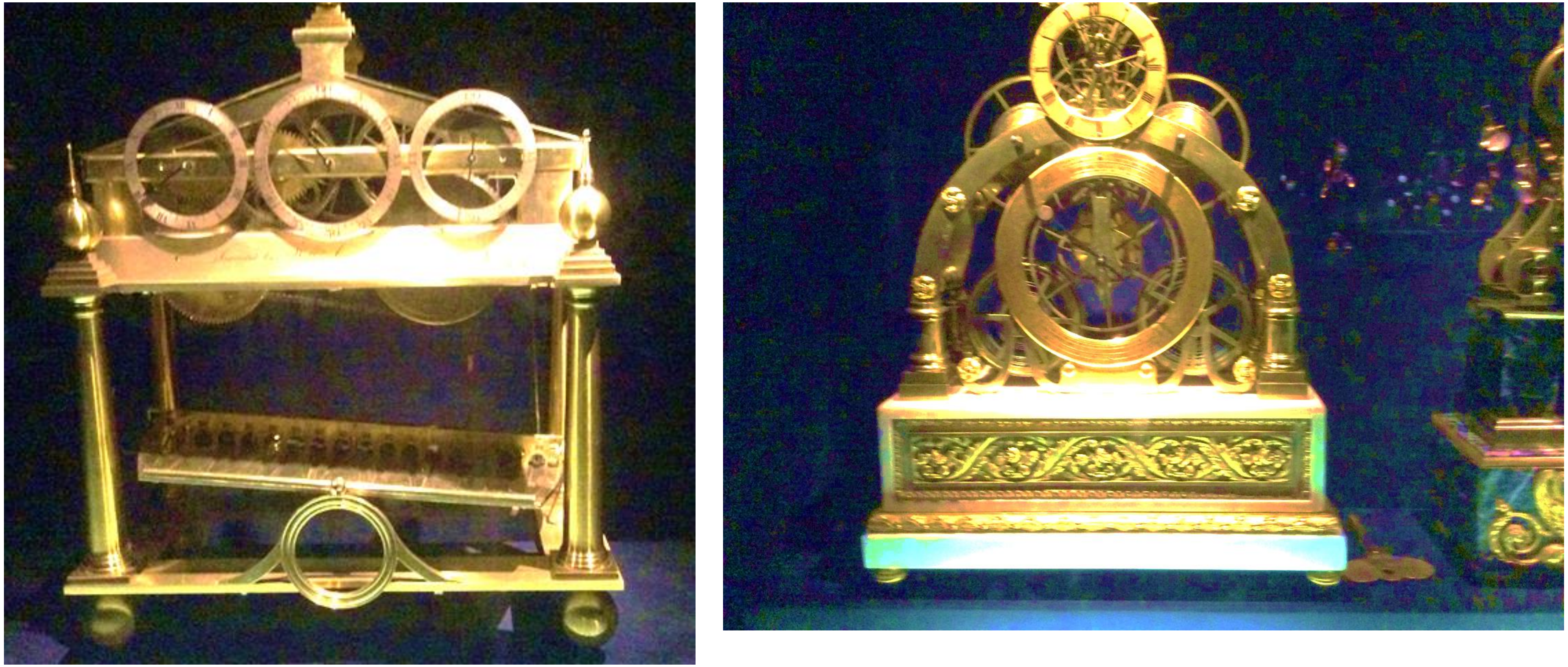


Figure 2.7. Some antique clocks in the Museum of Islamic Art in Jerusalem

Figure 2.8. Some antique clocks in the Museum of Islamic Art in Jerusalem
More pictures may be seen in: ariehbennaim.com

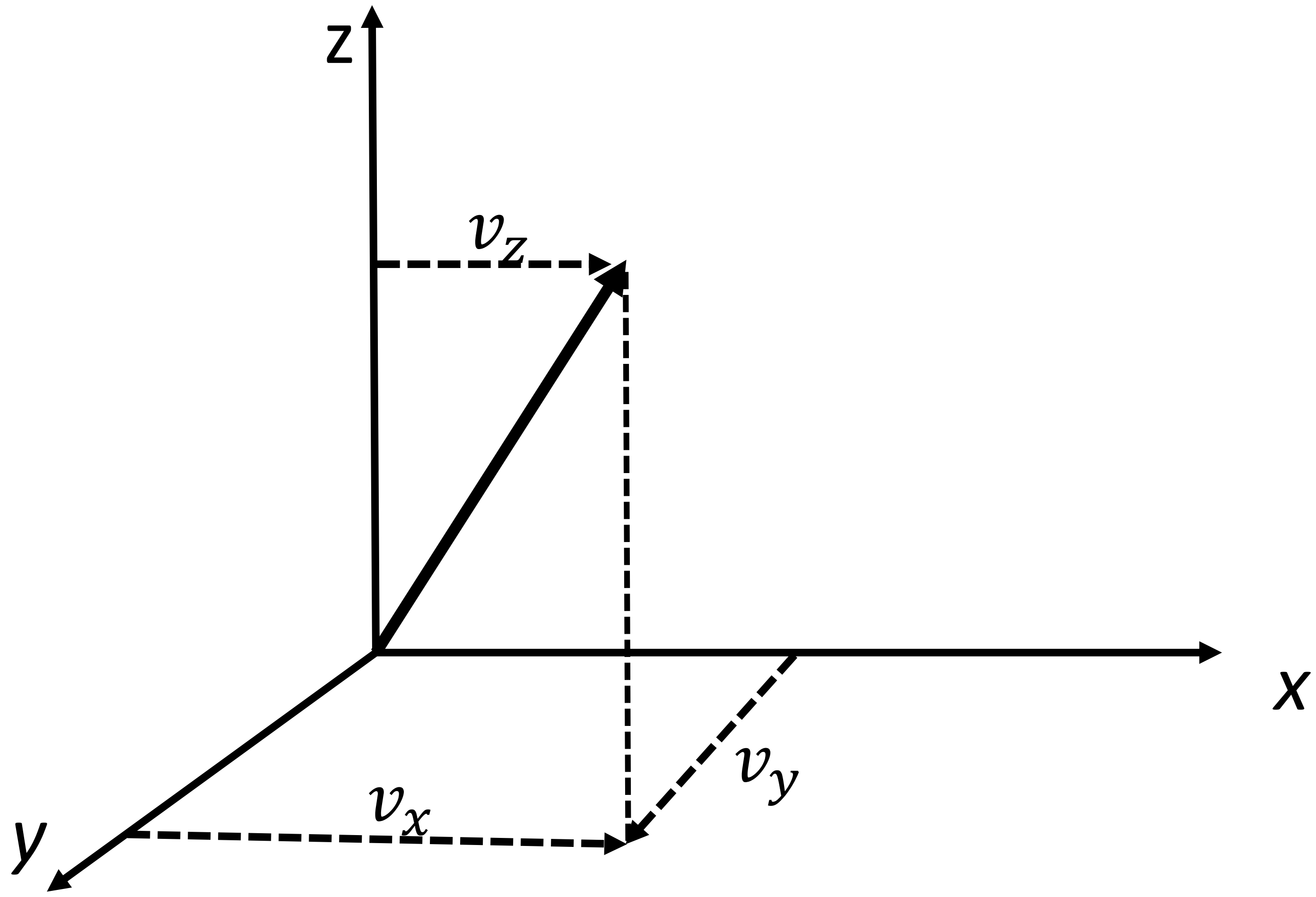


Figure 3.1. The three components of the *velocity*: v_x, v_y, v_z and the *absolute velocity*, or *speed*, $v = \sqrt{v_x^2 + v_y^2 + v_z^2}$

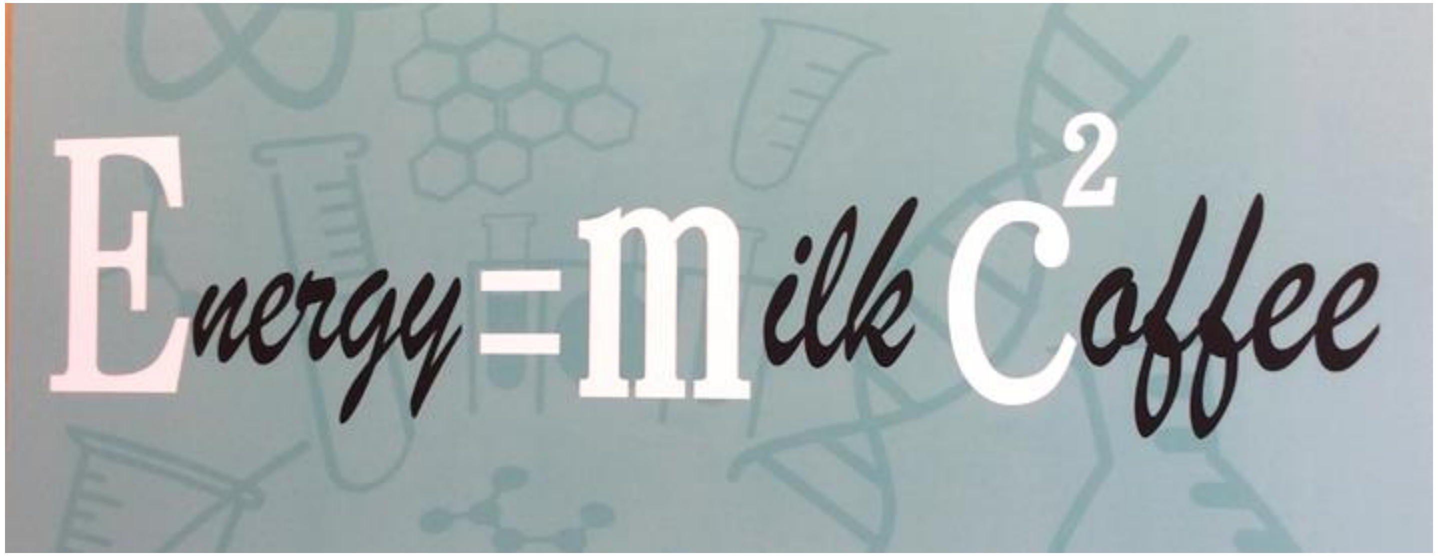


Figure 3.2. “Practical interpretation” of Einstein’s formula

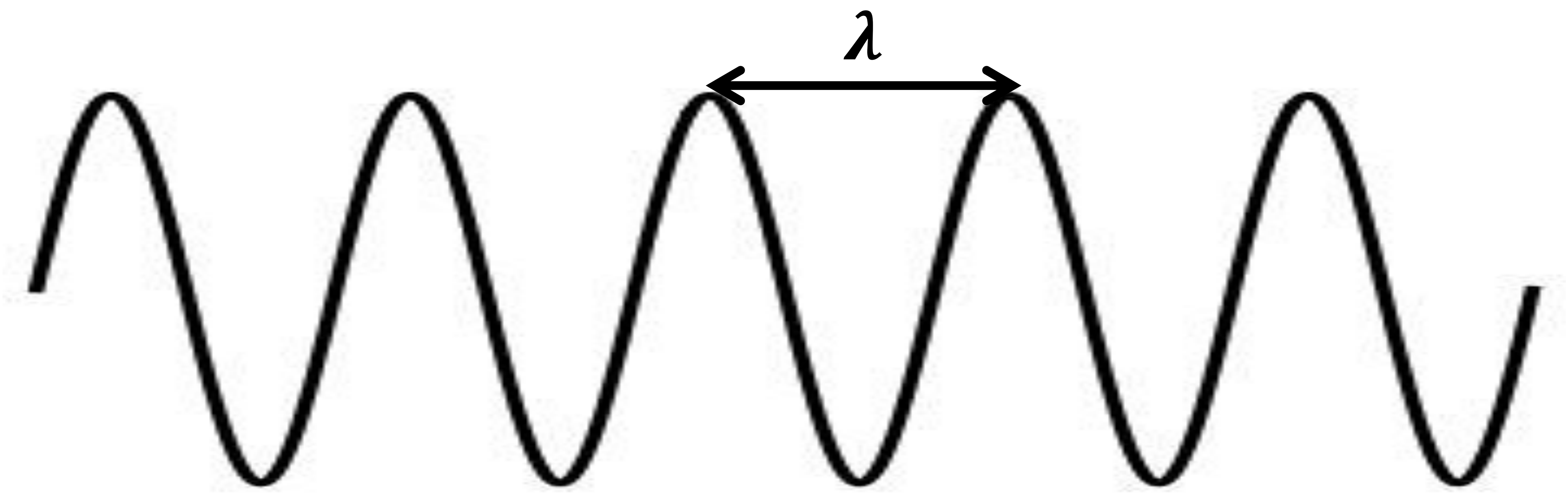


Figure 3.3. A typical wave.
The wavelength is defined as the distance between two crests of the wave, λ

Figure 3.4. A typical water-wave caused by a pebble hitting the water.

(a)

(b)

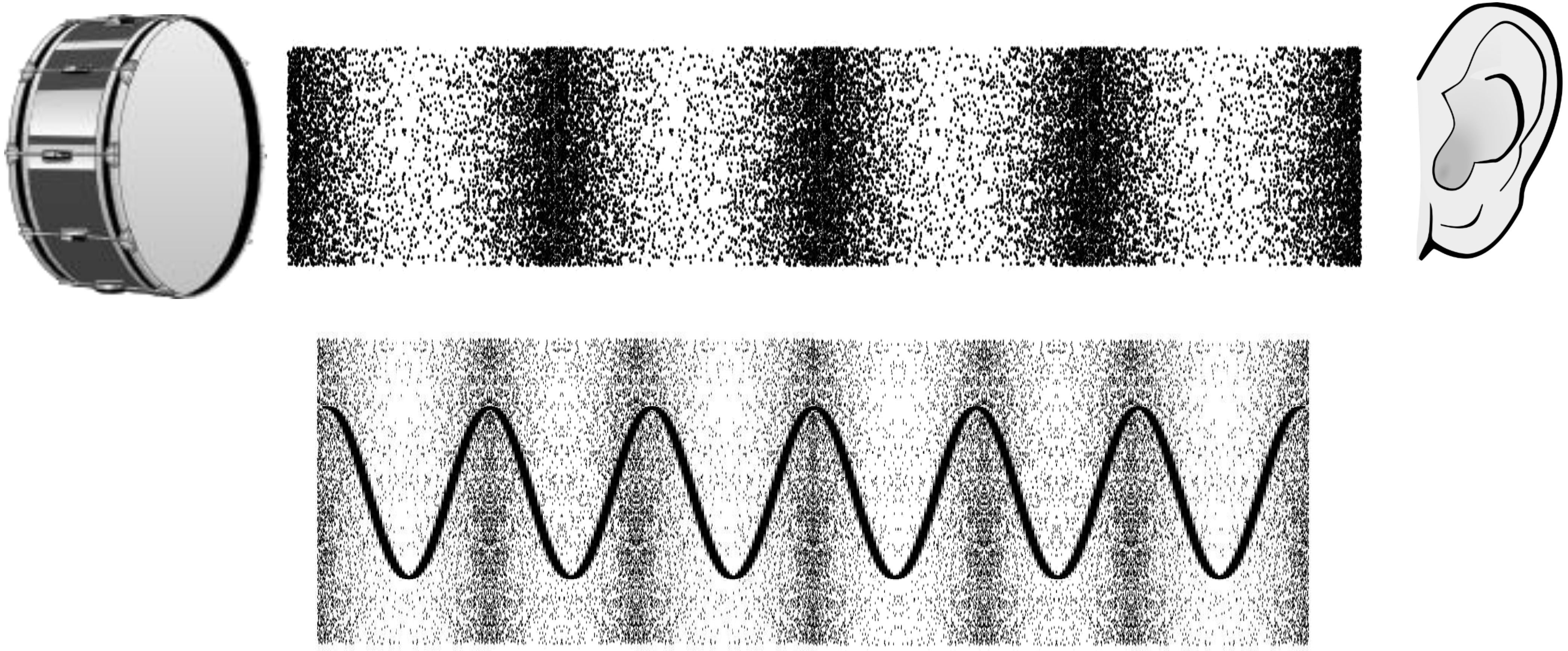


Figure 3.5. (a) Sound waves originating from a vibrating membrane and propagating as alternating regions of high and low density of the air. When reaching the ear they induce vibrations in the eardrum. (b) Sound waves are shown as waves of high and low density of the air.

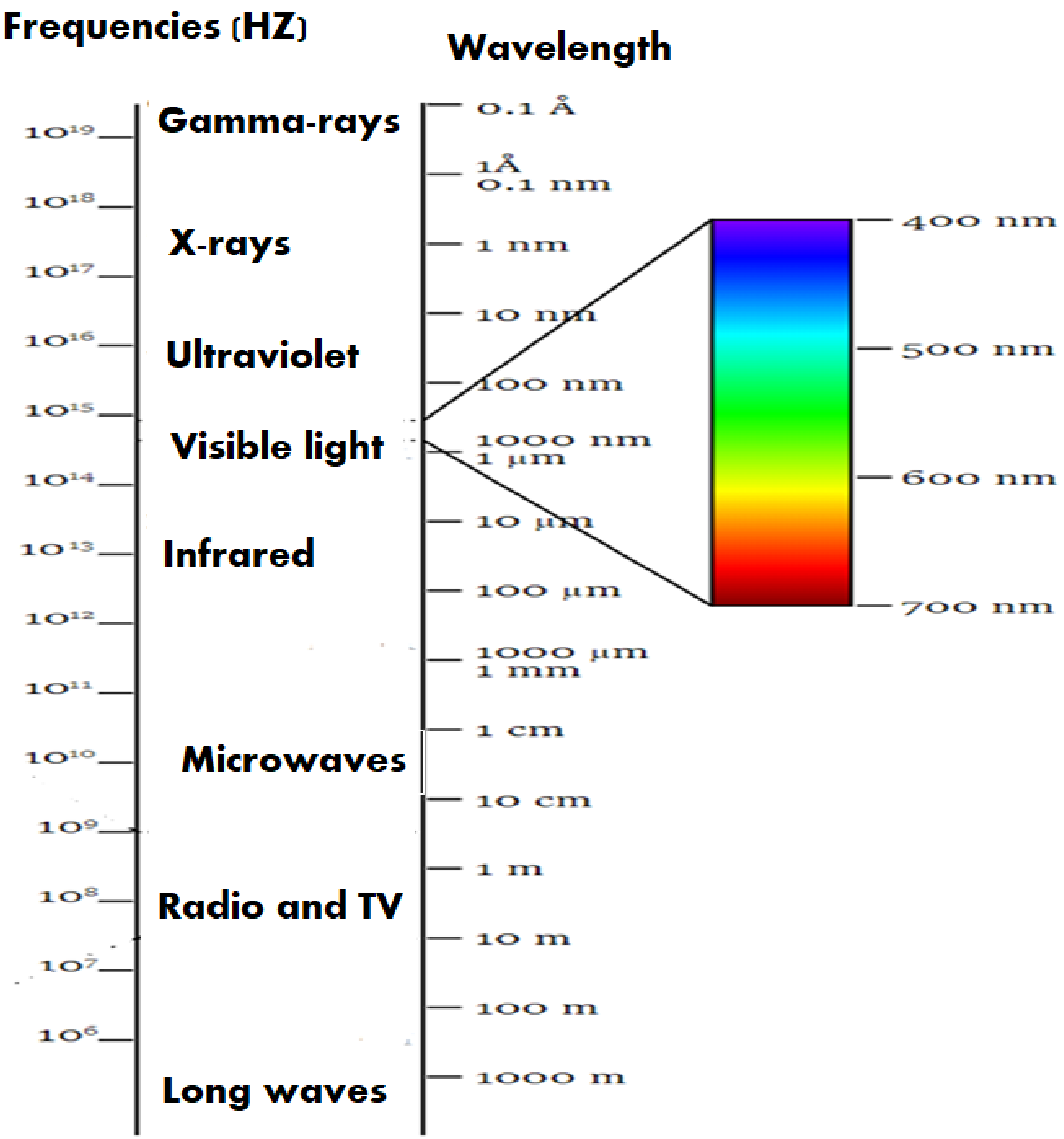


Figure 3.6. Spectrum of the electromagnetic waves.

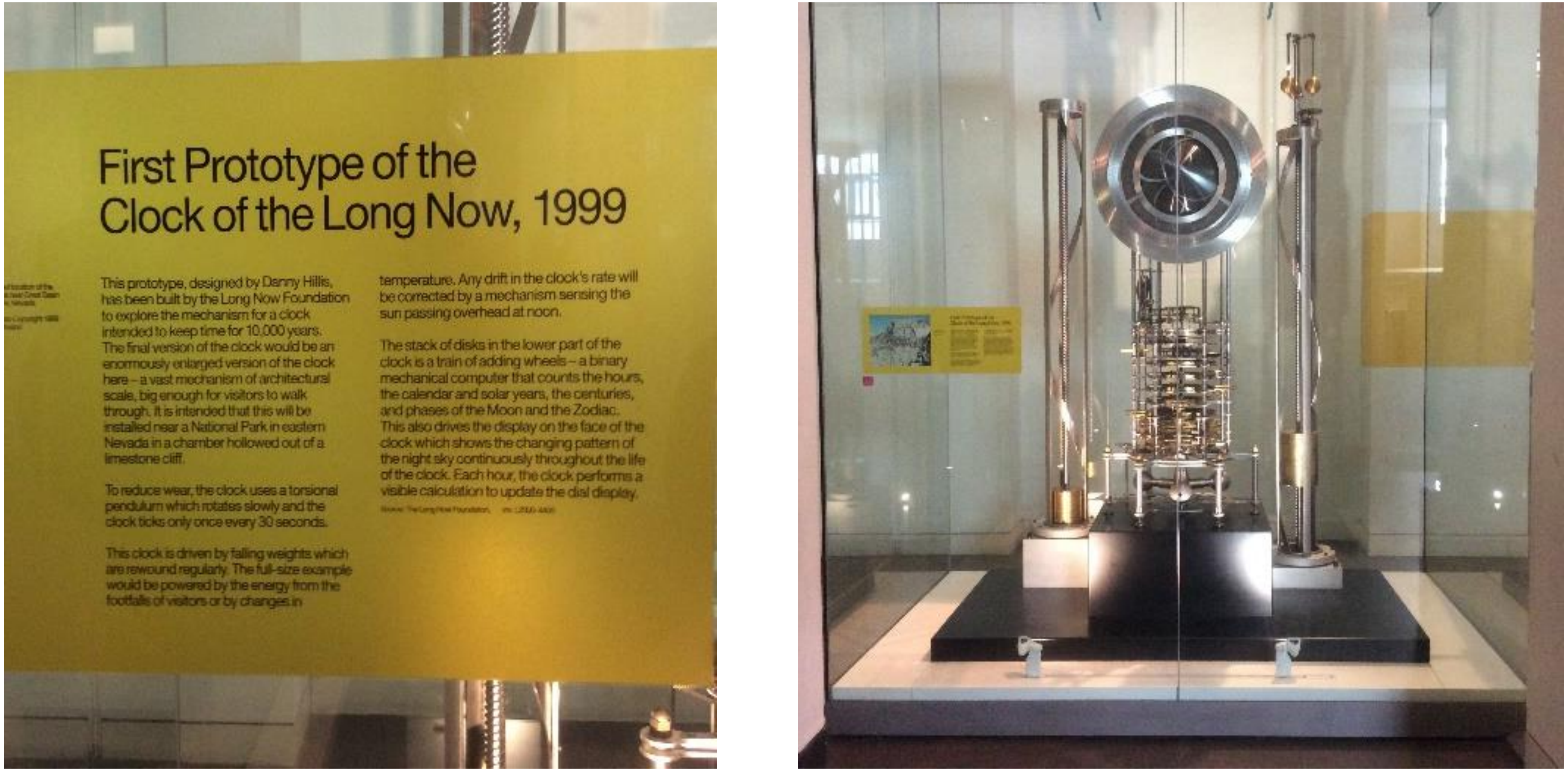


Figure 4.3. Clock of the Long Now in the Science Museum, London. More pictures may be seen in: ariehbennaim.com

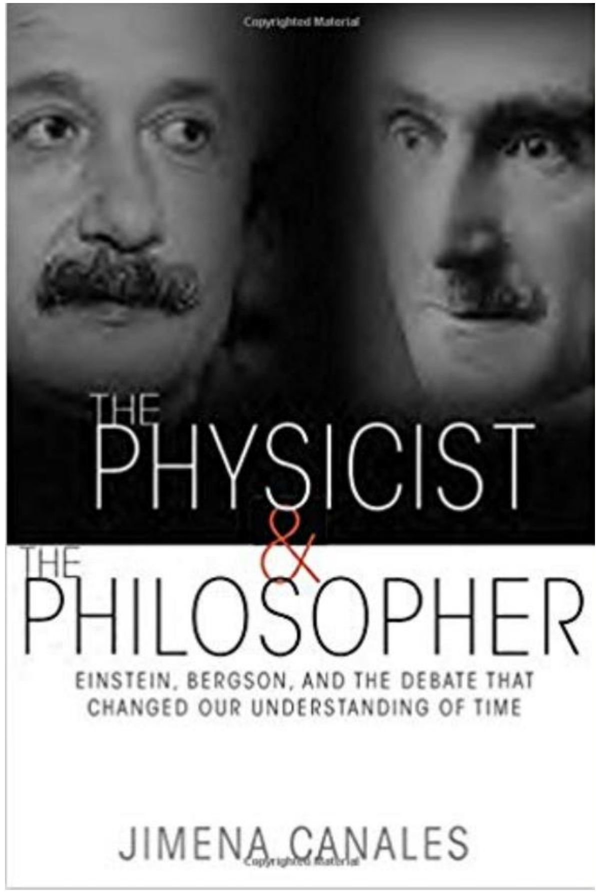
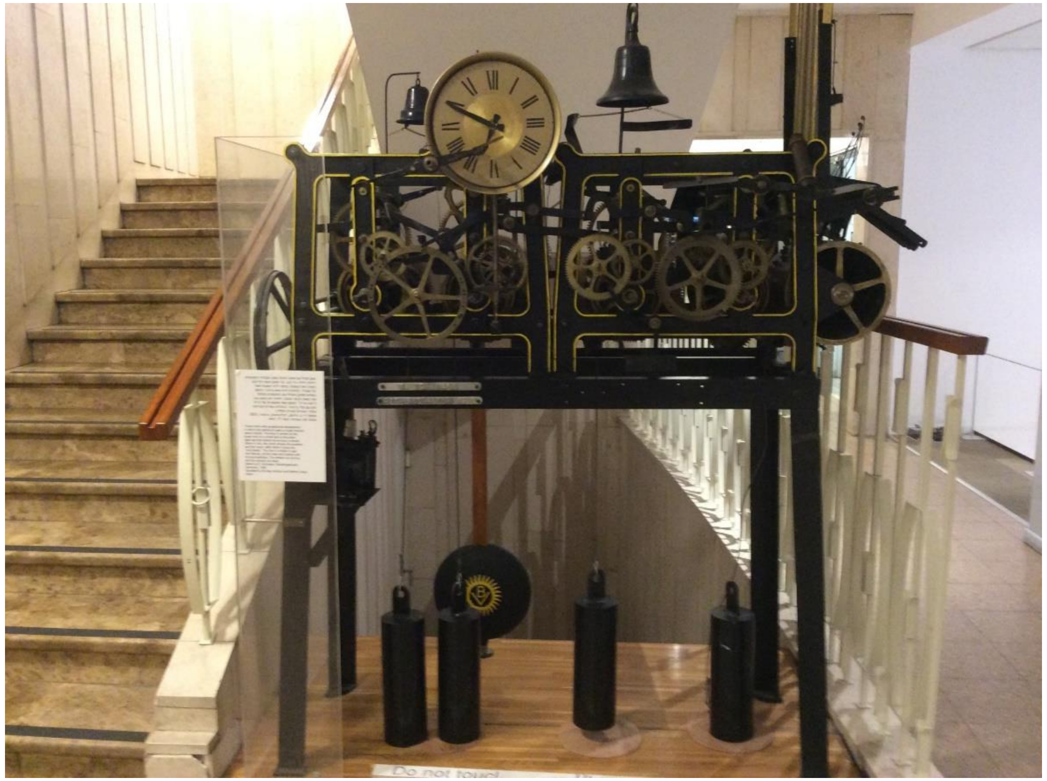


Figure 5.1. Cover of Canales's book

Figure 5.2. The entrance to the Stonehenge.
More pictures may be seen in: ariehbennaim.com

Figure 5.3. Some pictures from Stonehenge.
More pictures may be seen in: ariehbennaim.com

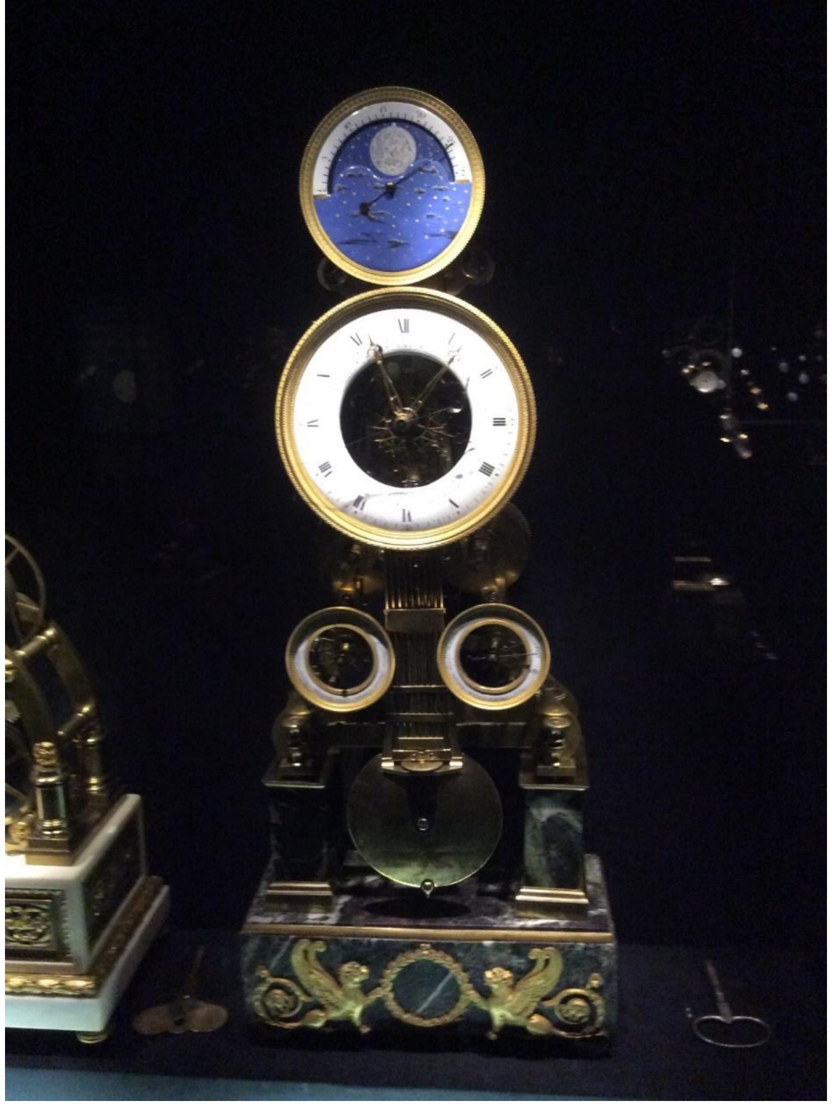


At the entrance to the clocks exhibition of the Museum of Islamic Art in Jerusalem

שעון מגדל עם מחגר מיוחד ממנו מקבלת המשקולת
דחיפה יחידה כל דקה. על השעון עצמו לוח קטן
המורה את השעות, בנוסף ללוח השעות אשר
על המגדל. המחוגים זזים פעם בדקה. השעון
כשהוא מותקן במגדל ועם הפעמונים מצלצל
את השעה ורבעי השעה, ולאחר מכן מנגנן את
ה"אוה מריה". השעון עשוי ממסגרות של ברזל
יצוק עם מלוי ברונזה. הגלגלים עשויים מברונזה
וגלגלי השיניים עשויים מפלדה.
מעשה ידי ב. וורטמן, רקלינגהאוזן, גרמניה, 1930
מתנת חנה ועמיהוד כספי ז"ל, חיפה

Tower clock with exceptional escapement in which the pendulum gets a single impulse every minute. The time is shown on the tower and on a small dial on the clock itself and the hands move once a minute. When in situ, the clock chimes the quarters and the hours, after which it plays the "Ave Maria". The clock is made of cast iron frames, all the holes are bushed with bronze bushings, The wheels are bronze and the pinions are steel.
Made by B. Vortmann, Recklinghausen, Germany, 1930
Donated by the late Amihud and Hanna Caspi, Haifa

In the **rolling ball clock** time is measured with a small steel ball that rolls down grooves on an inclined plate. At the end of the course the plate inclines in the opposite direction and the ball turns and begins to roll back. This movement, invented in the late 16th century, is based on Galileo's law that bodies on an inclined surface will cover a given distance in a constant time period. The law inspired various clocks produced in England at the beginning of the 19th century.

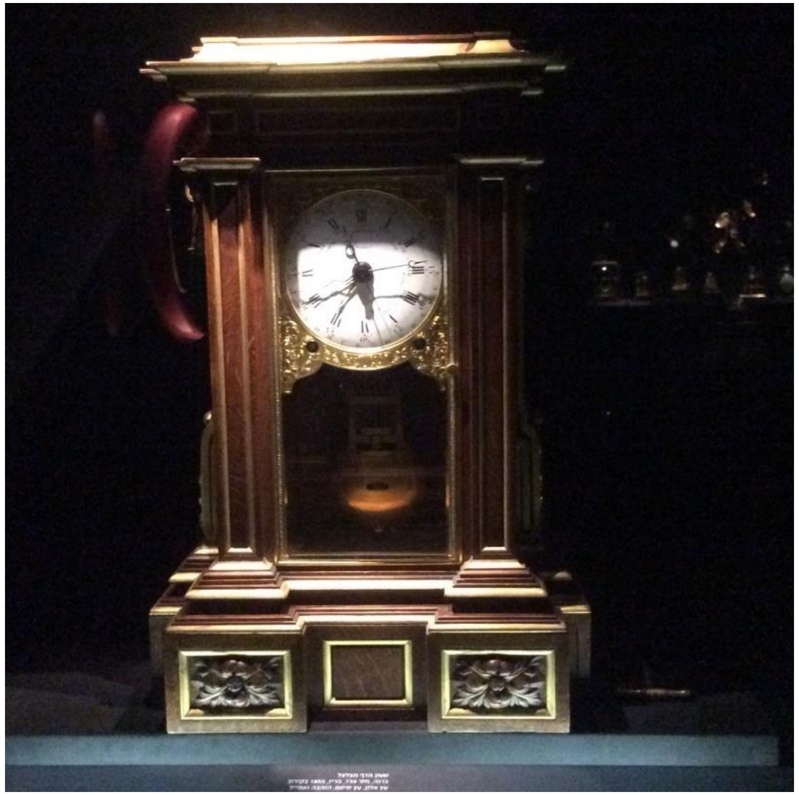



4. שעון כרכרה לשמונה ימים בלא דריכה
מצלצל רבעי שעה
תומפסון ופרופז, לונדון, 1880 בקירוב
מתכת מוזהבת ומוכספת
Eight-day quarter striking
carriage clock
Tompson & Profaze, London, c. 1880
Gilt and silvered metal
5. שעון כרכרה מצלצל
פרדיננד ברתולד,
פריז, 1800 בקירוב
מתכת מוזהבת
Striking carriage clock
Ferdinand Berthould,
Paris, c. 1800
Gilt metal
6. שעון נמתח מאליו עם לוח שנה
מצלצל רבעי שעה
ל' לה־רוי ושות', פריז, סוף המאה ה־19
זהב ואמייל
Quarter repeating perpetual
calendar watch
L. Leroy et Cie, Paris, late 19th century
Gold and enamel

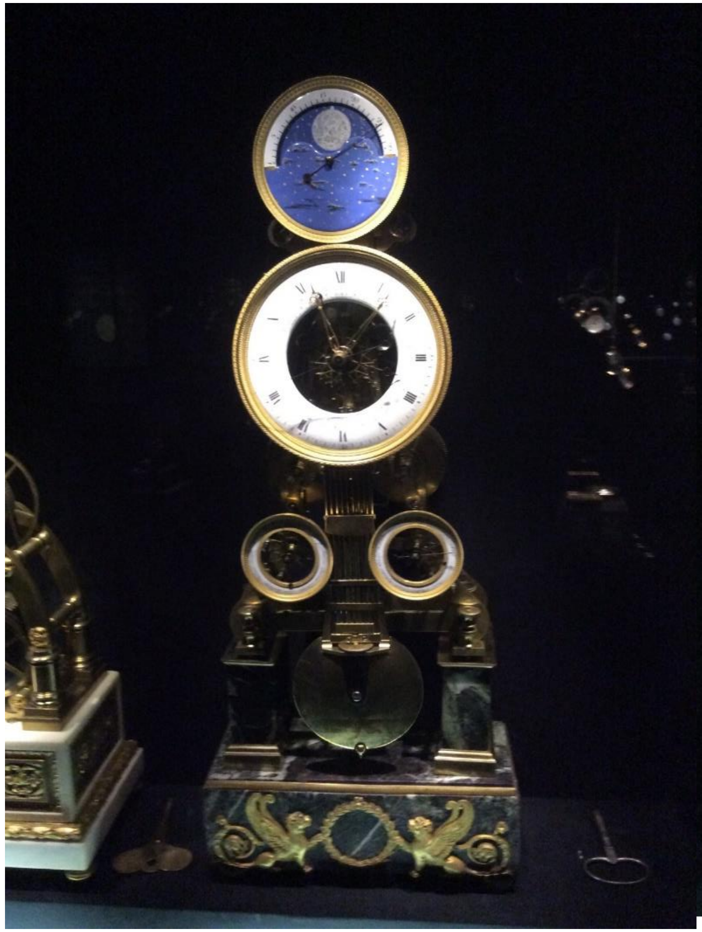
6. שעון מוזיקלי
שווייץ, 1800 בקירוב
7. שעון שולחן עם צלצול מעורר
מצלצל רבעי שעה
8. שעון נייד מצלצל
ג'יימס מאריי, לונדון, 1840 בקירוב



ساعة العربة ملائمة للسف
The carriage clock, intended for

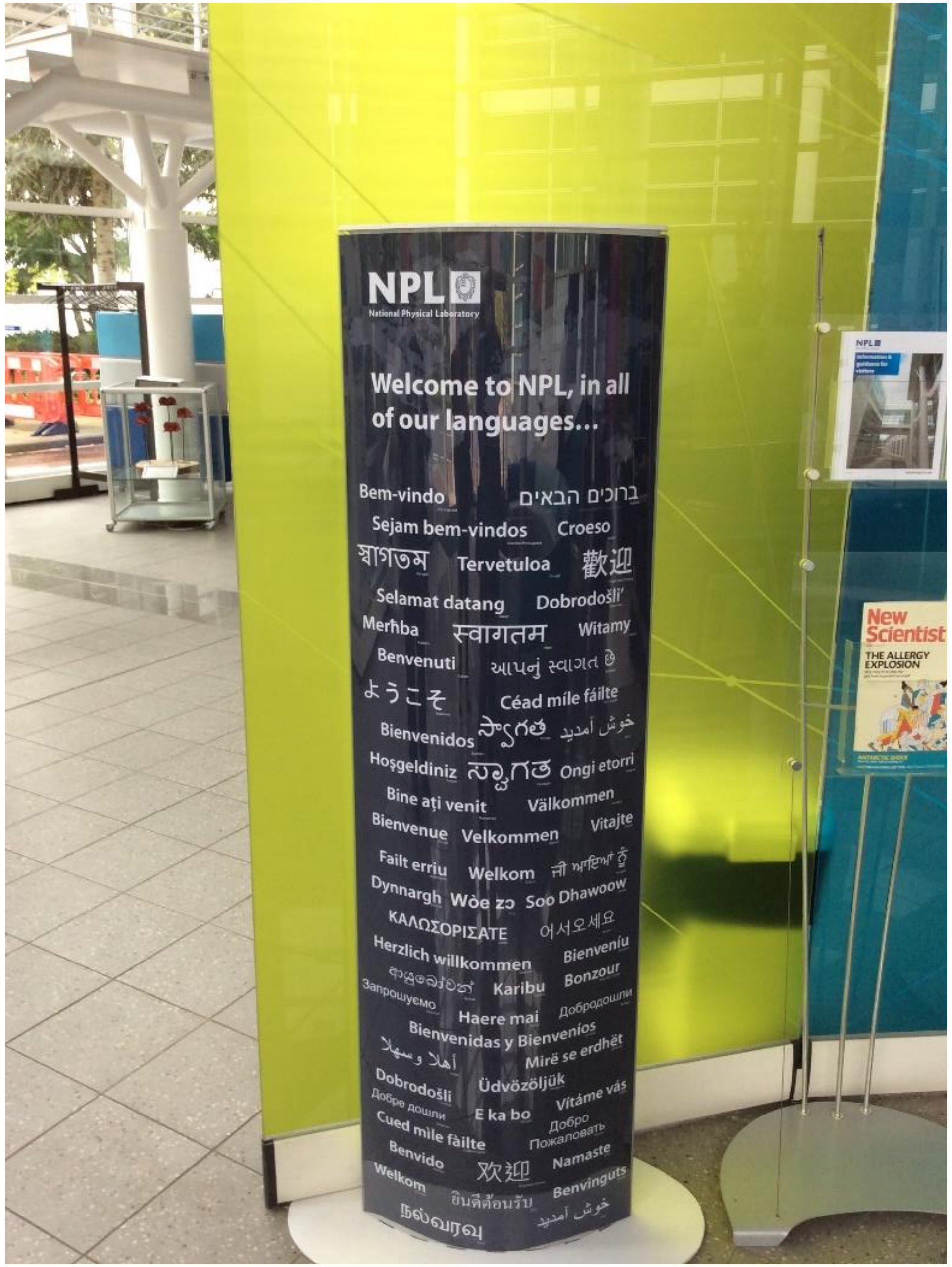



18
17
19

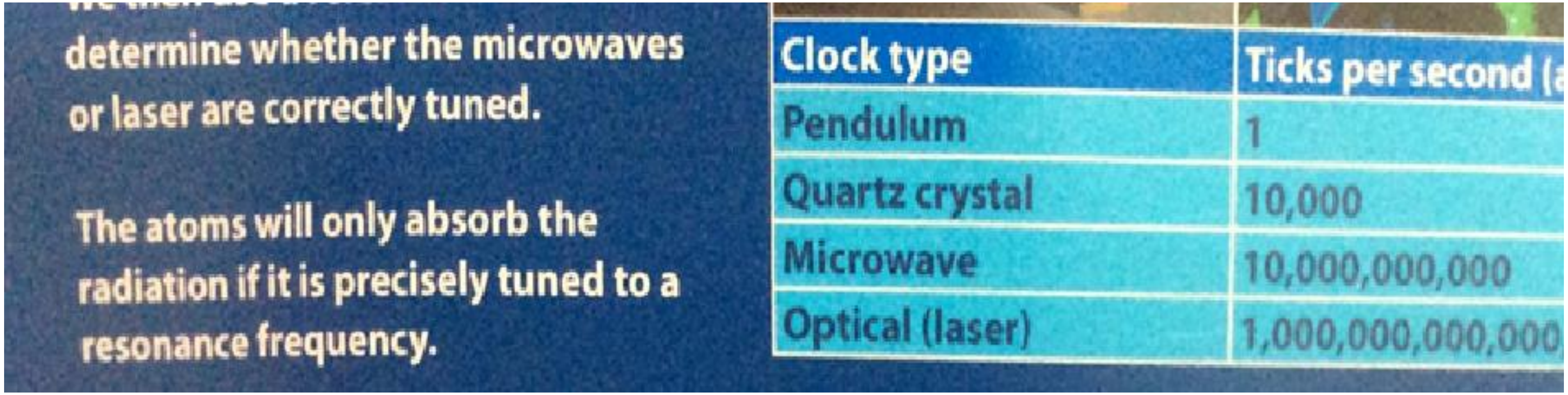



Sympathique clock
Carriage clock by L. Rabi, No. 5,
c. 1812
Gilt metal and silver
Pocket watch by Breguet, No. 722
Gold and silver
4. שעון ה"סימפתיק"
שעון מרכבה, ל' ראבי, מס' 5,
1812 בקירוב
מתכת מוזהבת וכסף
שעון כיס, ברגה, מס' 722
זהב וכסף

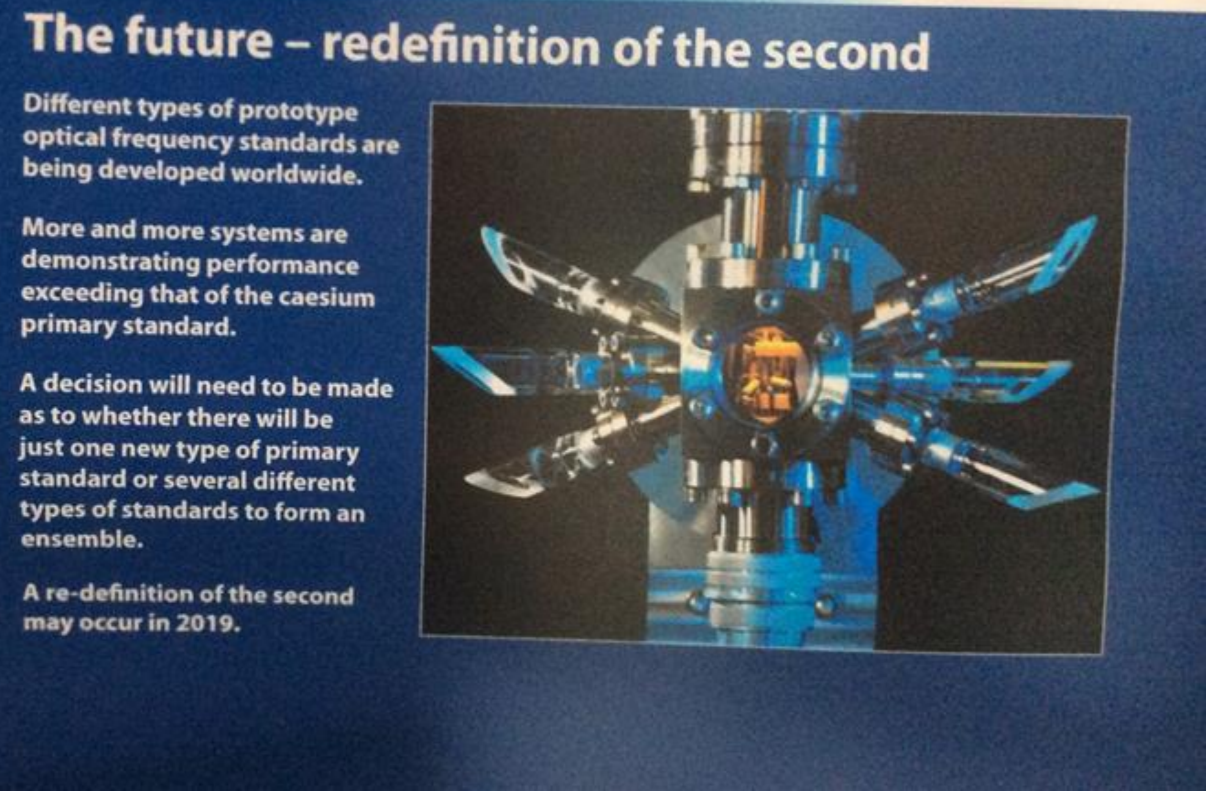
Figures from National Physics Laboratory (NPL)

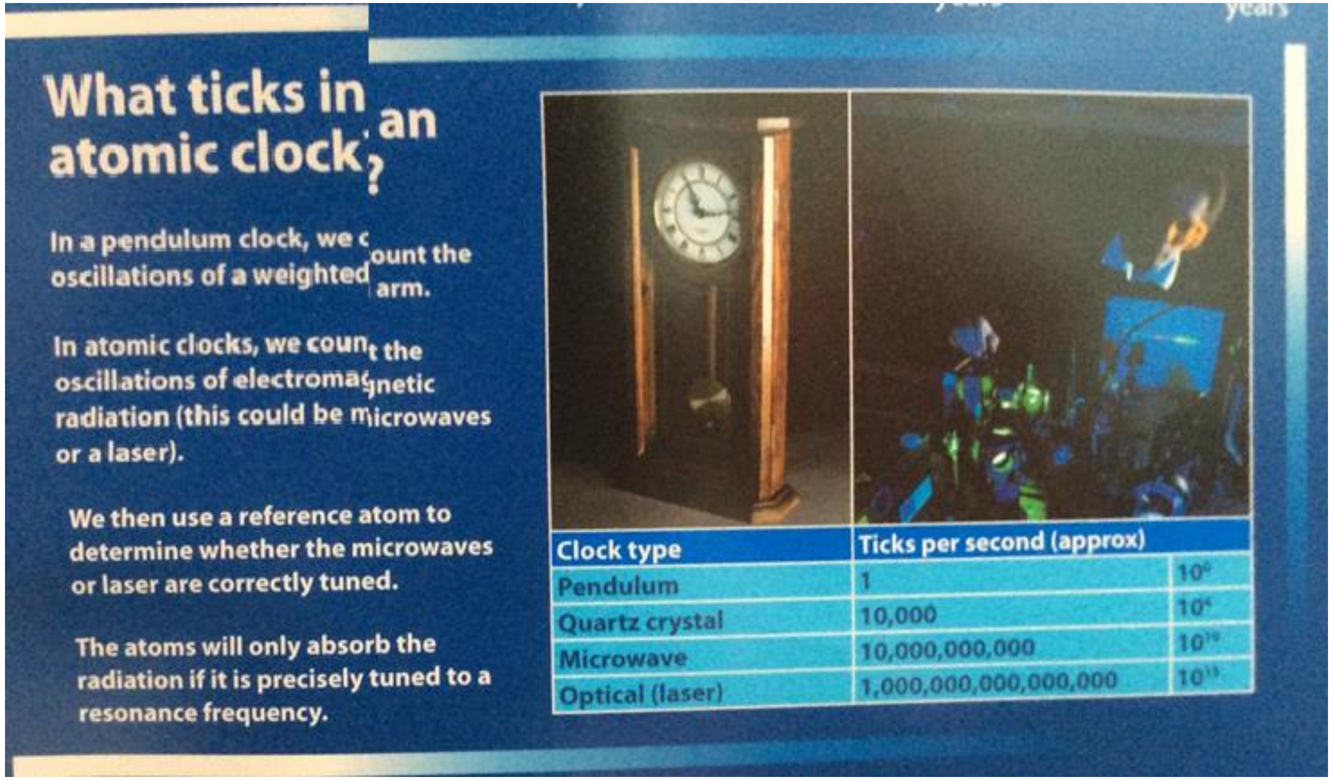

NPL
National Physical Laboratory
Welcome to NPL, in all of our languages...
Bem-vindo
ברוכים הבאים
Sejam bem-vindos
Croeso
Tervetuloa
歡迎
Selamat datang
Dobrodošli
Merħba
स्वागतम्
Witamy
Benvenuti
ようこそ
Céad míle fáilte
Bienvenidos
Hoşgeldiniz
Ongi etorri
Bine ați venit
Välkommen
Bienvenue
Velkommen
Vitajte
Failt erriu
Welkom
Dynnargh
Soo Dhawoow
ΚΑΛΩΣΟΡΙΣΑΤΕ
어서오세요
Herzlich willkommen
Bienveniu
Karibu
Bonzour
Haere mai
Bienvenidas y Bienvenidos
Mirë se erdhët
Dobrodošli
Üdvözöljük
Vítáme vás
E ka bo
Cued mile fàilte
Benvido
欢迎
Namaste
Welkom
Benvinguts
New Scientist
THE ALLERGY EXPLOSION


NPL
National Physical Laboratory


determine whether the microwaves or laser are correctly tuned.
The atoms will only absorb the radiation if it is precisely tuned to a resonance frequency.
Clock type
Ticks per second (a
Pendulum
1
Quartz crystal
10,000
Microwave
10,000,000,000
Optical (laser)
1,000,000,000,000


NPL
National Physical Laboratory
QMI
Quantum Metrology Institute
The future of time
Steven King
1994
1967
2019
What ticks in an atomic clock?
How do we tell the time?


