Fermi

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1 Prelude

Hmmmmm.

2 Logarithms and Exponents

Logarithms	Value	Powers	Value
$\log_{10} 2$	0.30	$10^{0.1}$	1.26
$\log_{10} 3$	0.48	$10^{0.2}$	1.58
$\log_{10} 4$	0.60	$10^{0.3}$	2.00
$\log_{10} 5$	0.70	$10^{0.4}$	2.51
$\log_{10} 6$	0.78	$10^{0.5}$	3.14
$\log_{10} 7$	0.85	$10^{0.6}$	3.98
$\log_{10} 8$	0.90	$10^{0.7}$	5.01
$\log_{10} 9$	0.95	$10^{0.8}$	6.31
		$10^{0.9}$	7.94

3 Physics Olympics

Constant	Value	Details
Planck's constant	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$	$E = hv$
Mass of electron	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$	
Mass of proton	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$	
Elementary charge	$e = 1.60 \times 10^{-19}\,\mathrm{C}$	
Radius of earth	$r_{earth} = 6.38 \times 10^{6}\,\mathrm{m}$	
Mass of earth	$m_{earth} = 5.98 \times 10^{24}\,\mathrm{kg}$	
Radius of sun	$r_{sun} = \mathrm{m}$	
Mass of sun	$m_{sun} = 1.98 \times 10^{30}\,\mathrm{kg}$	
Radius of moon	$r_{moon} = 1.74 \times 10^{6}\,\mathrm{m}$	
Mass of moon	$m_{moon} = 7.35 \times 10^{22}\,\mathrm{kg}$	
Astronomical Unit	$AU = 1.50 \times 10^{11}\,\mathrm{m}$	
Distance from earth to moon	$d_{earthtomoon} = 3.84 \times 10^{6}\,\mathrm{m}$	
Seconds in a day	$s_{day} = 8.64 \times 10^{4}\,\mathrm{s}$	
Seconds in a month	$s_{month} = 2.62 \times 10^{6}\,\mathrm{s}$	
Seconds in a year	$s_{year} = 3.16 \times 10^{7}\,\mathrm{s}$	

4 Lengths

Object	Size	Order of Magnitude
Proton, Neutron	1 femtometer	10^{-15}
Uranium neucleus		$10^{-14.5}$
Gamma ray		10^{-12}
Hydrogen, Helium atom		10^{-11}
X-ray, Glucose, Alpha helix		$10^{-9.2}$
Carbon nanotube, Buckyball		10^{-9}
DNA		$10^{-8.3}$
Transistor gate		$10^{-7.6}$
Virus		$10^{-7.5}$ to $10^{-6.5}$
Ultraviolet		$10^{-7.3}$
Smallest visible thing to an optical microscope		$10^{-6.8}$
Violet light		$10^{-6.4}$
Red light		$10^{-6.0}$
Bacteria		$10^{-5.9}$
Red blood cell, White blood cell, Cell nucleus	$10^{-5.3}$	
Mist droplet		$10^{-5.0}$
Infared		$10^{-4.6}$
Smallest visible thing to the human eye		$10^{-4.1}$
Paper		$10^{-3.9}$

Amoeba	$10^{-3.6}$
LCD pixel	$10^{-3.5}$
Grain of salt	$10^{-3.3}$
Grain of rice	$10^{-2.5}$
Microwave length, Penny, Marble	$10^{-1.8}$
Oak tree, Average US house	$10^{1.0}$
Blue whale	$10^{1.2}$
Boeing 747, Redwood tree, Statue of liberty	$10^{1.5}$
Football field, International space station, Saturn V	$10^{2.0}$
Titanic	$10^{2.1}$
Great pyramid of Giza	$10^{2.2}$
Eiffel tower	$10^{2.3}$
Hoover dam	$10^{2.4}$
Vatican city	$10^{2.9}$
AM radio wave	$10^{3.3}$
Central park	$10^{3.4}$
Mount everest, Large hadron collider	$10^{3.8}$
Haley's comet	$10^{3.9}$
Depth of the mariana trench	$10^{4.1}$
Marathon, Neutron star	$10^{4.3}$
Grand canyon	$10^{5.3}$
California, Italy	$10^{5.6}$
Pluto	$10^{6.1}$
Moon, USA	$10^{6.5}$
Mercury, Asia	$10^{6.6}$
Mars	$10^{6.7}$
Earth, Venus	$10^{6.9}$
Minecraft world	$10^{6.5}$
Neptune, Uranus	$10^{7.7}$
Saturn	$10^{7.9}$
Distance from earth to moon	$10^{8.3}$
The sun	$10^{8.8}$
Distance from earth to sun	10^{11}
Distance from sun to neptune	$10^{12.5}$
Light-day	$10^{13.2}$
Light-year	$10^{15.6}$
Milky way, Andromeda	$10^{20.9}$
Observable universe	$10^{26.7}$

5 Forces

Hmmmmm.

6 Mass

Hmmmmm.

7 Time

Hmmmmm.

8 Energy

8.1 General Facts

- $1\,\mathrm{kW\,h} = 3.6 \times 10^6\,\mathrm{J}$

- $1\,\mathrm{W\,year} = 8.74\,\mathrm{kW\,h}$
- Average cost: 14 cents per kilowatt-hour
- Average home usage per year: $11\,280\,\mathrm{kW\,h}$
- Average home usage per month: $950\,\mathrm{kW\,h}$
- Average home usage per day: $31\,\mathrm{kW\,h}$

8.2 Electronics

- iPhone battery: $1570\,\mathrm{mA\,h}$ at $3.7\,\mathrm{V}$ ($5.92\,\mathrm{W\,h}$)
- iPhone power consumption (idle – 250 hours): $23.7\,\mathrm{mW}$
- iPhone power consumption (talk/internet/video – 10 hours): $592\,\mathrm{mW}$
- iPhone power consumption (audio – 40 hours): $148\,\mathrm{mW}$
- iPad battery: $8827\,\mathrm{mA\,h}$ ($118\,\mathrm{