The future – redefinition of the second
Different types of prototype optical frequency standards are being developed worldwide.
More and more systems are demonstrating performance exceeding that of the caesium primary standard.
A decision will need to be made as to whether there will be just one new type of primary standard or several different types of standards to form an ensemble.
A re-definition of the second may occur in 2019.

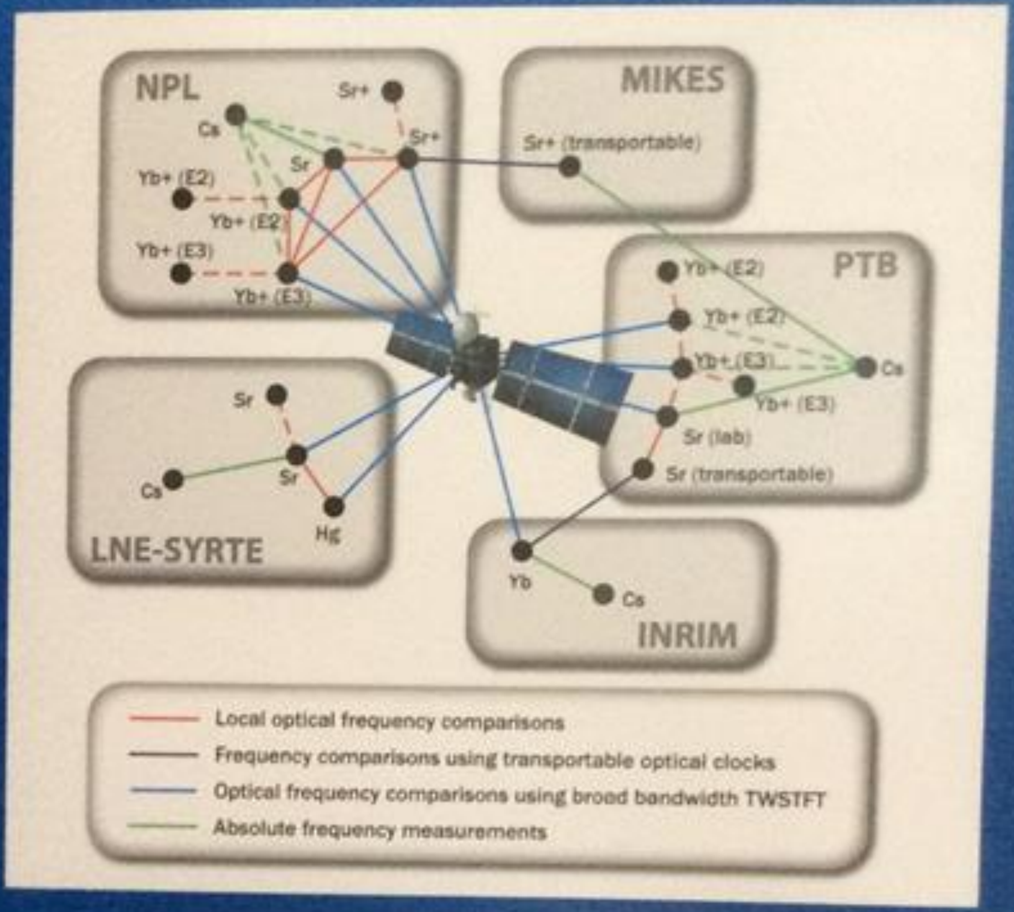

What ticks in an atomic clock?
In a pendulum clock, we count the oscillations of a weighted arm.
In atomic clocks, we count the oscillations of electromagnetic radiation (this could be microwaves or a laser).
We then use a reference atom to determine whether the microwaves or laser are correctly tuned.
The atoms will only absorb the radiation if it is precisely tuned to a resonance frequency.
Clock type | Ticks per second (approx)
Pendulum | 1 | 10^0
Quartz crystal | 10,000 | 10^4
Microwave | 10,000,000,000 | 10^{10}
Optical (laser) | 1,000,000,000,000,000 | 10^{15}

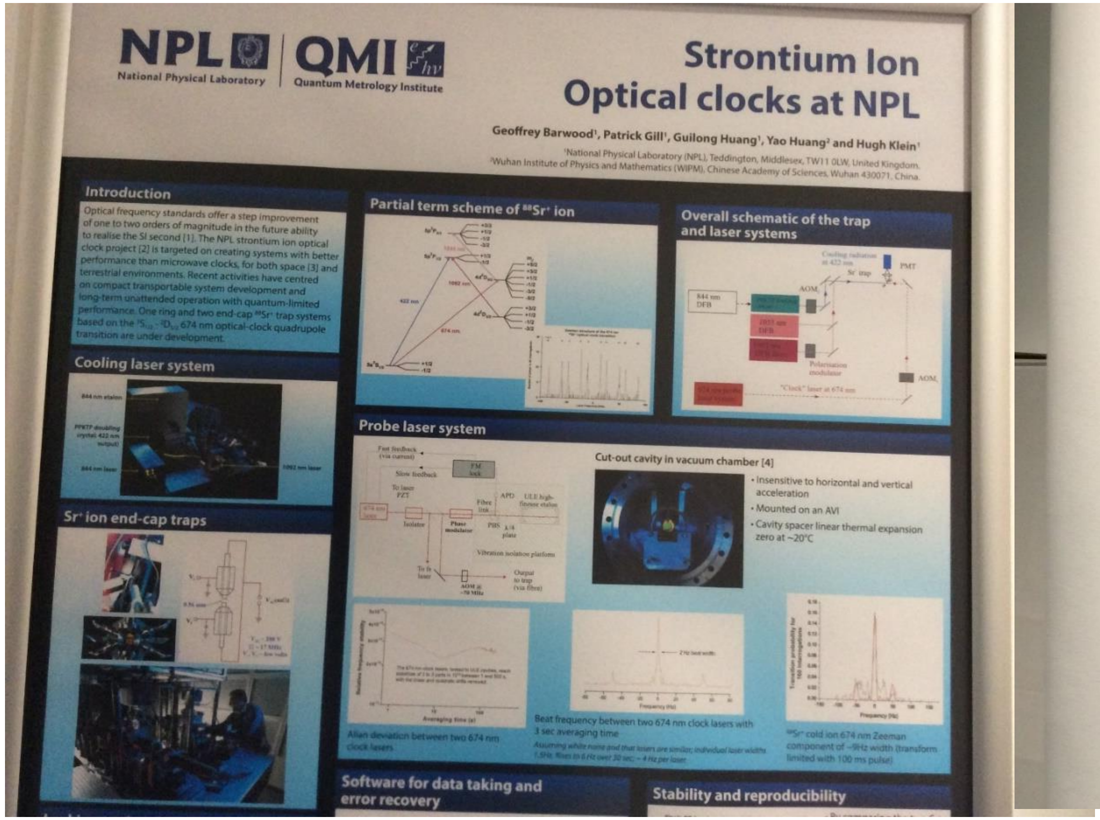
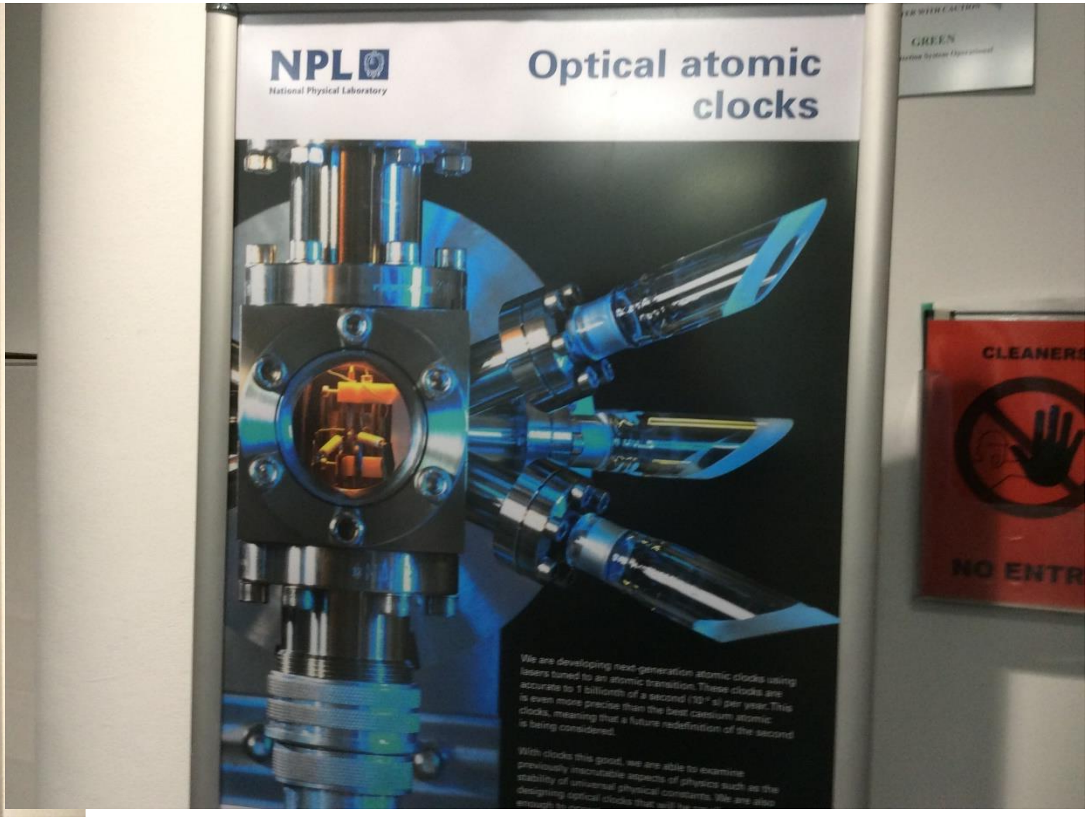
How do we tell the time?

Great care is taken to ensure that perturbing effects such as electric and magnetic fields and gravity are well calibrated and corrected for.

By continually averaging our data, we reduce the statistical noise and improve our measurement precision to match our accuracy.

Finally, this derived "unperturbed" frequency is compared with others in order to generate a timescale.

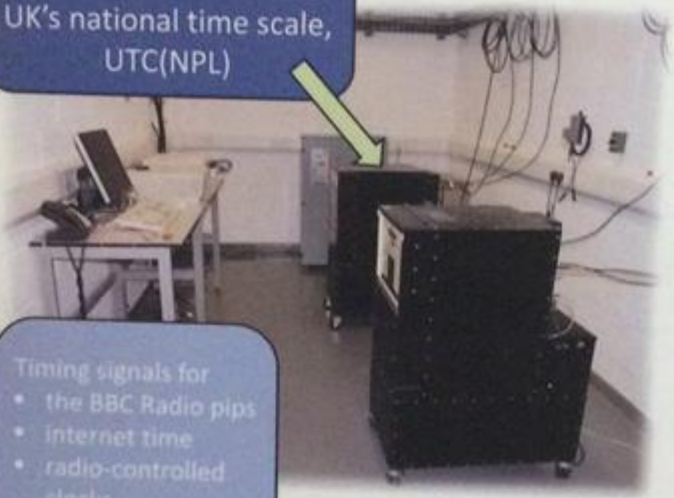



NPL
National Physical Laboratory
QMI
Quantum Metrology Institute
Strontium Ion Optical clocks at NPL
Geoffrey Barwood[1], Patrick Gill[1], Guilong Huang[1], Yao Huang[2] and Hugh Klein[1]
[1]National Physical Laboratory (NPL), Teddington, Middlesex, TW11 0LW, United Kingdom.
[2]Wuhan Institute of Physics and Mathematics (WIPM), Chinese Academy of Sciences, Wuhan 430071, China.
Introduction
Optical frequency standards offer a step improvement of one to two orders of magnitude in the future ability to realise the SI second [1]. The NPL strontium ion optical clock project [2] is targeted on creating systems with better performance than microwave clocks, for both space [3] and terrestrial environments. Recent activities have centred on compact transportable system development and long-term unattended operation with quantum-limited performance. One ring and two end-cap $^{88}Sr^+$ trap systems based on the $^2S_{1/2}$ - $^2D_{5/2}$ 674 nm optical-clock quadrupole transition are under development.
Partial term scheme of $^{88}Sr^+$ ion
Overall schematic of the trap and laser systems
Cooling laser system
Probe laser system
Cut-out cavity in vacuum chamber [4]
• Insensitive to horizontal and vertical acceleration
• Mounted on an AVI
• Cavity spacer linear thermal expansion zero at ~20°C
Sr+ ion end-cap traps
Allan deviation between two 674 nm clock lasers
Beat frequency between two 674 nm clock lasers with 3 sec averaging time
$^{88}Sr^+$ cold ion 674 nm Zeeman component of ~9Hz width (transform limited with 100 ms pulse)
Software for data taking and error recovery
Stability and reproducibility

NPL
National Physical Laboratory
Optical atomic clocks
CLEANERS
NO ENTR

Hydrogen Maser Clocks

NPL

This maser is the reference clock for the UK's national time scale, UTC(NPL)



Timing signals for
- the BBC Radio pips
- internet time
- radio-controlled clocks

all come from here

This room houses two of the four hydrogen masers at NPL. A hydrogen maser is a commercially manufactured clock that can run continuously for many years and produces a highly stable output signal that oscillates at 10 MHz (10 million cycles per second). The oscillations can be counted electronically to keep track of time.

Applications

Optical clock evaluation—redefinition of the SI Second

Test the reproducibility of prospective optical primary standards.

Clock-based geodesy—gravitational red-shift

Measure height differences at the cm level by comparing optical clocks through fibre links.

Fundamental physics—Test of Special Relativity

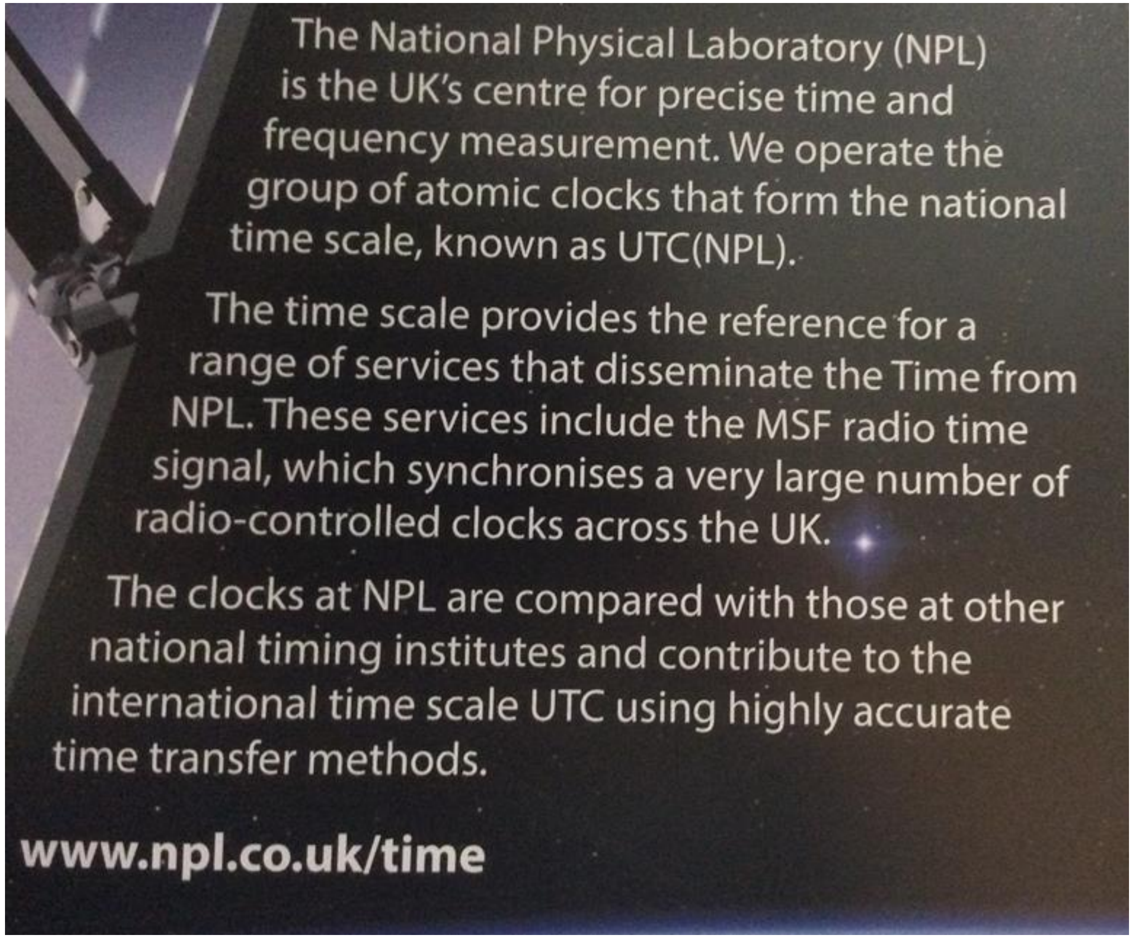
Analyse clocks for daily variations that might result from their different positions on the surface of the earth at it rotates. *P. Delva et al., arXiv:1703.04426*

Atomic Clock Ensemble in Space (ACES) support

Characterise MicroWave Link (MWL) and European Laser Timing (ELT) optical link by simultaneously comparing clocks over fibre.

Backbone for a future European optical clock network

Enable ultra-precise, SI traceable time and frequency dissemination to scientific customers—e.g. precision molecular spectroscopy.



The National Physical Laboratory (NPL) is the UK's centre for precise time and frequency measurement. We operate the group of atomic clocks that form the national time scale, known as UTC(NPL).
The time scale provides the reference for a range of services that disseminate the Time from NPL. These services include the MSF radio time signal, which synchronises a very large number of radio-controlled clocks across the UK.
The clocks at NPL are compared with those at other national timing institutes and contribute to the international time scale UTC using highly accurate time transfer methods.
www.npl.co.uk/time


The Time From NPL
12:44:11.38
BST (UTC+1)


NPL
National Physical Laboratory
QMI
Quantum Metrology Institute
Timescales


Time for the UK
The National Physical Laboratory (NPL) is the UK's centre for precise time and frequency measurement. We operate the national time scale, known as UTC(NPL), based on our ensemble of atomic clocks.
The UTC(NPL) time scale is disseminated across the UK by a range of services including:
• The MSF radio time signal;
• The NPL internet time service;
• The NPL*Time*® service, providing time over optical fibre to the finance sector.

Modelling of relativistic effects for comparisons between atomic clocks

Abinash Poudel and Setnam Shemar

British Museum


Grenville Room


Horizontal table clock, 1525
This clock is engraved in honour of its owner, King Sigismund I of Poland. Around the edge are his arms and an inscription in Latin: 'when you count the years 1525 Jacob Zech made me in Prague – it is true.' This clock contains the earliest surviving fusee, a device to even out the unequal force produced by the mainspring
Position of sun in heavens
Hours 1-24
Degrees of zodiac
Zodiac circle

How does a mechanical clock work?

All mechanical clocks have five elements that enable them to measure time. Despite refinements and variations, every mechanical clock in this gallery works on the same basic principles.

The five elements are clearly demonstrated by the Cassiobury Park clock, and explained in the animation on your right. The clock was made in 1610, but similar clocks were made in Europe from the 1300s onwards. It was installed in the clock-tower at Cassiobury Park, a country house near Watford, Hertfordshire. The top bar of the clock frame bears the scallop-shell mark of the maker Leonard Tennant. The clock strikes the hours on the large bell mounted above.

This animation shows how a mechanical clock works. It lasts 3½ minutes.

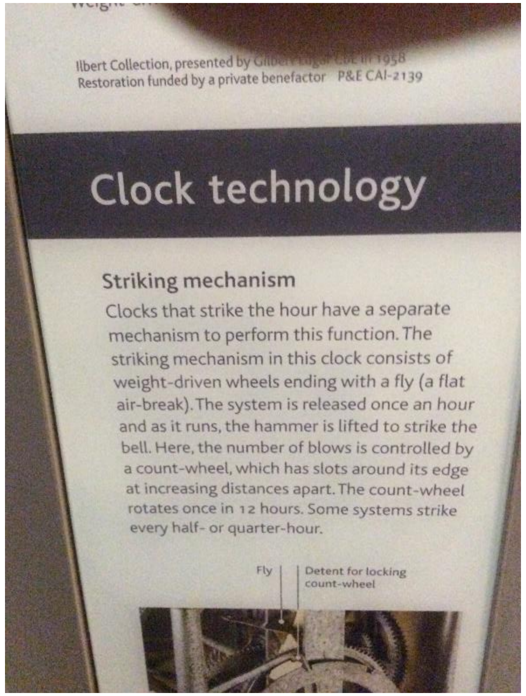
Turret clock

By Leonard Tennant, London
Weight-driven, verge escapement, foliot, hour-striking

Purchased from James Oakes in 1964
1964,2-3,1

Cassiobury Park near Watford, Hertfordshire.
The turret clock was originally installed in the clock tower to the left.

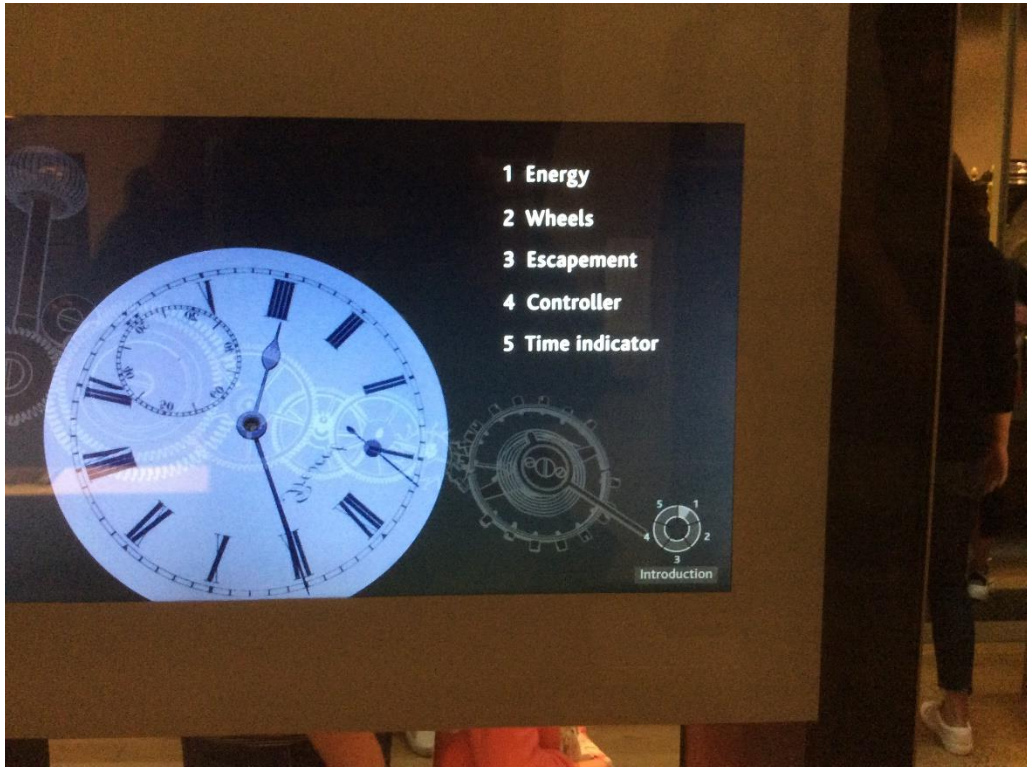
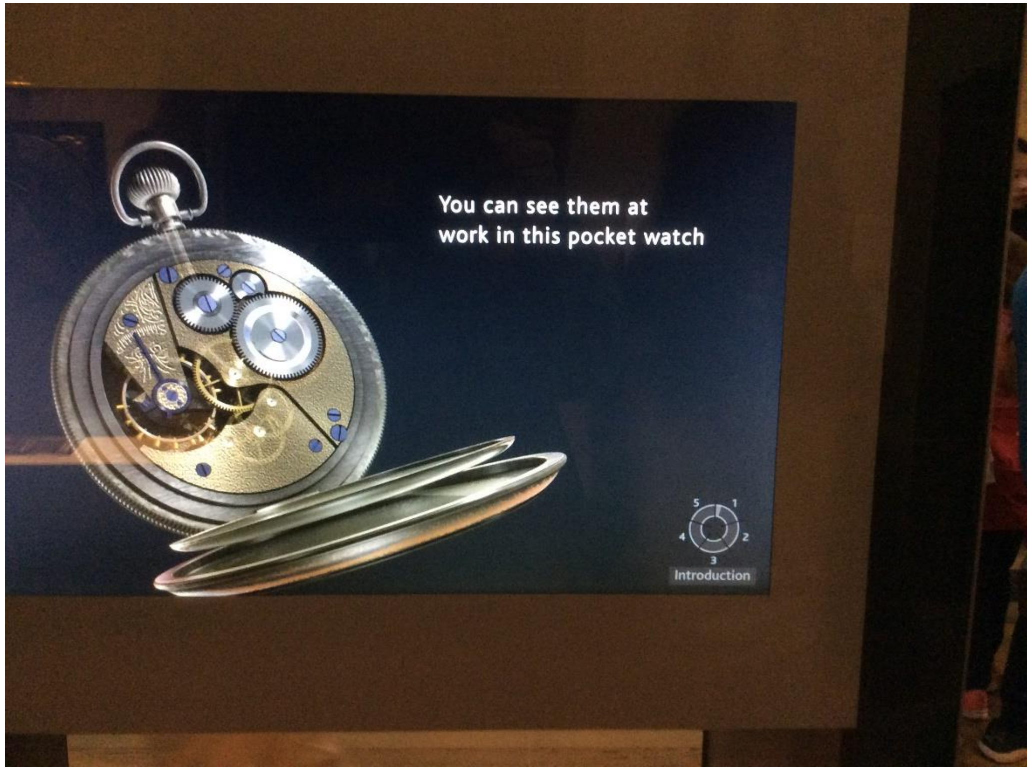
Courtesy of Watford Museum

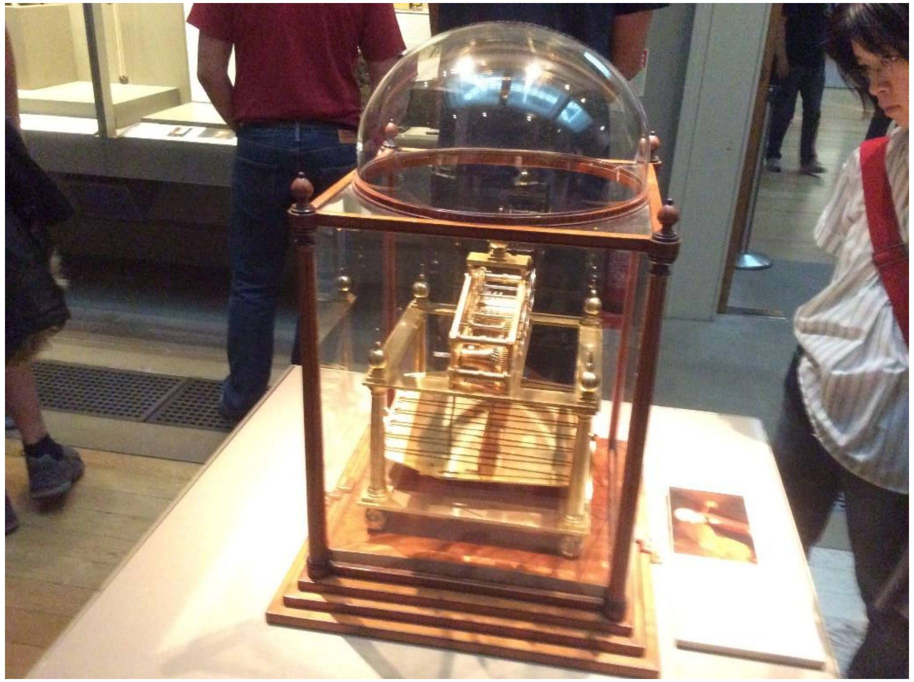


Ilbert Collection, presented by Gilbert Edgar CBE in 1958
Restoration funded by a private benefactor P&E CAI-2139
Clock technology
Striking mechanism
Clocks that strike the hour have a separate mechanism to perform this function. The striking mechanism in this clock consists of weight-driven wheels ending with a fly (a flat air-break). The system is released once an hour and as it runs, the hammer is lifted to strike the bell. Here, the number of blows is controlled by a count-wheel, which has slots around its edge at increasing distances apart. The count-wheel rotates once in 12 hours. Some systems strike every half- or quarter-hour.
Fly
Detent for locking count-wheel


Marine chronometer, 1813
This chronometer never went to sea. It was used for experiments by Breguet, its maker, then given to the Bishop of Cambrai in 1822. The dial shows the hours and minutes (left) and seconds (top centre). An inscription translates: 'The first piece in which the transmission from the train to the regulator occurs without friction. Made in 1813 by Breguet for Mr Belmas friend of the author No. 2741.'
By Abraham Louis Breguet and Son, Paris


MANY lives were lost in shipwrecks before sailors had a reliable method of navigating. In 1714 the English parliament offered £20,000 to whoever could devise a method of establishing longitude (east–west position). This huge prize was finally won by the clockmaker John Harrison. He made a mechanical timekeeper that could keep the time of a known location despite travelling in changing conditions. Navigators could tell how far east or west they had travelled by comparing this with the local time, calculated from the sun.
The chronometer became an essential tool for anyone travelling out of sight of land. It has now been replaced by GPS satellite navigation.
1714–1960s
Timekeeping at sea
Marine chronometers
After John Harrison's pioneering work, other makers competed to improve and simplify marine chronometers. The examples here were made by rivals John Arnold and Thomas Earnshaw. Both claimed to have invented the new spring-detent escapement in the 1780s.

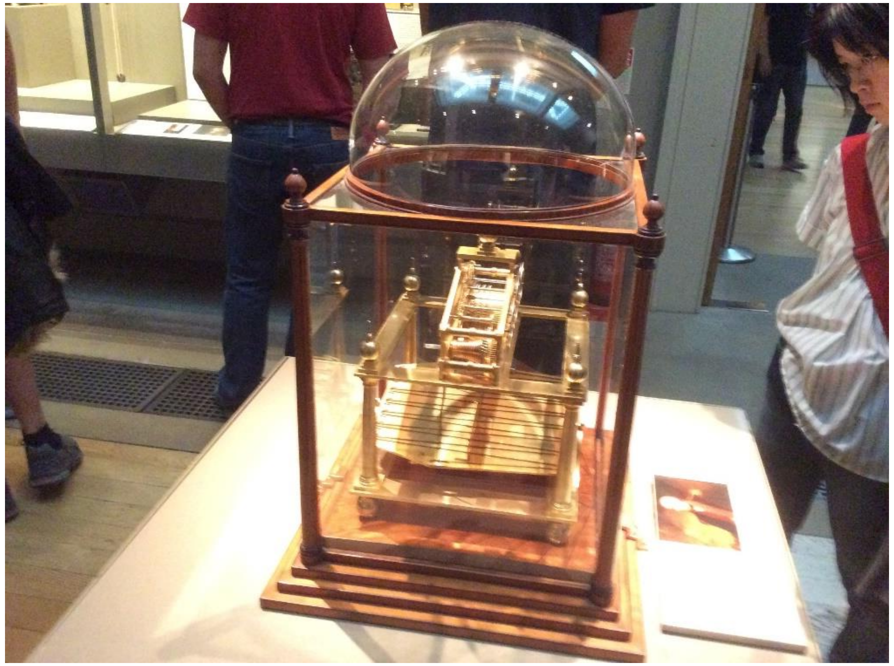


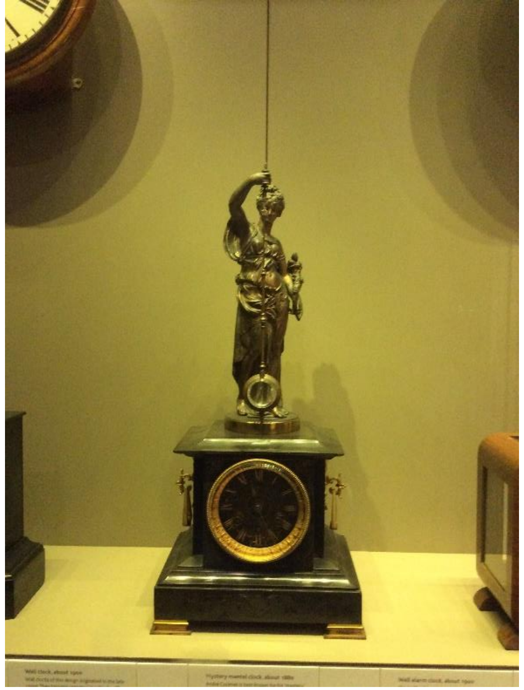


1 Energy
2 Wheels
3 Escapement
4 Controller
5 Time indicator
Introduction

You can see them at
work in this pocket watch
Introduction




1657–1670s
The pendulum changes everything

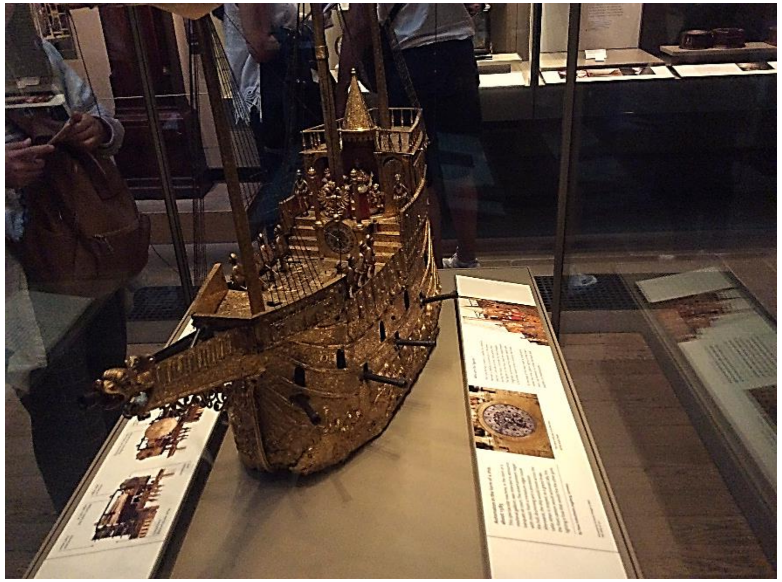

TRADITIONALLY, clocks were handmade in small workshops. But by the mid 1800s a radical change had taken place. Machine manufacture meant that clocks could be mass-produced. Factories were established in the Black Forest area of south Germany, the Jura in eastern France and New England, USA. By 1850, Jerome & Company in the USA were making nearly half a million clocks a year. A typical shelf clock could be made for under $2 and sold for as little as $20.
In England, old production methods continued and the expensive clocks could not compete with much cheaper imports. Clocks were now available to large sections of the population who could not have afforded them before.
1850–1950
Clocks for everyone
Shelf clock, about 1850

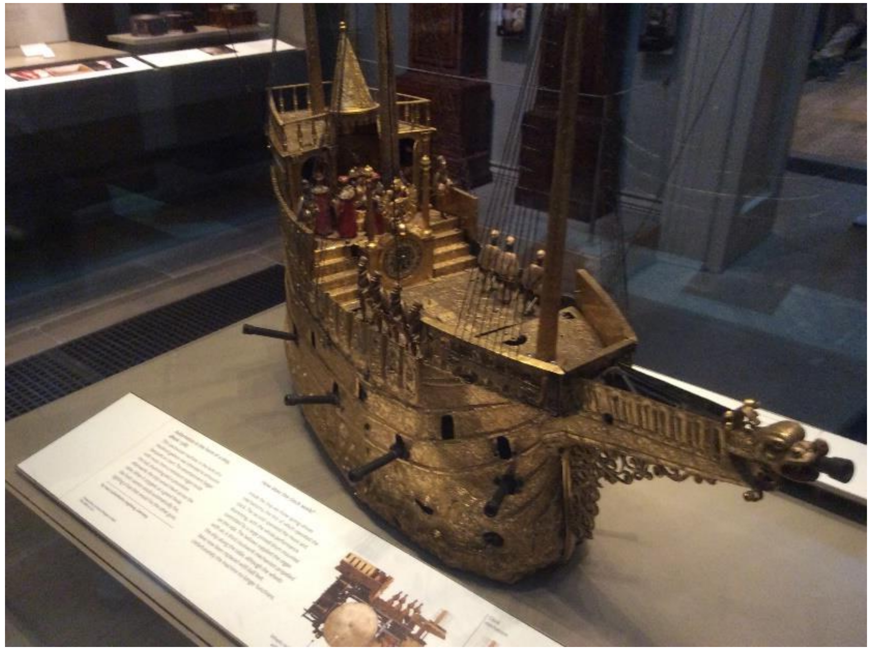


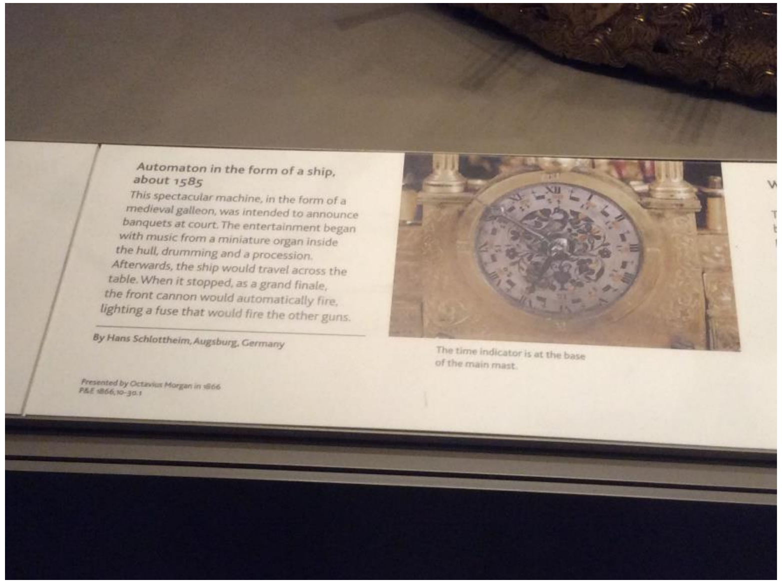



1850–1950
Clocks for everyone
Shelf clock, about 1850


Radio alarm clock, 2008
'Atmos' mantel clock, about 1955
'Atmos' clocks were introduced in 1928 by
J.L. Reutter. This one is powered by a sensitive
gas-thermometer. Metallic bellows contain
ethyl-chloride, which expands and contracts
in changing temperatures. The movement of
the bellows is used to create a winding action.
Only a small movement is needed to keep






Automaton in the form of a ship, about 1585
This spectacular machine, in the form of a medieval galleon, was intended to announce banquets at court. The entertainment began with music from a miniature organ inside the hull, drumming and a procession. Afterwards, the ship would travel across the table. When it stopped, as a grand finale, the front cannon would automatically fire, lighting a fuse that would fire the other guns.
By Hans Schlottheim, Augsburg, Germany
Presented by Octavius Morgan in 1866
P&E 1866,10-30.1
The time indicator is at the base of the main mast.

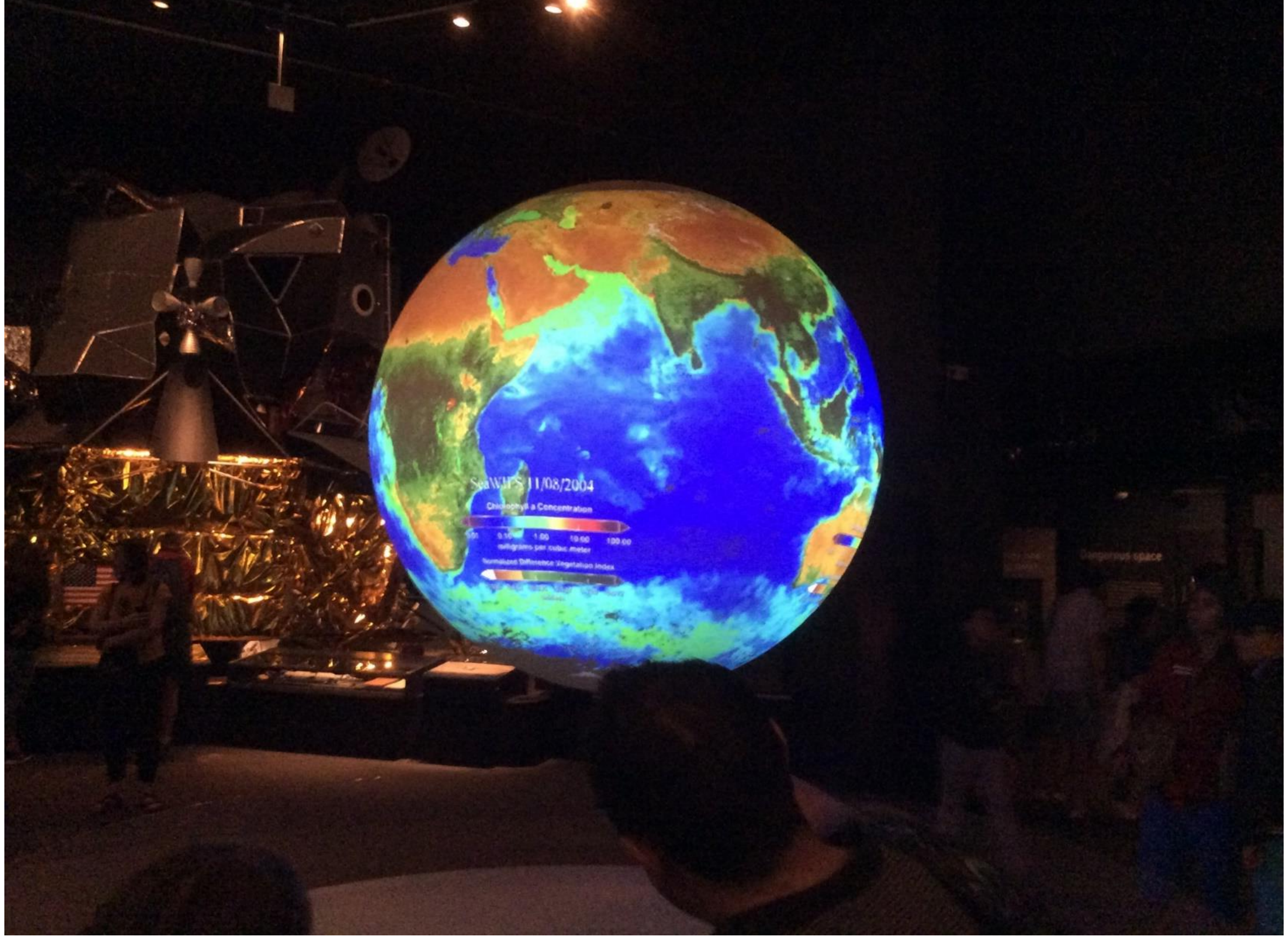
Musical, automaton table clock

Lord Macartney's British Embassy to China from 1792 to 1794 was set up to improve trading conditions. Britain wanted China to open up a greater number of ports for direct trade and to allow a permanent embassy in Beijing. Macartney presented gifts from King George III (ruled 1760–1820) to the Qianlong emperor (ruled 1736–95), comprising the finest scientific equipment and manufactured goods. In exchange, they were given silk and luxury goods. Although the diplomatic encounter was unsuccessful, the Qing court admired the foreign automaton clocks.

This one incorporates a model fountain with spirally rotating glass columns and eight cavorting dolphins, which would have appealed to the emperor, who commissioned European architects to build formal fountains at his Summer Palace.

1780–90, made in London, 1958,1006.1959, donated by G. Edgar

Science Museum


SeaWiFS 11/08/2004
1.00
10.00
100.00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ARSENAL
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Accessible toilet
PRETTYLITTLETHING
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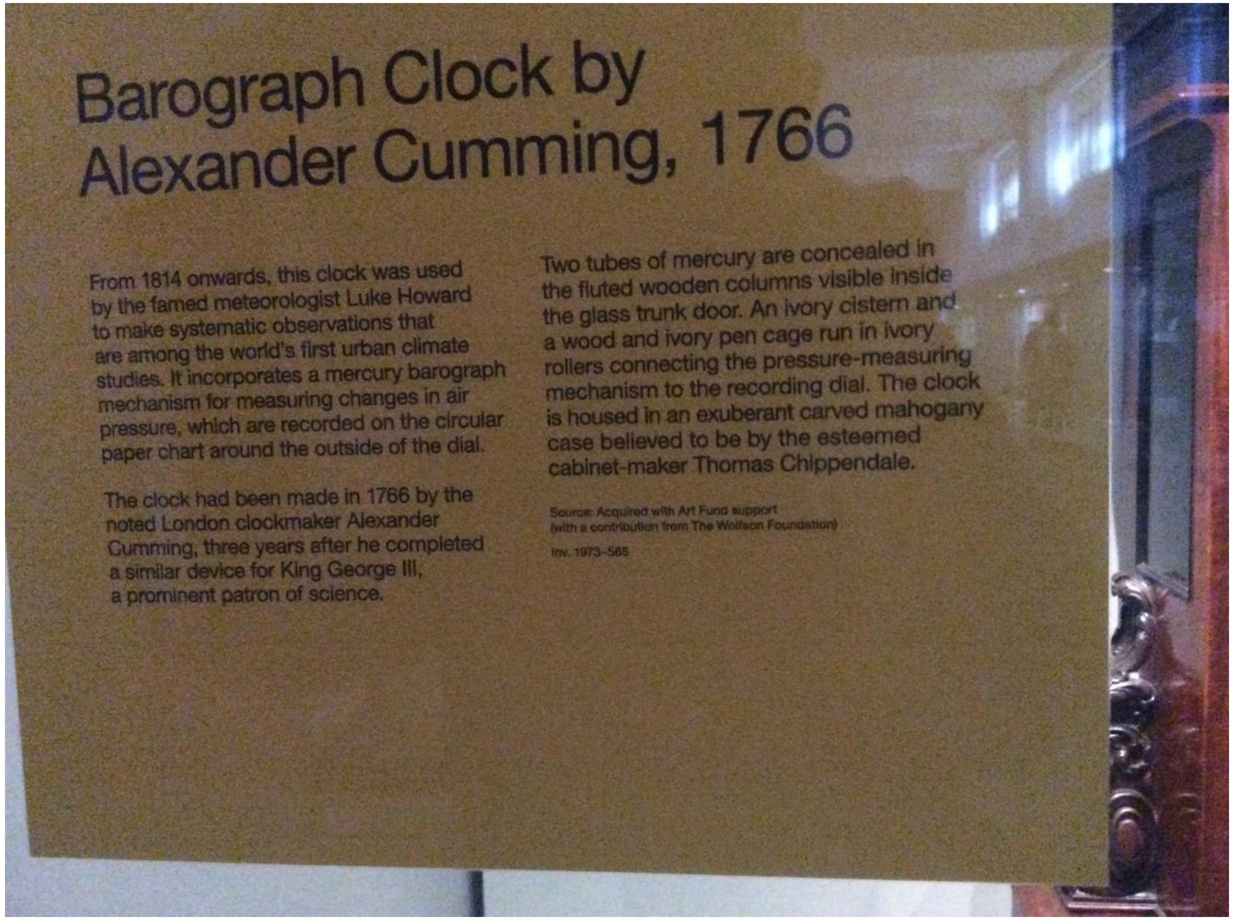
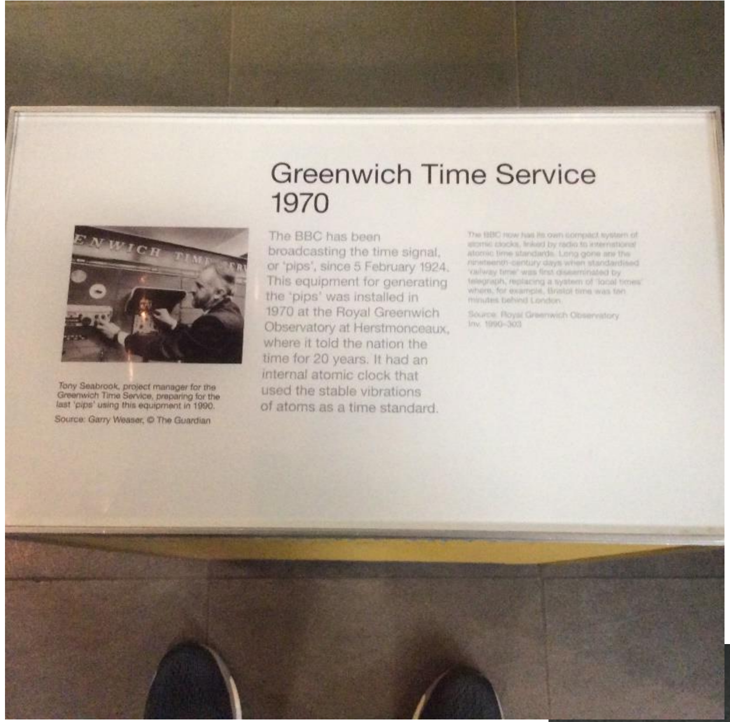
sushi & bento
CHANGE
SUMMER SALAD


Barograph Clock by
Alexander Cumming, 1766


Barograph Clock by
Alexander Cumming, 1766
From 1814 onwards, this clock was used by the famed meteorologist Luke Howard to make systematic observations that are among the world's first urban climate studies. It incorporates a mercury barograph mechanism for measuring changes in air pressure, which are recorded on the circular paper chart around the outside of the dial.
The clock had been made in 1766 by the noted London clockmaker Alexander Cumming, three years after he completed a similar device for King George III, a prominent patron of science.
Two tubes of mercury are concealed in the fluted wooden columns visible inside the glass trunk door. An ivory cistern and a wood and ivory pen cage run in ivory rollers connecting the pressure-measuring mechanism to the recording dial. The clock is housed in an exuberant carved mahogany case believed to be by the esteemed cabinet-maker Thomas Chippendale.
Source: Acquired with Art Fund support
(with a contribution from The Wolfson Foundation)
Inv. 1973–565


40. Universal sundial by George Adams, late eighteenth century
44. Watch with cylinder escapement by John Holmes, late eighteenth century


Manufactures
XXVI. Decoration Furniture and Upholstery, including Paper-hangings, Papier-mache, and Japanned Goods
138. Carved wooden saint
139. Wooden chair
138
140
Manufactures
XXVII. Manufactures in Mineral Substances, for building or decorations
121. Brick
122. Telegraph insulators
123. Malting tile
126
125
Machinery


Greenwich Time Service 1970
The BBC has been broadcasting the time signal, or 'pips', since 5 February 1924. This equipment for generating the 'pips' was installed in 1970 at the Royal Greenwich Observatory at Herstmonceaux, where it told the nation the time for 20 years. It had an internal atomic clock that used the stable vibrations of atoms as a time standard.
Tony Seabrook, project manager for the Greenwich Time Service, preparing for the last 'pips' using this equipment in 1990.
Source: Garry Weaser, © The Guardian


Manufactures
XXVI. Decoration Furniture and Upholstery, including Paper-hangings, Papier-mache, and Japanned Goods
138. Carved wooden saint
139. Wooden chair
This was used in the offices of the London & Birmingham Railway Company.
140
Machinery
X.b. Horological Instruments
140. Clock from Tyler's pharmacy
Machinery
X.b. Horological Instruments

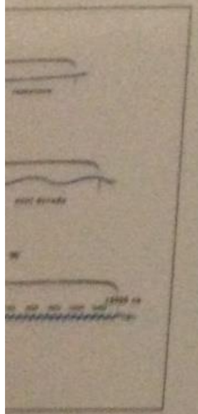

First Prototype of the Clock
of the Long Now, 1999
A new view
of time


GREENWICH TIME SERVICE

Now, 1999

Brand, who championed sustainable living in the 1960s, hopes that the clock will 'do for thinking about time what the photographs of the Earth from space have done for thinking about the environment'. In 1986, computing pioneer Danny Hillis launched this prototype mechanism of a vast and well-engineered mechanical clock to act as a focus for long-term responsibility.

of the Long Now, 19



nce the
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clock,
it, that
ime

'Civilisation has revved itself into a pathologically short attention span ... and some sort of balancing corrective to shortsightedness is needed – some mechanism or myth which encourages the long view.' With this statement, Stewart Brand reveals the thinking behind a project to build a clock which will keep time for 10,000 years – a period the artist and musician Brian Eno called 'the Long Now'.

Brand, who champio
in the 1960s, hopes
thinking about time
the Earth from spac
about the environm
pioneer Danny Hillis
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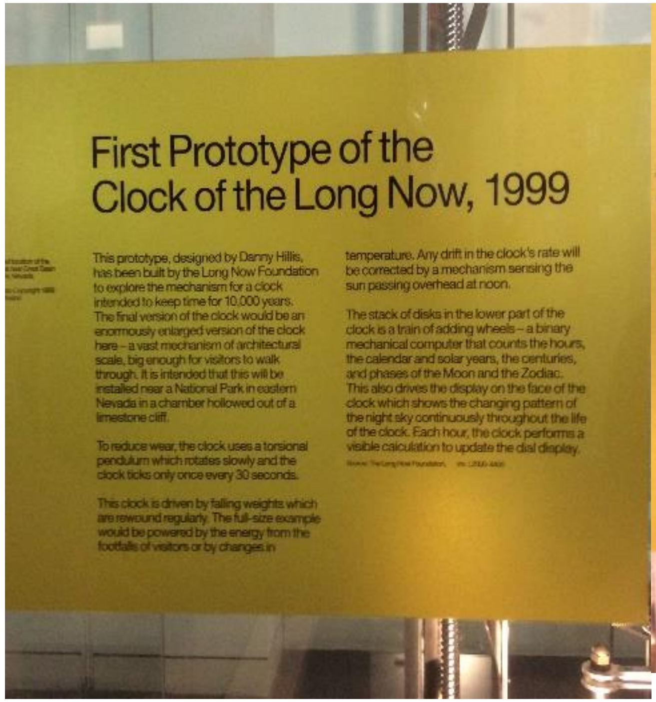
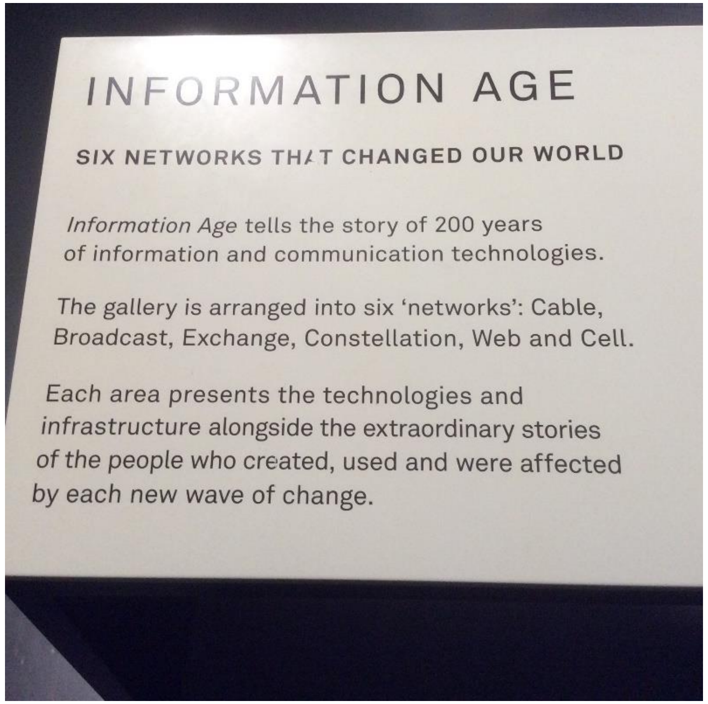
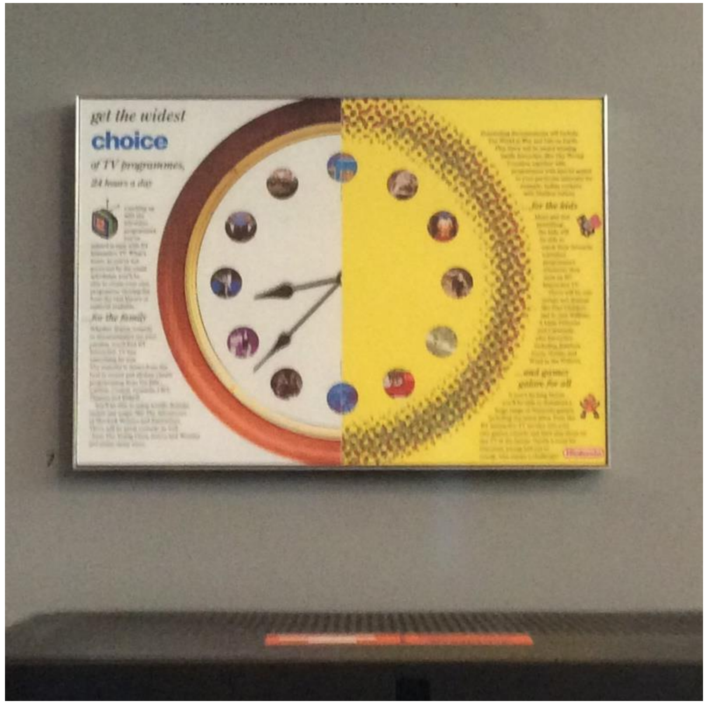
term responsibility.

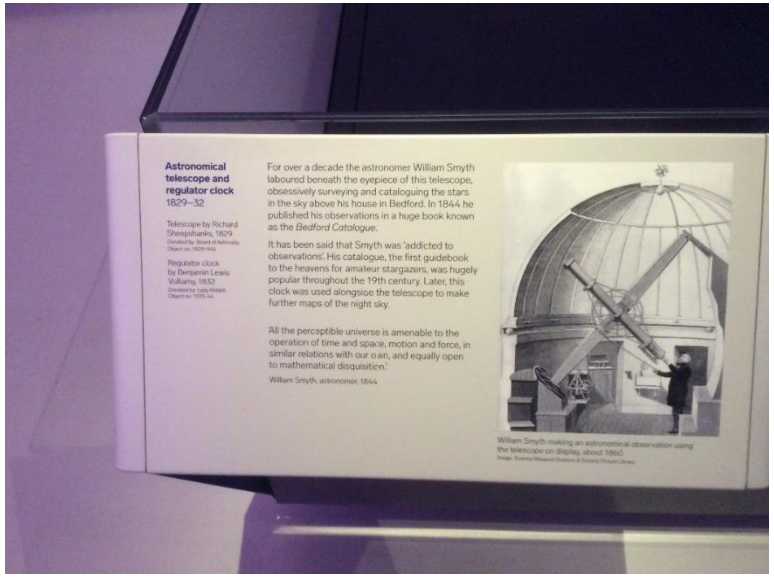

First Prototype of the
Clock of the Long Now, 1999
This prototype, designed by Danny Hillis, has been built by the Long Now Foundation to explore the mechanism for a clock intended to keep time for 10,000 years. The final version of the clock would be an enormously enlarged version of the clock here – a vast mechanism of architectural scale, big enough for visitors to walk through. It is intended that this will be installed near a National Park in eastern Nevada in a chamber hollowed out of a limestone cliff.
To reduce wear, the clock uses a torsional pendulum which rotates slowly and the clock ticks only once every 30 seconds.
This clock is driven by falling weights which are rewound regularly. The full-size example would be powered by the energy from the footfalls of visitors or by changes in temperature. Any drift in the clock's rate will be corrected by a mechanism sensing the sun passing overhead at noon.
The stack of disks in the lower part of the clock is a train of adding wheels – a binary mechanical computer that counts the hours, the calendar and solar years, the centuries, and phases of the Moon and the Zodiac. This also drives the display on the face of the clock which shows the changing pattern of the night sky continuously throughout the life of the clock. Each hour, the clock performs a visible calculation to update the dial display.

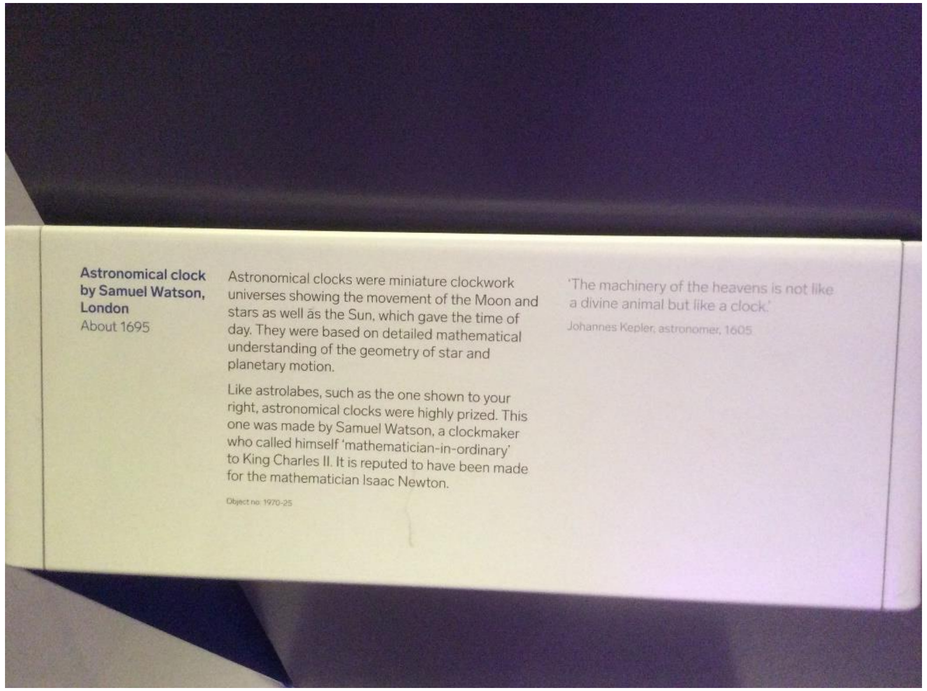

INFORMATION AGE


INFORMATION AGE
SIX NETWORKS THAT CHANGED OUR WORLD
Information Age tells the story of 200 years of information and communication technologies.
The gallery is arranged into six 'networks': Cable, Broadcast, Exchange, Constellation, Web and Cell.
Each area presents the technologies and infrastructure alongside the extraordinary stories of the people who created, used and were affected by each new wave of change.

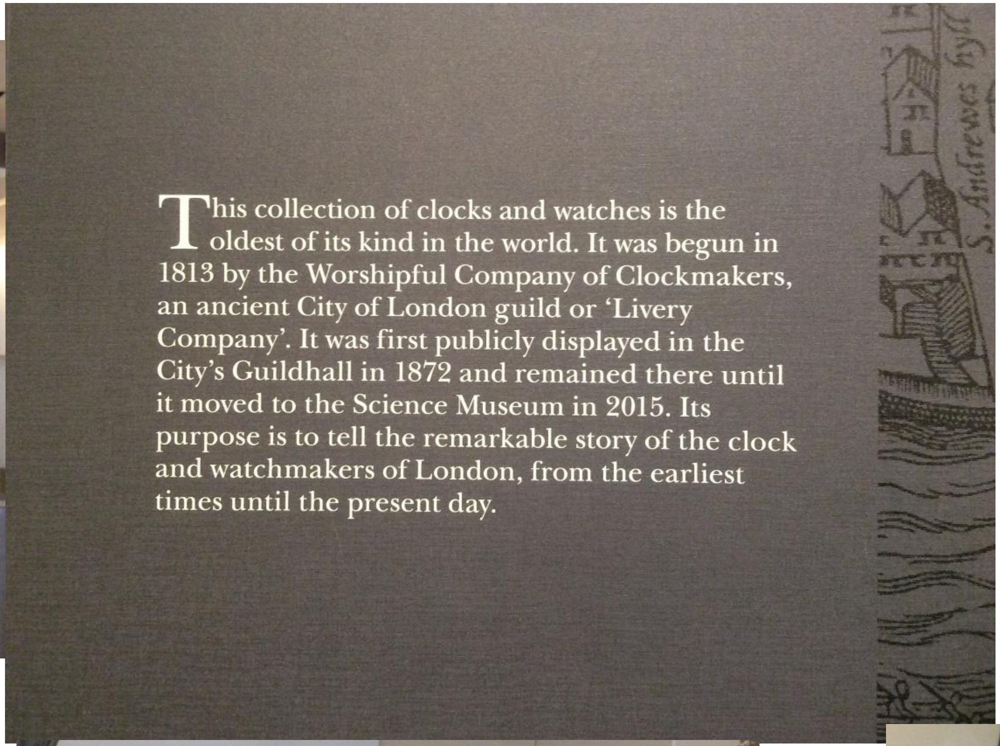

get the widest
choice
of TV programmes,
24 hours a day


Calculating machine
About 1939
This office calculating machine was used at the Scientific Computing Service (SCS) from about 1939 to 1965. The SCS, founded in 1937, employed mathematically trained women using machines such as this to solve a wide range of practical mathematical problems.
The company acted like a human version of modern general-purpose computers. Complicated problems were broken down into many smaller calculations, each carried out by different employees. This meant that solutions could be found more quickly than if only one person worked on the problem.
'During the early part of the war, map projections and military grids involving tremendous and exact calculations were needed as quickly as we could produce them. Those office machines enabled us to do the work in very quick time.'
Leslie Comrie, founder of the SCS, 1942
Beryl Waters, SCS mathematician, studying drawings of a calculating machine, 1942.


Astronomical telescope and regulator clock
1829–32
Telescope by Richard Sheepshanks, 1829
Regulator clock by Benjamin Lewis Vulliamy, 1832
For over a decade the astronomer William Smyth laboured beneath the eyepiece of this telescope, obsessively surveying and cataloguing the stars in the sky above his house in Bedford. In 1844 he published his observations in a huge book known as the *Bedford Catalogue*.
It has been said that Smyth was 'addicted to observations'. His catalogue, the first guidebook to the heavens for amateur stargazers, was hugely popular throughout the 19th century. Later, this clock was used alongside the telescope to make further maps of the night sky.
'All the perceptible universe is amenable to the operation of time and space, motion and force, in similar relations with our own, and equally open to mathematical disquisition.'
William Smyth, astronomer, 1844
William Smyth making an astronomical observation using the telescope on display, about 1860.


Astronomical clock by Samuel Watson, London
About 1695
Astronomical clocks were miniature clockwork universes showing the movement of the Moon and stars as well as the Sun, which gave the time of day. They were based on detailed mathematical understanding of the geometry of star and planetary motion.
Like astrolabes, such as the one shown to your right, astronomical clocks were highly prized. This one was made by Samuel Watson, a clockmaker who called himself 'mathematician-in-ordinary' to King Charles II. It is reputed to have been made for the mathematician Isaac Newton.
Object no: 1970-25
'The machinery of the heavens is not like a divine animal but like a clock.'
Johannes Kepler, astronomer, 1605

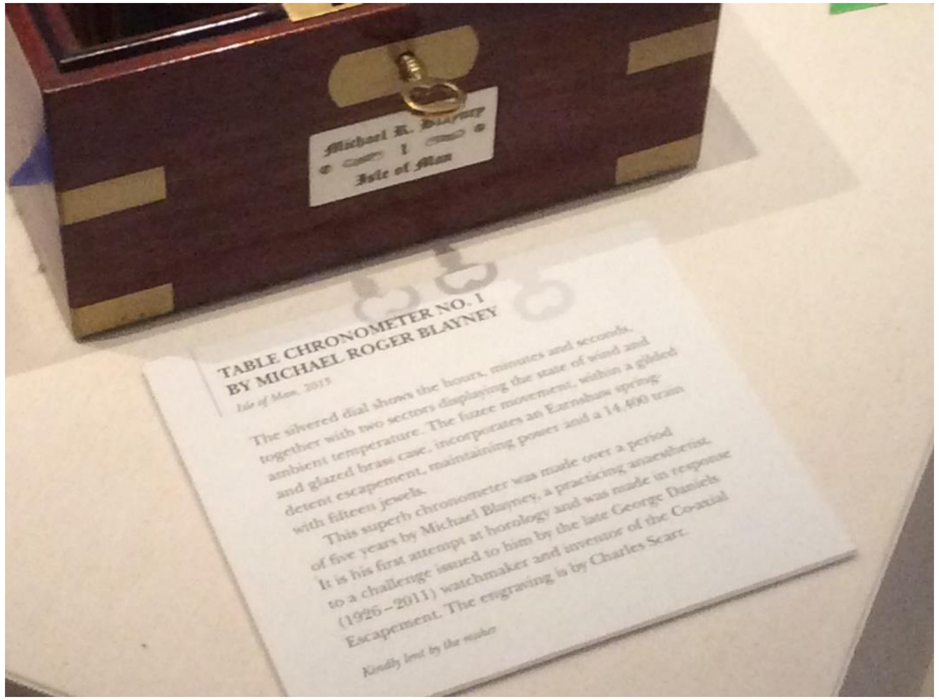

Dr GEORGE DANIELS, CBE, FBHI 1926-2011

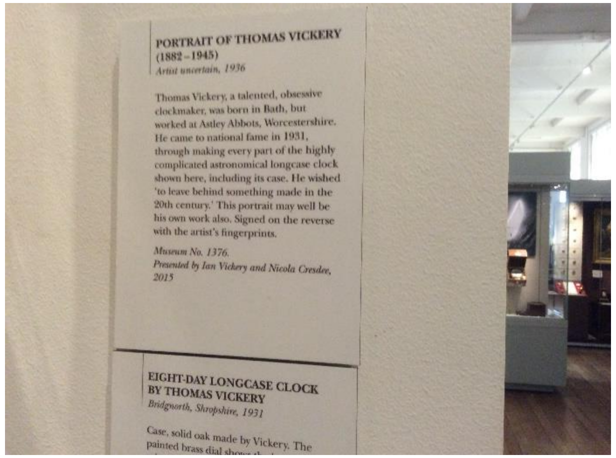

This collection of clocks and watches is the oldest of its kind in the world. It was begun in 1813 by the Worshipful Company of Clockmakers, an ancient City of London guild or 'Livery Company'. It was first publicly displayed in the City's Guildhall in 1872 and remained there until it moved to the Science Museum in 2015. Its purpose is to tell the remarkable story of the clock and watchmakers of London, from the earliest times until the present day.


THE CLOCKMAKERS OF LONDON


XXIII
GEORGE DANIELS 'THE GREATEST WATCHMAKER OF THE 20TH CENTURY'
George Daniels, CBE, DSc, FBHI, FSA (1926–2011) is regarded as one of the greatest watchmakers of the late 20th and early 21st centuries. Through sheer force of personality, determination, inventiveness and hard work, he made some of the most ingenious, beautiful and accurate mechanical watches of his period, so earning himself worldwide fame and a considerable fortune.
George Daniels was brought up in abject poverty in east London. Lacking parental affection, he was forced to become entirely self-sufficient. Aged five, he secretly prised the back from his family's alarm clock. As he watched its wheels turn, he realised they were a metaphor for his own life: moving inexorably onward, but without outside assistance. Inspired by this, he determined to learn the secrets of horology, despite his parents' opposition.
Conscription into the army in 1944 brought liberation. His voracious appetite for learning was set free. His natural ability to understand mechanics blossomed.


XX
LONDON CLOCKMAKING
IN THE 20TH CENTURY
The nature of timekeeping and timekeepers changed dramatically during the 20th century. Despite early efforts to cling to the past and later attempts to adapt to the future, London gradually ceased to be a major horological manufacturing centre. Traditional skills survived in the hands of restorers, conservators and 'artist craftsmen'.
Some of the finest clocks, pocket watches and chronometers ever made were produced in London between 1900 and 1914. But despite prizes offered by the Clockmakers' Company to encourage quality and a dramatic increase in demand prompted by the First World War, the old-fashioned methods of manufacture proved unsustainable. Repeated attempts to mass-produce the newly popular wristwatch failed.
Many old London firms were unable to adapt. They merged, became importers, took up repairing, made reproductions or simply closed. Those that survived mostly moved out of London to reduce costs. Government took little interest. The Second World War again brought respite, but by then the nature of timekeeping throughout the world had begun to change. In electricity, tuning forks, quartz crystals and even caesium, extraordinary timekeeping qualities were gradually found and exploited. Accurate time increasingly became available through telephone, radio, television and computers. Radio and satellite navigation superseded traditional chronometry. Clockwork was used less for domestic timekeeping and as the century progressed, powered gramophones


Michael R. Blayney
1
Isle of Man
TABLE CHRONOMETER NO. 1
BY MICHAEL ROGER BLAYNEY
Isle of Man, 2015
The silvered dial shows the hours, minutes and seconds, together with two sectors displaying the state of wind and ambient temperature. The fuzee movement, within a gilded and glazed brass case, incorporates an Earnshaw spring-detent escapement, maintaining power and a 14,400 train with fifteen jewels.
This superb chronometer was made over a period of five years by Michael Blayney, a practicing anaesthetist. It is his first attempt at horology and was made in response to a challenge issued to him by the late George Daniels (1926–2011) watchmaker and inventor of the Co-axial Escapement. The engraving is by Charles Scarr.
Kindly lent by the maker


PORTRAIT OF THOMAS VICKERY
(1882–1945)
Artist uncertain, 1936
Thomas Vickery, a talented, obsessive clockmaker, was born in Bath, but worked at Astley Abbots, Worcestershire. He came to national fame in 1931, through making every part of the highly complicated astronomical longcase clock shown here, including its case. He wished 'to leave behind something made in the 20th century.' This portrait may well be his own work also. Signed on the reverse with the artist's fingerprints.
Museum No. 1376.
Presented by Ian Vickery and Nicola Cresdee, 2015
EIGHT-DAY LONGCASE CLOCK
BY THOMAS VICKERY
Bridgnorth, Shropshire, 1931
Case, solid oak made by Vickery. The painted brass dial

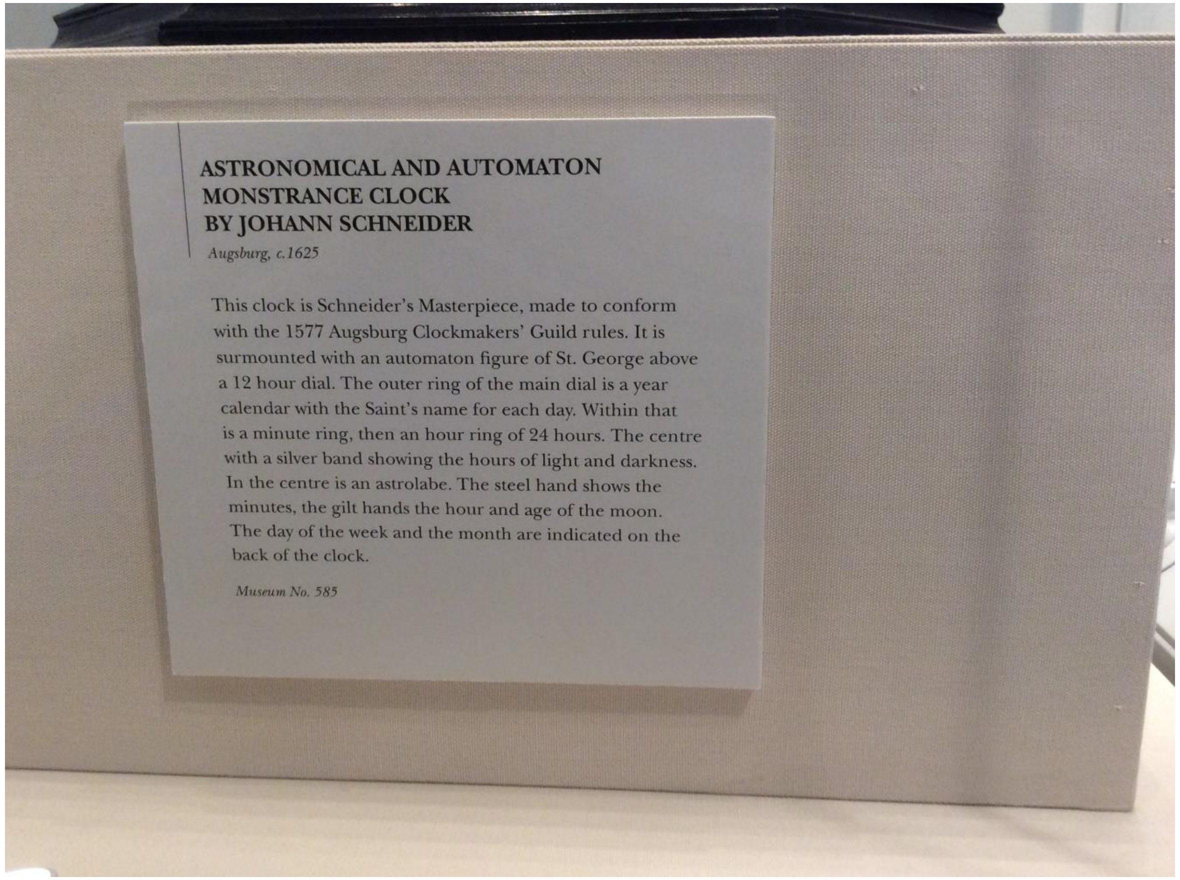

THE
NELTHROPP
COLLECTION
Few private horological collections survive intact from the 19th century. The clocks and watches in this case, however, constitute the greater part of the collection of Rev. Henry Leonard Nelthropp FSA. The collection was made initially without the benefit of any reference books and was presented to the Clockmakers' in 1894. It is a fascinating insight into the mind of a pioneering private collector.
Rev. Henry Nelthropp FSA (1820–1901) began his career as a curate in Bristol. He then served as Chaplain to the British Legation in Switzerland (1851–1858) but after receiving an inheritance, retired to London. From c.1854, he had indulged in his fascination for horology and had begun to collect. He built up a remarkable knowledge of his subject, although few


MARINE CHRONOMETER BY JOSEPH
CROUCHER AND J.G. ULRICH


HOLMES


IX
THOMAS TOMPION


LONGCASE CLOCK
BY THOMAS TOMPION


ASTRONOMICAL AND AUTOMATON
MONSTRANCE CLOCK
BY JOHANN SCHNEIDER
Augsburg, c.1625
This clock is Schneider's Masterpiece, made to conform with the 1577 Augsburg Clockmakers' Guild rules. It is surmounted with an automaton figure of St. George above a 12 hour dial. The outer ring of the main dial is a year calendar with the Saint's name for each day. Within that is a minute ring, then an hour ring of 24 hours. The centre with a silver band showing the hours of light and darkness. In the centre is an astrolabe. The steel hand shows the minutes, the gilt hands the hour and age of the moon. The day of the week and the month are indicated on the back of the clock.
Museum No. 585

Dublin, Ireland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NOW £5.99
WAS £30
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£30
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LONDON


LYCEUM
TAVERN


NatWest
Welcome

Climb London's
superstar attraction



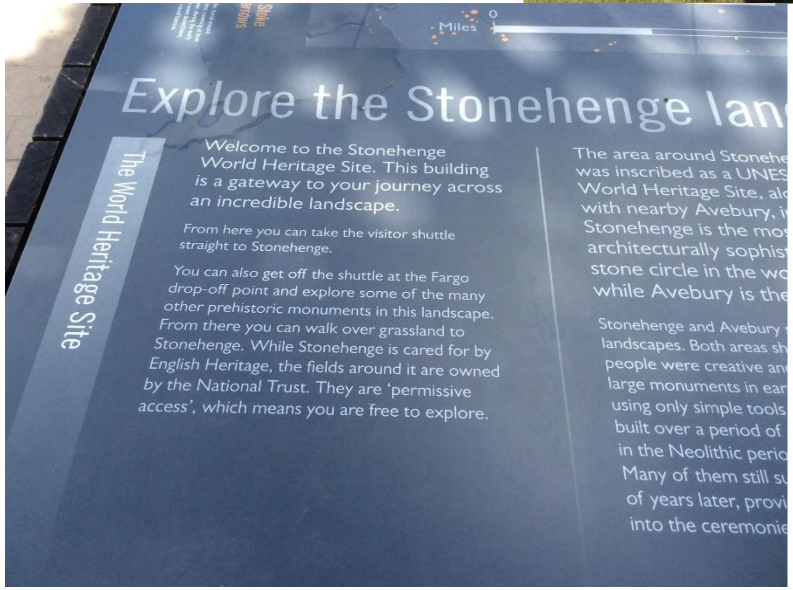
EVENING TELEGRAPH
PEOPLE'S FRIEND
PEOPLE'S JOURNAL
DUNDEE COURIE



BURGER KING
LEGO

Stonehenge


ENGLISH HERITAGE
STONEHENGE
Open


Explore the Stonehenge lan
The World Heritage Site
Welcome to the Stonehenge World Heritage Site. This building is a gateway to your journey across an incredible landscape.
From here you can take the visitor shuttle straight to Stonehenge.
You can also get off the shuttle at the Fargo drop-off point and explore some of the many other prehistoric monuments in this landscape. From there you can walk over grassland to Stonehenge. While Stonehenge is cared for by English Heritage, the fields around it are owned by the National Trust. They are 'permissive access', which means you are free to explore.
Miles


ENGLISH HERITAGE
STONEHENGE


Midsummer sunrise and midwinter sunset
Time of Stonehenge
Stonehenge is celebrated for being aligned on the midsummer sunrise, which attracts thousands of people on the longest day of the year. But more important to prehistoric people may have been the midwinter sunset.
If you were to stand in the centre of the monument and look towards the Avenue, the sun rises just to the left of the Heel Stone. When other stones were standing in the entrance, it may have given the impression of a corridor along which the sunlight would have shone into the centre of the monument.
The midwinter sunset is directly opposite the midsummer sunrise. Viewed from the centre, the midwinter sun would have set between the two upright stones of the tallest sarsen trilithon. We know that people were feasting at midwinter at nearby Durrington Walls, so perhaps midwinter ceremonies took place here too.
ENGLISH HERITAGE
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Many of the stones on this south-west side of Stonehenge have fallen and broken or have been removed from the site. Those that remain are not as regular in shape, and are not as finely worked, as the stones on the opposite entrance side of the monument.
ENGLISH HERITAGE
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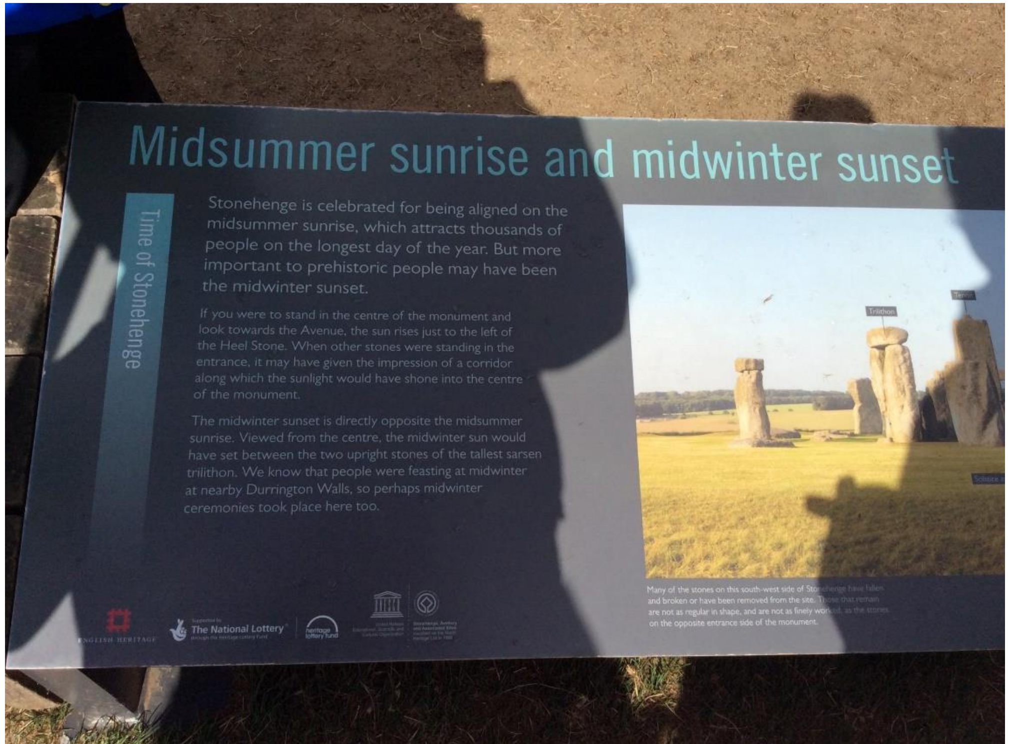
heritage lottery fund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Trilithon
Many of the stones on this south-west side of Stonehenge have fallen and broken or have been removed from the site. Those that remain are not as regular in shape, and are not as finely worked, as the stones on the opposite entrance side of the monument.
ENGLISH HERITAGE
The National Lottery
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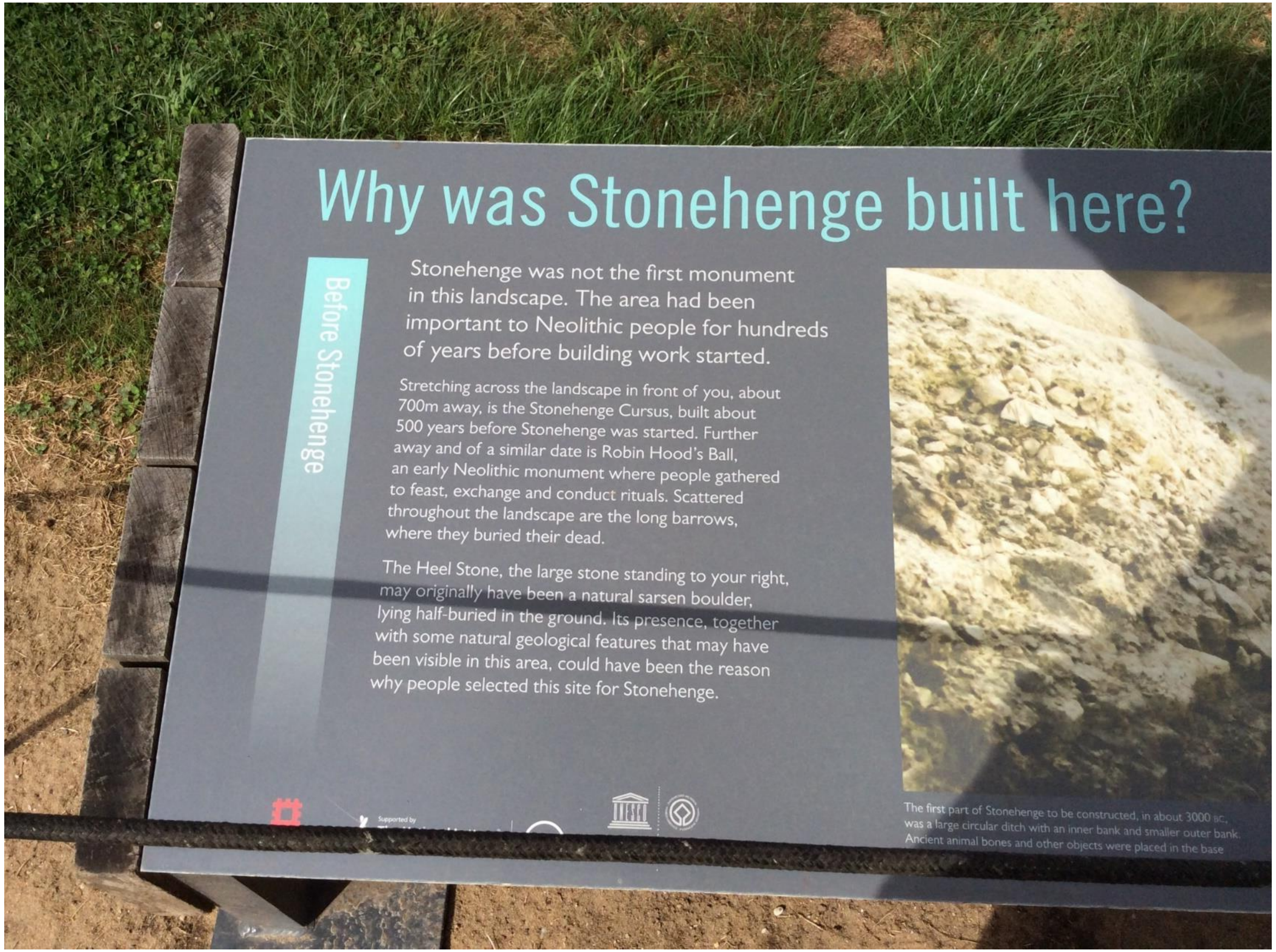
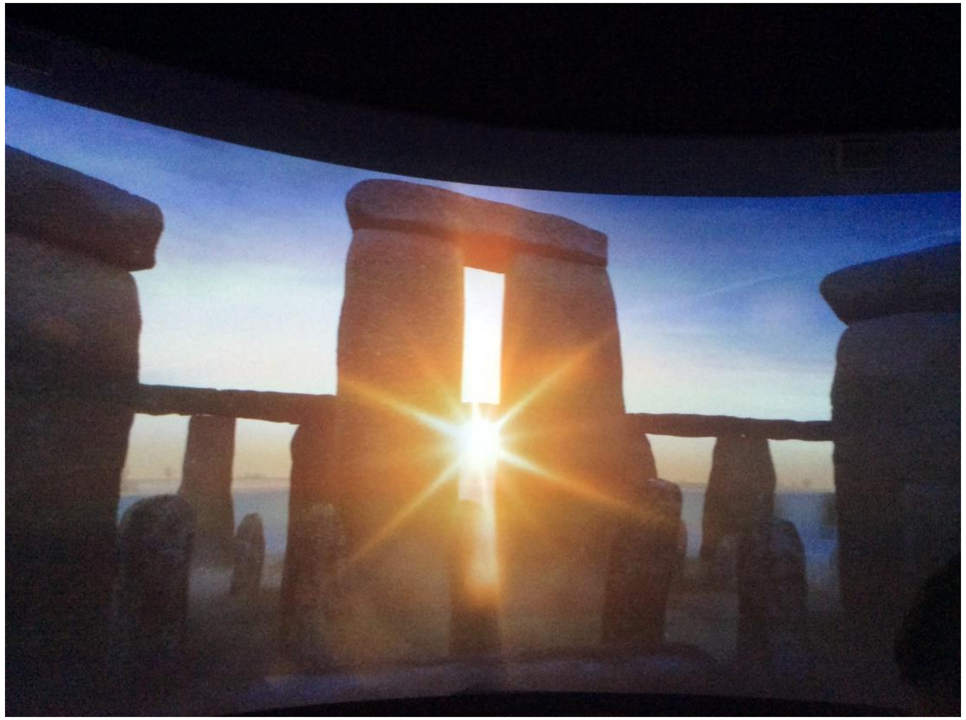
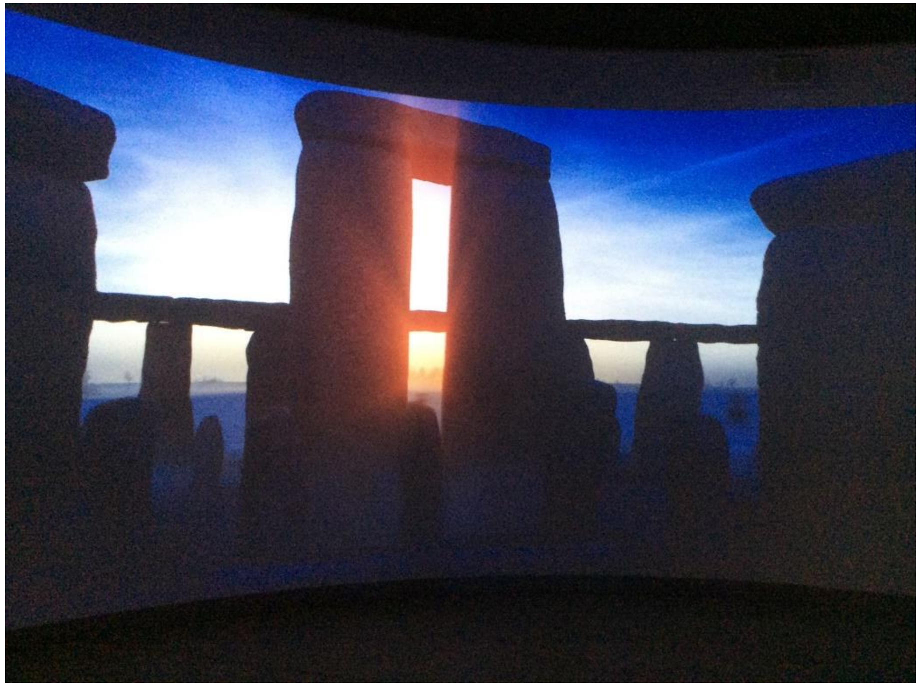
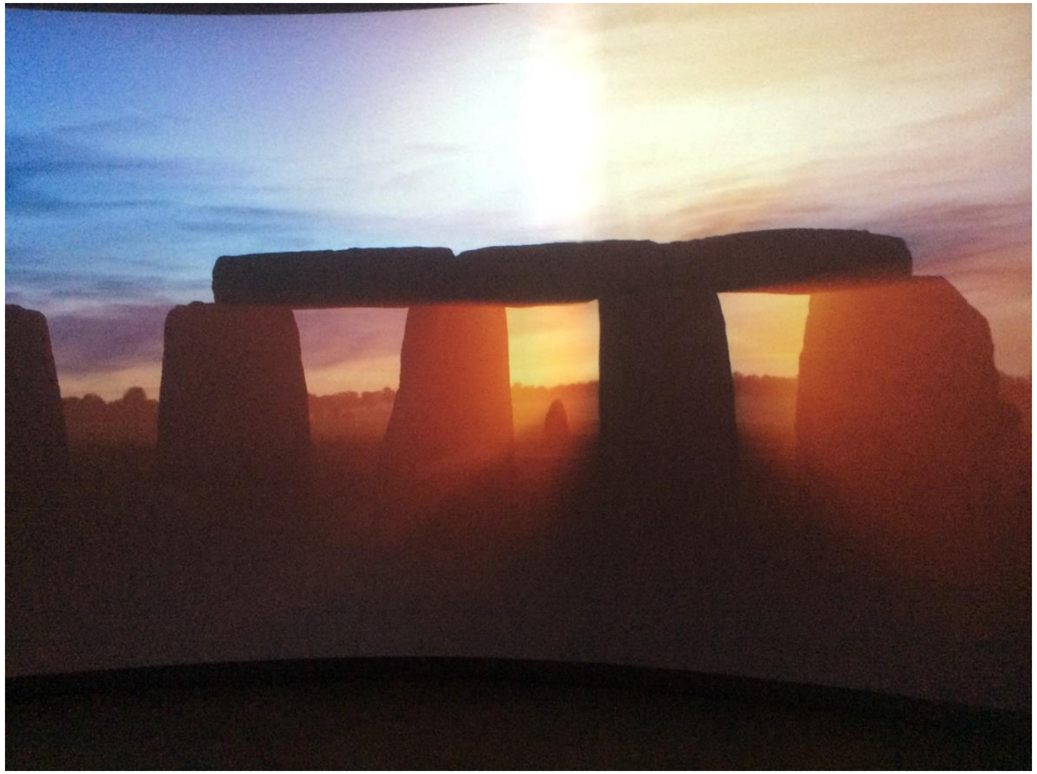
MIDWINTER SUNSET


MIDWINTER SUNSET


Why was Stonehenge built here?
Before Stonehenge
Stonehenge was not the first monument in this landscape. The area had been important to Neolithic people for hundreds of years before building work started.
Stretching across the landscape in front of you, about 700m away, is the Stonehenge Cursus, built about 500 years before Stonehenge was started. Further away and of a similar date is Robin Hood's Ball, an early Neolithic monument where people gathered to feast, exchange and conduct rituals. Scattered throughout the landscape are the long barrows, where they buried their dead.
The Heel Stone, the large stone standing to your right, may originally have been a natural sarsen boulder, lying half-buried in the ground. Its presence, together with some natural geological features that may have been visible in this area, could have been the reason why people selected this site for Stonehenge.
The first part of Stonehenge to be constructed, in about 3000 BC, was a large circular ditch with an inner bank and smaller outer bank. Ancient animal bones and other objects were placed in the base
Supported by

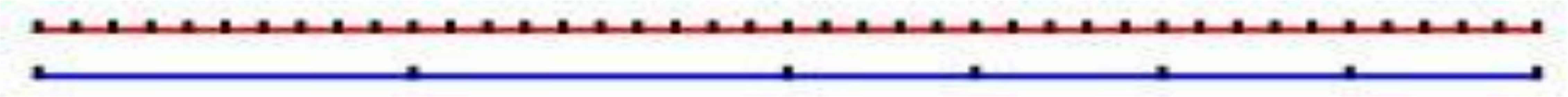




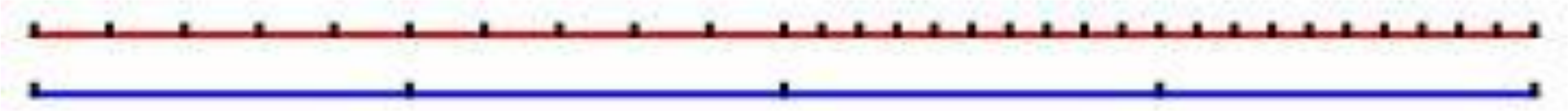


Chapter 6

1i. Non-equal year-lengths and equal day-lengths; some years ten days, some years five days



1ii. Equal year-lengths and non-equal day-lengths; some years ten days, some years five day



1iii. Non-equal year-lengths and non-equal day-lengths; five days in each year

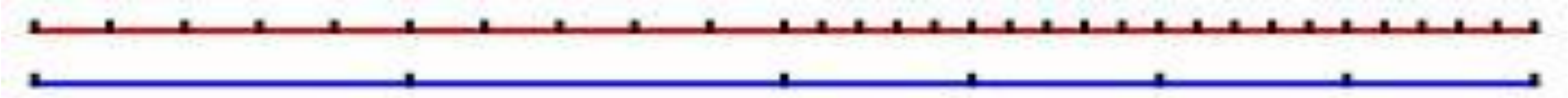
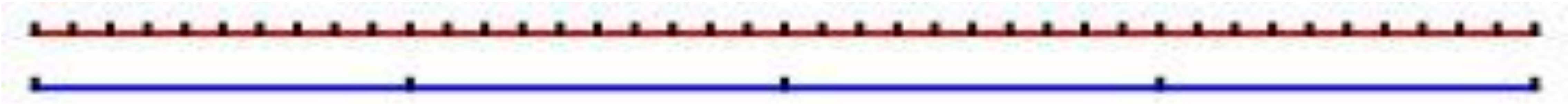


Figure 6.1. The three possible cases when we find different number of days(red line) in each year (blue line).

2i. Equal year-lengths and equal day-lengths; ten days in each year



2ii. Non-equal year-lengths and non-equal day-lengths; five days in each year

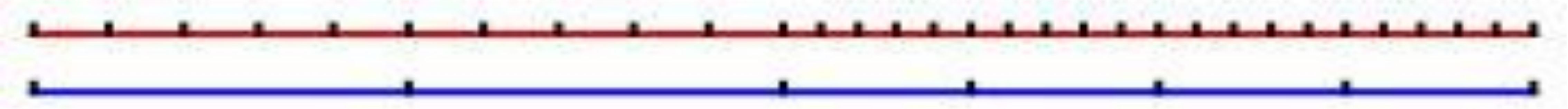


Figure 6.2. The two possible cases when we find the same number of days in each year.

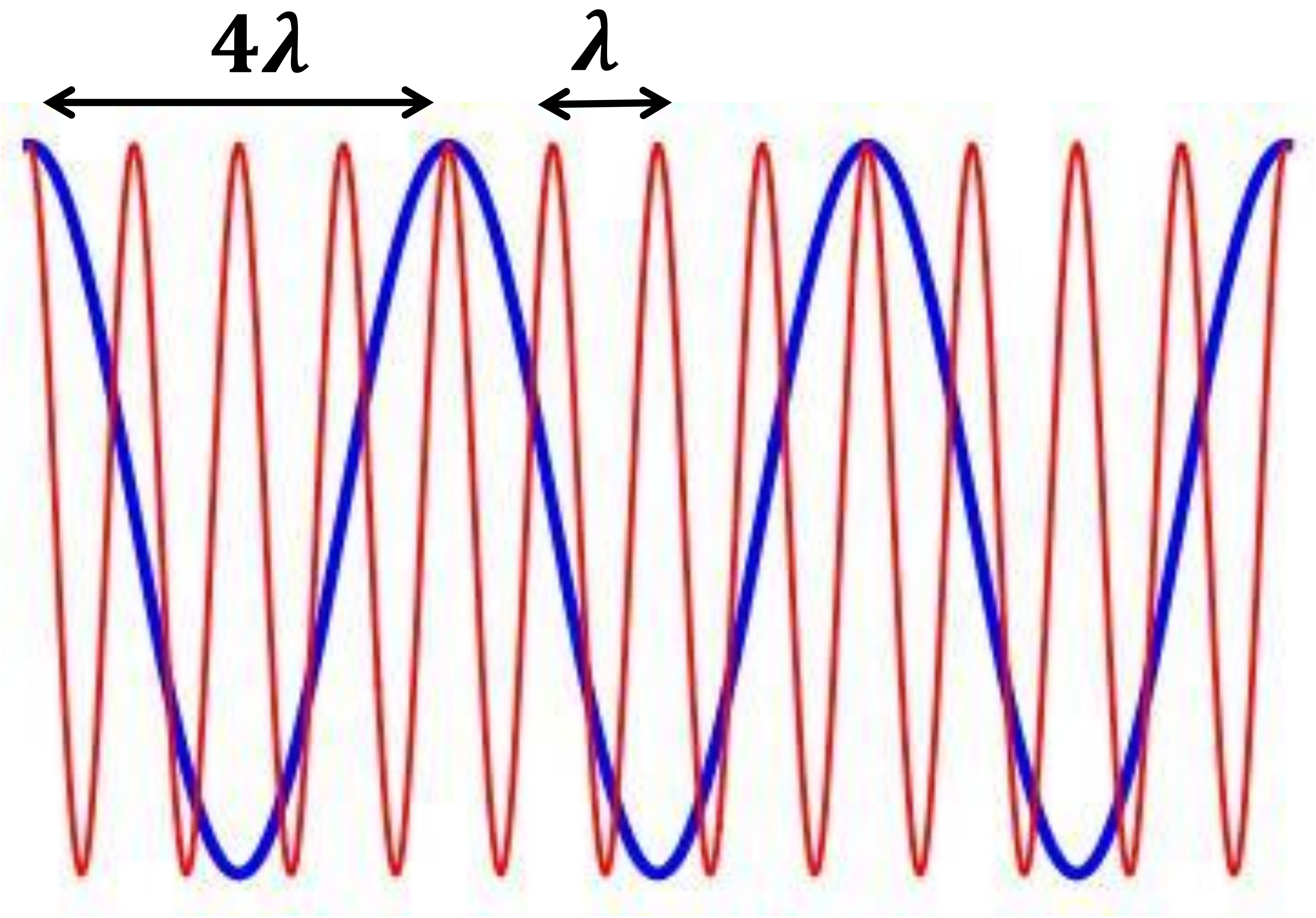


Figure 6.3. Two possible waves of two clocks.
The wavelength of the blue clock is four times longer than the wavelength of the red clock.

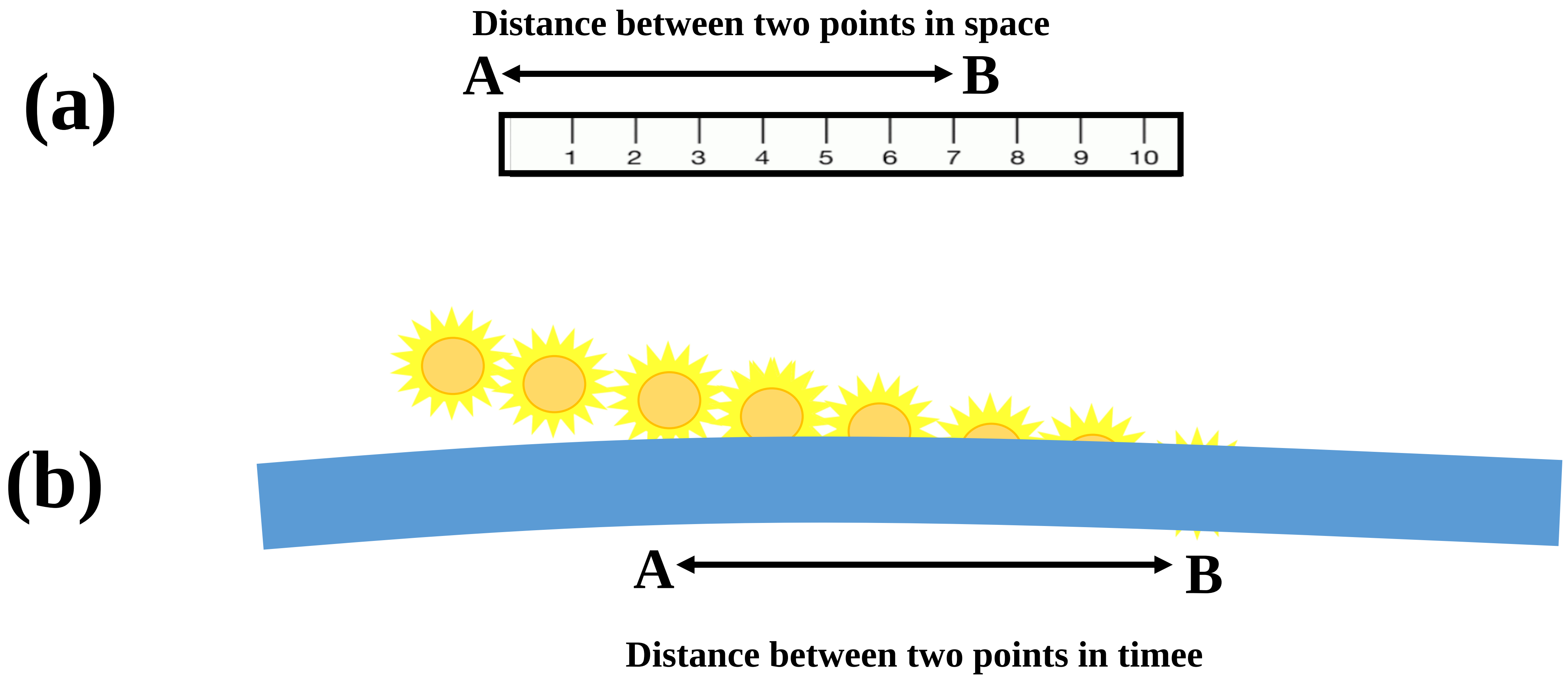


Figure 6.4.
(a) Measuring the distance between two points in space A and B with a ruler.
(b) Measuring the length of time from the moment the sun “touches” the horizon until it disappears.

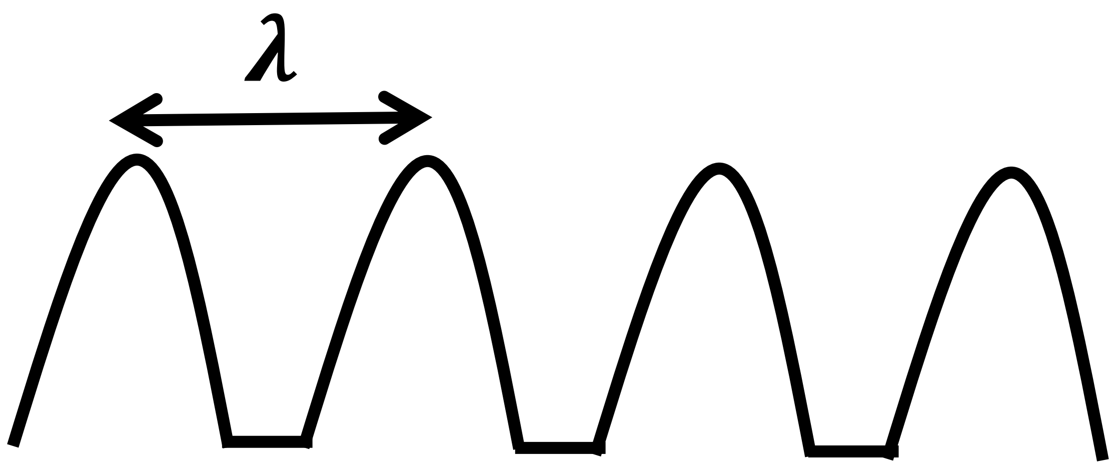


Figure 6.5. Representation of the heartbeat as a periodic phenomenon. The time length between two successive beats is denoted by λ.

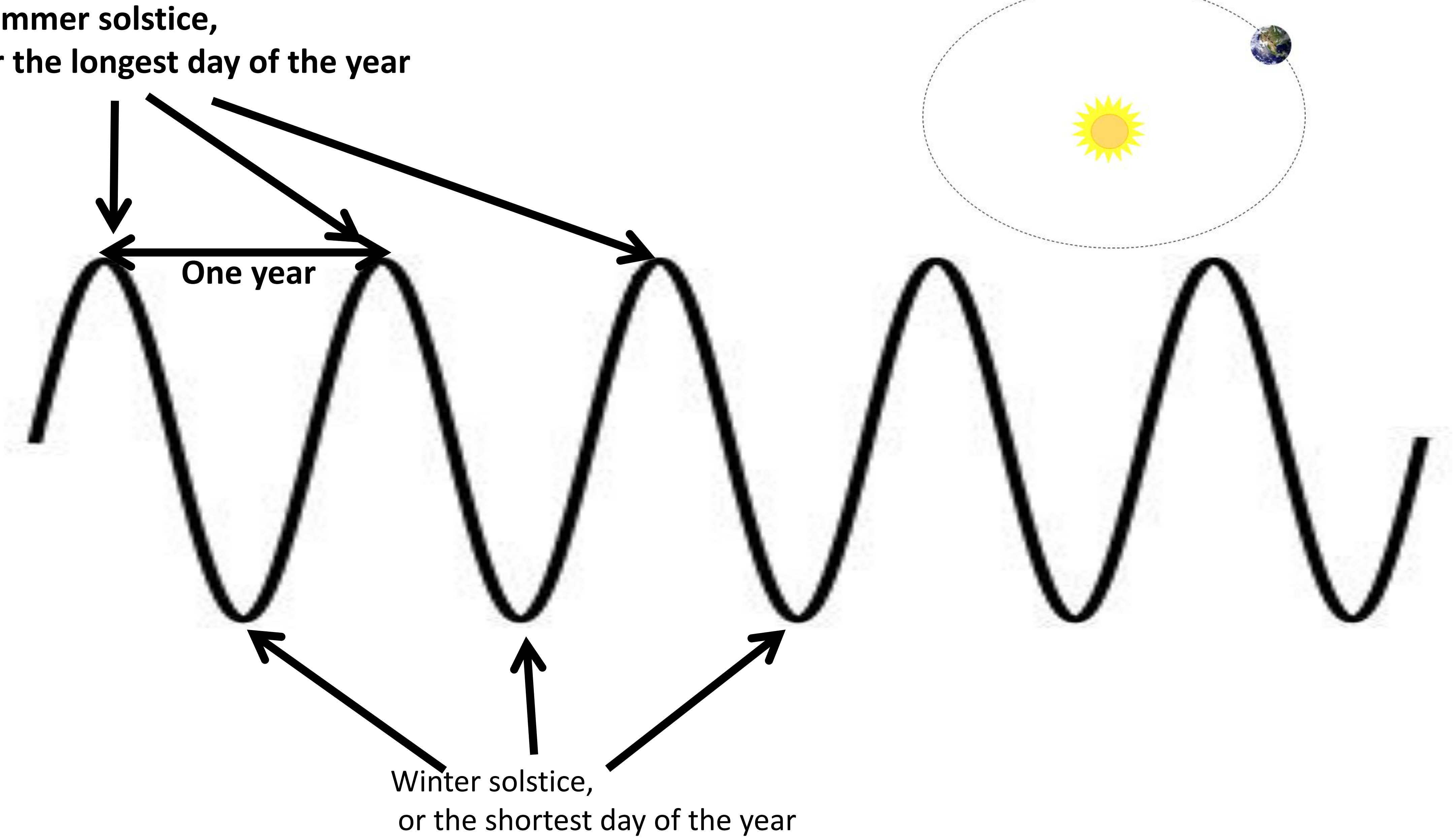


Figure 6.6. Representation of the motion of the earth around the sun as a periodic phenomenon. The time length between two successive crests of the wave is one year.

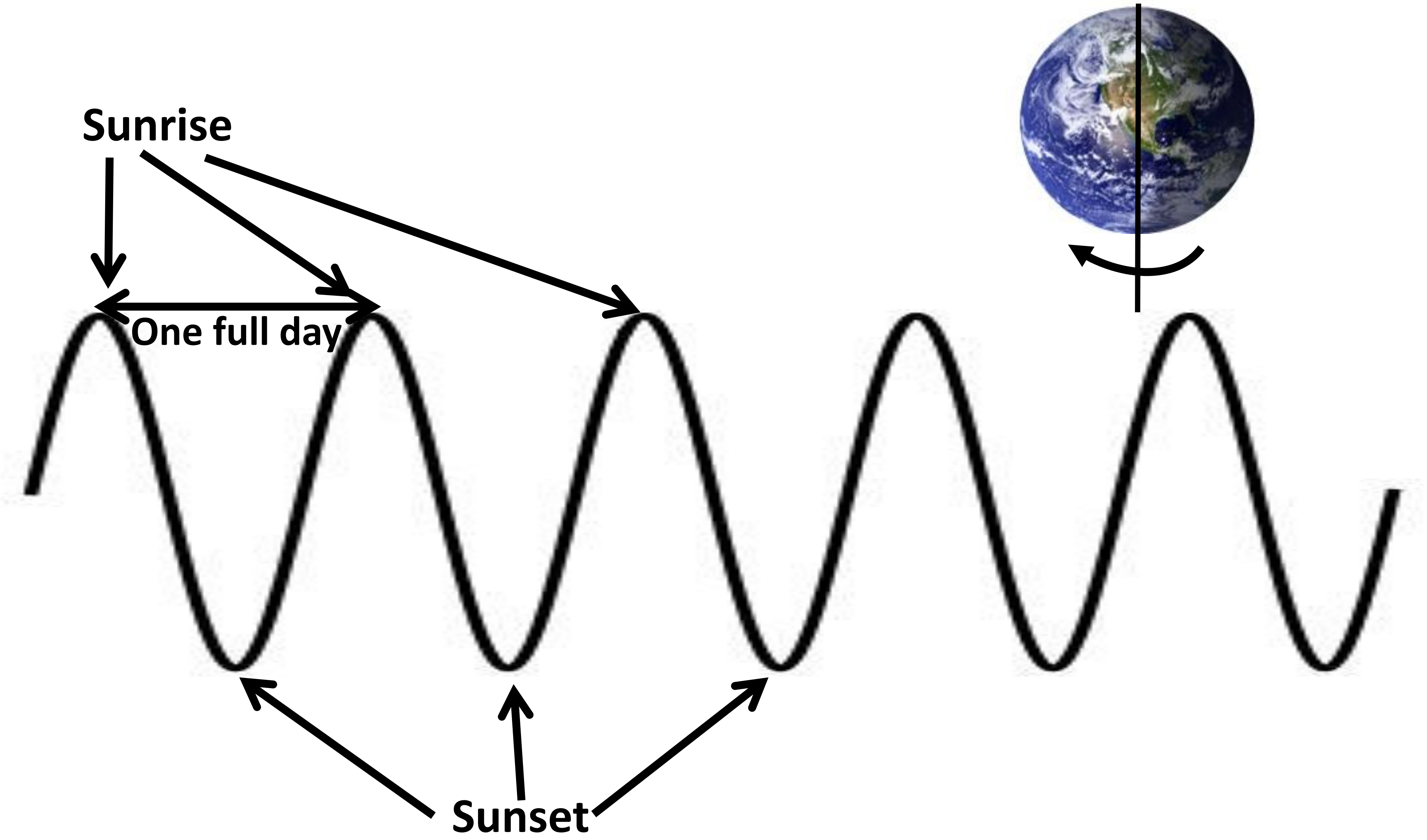
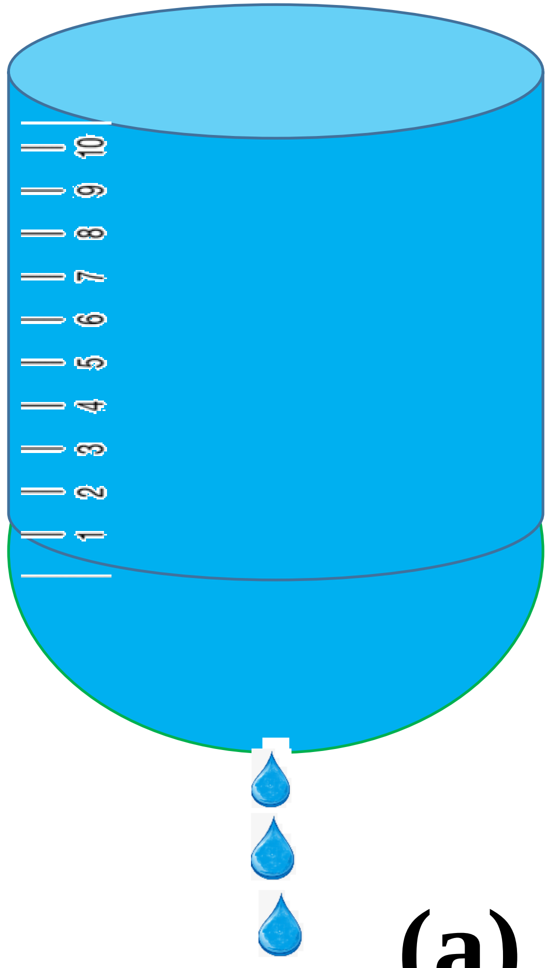


Figure 6.7. Representation of the rotation of the earth as a periodic phenomenon. The time length between two successive crests of the wave is one day.

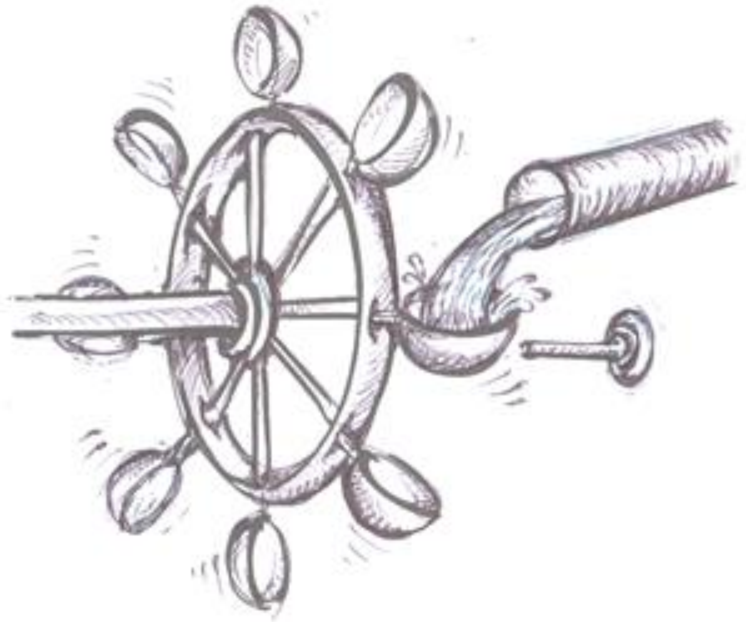
Figure 6.8. Sundial in Mahane Yehuda, Jerusalem, taken at 11:15 am.

Figure 6.9b. Sundial in Teddy Park, Jerusalem, taken at 13:30, and 15:15 pm, respectively.

Figure 6.9a. Sundial in Teddy Park, Jerusalem taken at 10:30 am, and 12:00 pm, respectively.



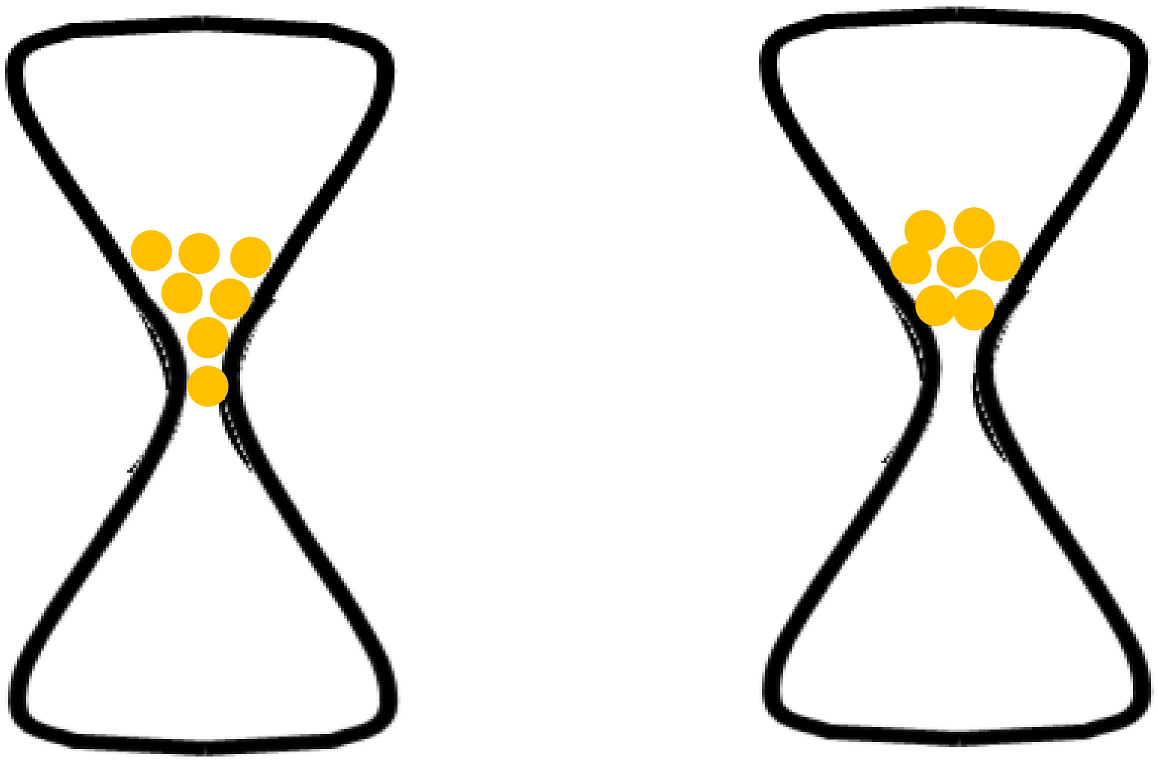
(a)



(b)

Figure 6.10. Two water clocks.
(a) Dripping of water from a bowl with marks on its side.
(b) Water rotating a wheel.

Figure 6.11. Sand clocks (a) From the clock museum in Vienna



(a) (b)

Figure 6.12. Two possible “configurations in a sand clock. In (a) a “smooth” flow of sand In (b) “clogging” of the sand particles

Candle clock, Austria 16th century. Wien museum.

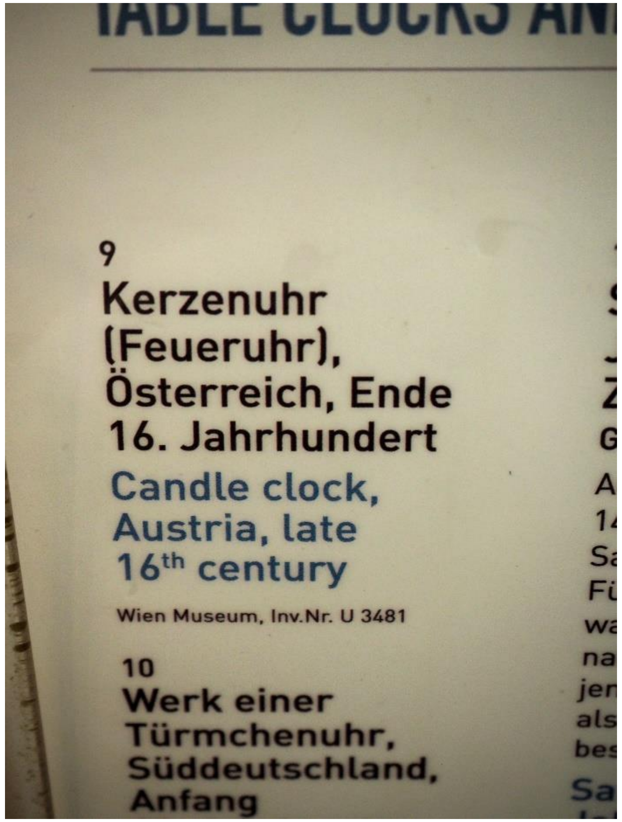
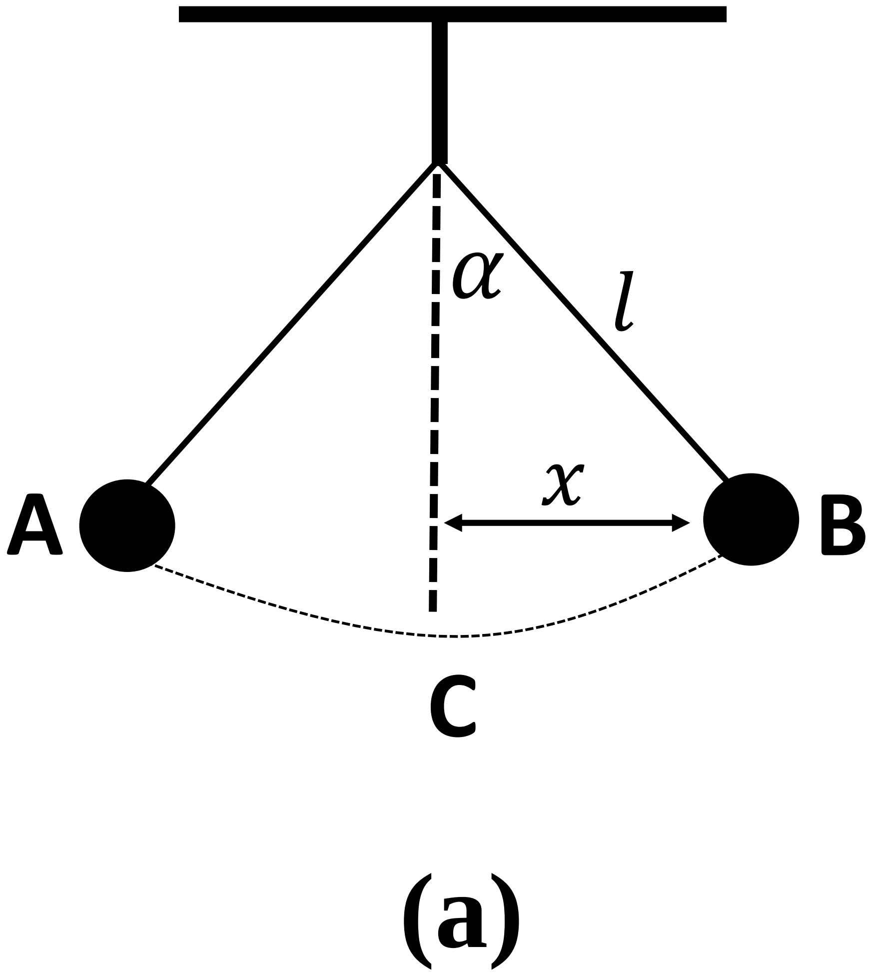


Figure 6.13. Candle clocks Austria 16th century, from the clock museum in Vienna. The nails falling on the plate Left.



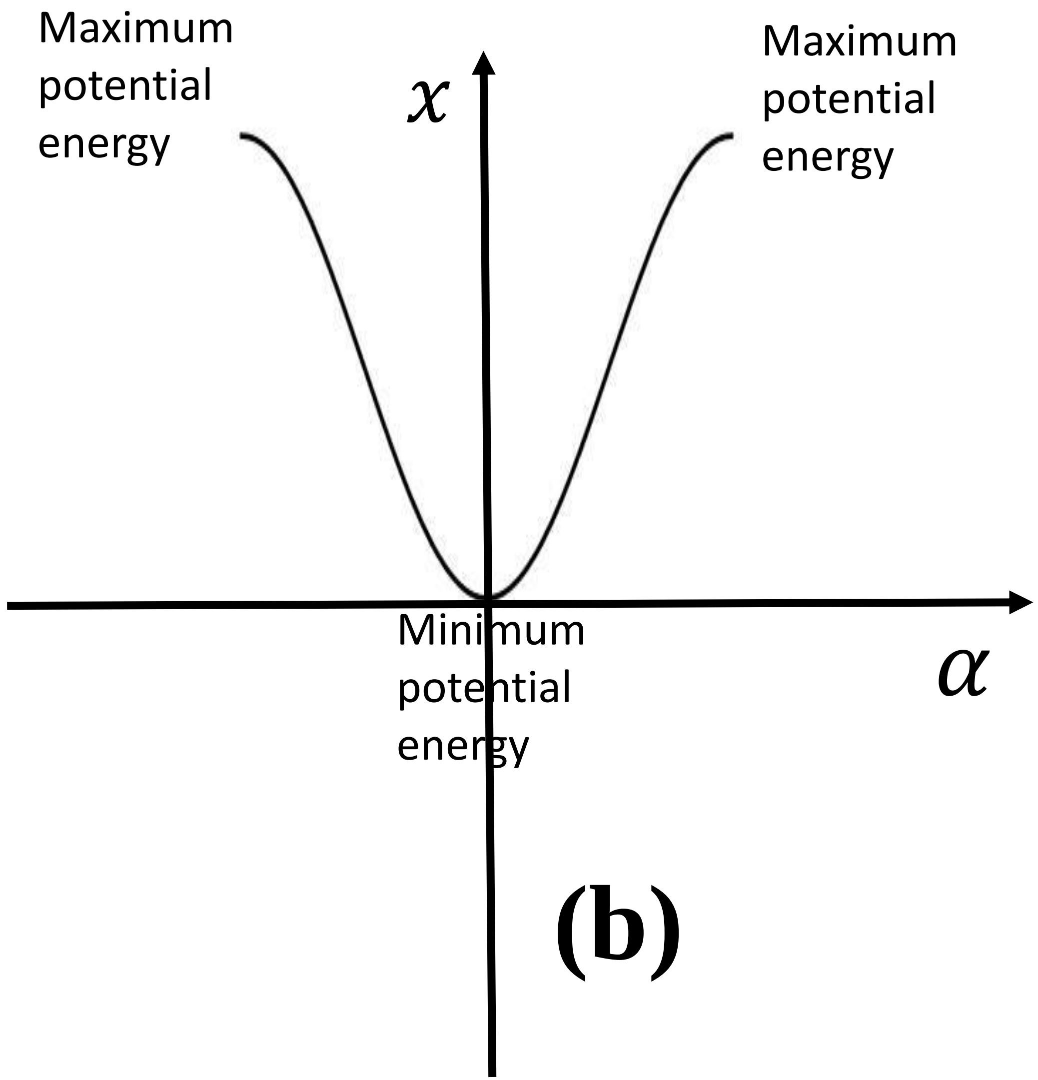


Figure 6.14. A pendulum

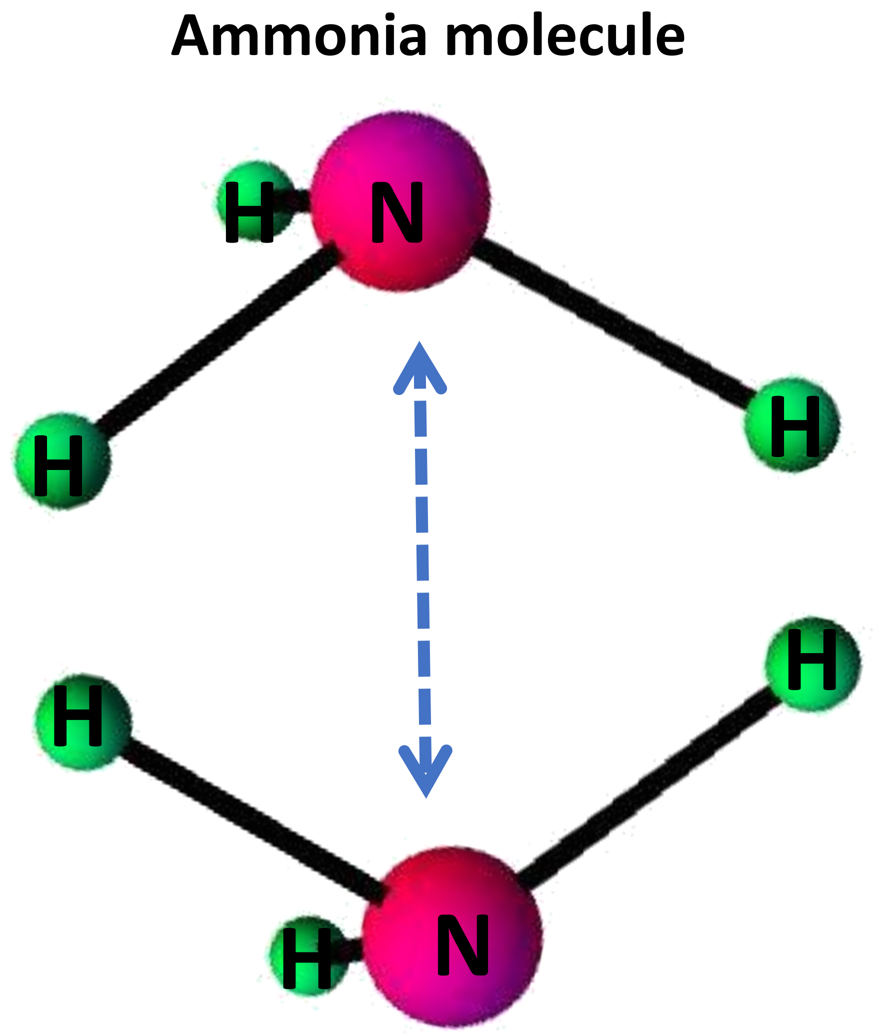


Figure 6.15. Two states of the ammonia molecule

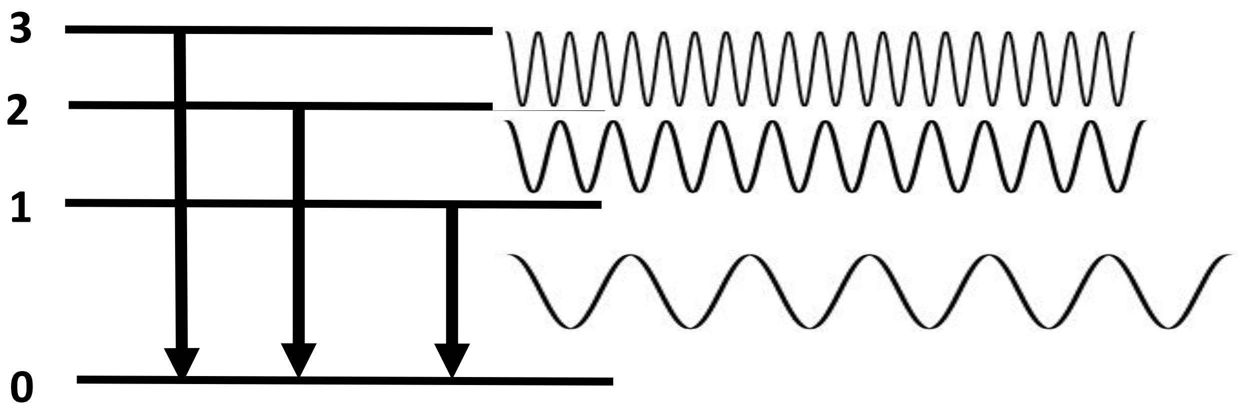


Figure 6.16. Radiation with different frequencies resulting from electron transfer between different energy states.

An unexpected encounter: the Joker by Konstantin Chaykin

Joker

Don't worry, be happy: Joker on the wrist at 2:10 pm

Mortal enemies or secret friends? Konstantin Chaykin Joker and Rolex "Batman"

Russian Horological Humor   with the Konstantin Chaykin Joker

A comical face that tells the time as well as the phase of the moon.


Konstantin Chaykin


ЧАСЫ В РОССИИ
В НОМИНАЦИИ
«ЧАСЫ ГОДА. ВЫБОР ПУБЛИКИ»
НАГРАЖДАЕТСЯ
KONSTANTIN CHAYKIN
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ПУТНИК


KONSTANTIN CHAYKIN


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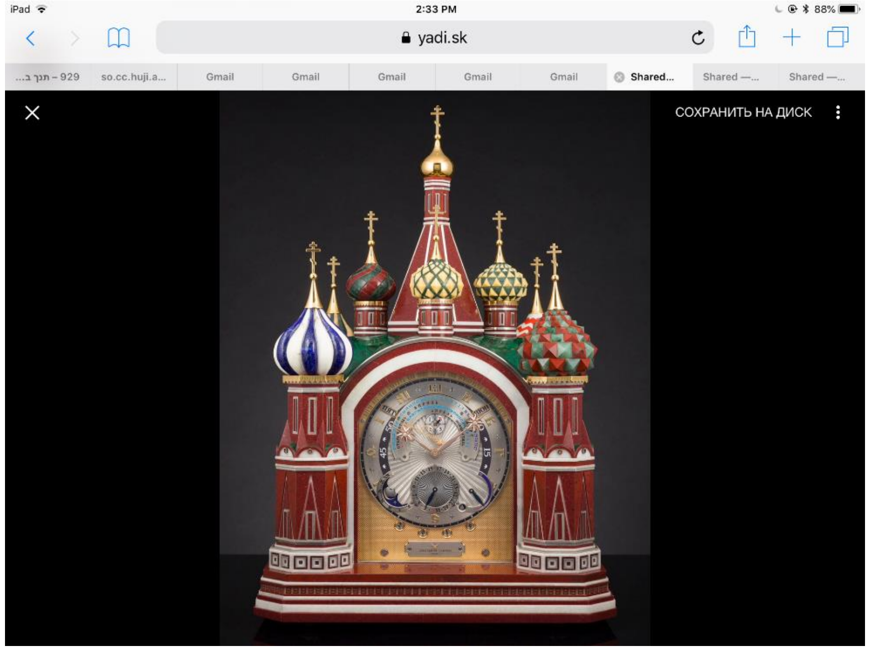
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СОХРАНИТЬ НА ДИСК
ANDERSEN CHAYKIN

KS01RG06015C

Caliber: KL104-1
Frequency 21.600 vibrations per hour, 37 jewels, anchor escapement, balance axis shock absorber, 48 hours power reserve
Functions: hours, minutes (retrograde display), day/night, moon phases
Dial: rose gold, gold minute hand, gold hour (day/night) indicator, natural 12 mm South Sea pearl representing the Moon, half sphere made of rhodanized silver
Case: 18-carat rose gold, diameter 50 mm, sapphire caseback
Water-resistance: 3 ATM

Limited series: 10 pieces


TOURBILLON

1. ISINGLASS WINDOWS

Russia, XVII century

Wood, isinglass, tinplated iron

2. TOWER CLOCK WORKS

1539

Veliky Novgorod

Master Semen Chasovik (which literally means "The Clock Master")

Iron, hammerwork, benchwork

An inscription engraved on the central gear:

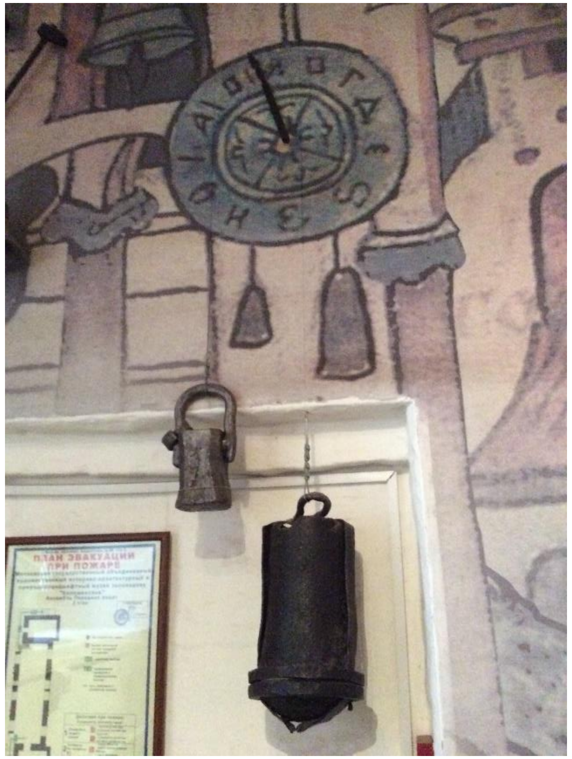
"By blessing and order of Macarius, archbishop of Veliky Novgorod and Pskov, and at the times of hegumen Alexius the clock was made for Solovki by master Semen Chasovik' (which literally means 'the Clock Master")."

In the XVII century, in the Organ Chamber of the Front Gate there were located mechanisms activating the lions installed near the main entrance to the Tsar's Courtyard. Over the Organ Chamber there is a Clock Chamber with an installed tower clock mechanism. The collection of tower clock mechanisms of the XVI-XIX centuries is the only one of this kind in Russia. You can see the most ancient out of surviving mechanisms made by Russian master Semen Chasovik (which literally means 'the Clock Master) in 1539 for Solovetsky Monastery. There are an inscription and the name of the master engraved on the gear.

The more complicated clock mechanism with the anchor escapement was made in the middle of the XVII century by master Rezantsev for Paphnutiev Borovsky Monastery near Kaluga. Its carcass is made of 17 sheets of forged iron marked with stamps of the Demidov Factory of 1774. Speaking about Nikolo-Perervinsky Monastery, its clock mechanism made by Ivan Yurin as well as a clock-face with two discs have been preserved till our days. There were Roman numerals depicted on the front face and the Moon and stars represented on the back disc. The latter could indicate the phases of the Moon when been rotated. Among exhibits you can see a clock mechanism that used to be installed in the Clock Chamber of the Front Gate over the Organ Chamber. Nowadays there is a mechanism of the XIX century from the Sukharevskaya Tower in Moscow transported to Kolomenskoye in the 1930s by Peter Baranovsky, the museum's director and architect. The clock is now installed in the western part of the Front Gate.

The integral part of the tower clock mechanisms were ponderous weights rotating a barrel and activating a gears system, bell hammers that made the clock strike not only every hour but every half an hour and a quarter, as well as bells of the XVII and XIX centuries.

On the windows of the Organ Chamber you can see isinglass frames of the XVII century: similar frames were installed in the Front Gate, administrative and ...premises of the Palace of Tsar Alexey Mikhailovich. The hall is decorated ... Moscow tower clock painted by Lazar Serb in


ПЛАН ЭВАКУАЦИИ
ПРИ ПОЖАРЕ

c

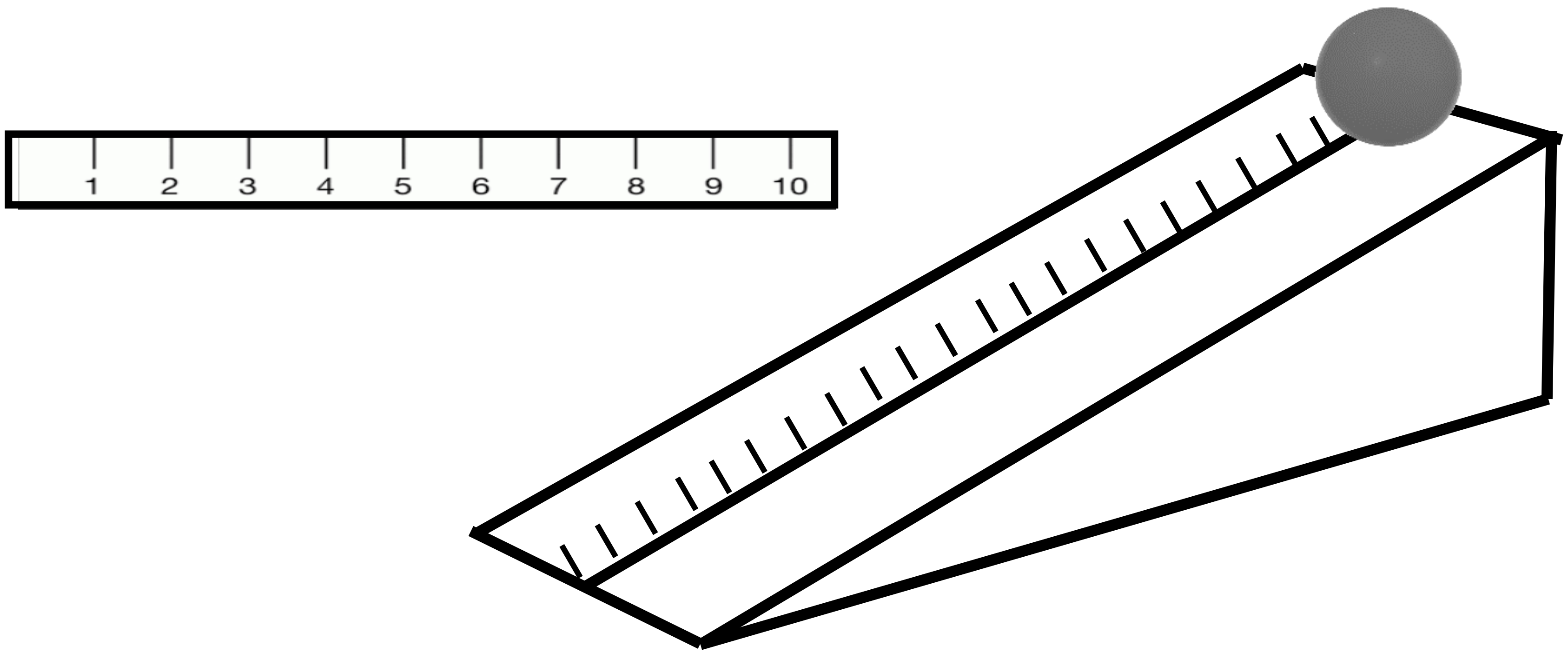


Figure 7.1. Experiment for measuring the speed of a falling ball on an inclined plane.

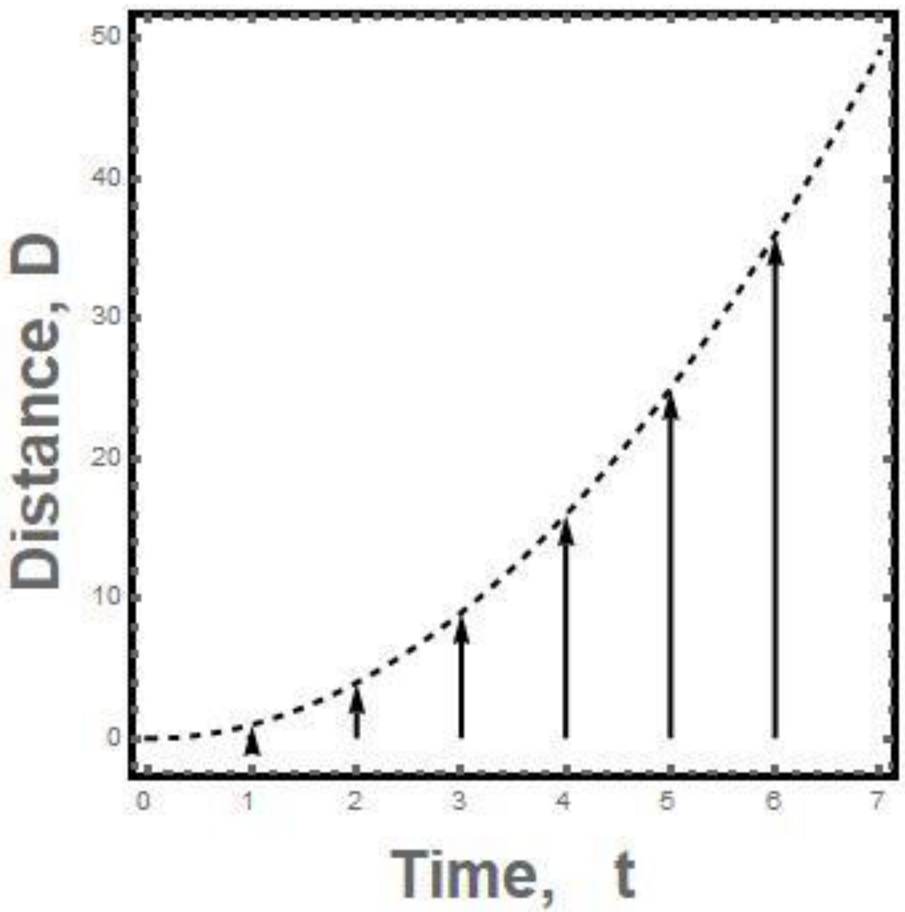


Figure 7.2.

Results of the experiment of a sliding ball; distance passed as a function of time.

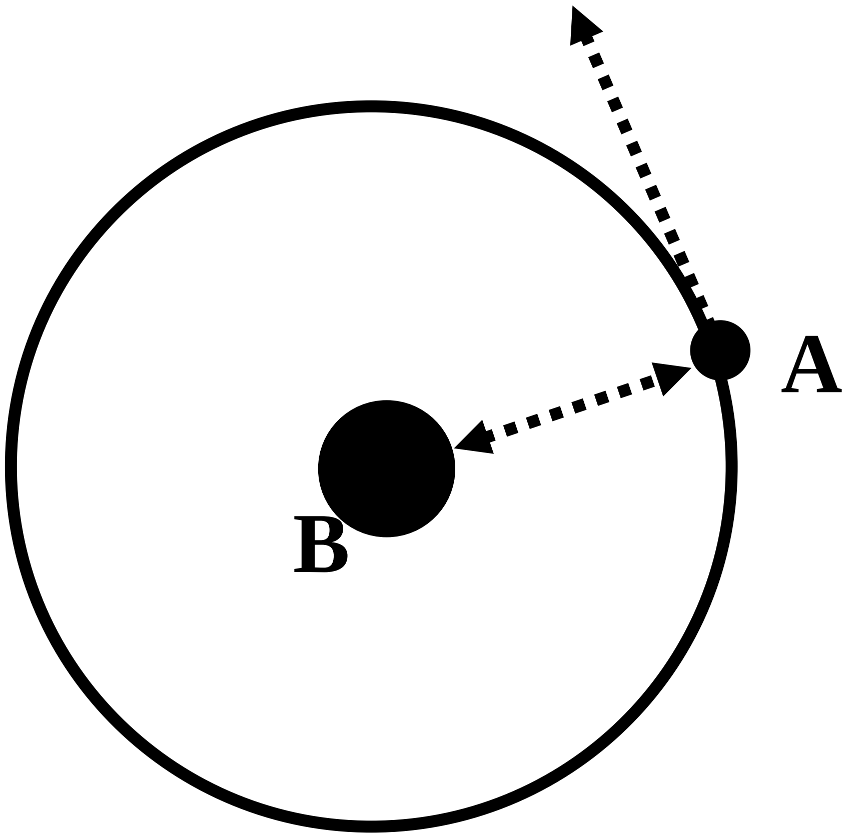


Figure 7.3. A ball **A** revolving around **B** counter clockwise. When the force between the two balls disappear, the ball **A** will continue to fly in a straight line and at a constant velocity.

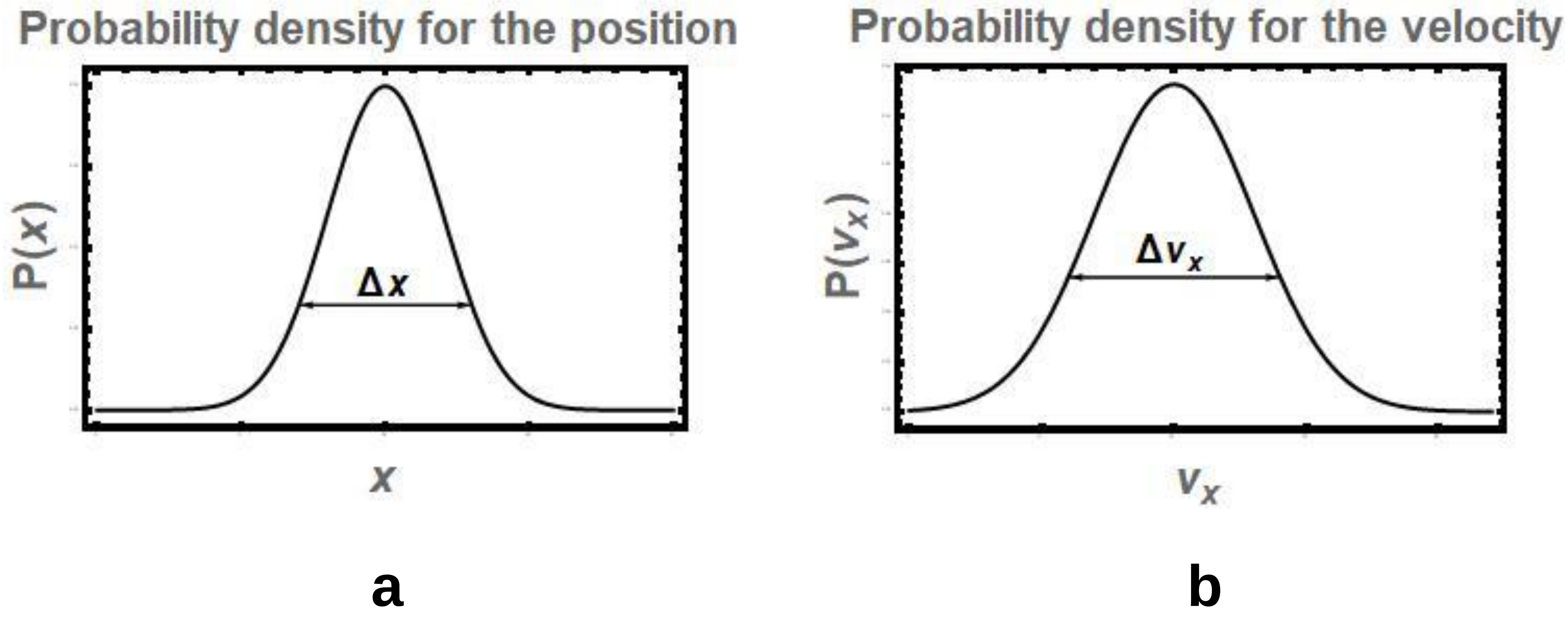
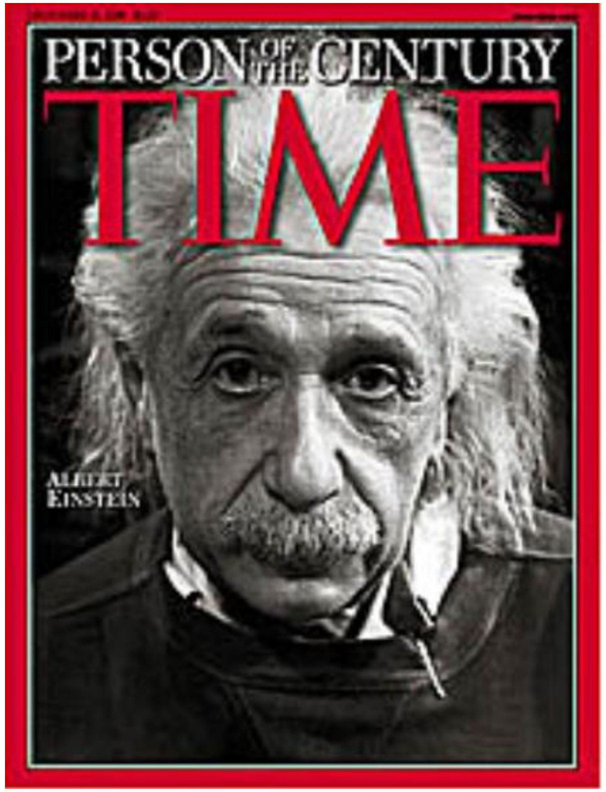


Figure 7.4. The probability of finding the particle (a) at location x, and (b) having velocity v_x.

Albert Einstein’s statue in the Hebrew University of Jerusalem campus.



Albert Einstein on the cover of Time magazine, December 31, 1999 (cover credit by Philippe Halsman).

Add truck or rocket

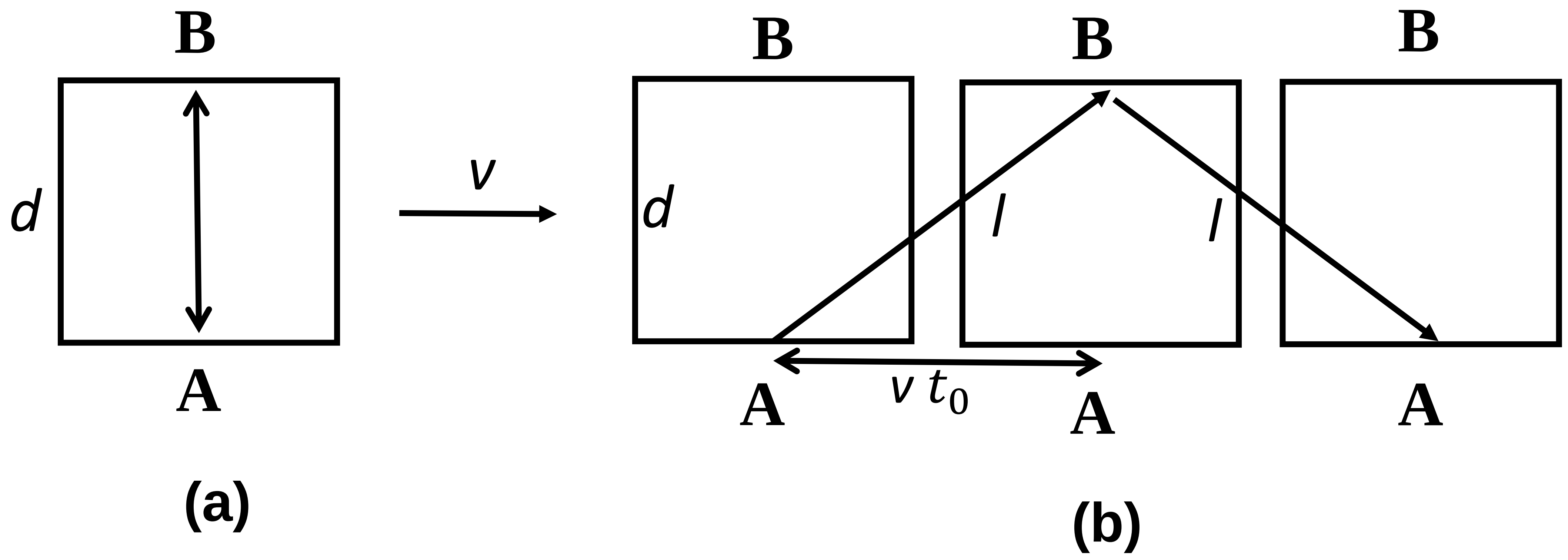


Figure 7.5. (a) The stationary light-clock.
A light ray is reflected between the two mirrors at points A and B.
The time it takes for the light to travel the distance d is: $t_0 = \frac{d}{c}$
(b) The same experimental set-up is moving in the x direction (perpendicular to the motion of light in (a)), at a constant velocity *v*.

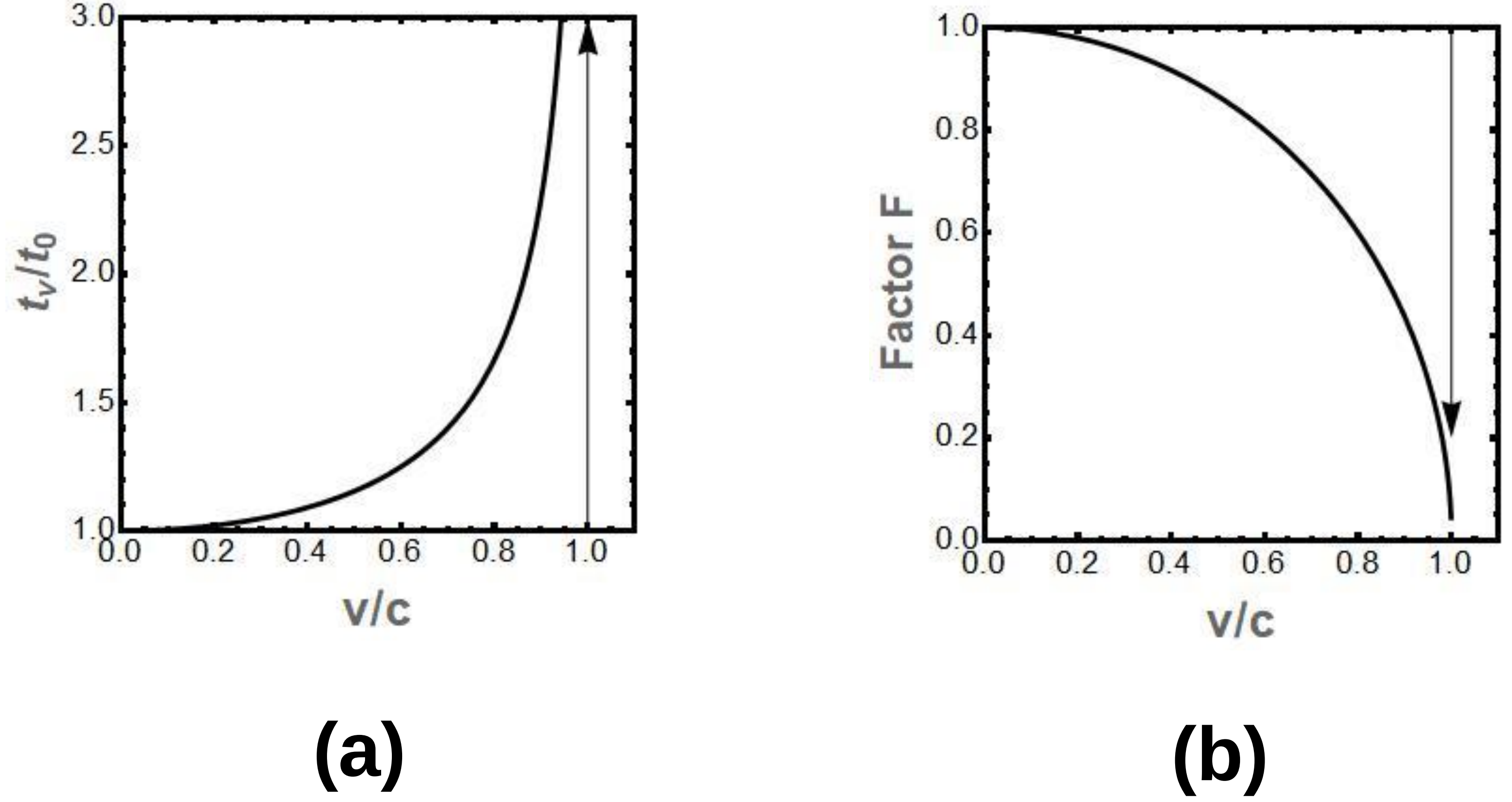


Figure 7.6. (a) The relative time units t_v/t_0 as a function of the velocity ratio v/c.
(b) The factor defined in equation (6) of Appendix E.

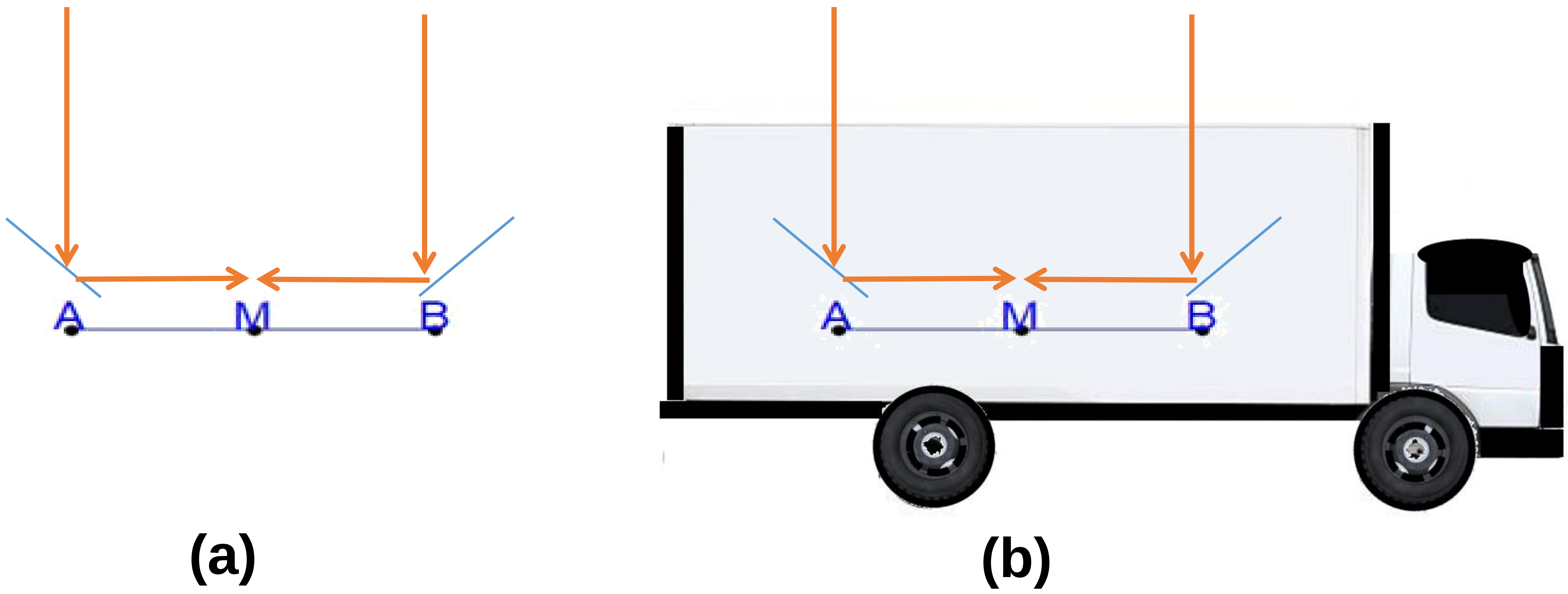
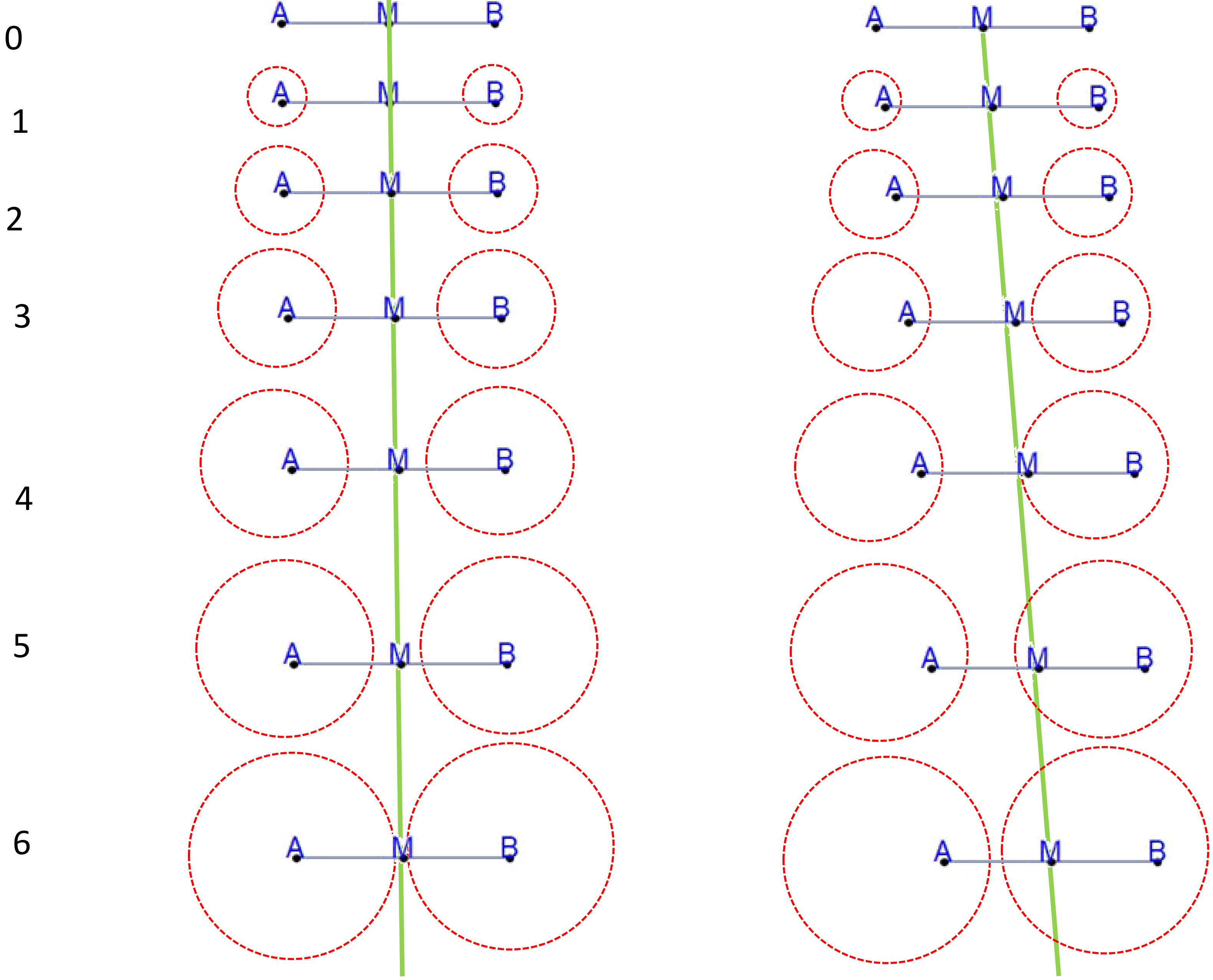


Figure 7.7. Lightning struck at the two ends of the table at points A and B.
(a) A stationary table. (b) The same experiment on a moving table.

Figure 7.8 (a)The two light-waves moving at a few units of time, shown on the left column, towards the center M.

(b) The same experiment but the whole table is moving to the right at a constant velocity. Note the motion of the point M indicated by the green line.



(a) (b)

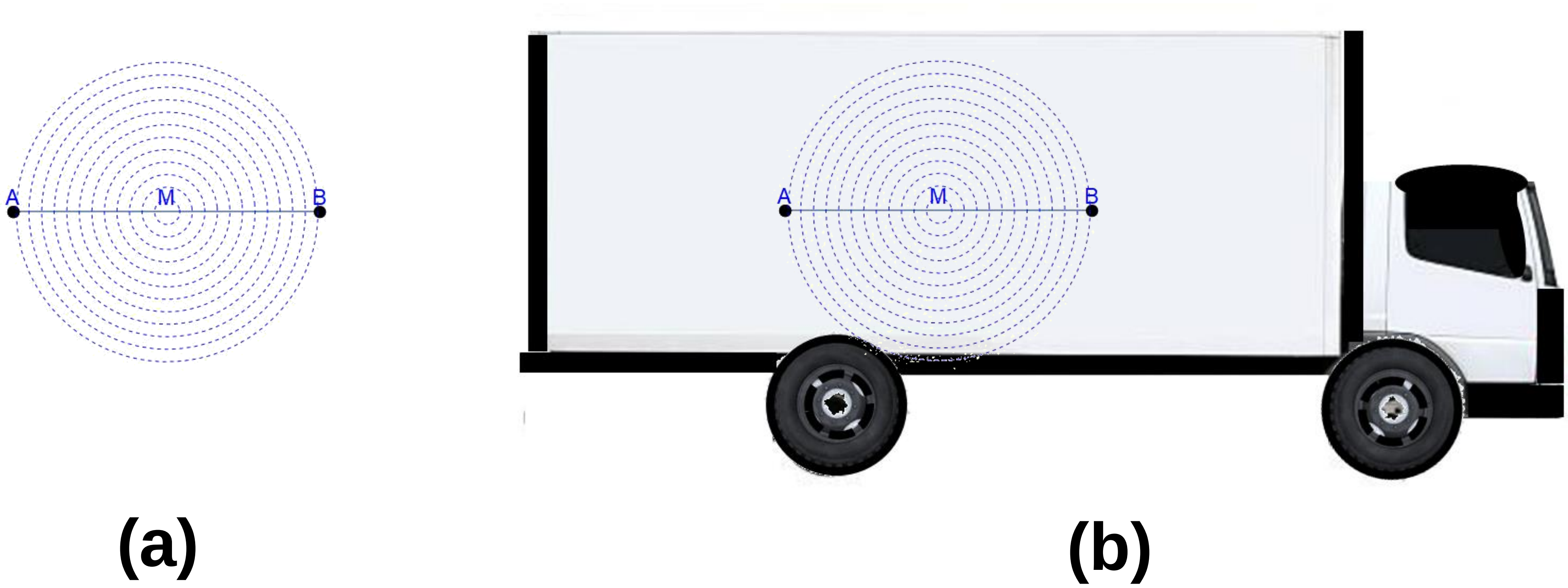
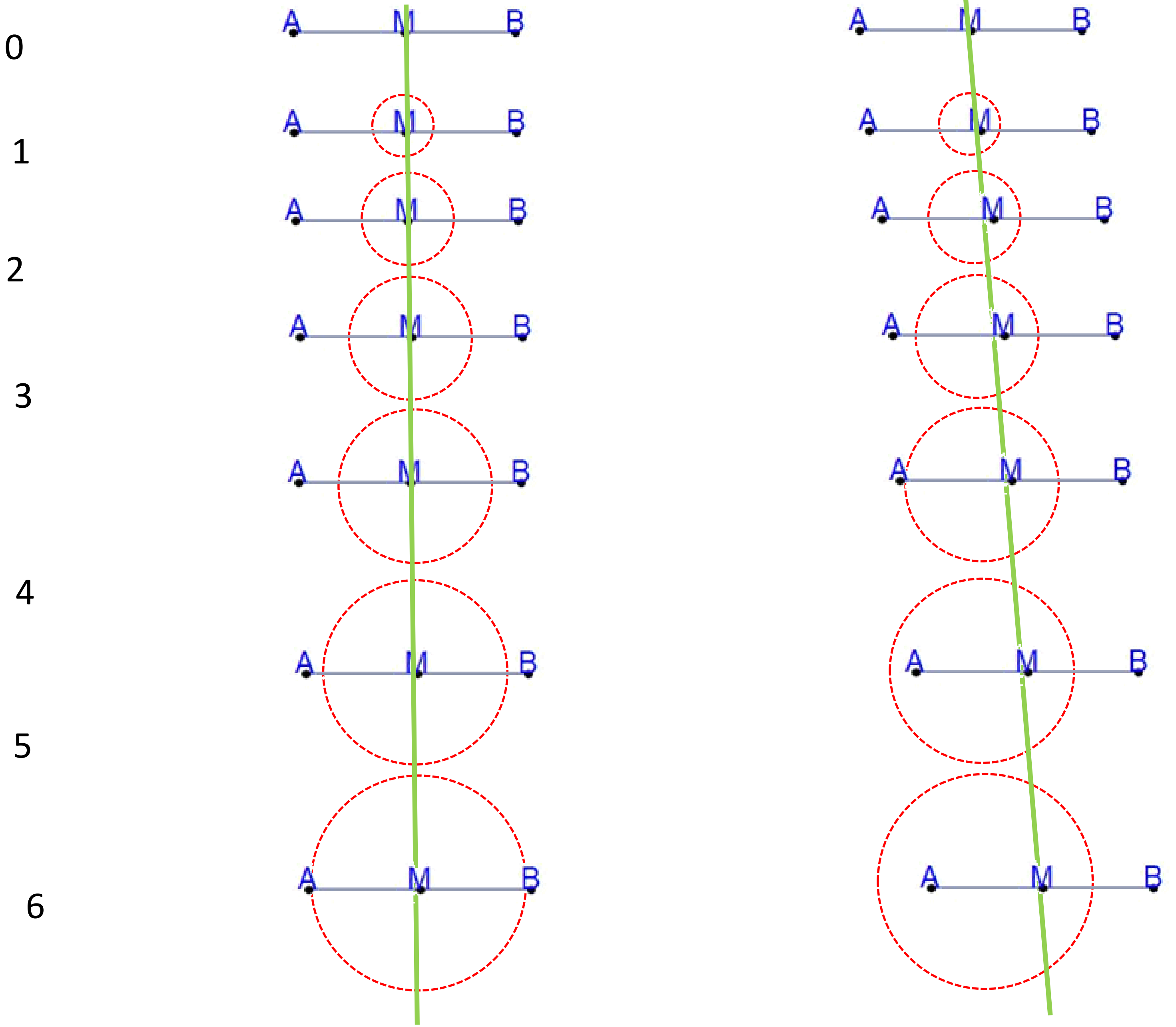
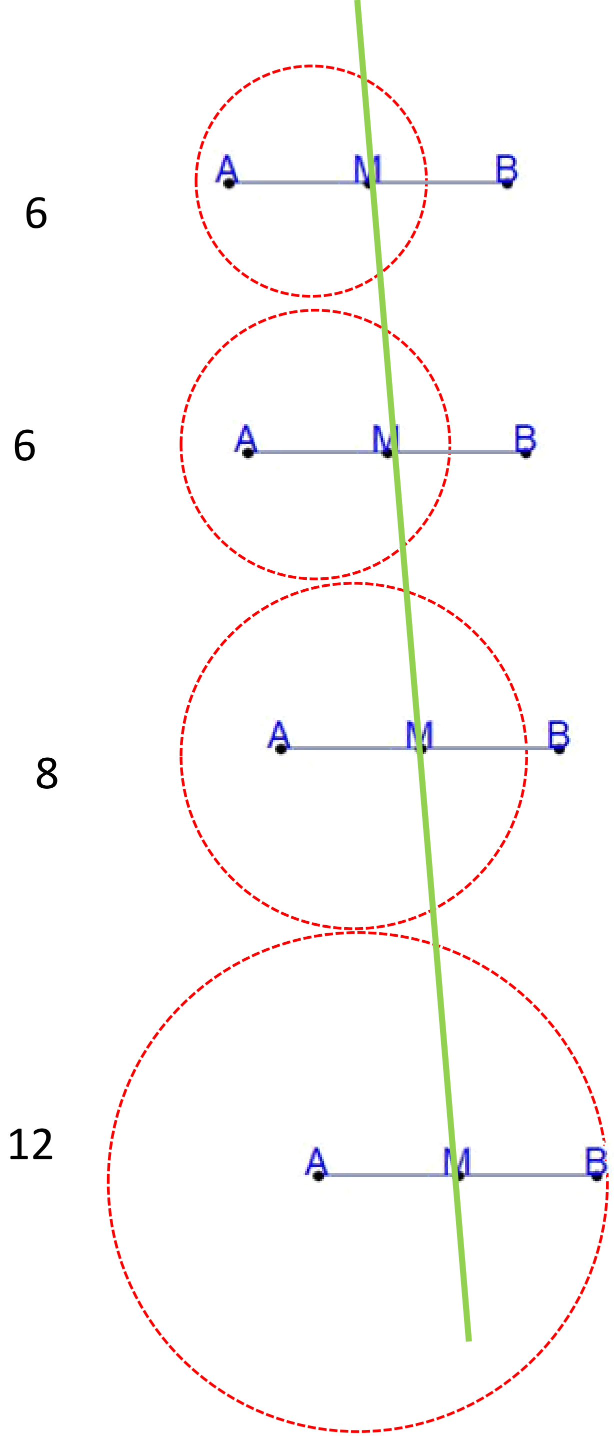


Figure 7.9 (a) Light-waves moving from M towards A and B, at a few units s of time, shown on the left column.
(b) The same experiment but the whole table is moving to the right at a constant velocity. Note the motion of the point M indicated by the green line.



(a) (b)

Continue of Figure 7.9c

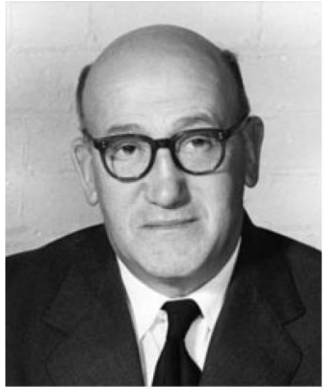


Continuation of Figure 7.10. Loop of an airplane. Add a plane at the center

Figure two twins in a cart, then one on the mountain and one on earth

Continuation of Figure 7.11. Two twins born in 2000, then separated. The one living on the top of the mountain ages faster than his brother.

Louis Essen

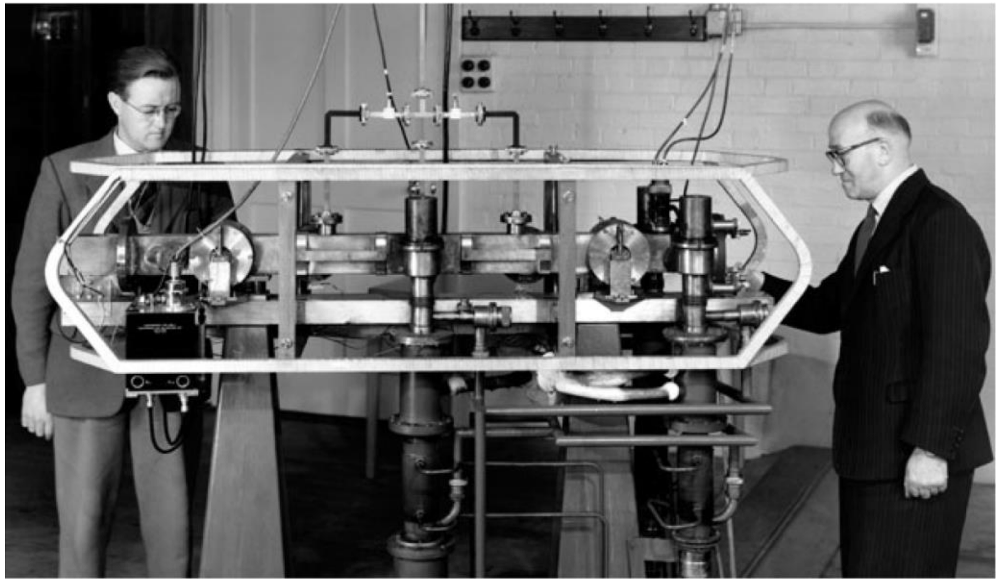


Louis Essen re-measured the velocity of light and challenged aspects of Einstein's special theory of relativity. But it was his research into the physics of frequency generation and measurement which changed the way the world now measures time. From the 1930s, when he worked on the world's first quartz oscillator-based clocks, to the 1960s, when international time switched from astronomical measurement to a "standard second" - based on his version of the atomic (caesium) clock, Essen was among the world leaders in physics.

It's 60 years since the world's first caesium atomic clock was built by Essen

Essen was invited to join the National Physical Laboratory shortly after graduation from university to work with D W Dye on 'tuning fork' clocks, and the possibility of using quartz oscillators to measure time. With Dye's death in 1933 Essen focused on the use of quartz oscillators and eventually designed the quartz ring clock.

During the war he helped to design vital technology, curing the problems of high frequency communication systems and designing special cables for use at microwave frequencies, as required for short wave radar. In 1946 he managed to record the speed of light as 299 792 kilometres per second (16 km/sec greater than the value accepted at the time). In 1950, using an improved resonator, he derived a value of 299 792.5 km/sec - within two metres per second of the laser-based figure adopted in 1975.




Energy=milk Coffee²

Faberge Museum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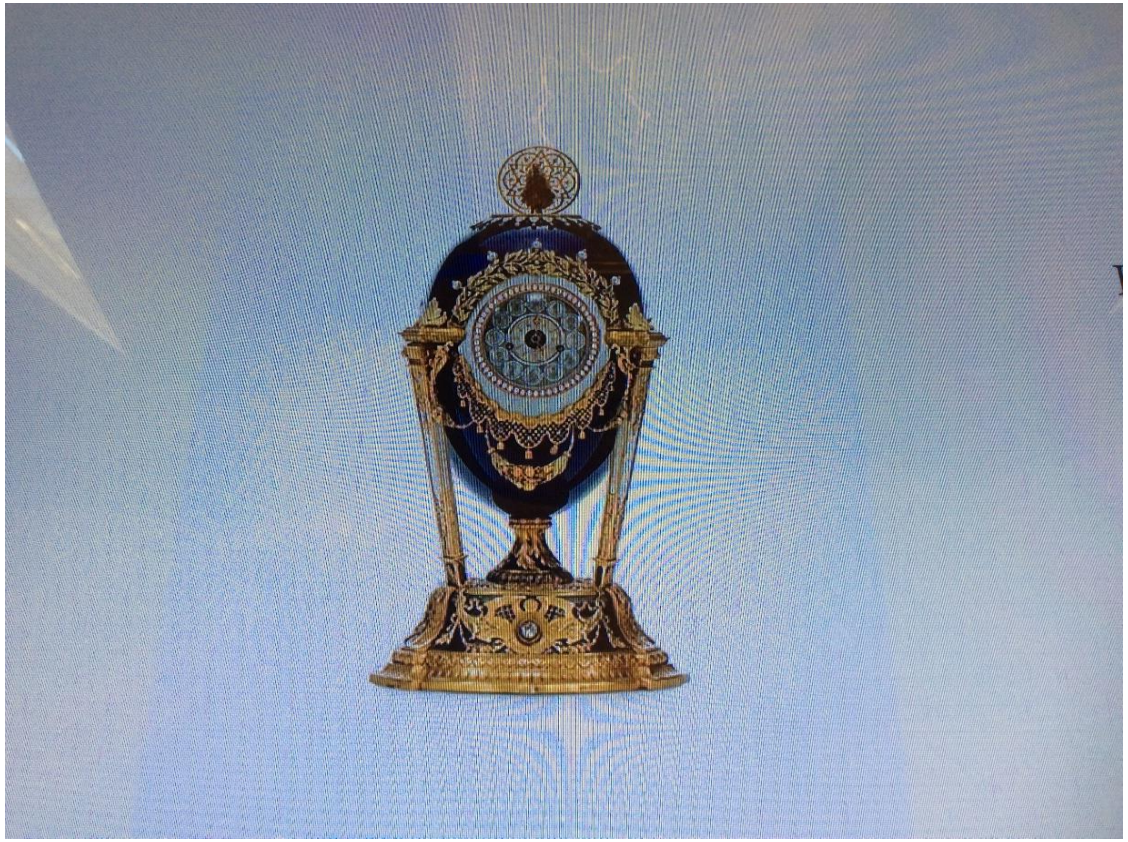

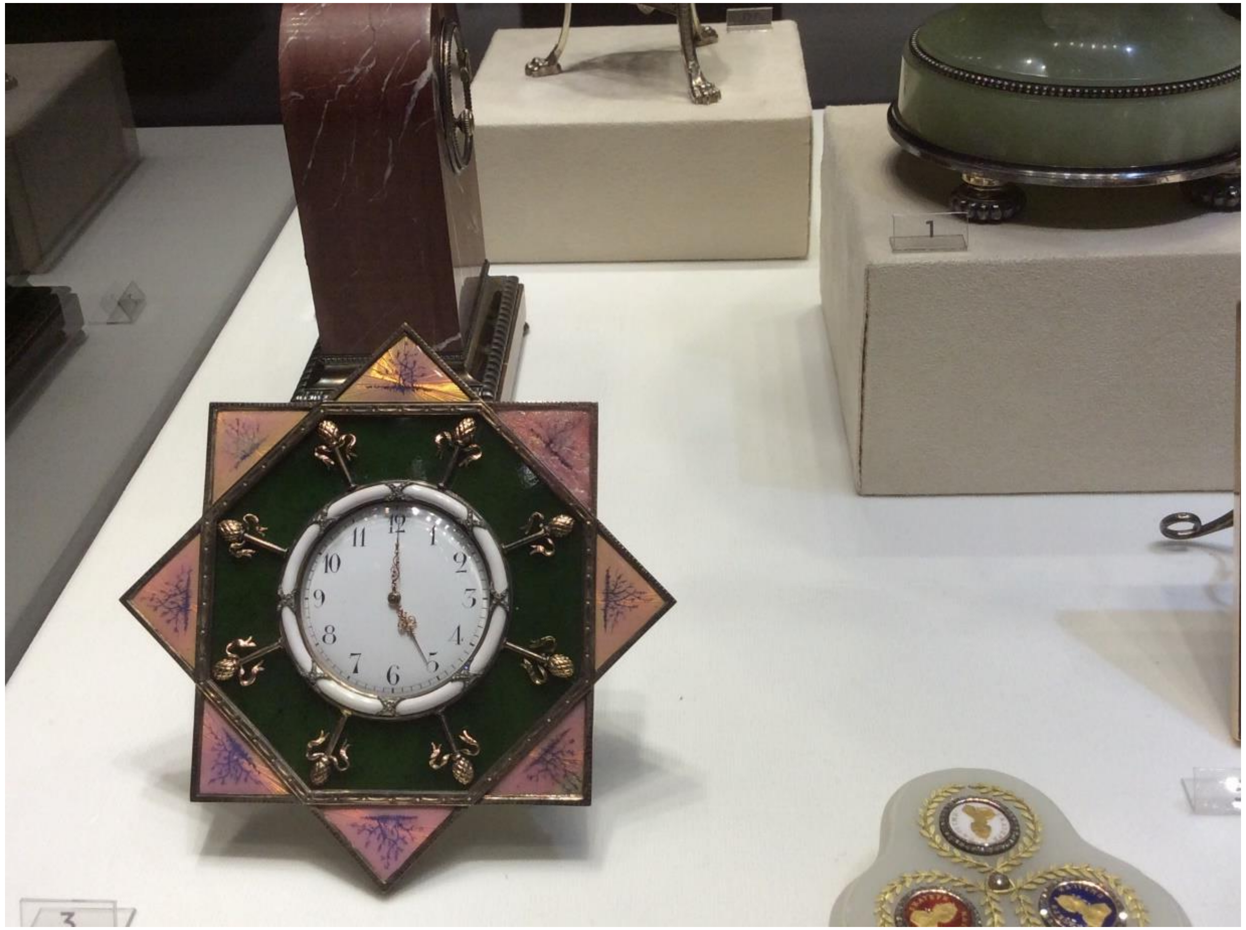
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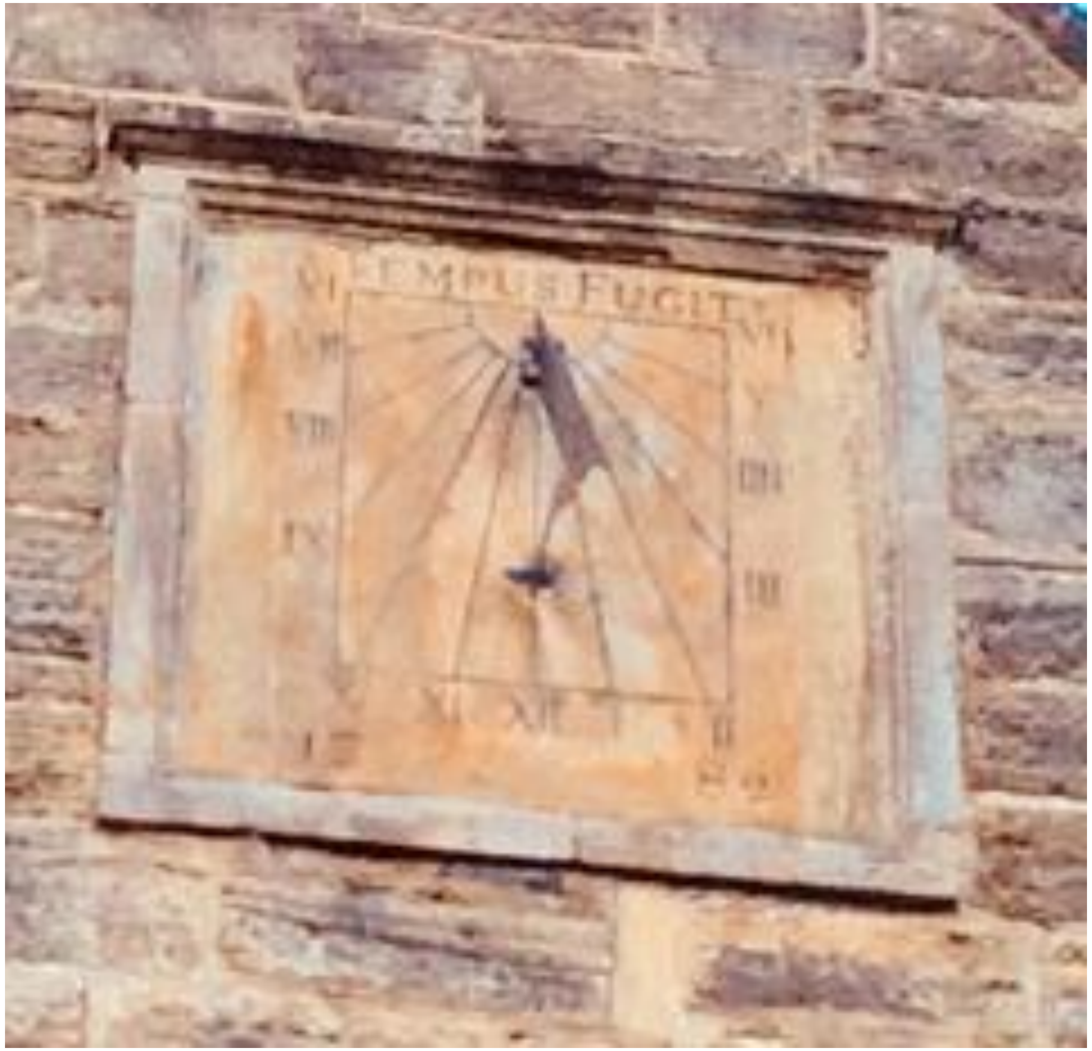
Chapter 8


EMPUS FUGIT


DEC
JAN
Spä̈ter
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Unter
Gang
lbauer
ein Wien


HIGHLIGHT
Astronomische Standuhr,
um 1810/15
Philipp Fertbauer, Wien
Philipp Fertbauer (1763–1820) zählt zu den bedeutendsten Vertretern der Wiener Uhrmacherkunst. Seine hochwertigen Fabrikate gehören zum Wertvollsten, was der Markt historischer Uhren heute zu bieten hat.
Astronomical clock,
about 1810/15
Philipp Fertbauer, Vienna
Philipp Fertbauer (1763–1820) was among the most important practitioners of the art of clockmaking in Vienna. The outstanding quality of his timepieces places them at the top end of the antique clock market today.
Wien Museum, Inv.Nr. U 232
IGHTS
KATALOG
Nr. 16


›Sägeuhr‹,
Wien, um 1780
Der Antrieb der Uhr erfolgt durch das eigene Gewicht, zum Aufziehen wird die Uhr in die Höhe geschoben. Im Lauf des Tages wandert sie nach unten, das Räderwerk greift dabei in die ›Säge‹ ein.
›Saw clock‹,
Vienna, about 1780
This clock is driven by its own weight and has to be pushed up to wind it. As it descends over the course of the day the wheelwork meshes with the ›saw‹.


HIGHLIGHT
Astronomische Kunstuhr, um 1762–1769
David a S. Cajetano [Rutschmann], Wien
Vor allem im 18. Jahrhundert widmeten sich wissenschaftlich hoch spezialisierte Kleriker, sogenannte Priestermechaniker, der Konstruktion astronomischer Uhren zur Abbildung der zeitgenössischen theologischen Vorstellungen des Kosmos. Diese ›astronomische Kunstuhr‹ wurde von dem Laienbruder David Rutschmann alias Frater David a Sancto Cajetano (1726–1796) im Wiener Augustiner Hofkloster angefertigt. Mithilfe neuartiger Räderberechnungen gelang dem Erbauer eine Unzahl zeittechnischer, kalendarischer und astronomischer Anzeigen. Dieses 1769 fertiggestellte Werk galt als Sensation.
Mehr Information erhalten Sie in der Box an der Wand.
Astronomical clock, about 1762–1769
David a S. Cajetano [Rutschmann], Vienna
More detailed information is provided in the wall box.
HIGHLIGHTS
KATALOG
Nr. 10




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8


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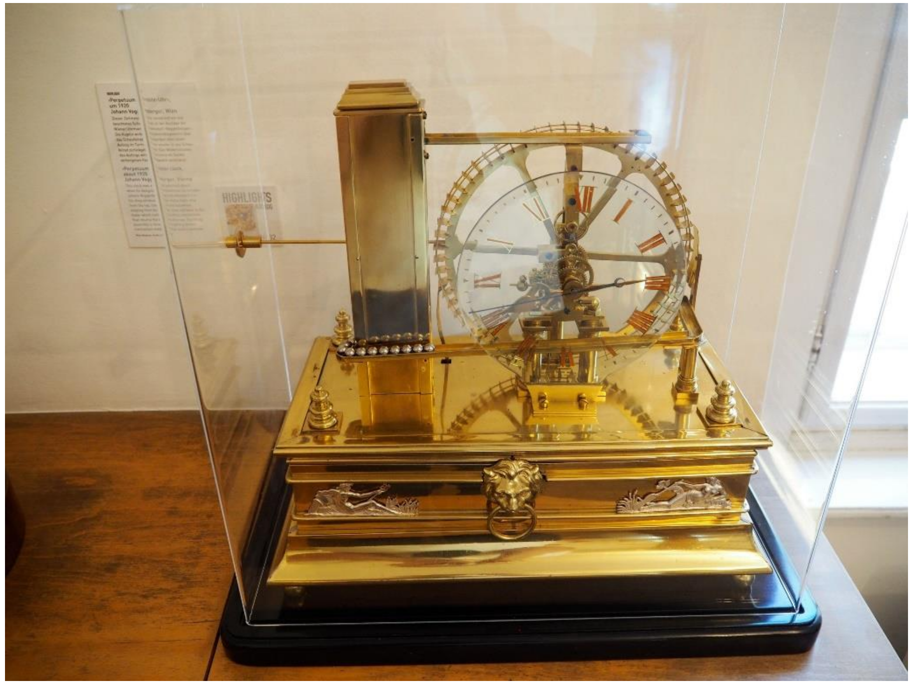

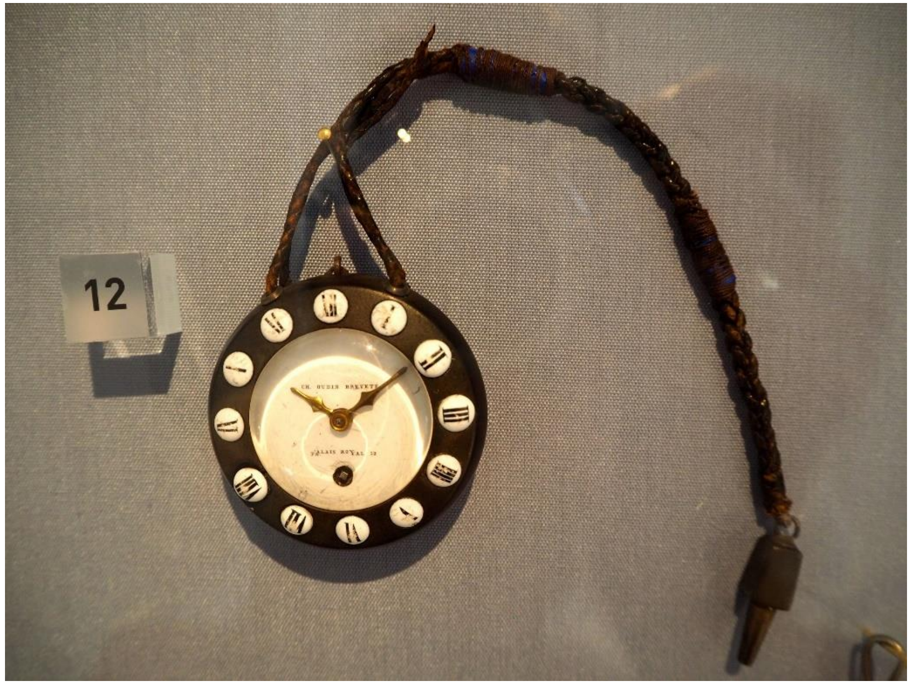
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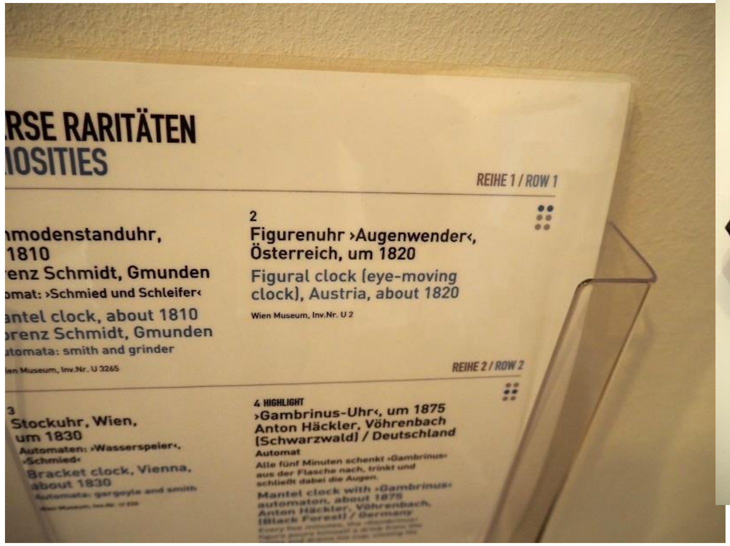

RSE RARITÄTEN
IOSITIES
REIHE 1 / ROW 1
nmodenstanduhr,
1810
renz Schmidt, Gmunden
omat: ›Schmied und Schleifer‹
antel clock, about 1810
orenz Schmidt, Gmunden
utomata: smith and grinder
en Museum, Inv.Nr. U 3265
2
Figurenuhr ›Augenwender‹,
Österreich, um 1820
Figural clock (eye-moving
clock), Austria, about 1820
Wien Museum, Inv.Nr. U 2
REIHE 2 / ROW 2
3
Stockuhr, Wien,
um 1830
Automaten: ›Wasserspeier‹,
›Schmied‹
Bracket clock, Vienna,
about 1830
Automata: gargoyle and smith
4 HIGHLIGHT
›Gambrinus-Uhr‹, um 1875
Anton Häckler, Vöhrenbach
(Schwarzwald) / Deutschland
Automat
Alle fünf Minuten schenkt ›Gambrinus‹
aus der Flasche nach, trinkt und
schließt dabei die Augen.
Mantel clock with ›Gambrinus‹
automaton, about 1875
Anton Häckler, Vöhrenbach
(Black Forest) / Germany

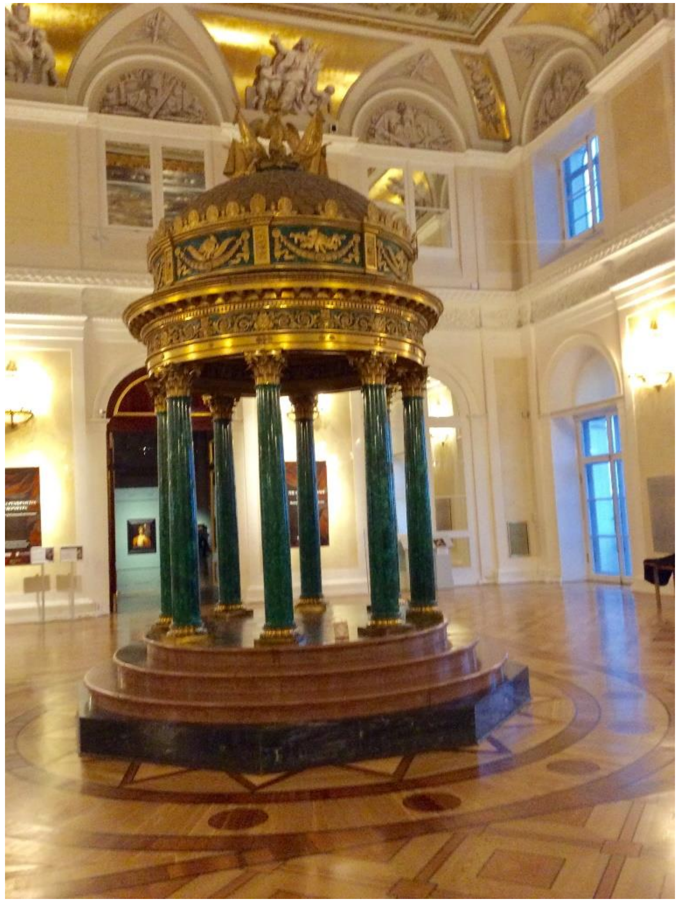

Rahmenuhr, um1860/70
Bing, Paris
Frame clock, about 1860/70
Bing, Paris

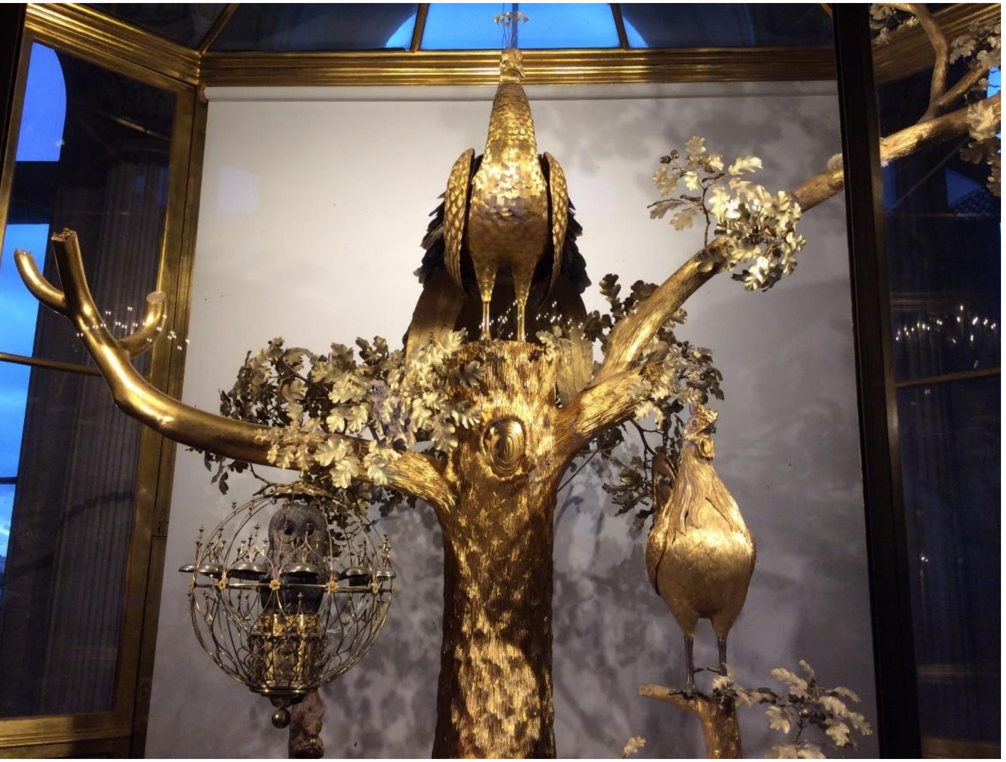

PATEK PHILIPPE
GENEVE

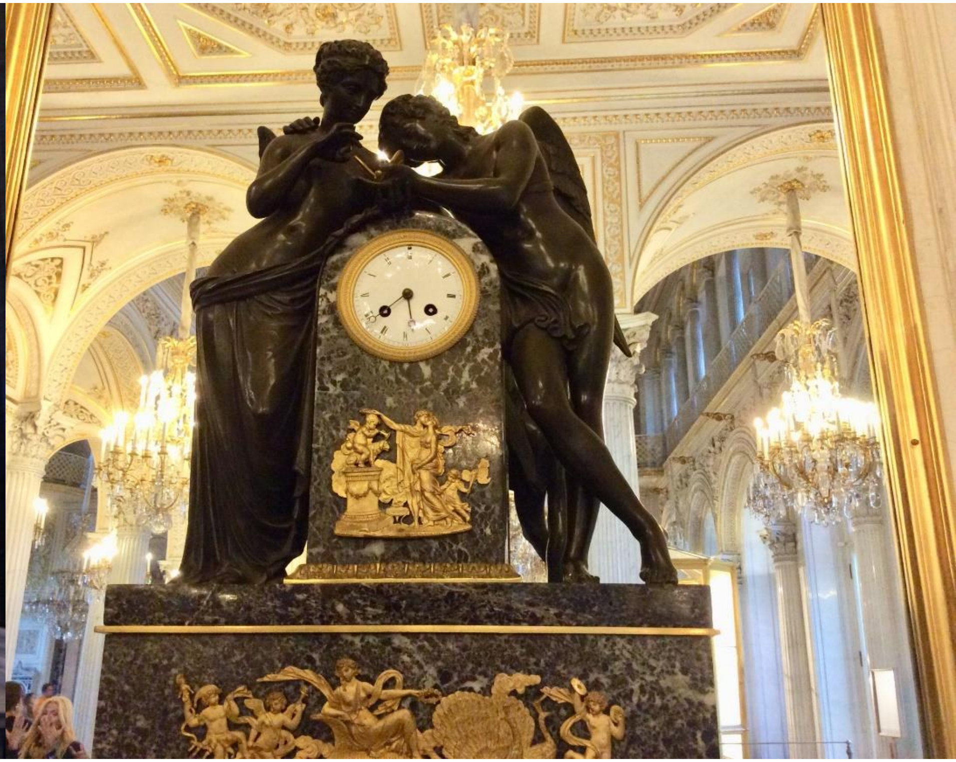

Wanduhr, Schwarzwald
(Deutschland), um 1870
Wall clock, Black Forest
(Germany), about 1870
Wien Museum, Inv.Nr. U 2865


Kommodenstanduhr,
Schweiz, 1857
Mantel clock,
Switzerland, 1857
Wien Museum, Inv.Nr. U 363

Hermitage museum







Chapter 9

(a) **(b)**

Figure 9.1. An urn containing four marbles, two black and two white.

Figure 9.2

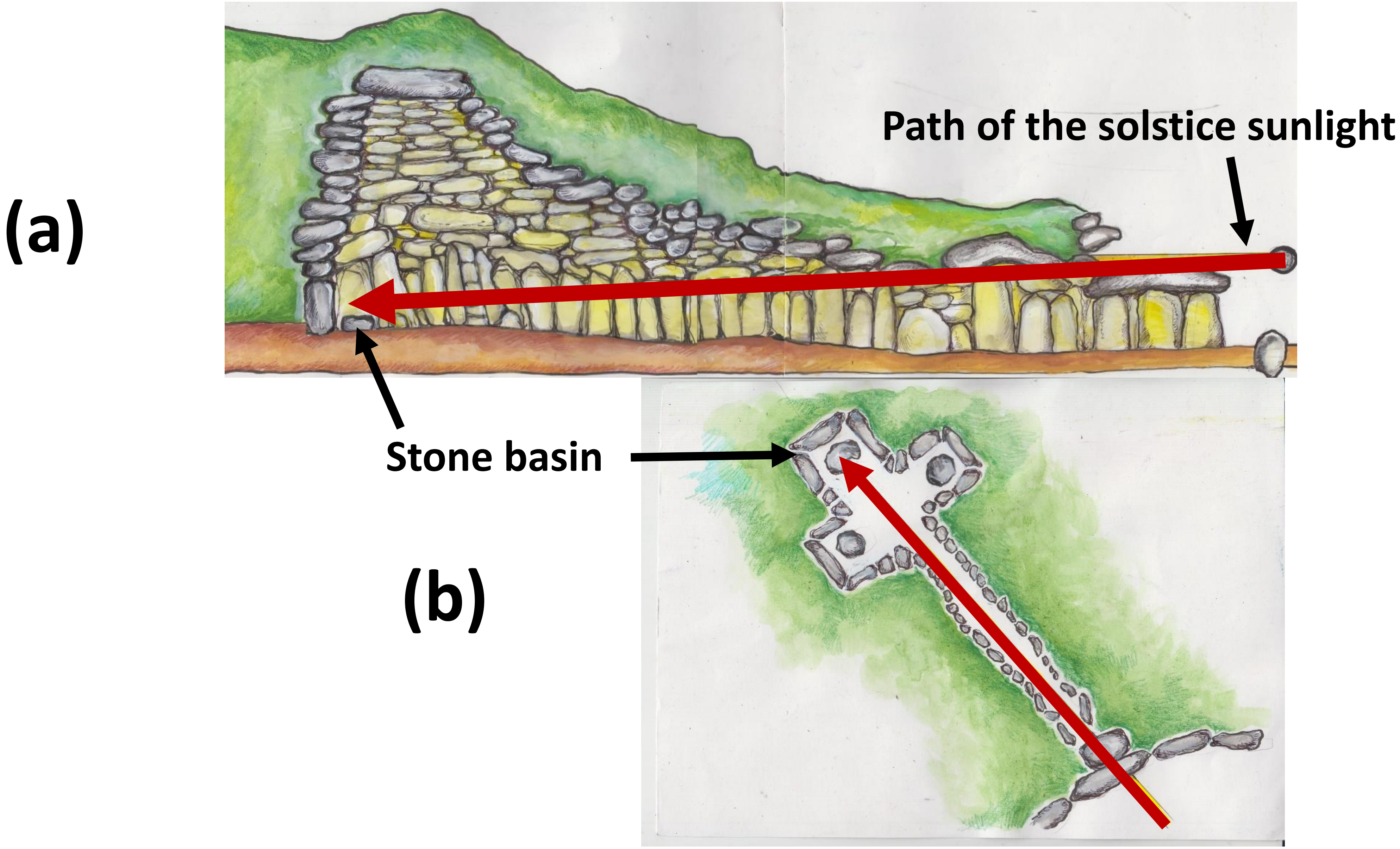


Figure 9.3 Two views of the passage of solstice light in Newgrange, from the southeast entrance into the Stone Basin (red arrow): (a) side diagram and (b) diagram from above


Winter Solstice 1967

Chapters 10, 11

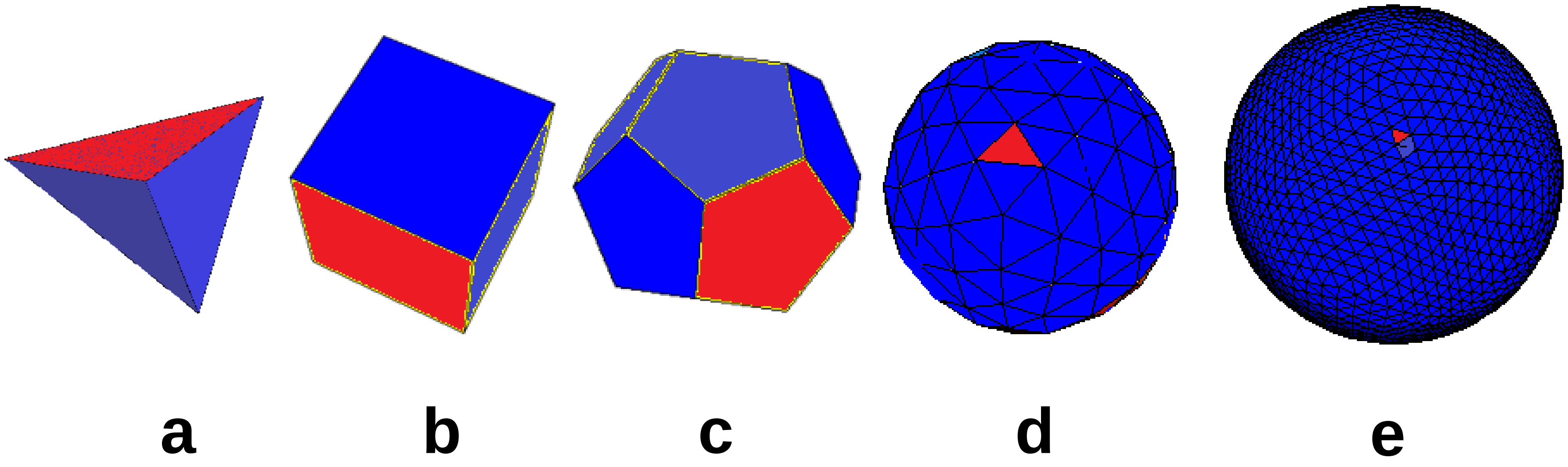


Figure 10.1. Dice with different number of faces.
In all of these dice one face is red and all the other faces are blue.

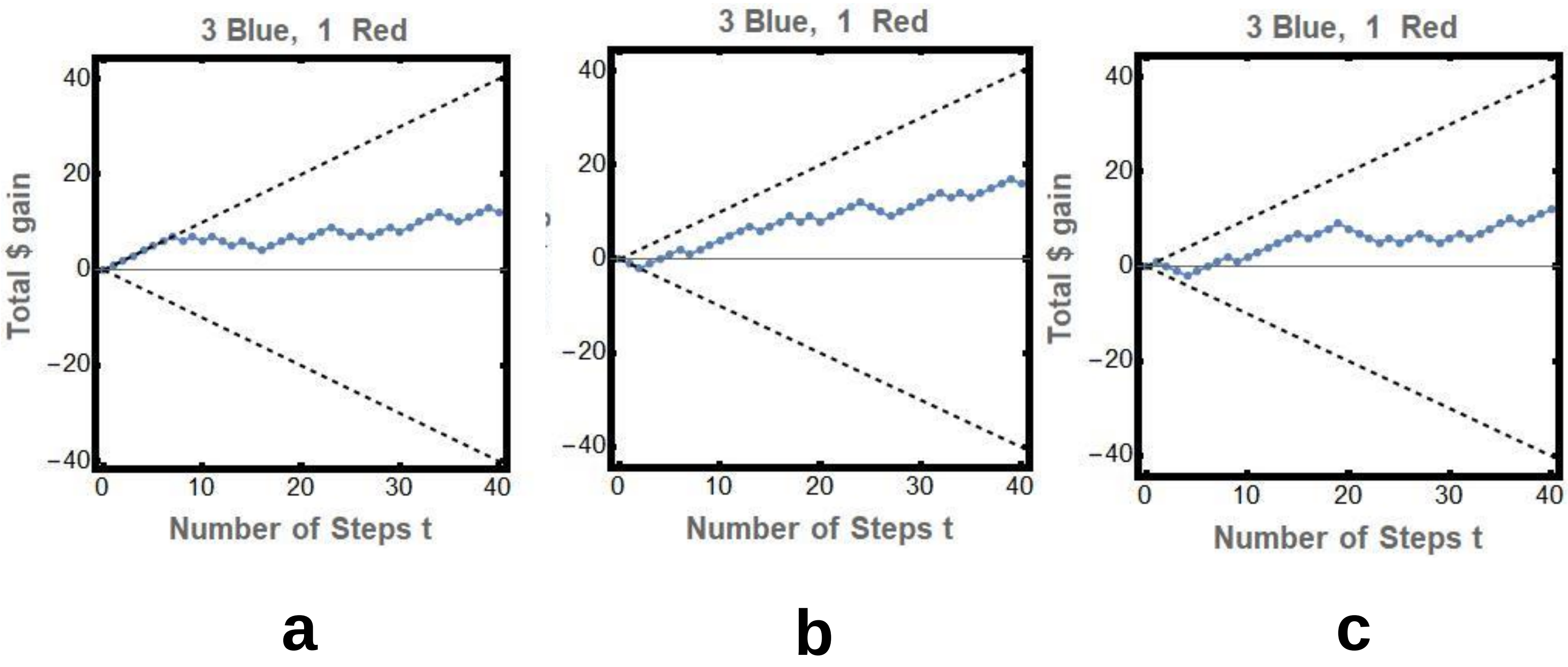
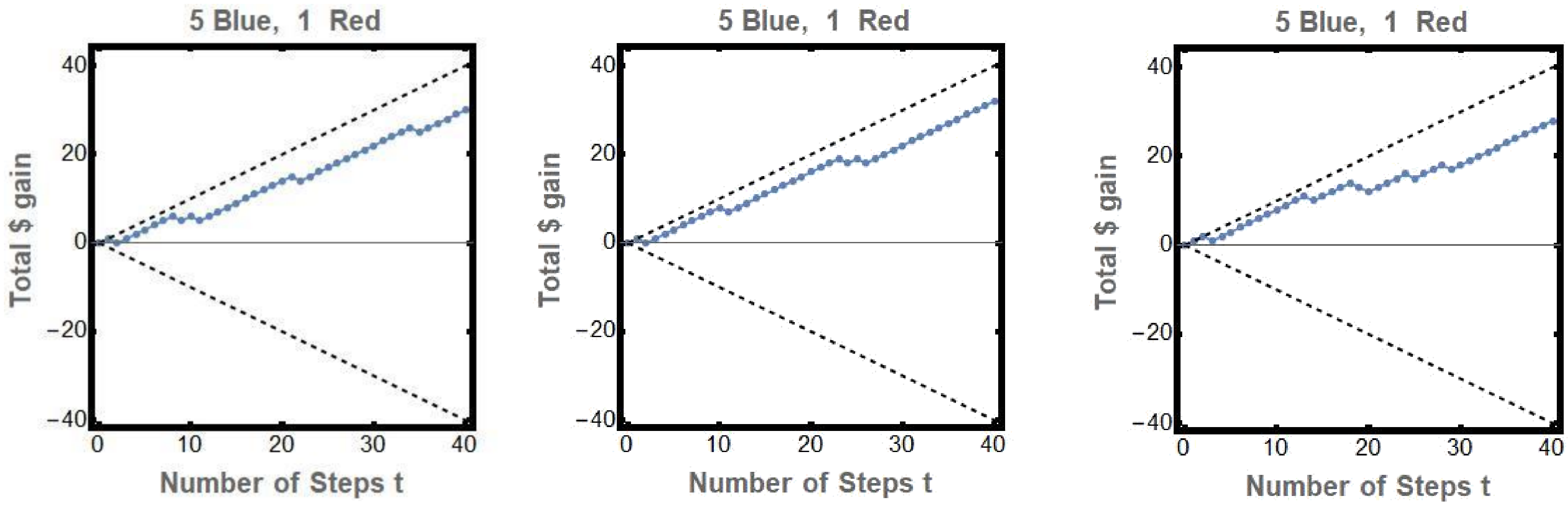
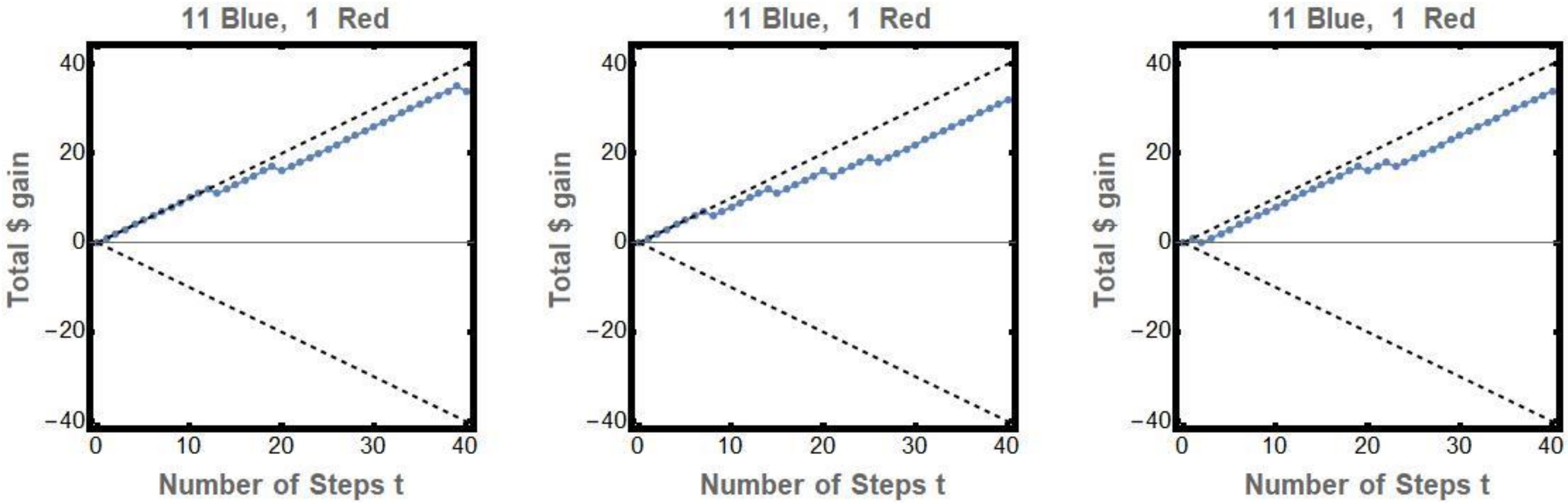


Figure 10.2. The total number of dollars you will have after t steps, in playing with the die having one red and three blue faces.
The two dashed lines are the “limiting” cases,
when you either gain or lose at each step.



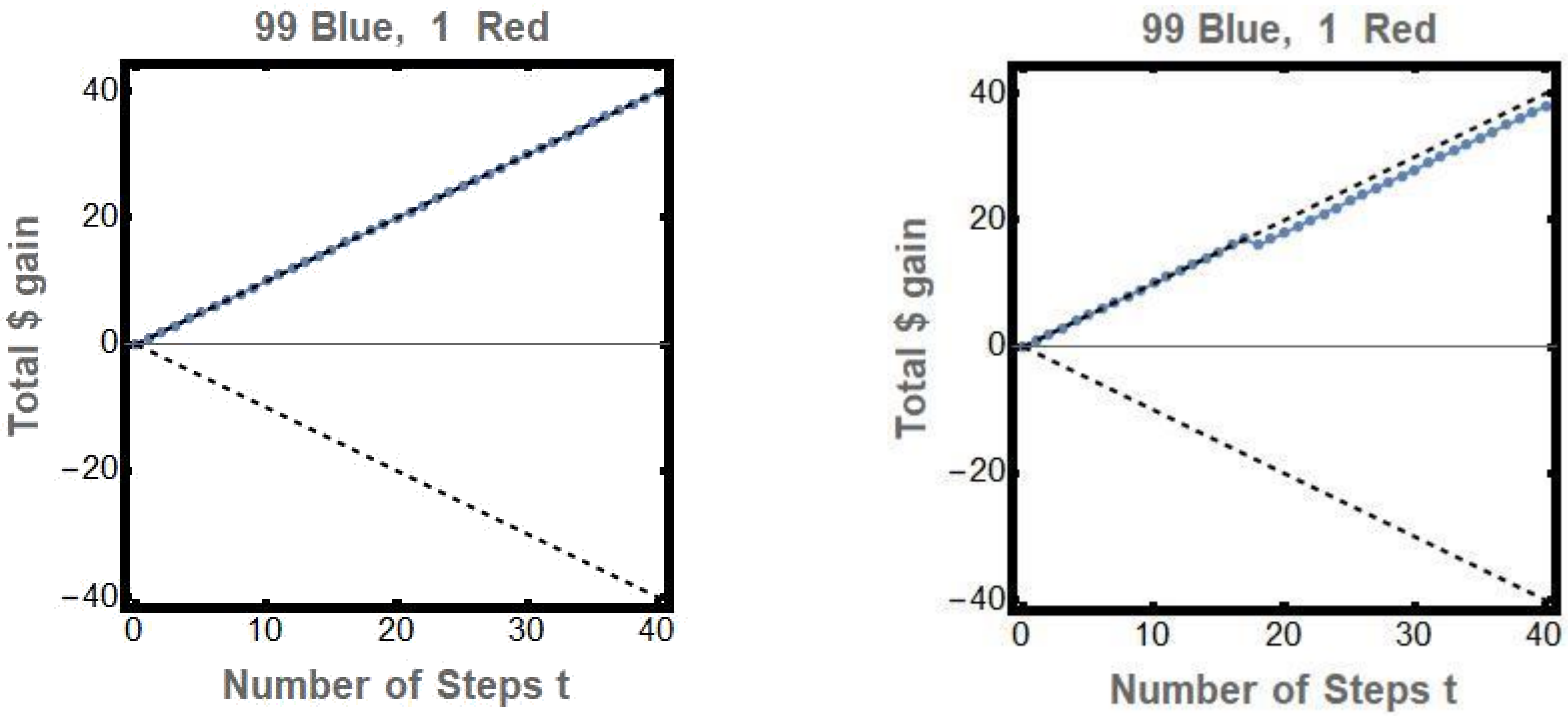
a b c

Figure 10.3. The total number of dollars you will have after t steps, in playing with the die having one red and five blue faces.
The two dashed lines are the “limiting” cases,
when you either gain or lose at each step.



a **b** **c**

Figure 10.4. The total number of dollars you will have after t steps, in playing with the die having one red and 11 blue faces.
The two dashed lines are the “limiting” cases,
when you either gain or lose at each step.



a **b**

Figure 10.5. The total number of dollars you will have after t steps, in playing with the die having one red and 99 blue faces.
The two dashed lines are the “limiting” cases, when you either gain or lose at each step.

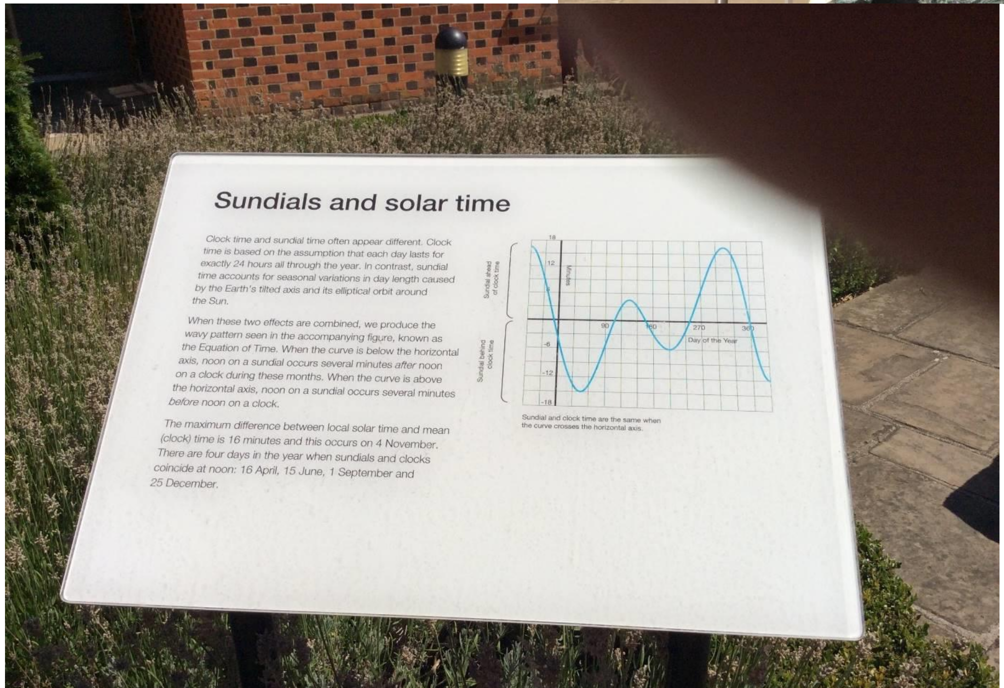

Royal
Observatory
Greenwich


'To find out the so much desired Longitude of Places for perfecting the art of Navigation'
— The Royal Charter for the Royal Observatory, 1675
Welcome to the Royal Observatory, the historic home of British astronomy, Greenwich Mean Time and the Prime Meridian of the world.
King Charles II signed a Royal Warrant in June 1675 to authorize building the Royal Observatory on the foundations of a tower in Greenwich Park. This site had been formerly used by Henry VIII as a guest house and hunting lodge. The Observatory was built with spare bricks from Tilbury Fort and recycled lead, iron and timber from the Tower of London. Labour and other costs were covered by the sale of decayed gunpowder for recycling. Christopher Wren's design was ready for the first Astronomer Royal, John Flamsteed, to take up residence in June 1676. The tight budget of £500 (just over £41,500 today) overran by just £20.

Welcome to the Royal Observatory, the historic home of British astronomy, Greenwich Mean Time and the Prime Meridian of the world.

King Charles II signed a Royal Warrant in June 1675 to authorize building the Royal Observatory on the foundations of a tower in Greenwich Park. This site had been formerly used by Henry VIII as a guest house and hunting lodge. The Observatory was built with spare bricks from Tilbury Fort and recycled lead, iron and timber from the Tower of London. Labour and other costs were covered by the sale of decayed gunpowder for recycling. Christopher Wren's design was ready for the first Astronomer Royal, John Flamsteed, to take up residence in June 1676. The tight budget of £500 (just over £41,500 today) overran by just £20.


udio guides


Sundials and solar time
Clock time and sundial time often appear different. Clock time is based on the assumption that each day lasts for exactly 24 hours all through the year. In contrast, sundial time accounts for seasonal variations in day length caused by the Earth's tilted axis and its elliptical orbit around the Sun.
When these two effects are combined, we produce the wavy pattern seen in the accompanying figure, known as the Equation of Time. When the curve is below the horizontal axis, noon on a sundial occurs several minutes *after* noon on a clock during these months. When the curve is above the horizontal axis, noon on a sundial occurs several minutes *before* noon on a clock.
The maximum difference between local solar time and mean (clock) time is 16 minutes and this occurs on 4 November. There are four days in the year when sundials and clocks coincide at noon: 16 April, 15 June, 1 September and 25 December.
Sundial ahead of clock time
Sundial behind clock time
Minutes
18
12
-6
-12
-18
90
270
Day of the Year
Sundial and clock time are the same when the curve crosses the horizontal axis.

Sundials and solar time

Clock time and sundial time often appear different. Clock time is based on the assumption that each day lasts for exactly 24 hours all through the year. In contrast, sundial time accounts for seasonal variations in day length caused by the Earth's tilted axis and its elliptical orbit around the Sun.

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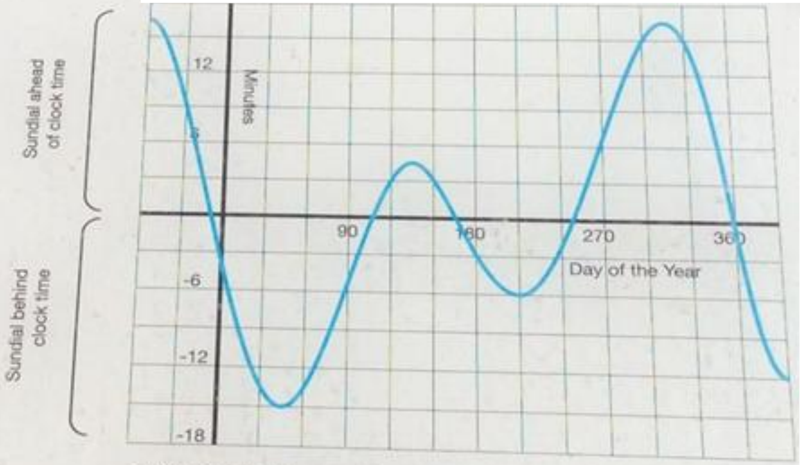


Sundial and clock time are the same when the curve crosses the horizontal axis.

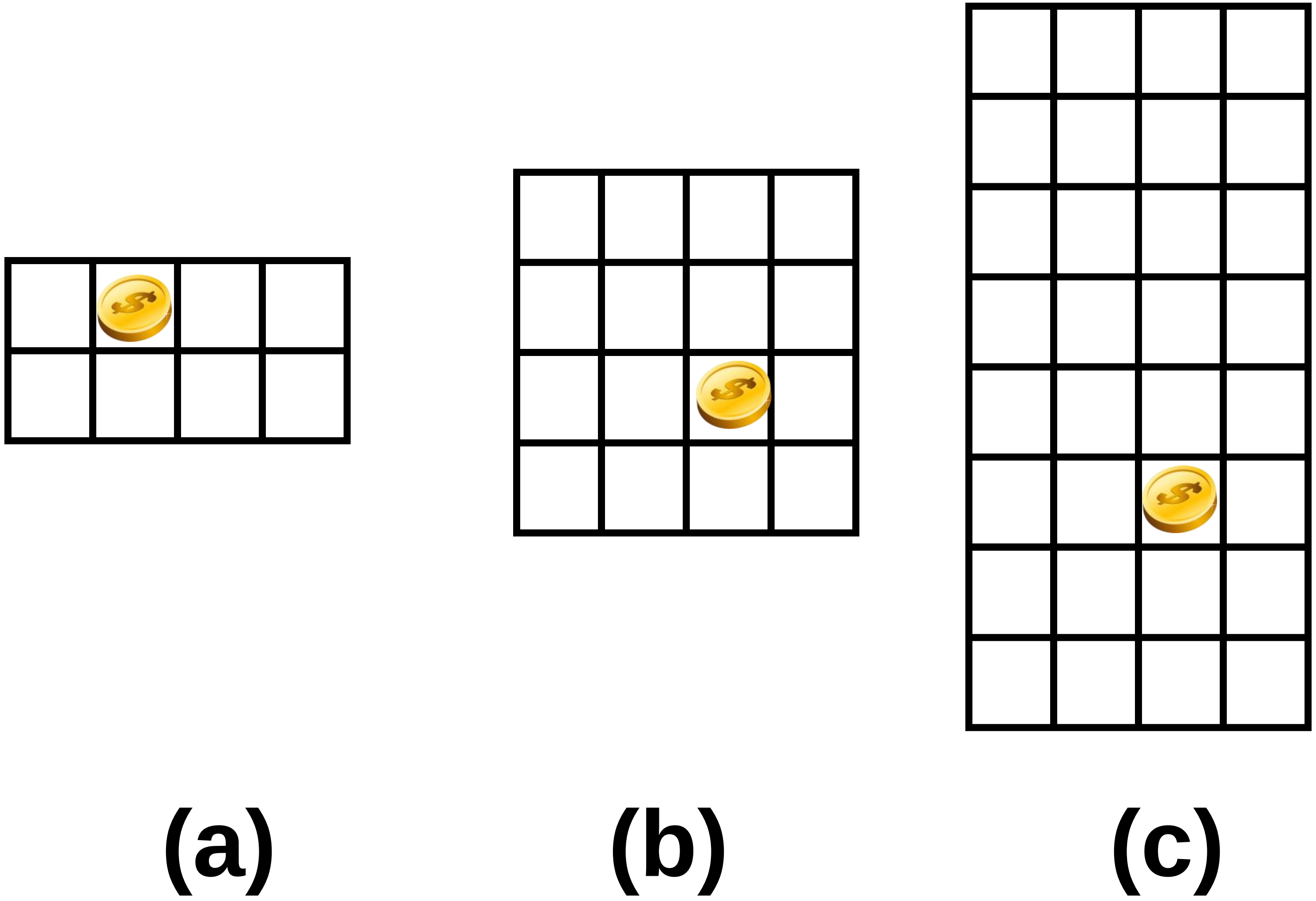


Figure 11.1. A coin is hidden in one of (a) eight boxes, (b) 16 boxes, and (c) 32 boxes.

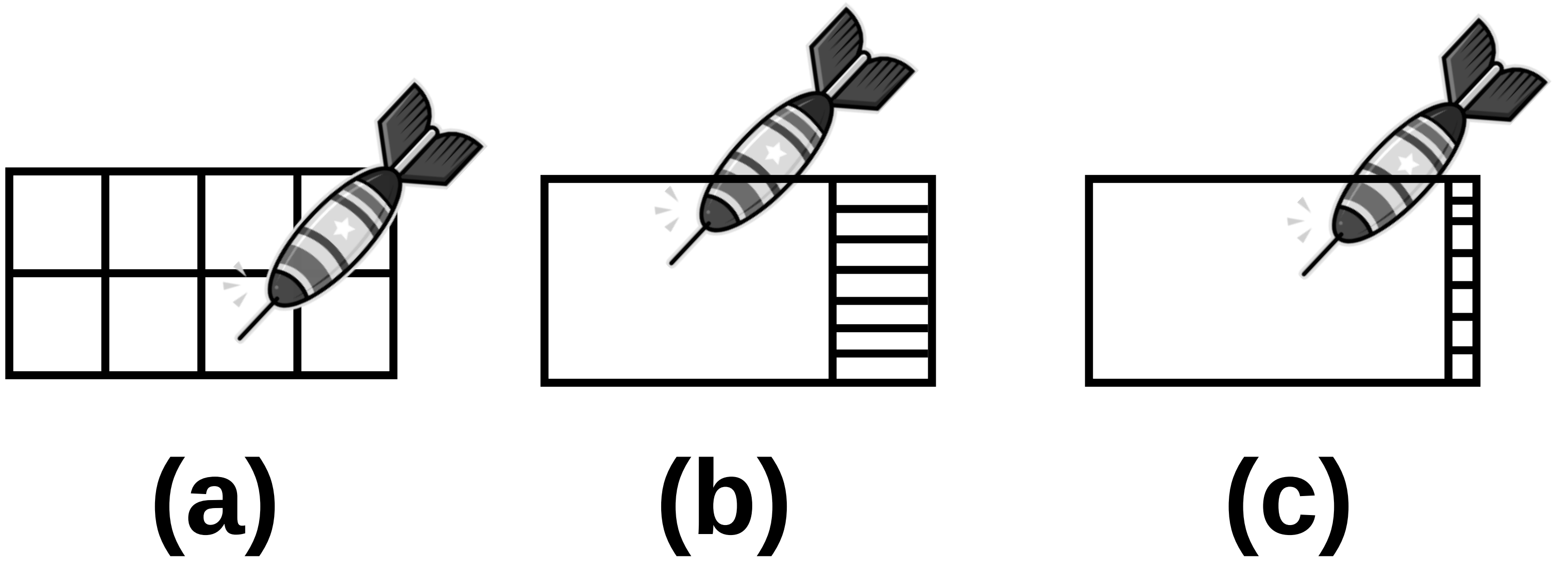


Figure 11.2. Uniform (a), and non-uniform games (b) and (c)

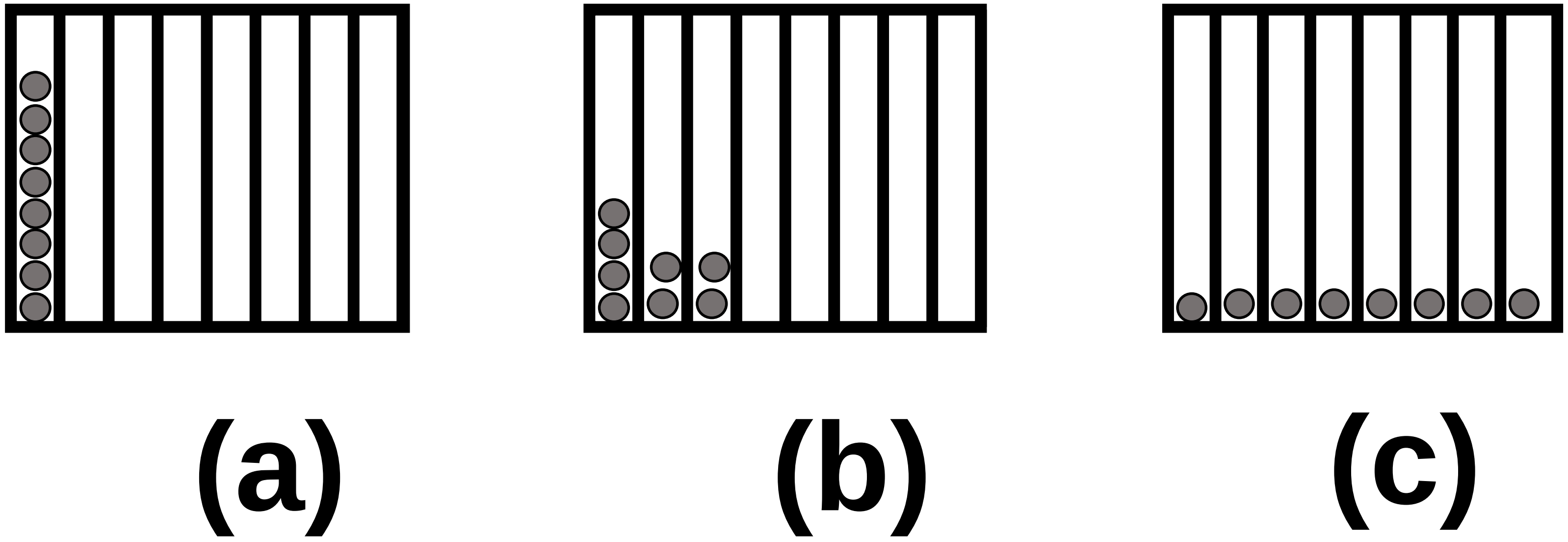
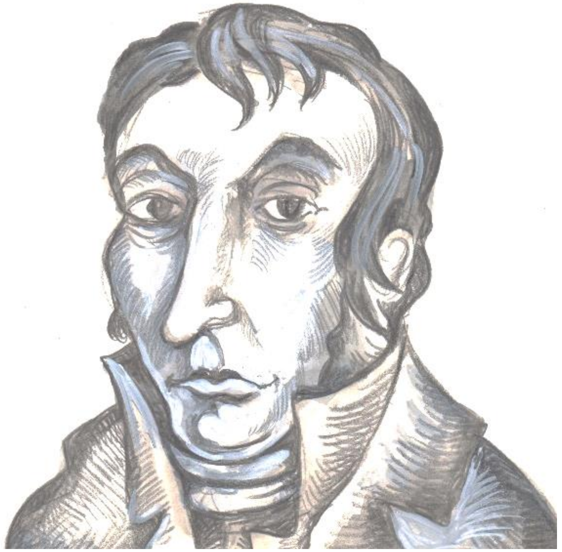


Figure 11.3. (a) The first distribution of eight marbles in eight cells.
(b) The second distribution of the eight marbles.
(c) The third distribution of the eight marbles.



$$\mathbf{A_V} \approx 6.022 \times 10^{23}$$

Figure 11.4. Amedeo Avogadro and Avogadro Number

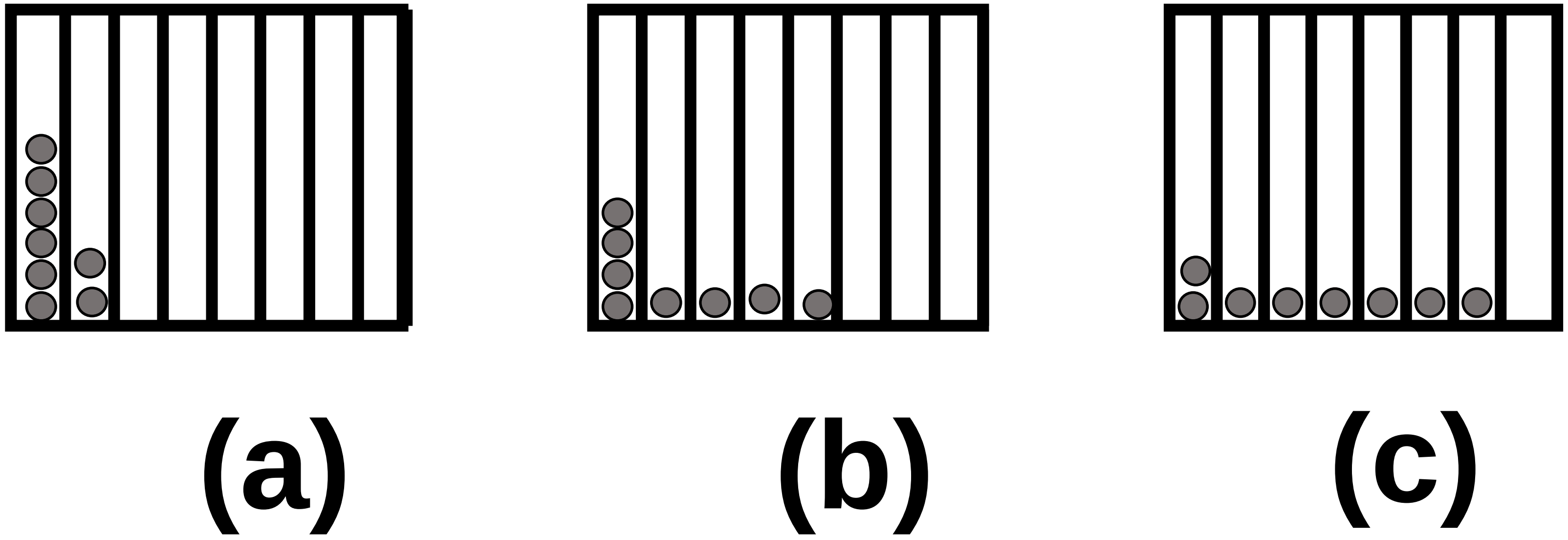


Figure 11.5. (a) The first distribution of eight marbles in eight cells.
(b) The second distribution of the eight marbles.
(c) The third distribution of the eight marbles.

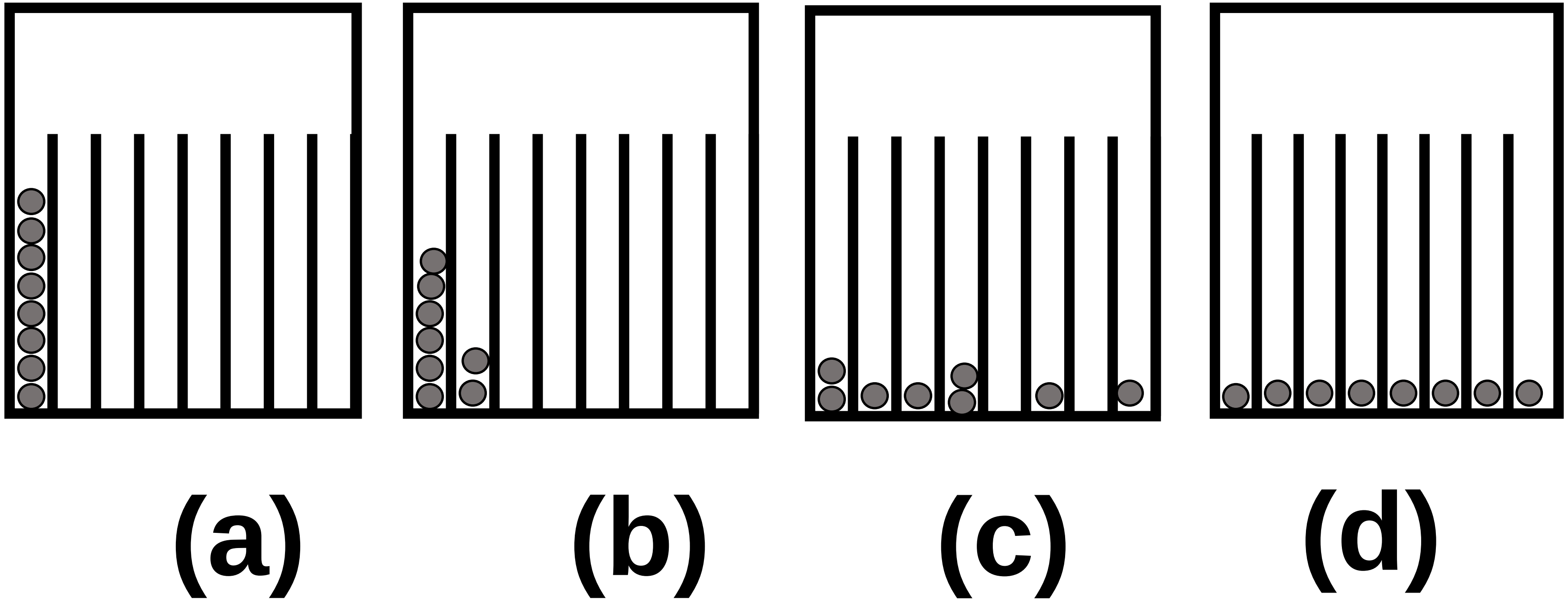


Figure 11.6. Same as in Figure 12.3,
but the marbles can move from one cell to another.
(a) The initial configuration of eight marbles in eight cells.
(b) The configuration of the eight marbles after a short period of time.
(c) The configuration of the eight marbles after a long period of time.
(d) The configuration after a very long period of time.

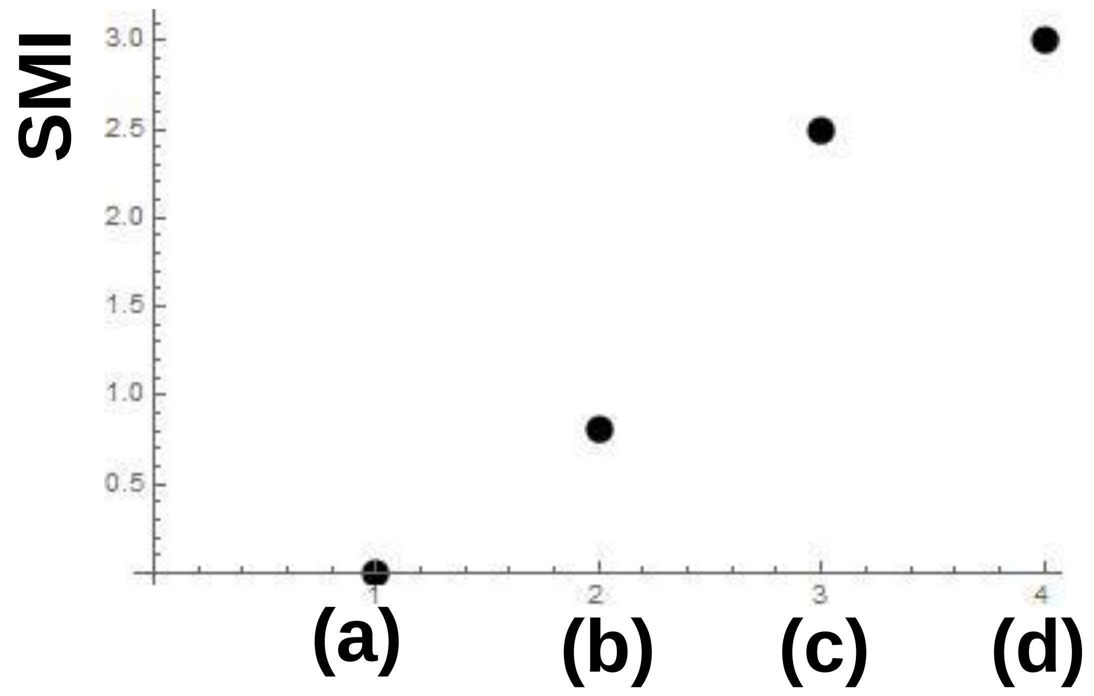


Figure 11.7. Values of the SMI for the four cases in figure 11.6.

$$\mathrm{SMI} = -\sum_{i=1}^{n} P_i \,\mathrm{Log}(P_i)$$

Claude Shannon

BOX 11.1 Shannon's Measure of Information.

$$\mathrm{SMI} = -\sum_{i=1}^{n} P_i \,\mathrm{Log}(P_i)$$

$$\mathrm{Pr(distribution} = \mathrm{C} \times 2^{\,N \times \mathrm{SMI(distribution)}}$$

BOX 11.2 Relationship between the
SMI per particle and the Super-Probability (Pr).

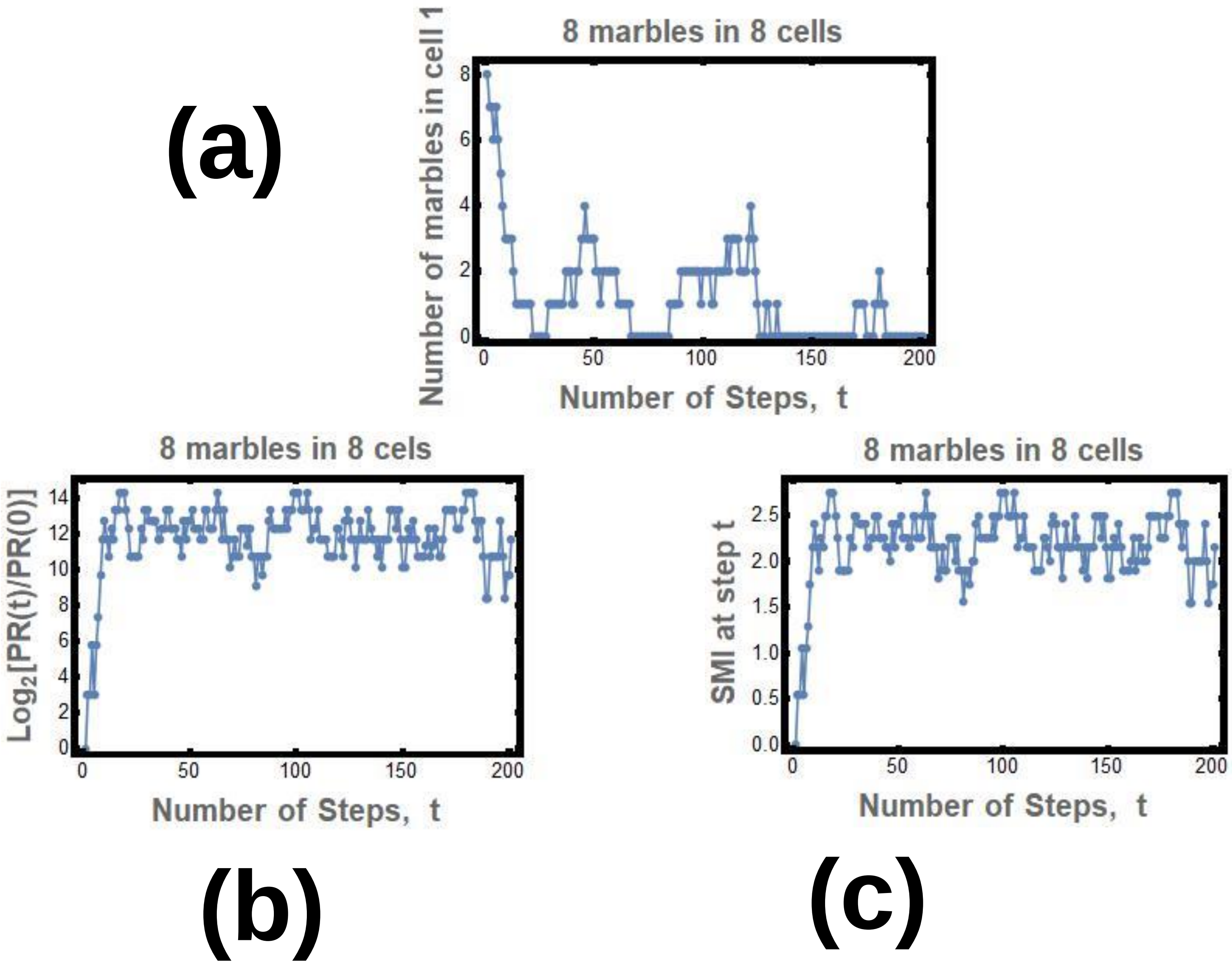


Figure 11.8. Simulated results for N = 8

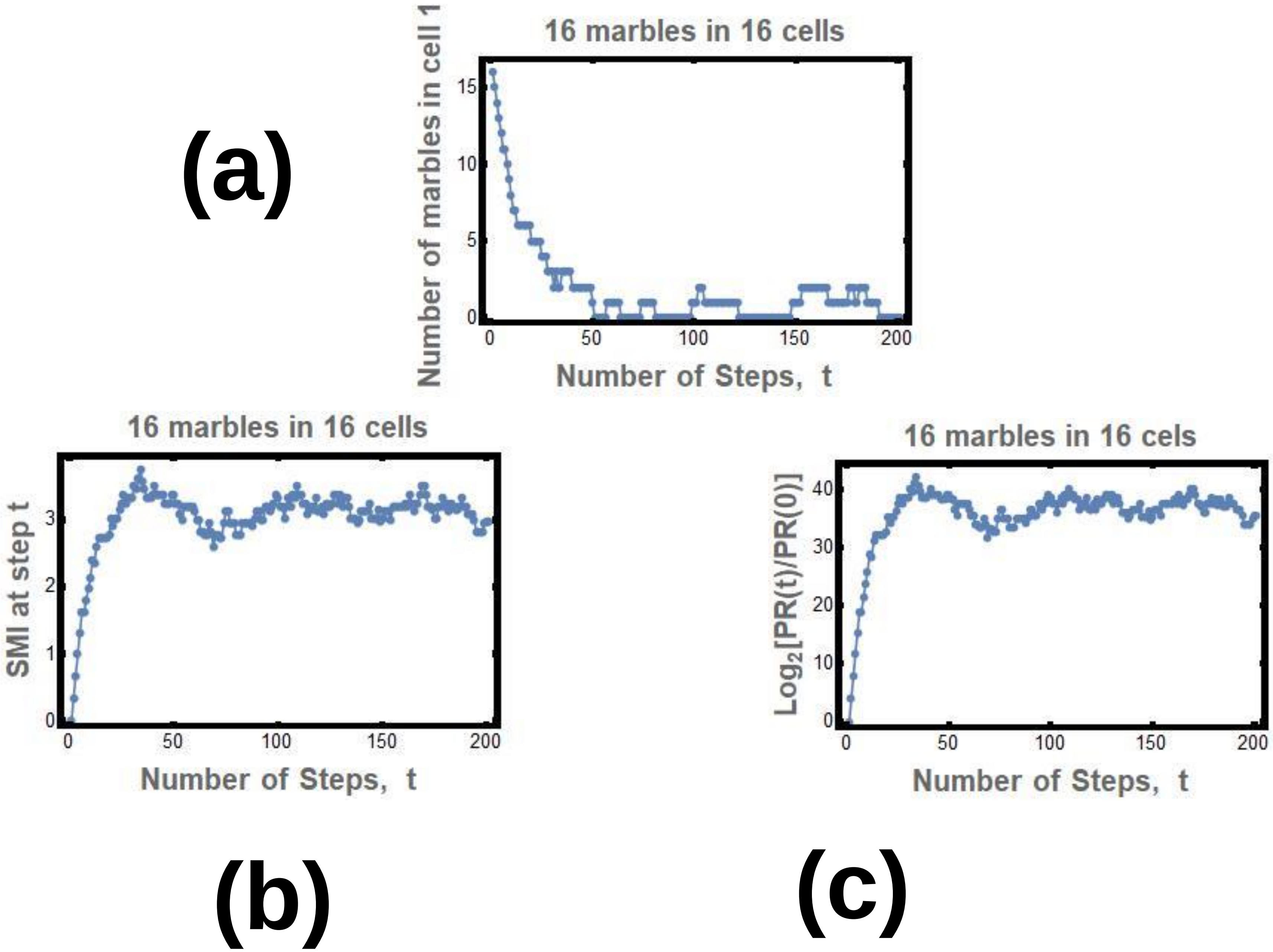


Figure 11.9. Simulated results for N = 16

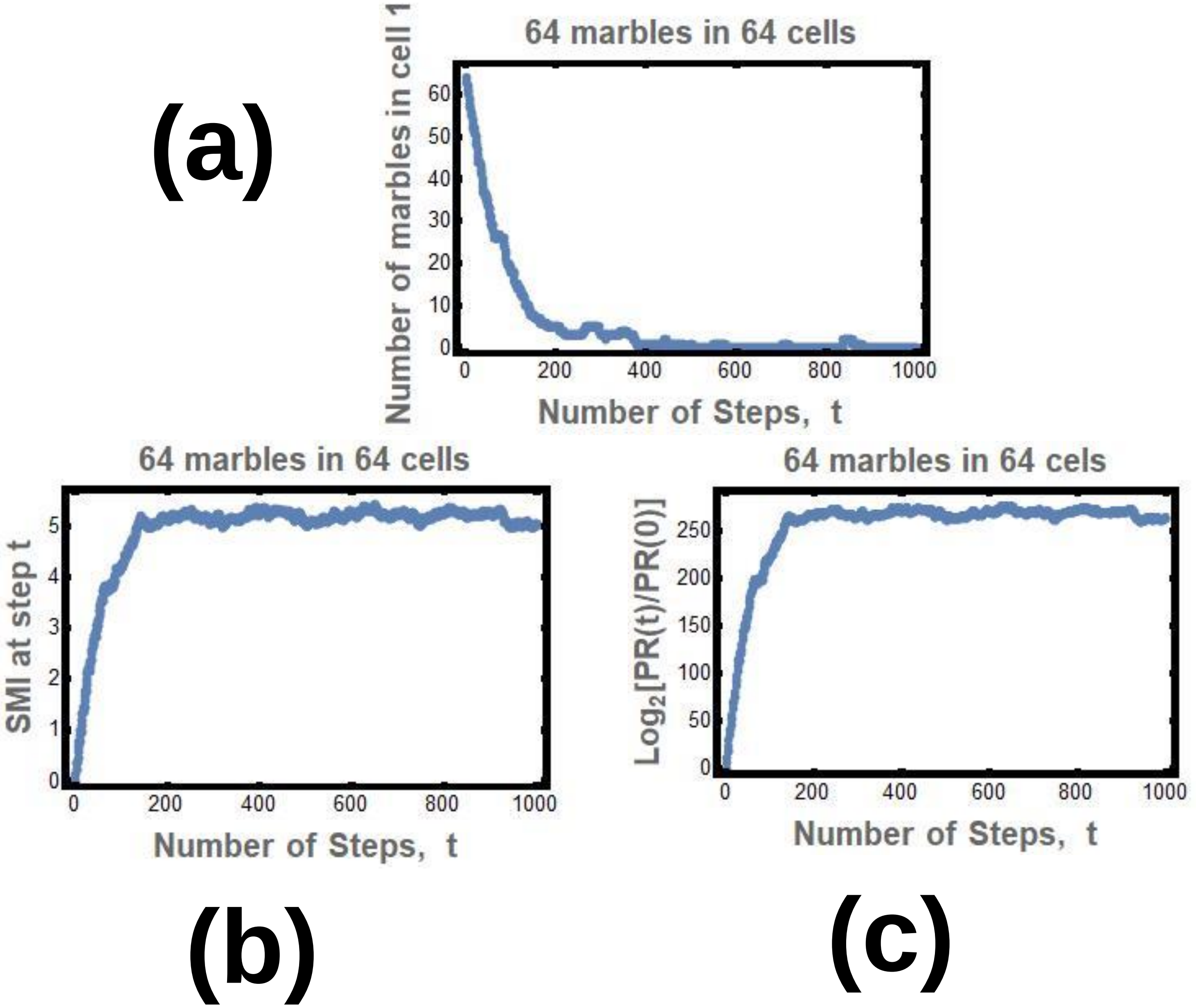


Figure 11.10. Simulated results for N = 64

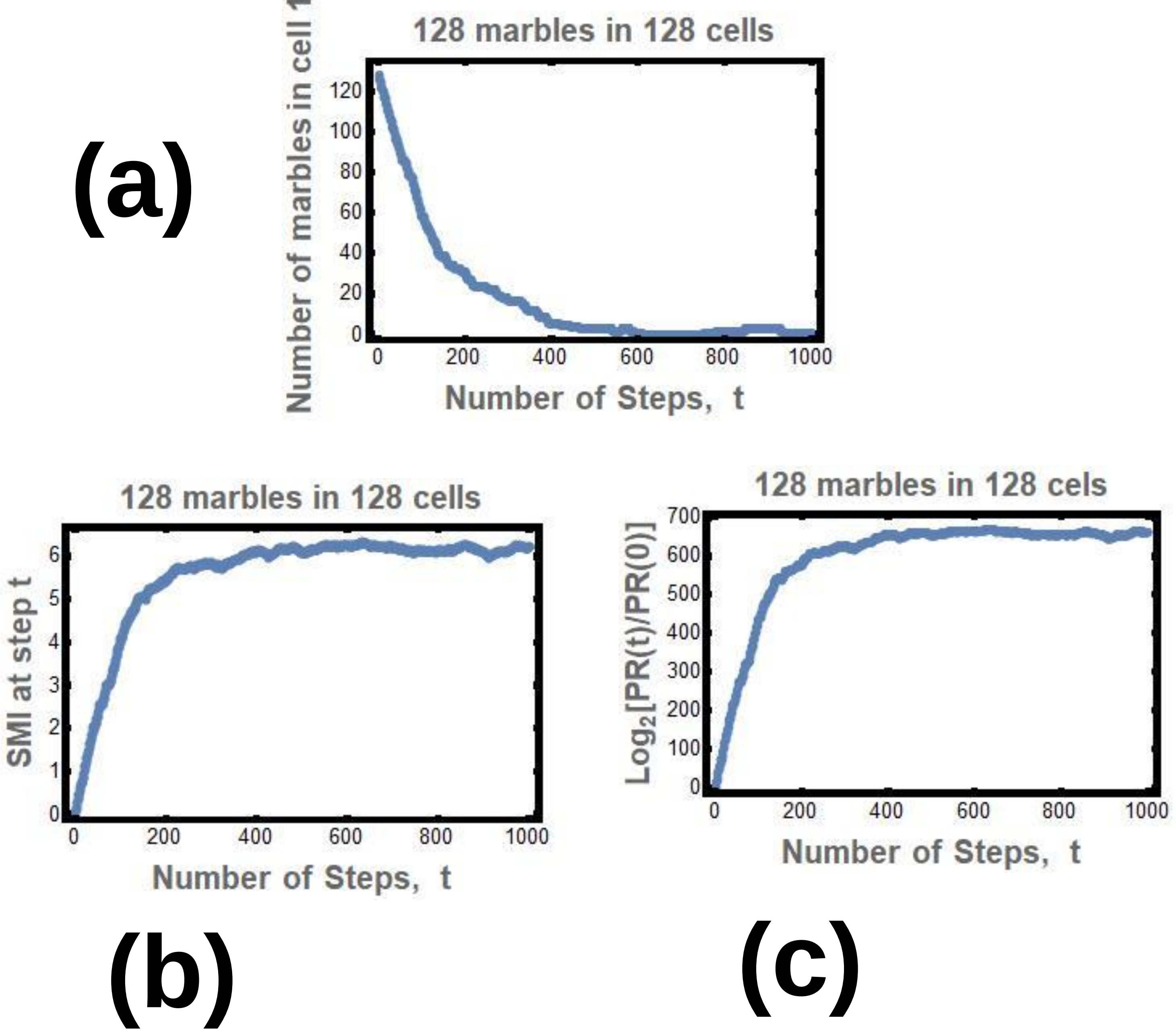


Figure 11.11. Simulated results for N = 128

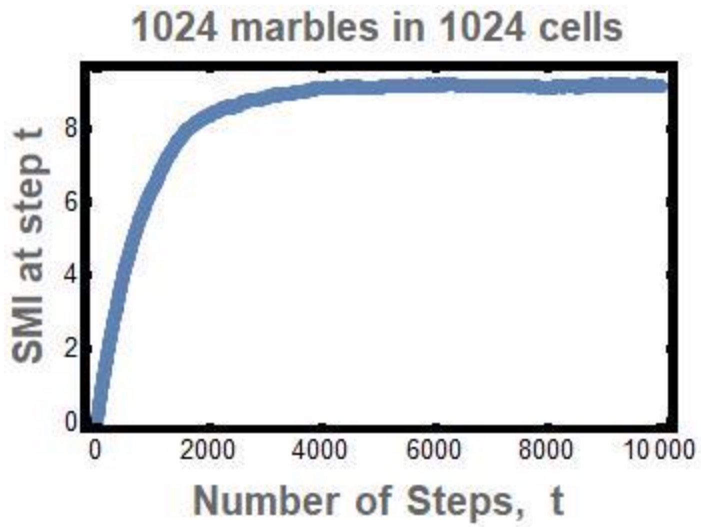


Figure 11.12. Simulated results for N = 1024

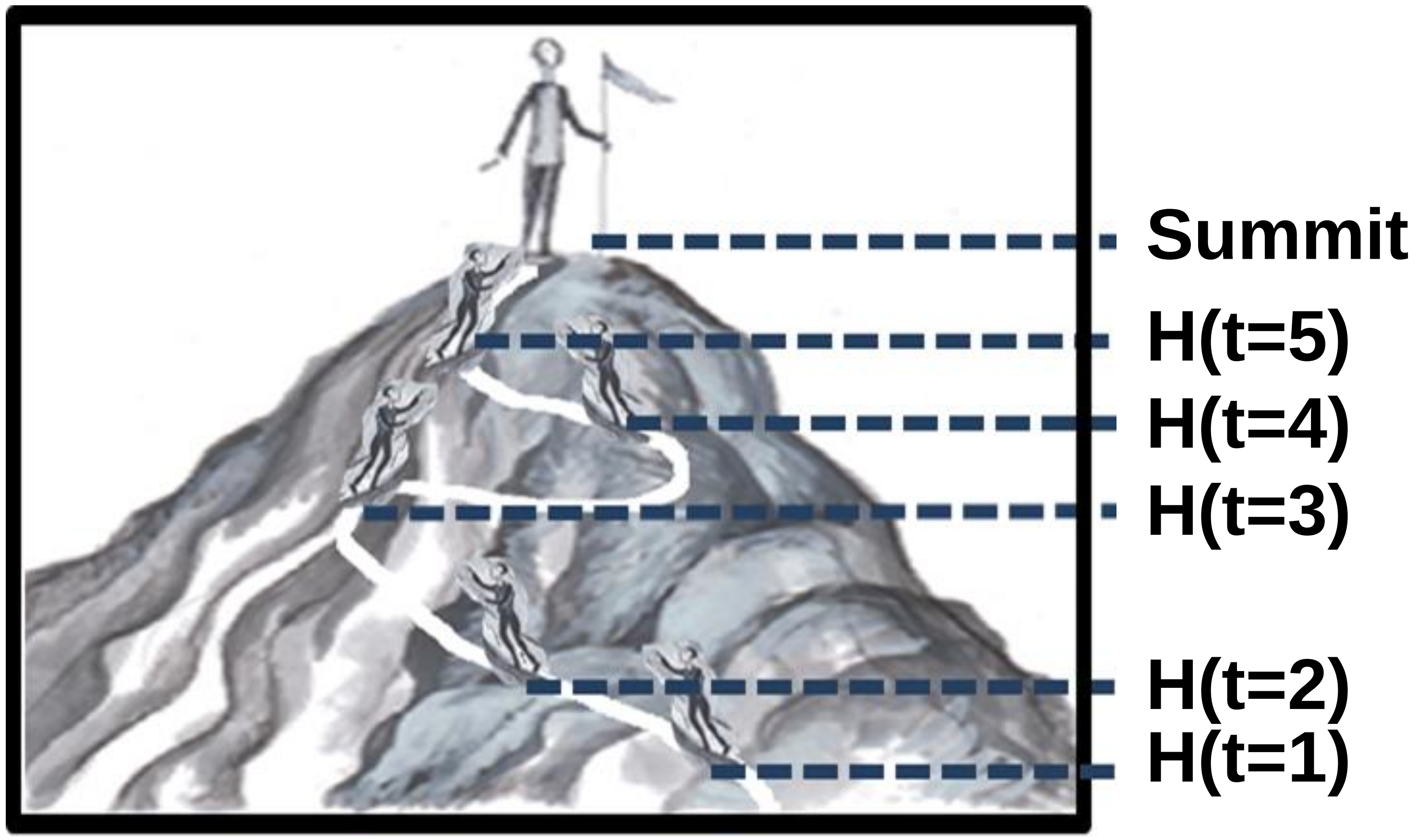


Figure 11.13. A person climbing a hill.
The height at which the person is changes with time H(t),
but the summit does not change with time.

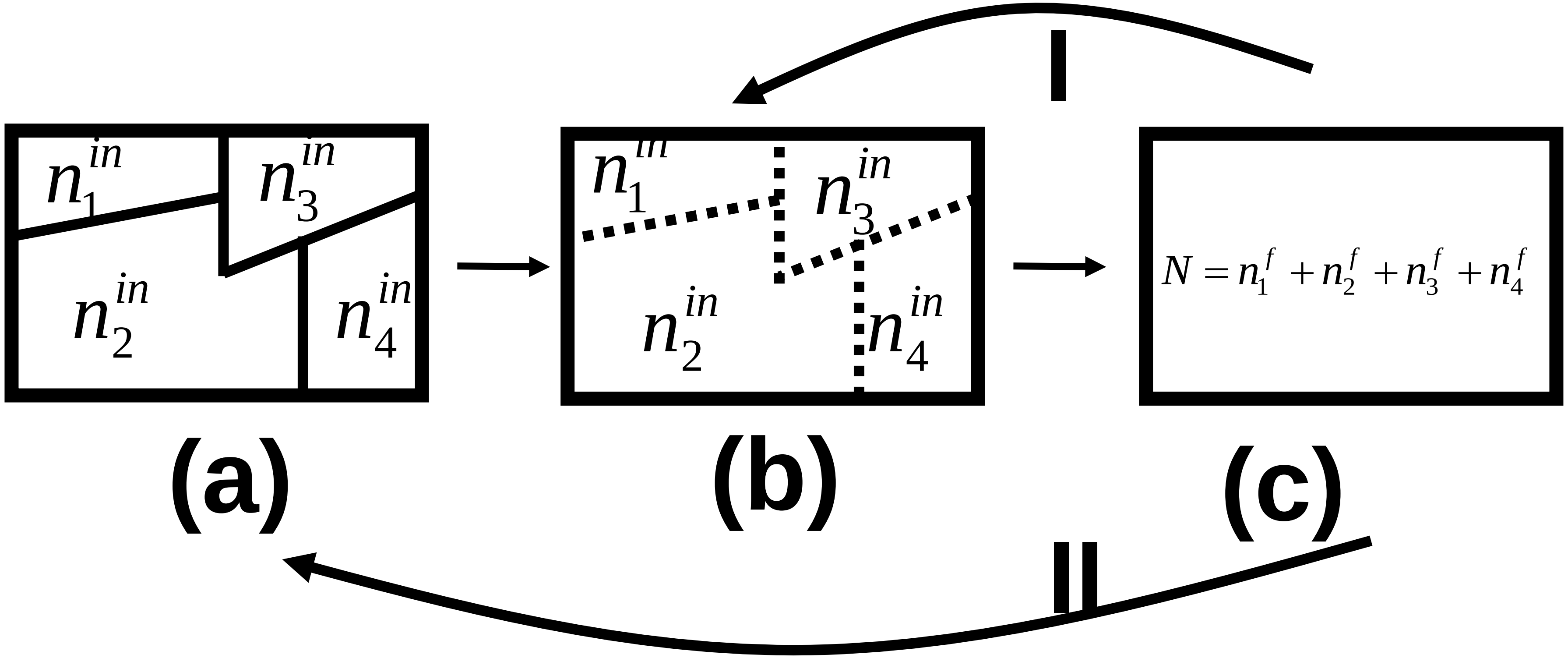


Figure 11.14. (a) A constrained equilibrium system.
(b) The same system as in (a), but with the constraint removed.
(c) The final unconstrained equilibrium state.
The system at state (c) can go back to (b), arrow I, but can never go back to (a), arrow II.

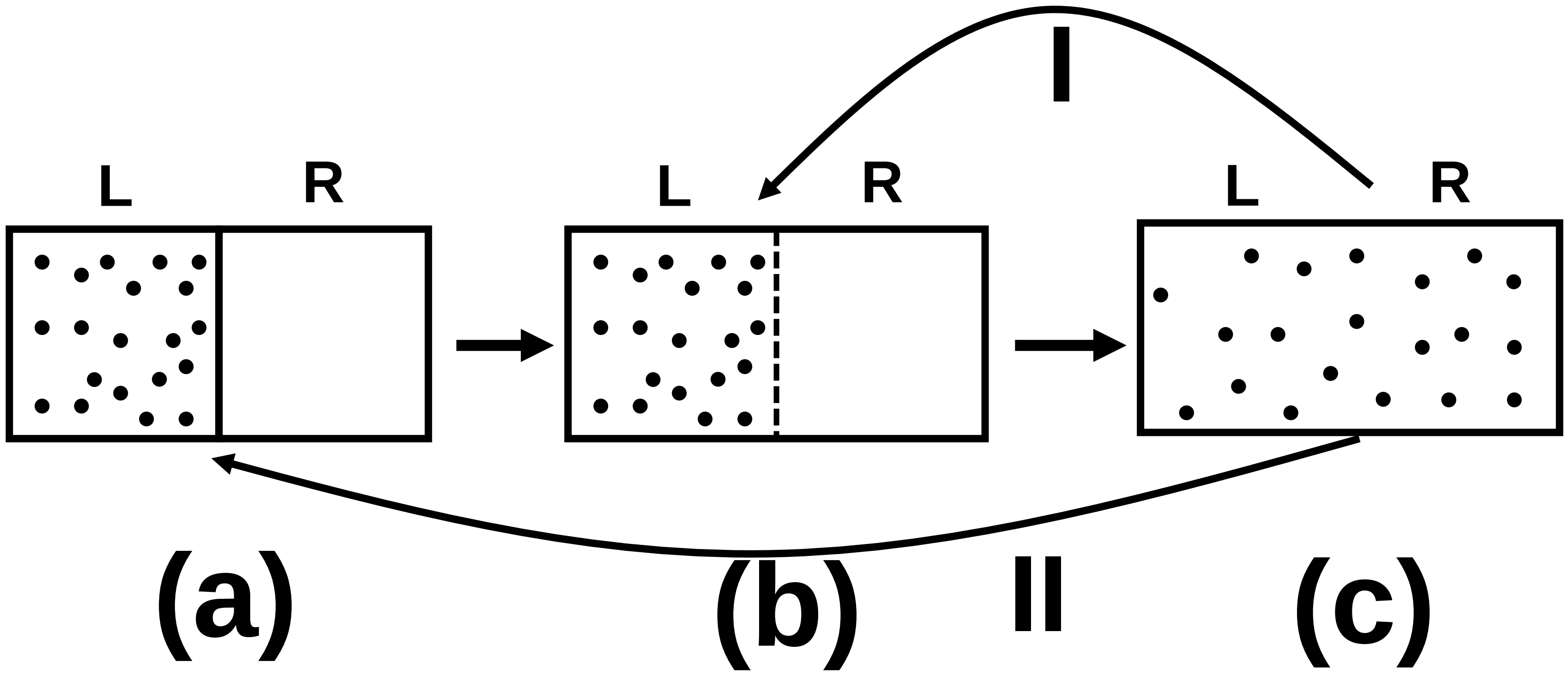


Figure 11.16. The initial, the final, and an intermediate state, in the expansion process.

Antique Clocks

Figure 11.16. From the old city of Jerualem.

Timepiece Antique Clocks brings horology to Dublin 8

By Joan Byrne | May 6, 2014.

Photo: Timepiece Antique Clocks

Horology is a trade not often heard of nowadays.
It is the study of mechanical timekeeping devices; clocks to you and me.
Upon realizing that Dublin lacked a dedicated antique clock store,
Kevin and Carol Chellar founded Timepiece Antique Clocks in 1986 on Patrick Street.
Initially the shop concentrated on the technical restoration of timepieces.
Later, the Chellars began to accumulate a stock of fine clocks and the business
of buying and selling antique clocks was underway.
The shop specializes in ancient clocks and it stocks the highest quality
French and European pieces, along with a selection of barometers and
other scientific instruments. In a street surrounded by the historical cathedrals of
St. Patricks and Christchurch, it is perhaps fitting that Timepiece Antique
Clocks is located between these two timeless buildings.
The shop is a source of great interest to tourists, particularly Americans with Irish connections.


Chas Craig
DUBLIN


JAMES McCABE
LONDON


TIMEPIECE
ANTIQUES


Beautiful Time





DUBLIN















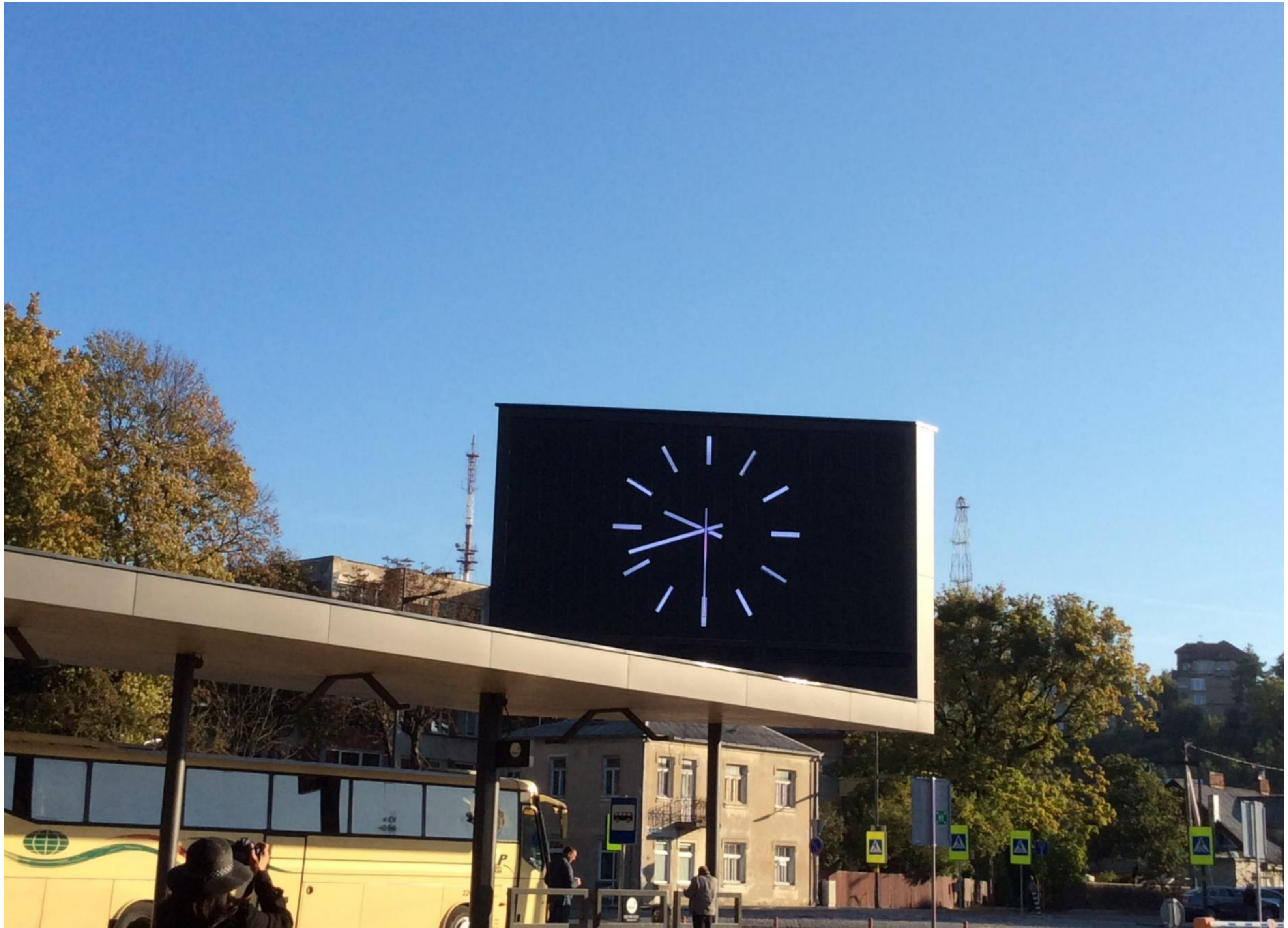

COSTA
COFFEE


Cornmarket

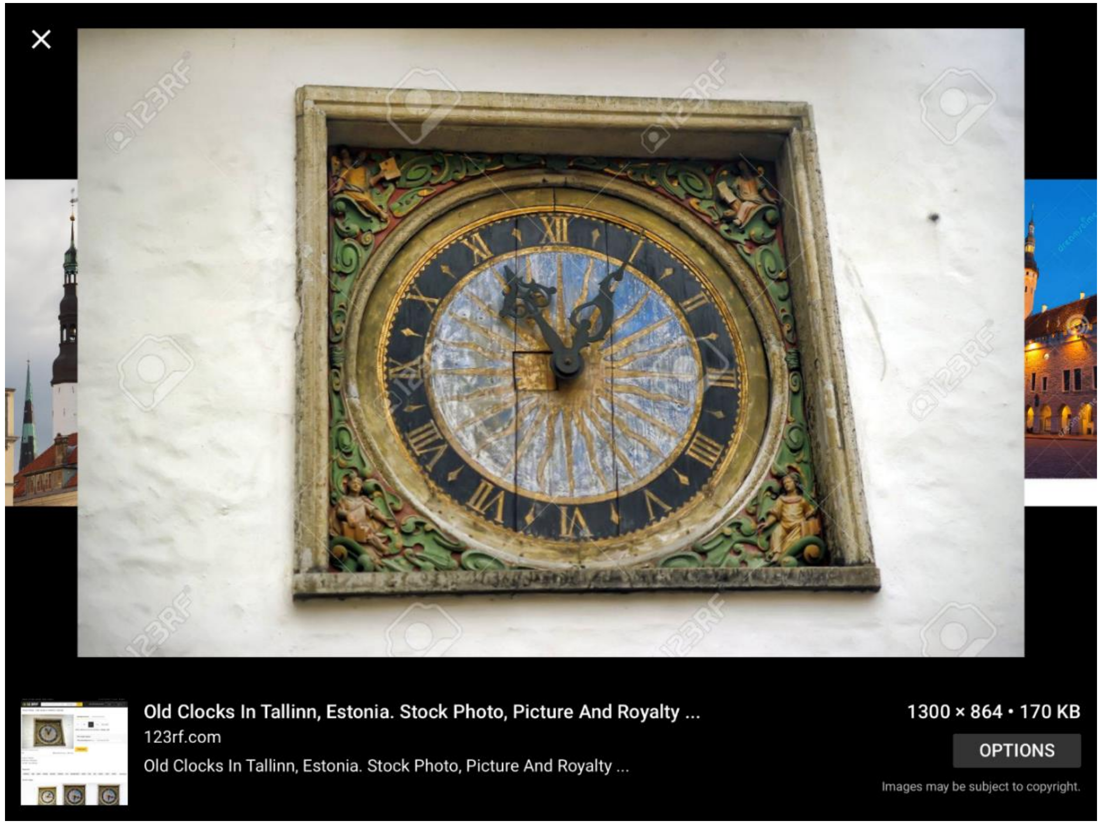
Antique clocks from Nazareth

A wall clock on a synagogue in Jerusalem

Chapter 12



Tallinn



Old Clocks In Tallinn, Estonia. Stock Photo, Picture And Royalty ...
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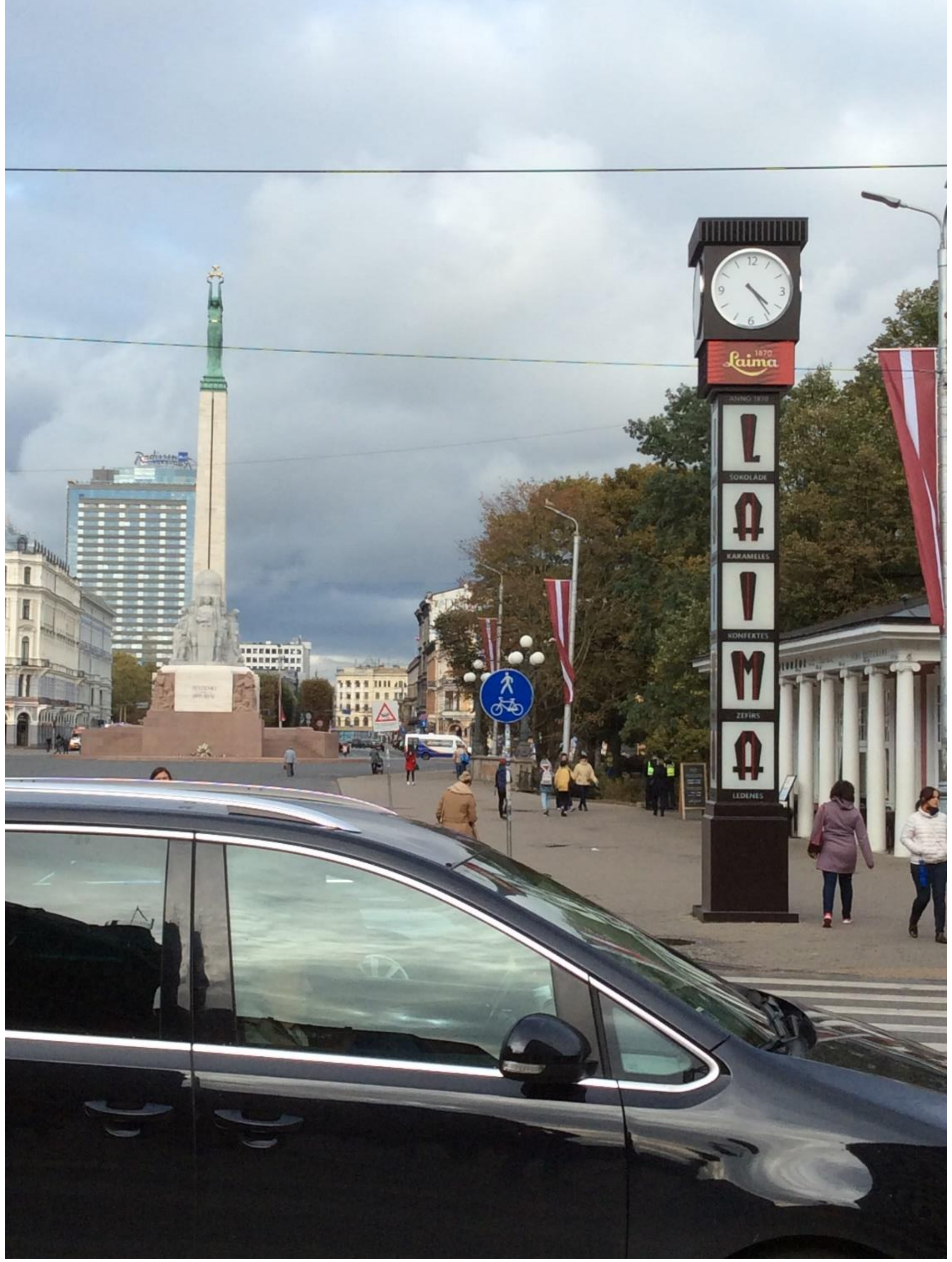
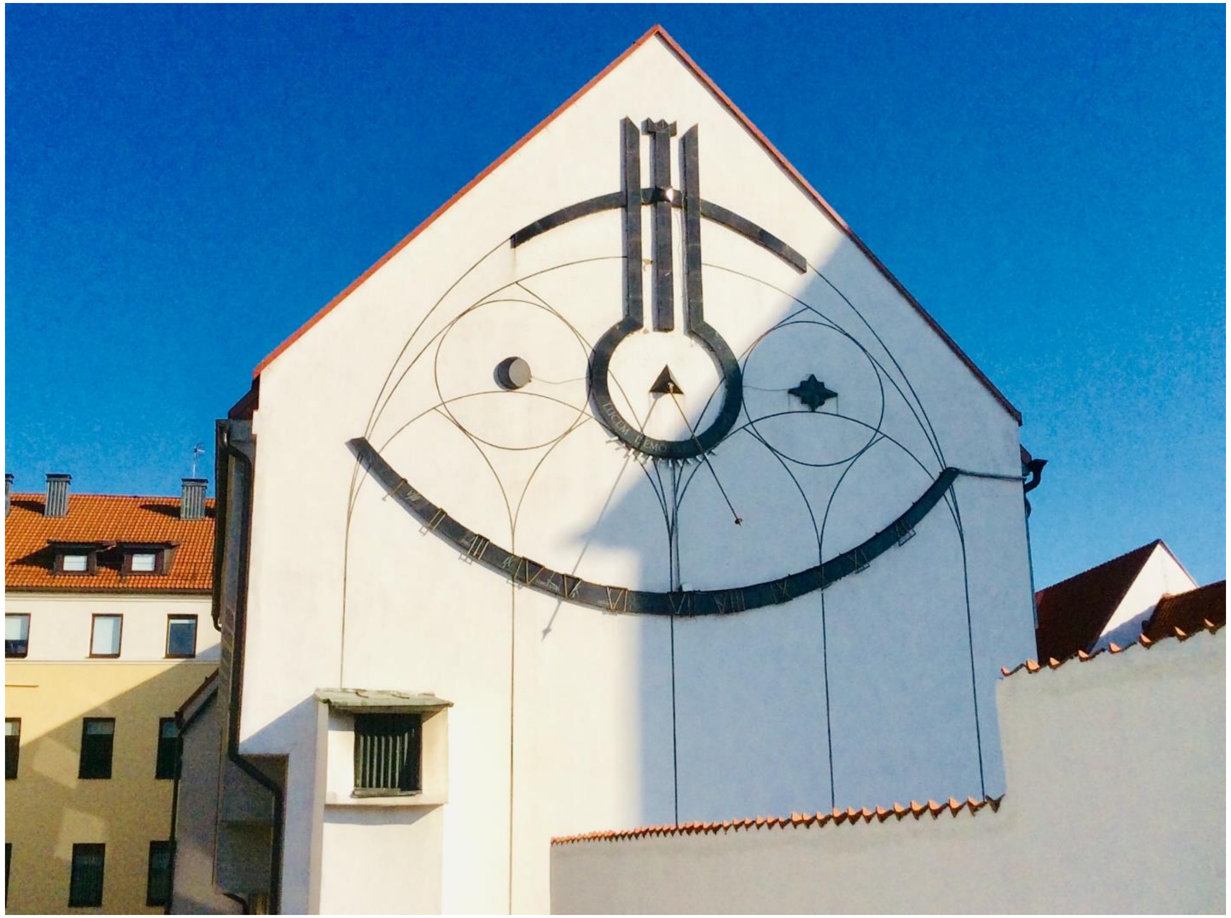

1870
Laima
LAIMA
KARAMELES
KONFEKTES
ZEFĪRS
LEDENES

Riga


RĪGA

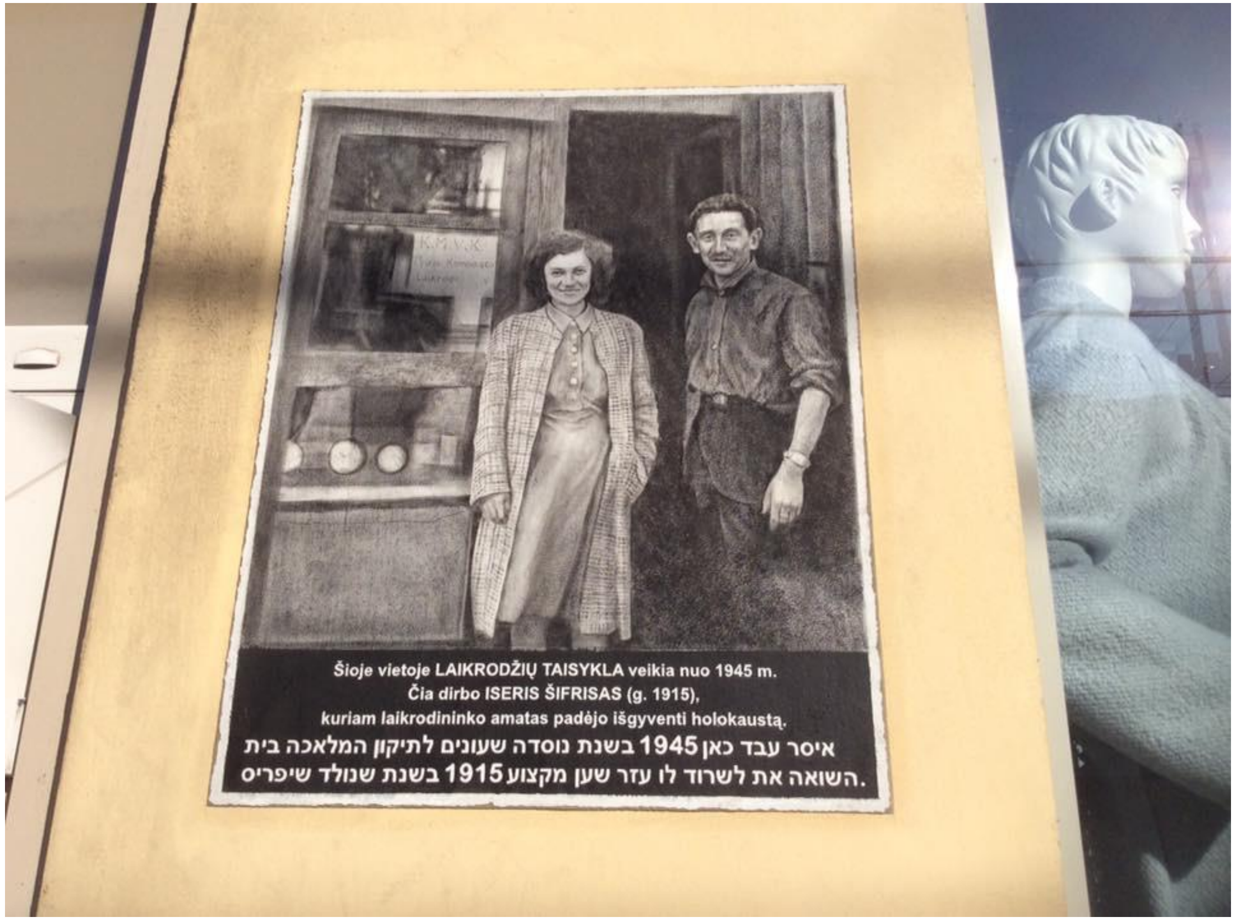

OMEGA
Constellation


VERO CAFE
PEGASAS



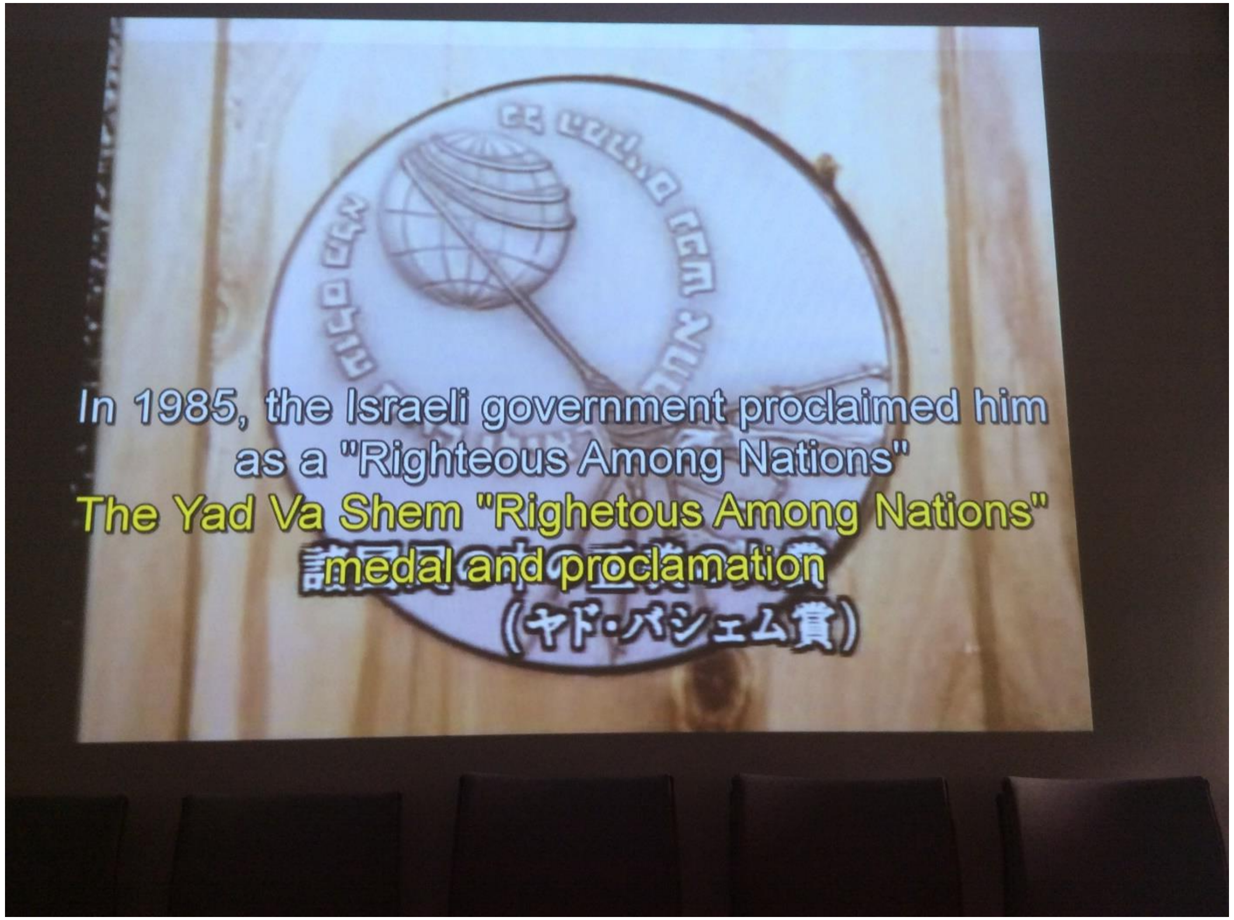

Vilniaus dailės akademija
KAUNO FAKULTETAS
VILNIAUS UNIVERSITETAS


2017



Šioje vietoje LAIKRODŽIŲ TAISYKLA veikia nuo 1945 m.
Čia dirbo ISERIS ŠIFRISAS (g. 1915),
kuriam laikrodininko amatas padėjo išgyventi holokaustą.
איסר עבד כאן 1945 בשנת נוסדה שעונים לתיקון המלאכה בית
השואה את לשרוד לו עזר שען מקצוע 1915 בשנת שנולד שיפריס.


2017


PRESTO
Gera mėgautis


In 1985, the Israeli government proclaimed him
as a "Righteous Among Nations"
The Yad Va Shem "Righetous Among Nations"
medal and proclamation
（ヤド・バシェム賞）


杉原千畝
CHIUNE
SUGIHARA
杉原千畝


DALÍ
ESPACE
DALÍ
PARIS
LA BOUTIQUE

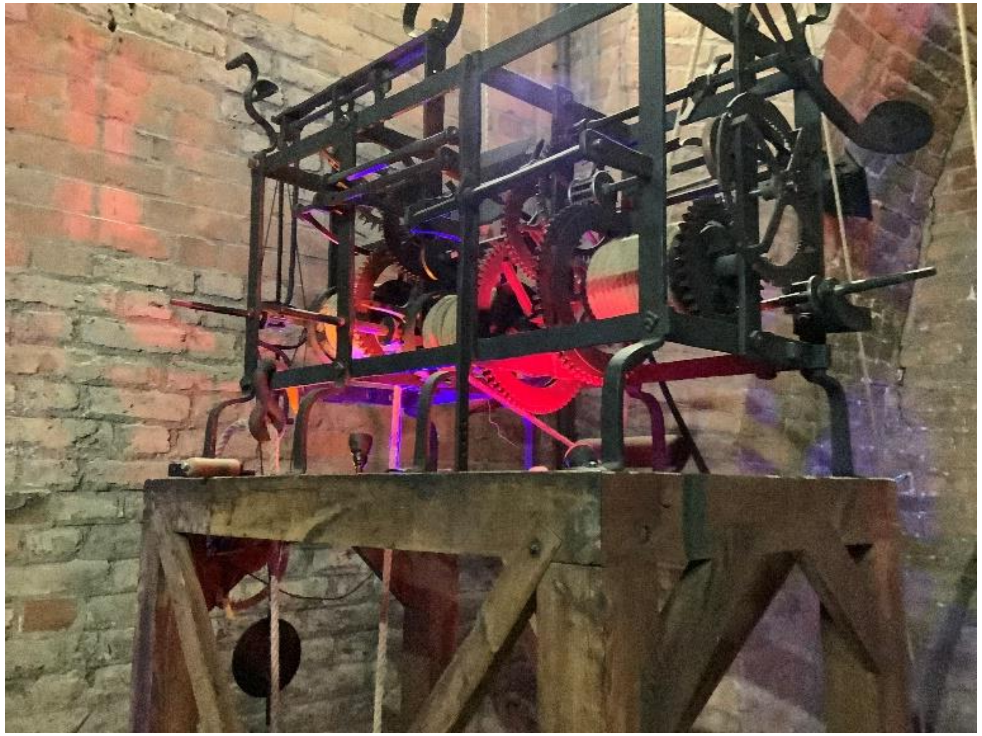
From Poland

Sigismund’s clock in the old city of Warsaw

In the old city of Warsaw

An astronomical clock in St. Mary’s Basilica in Gdansk

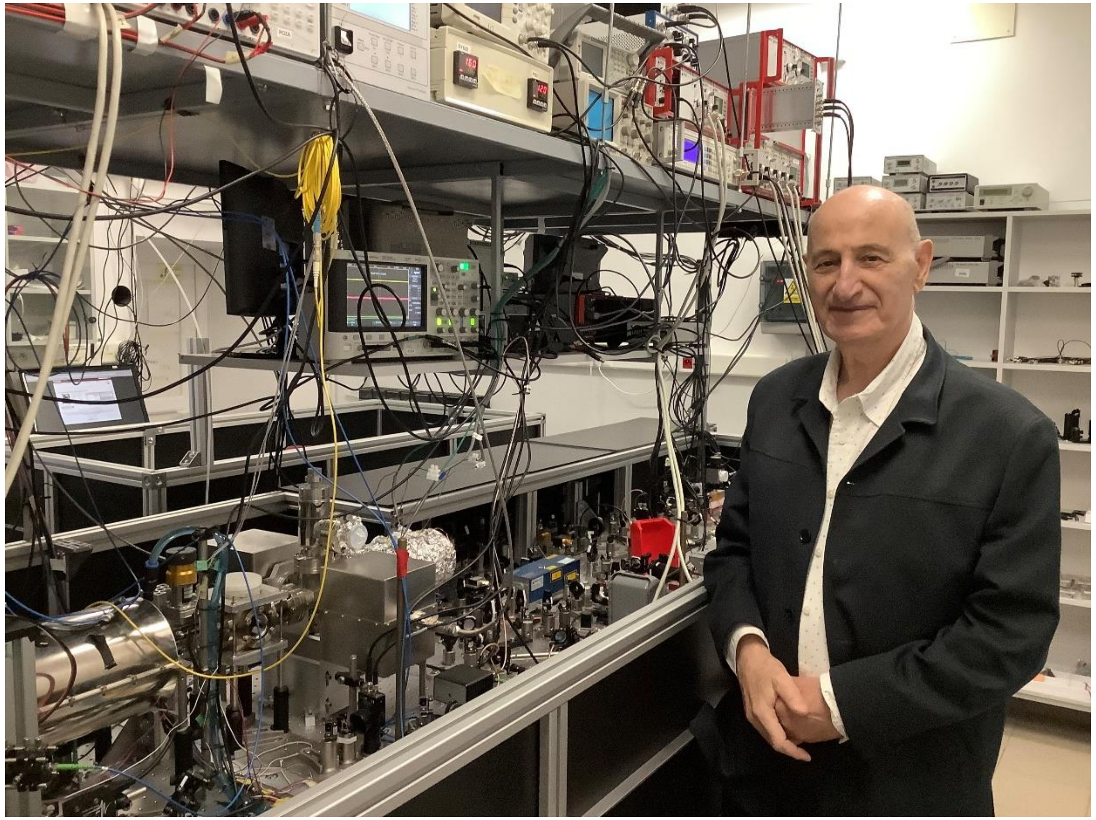
In the Clock museum, St. Catherine’s Church Gdansk

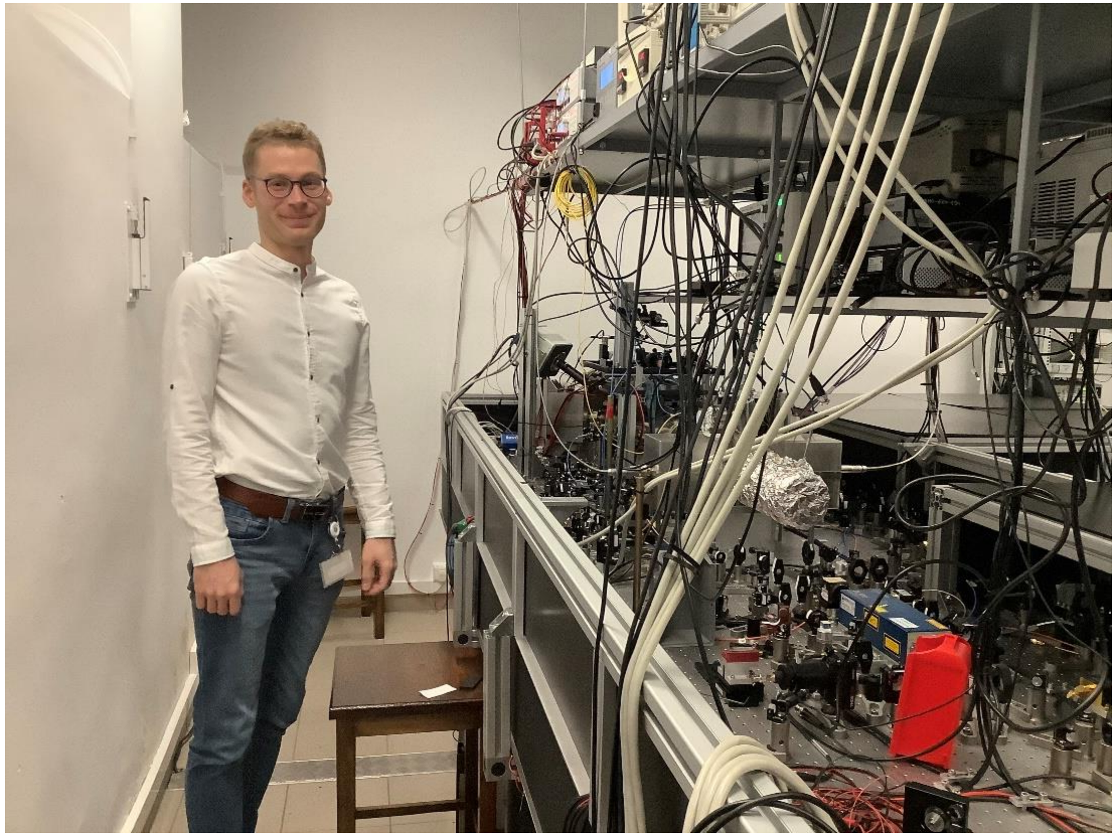


Sun dial in the old city of Warsaw

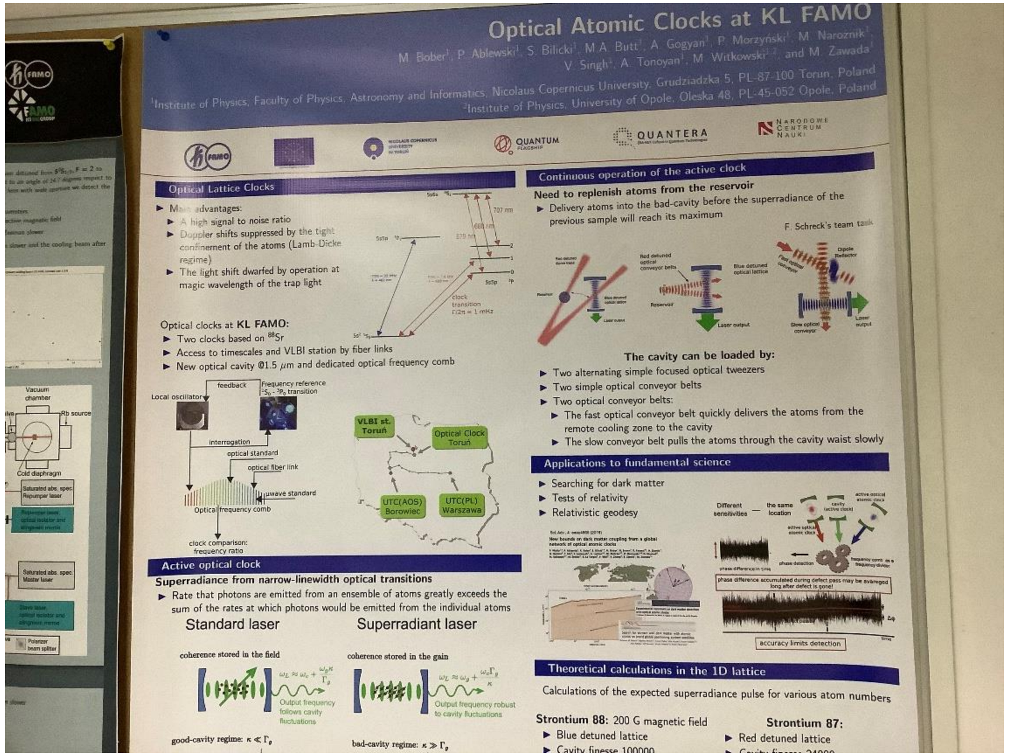
Torun, Copernicus monument

In the optical-atomic clock laboratory Copernicus university, Torun Poland





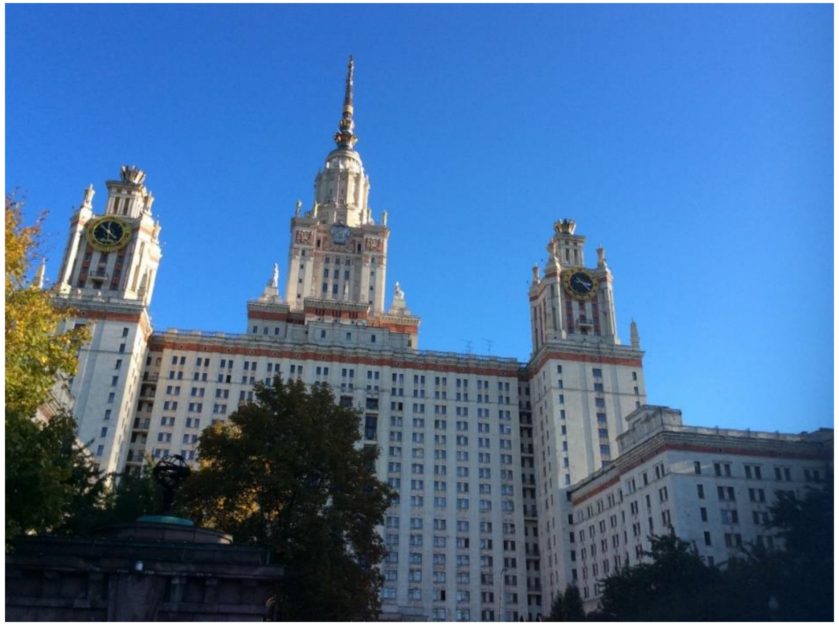
In the optical-atomic clock laboratory Copernicus university, Torun Poland



In Bydgoszcz, Poland

Poznan, The fighting goats clock

Moscow



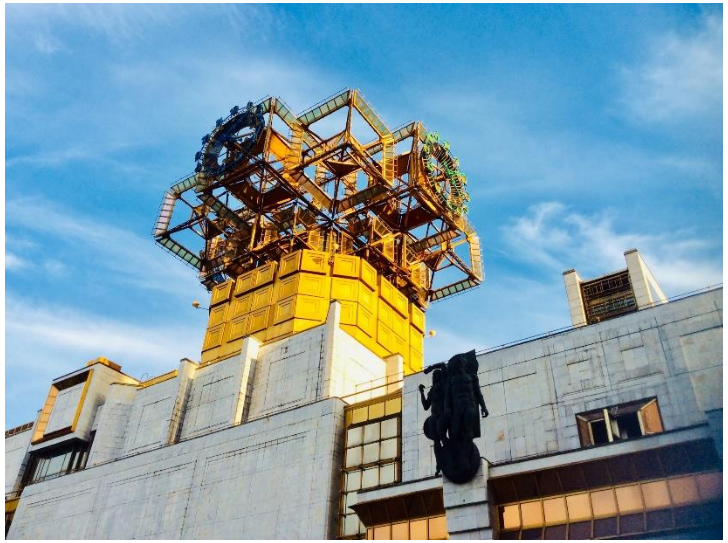

NEWBRIDGE
Quartz


QUARTZ

Madurai street

Mumbai

Academy of Science, Moscow



Mumbai


Polimer
MILAN
CLICK
CLICK
CLICK
BEENA

Madurai


FRIENDSHIP
MATTEL
DOLLS
Barbie Doll & Playset
CHINA - 6 PCS

Moscow

Jerusalem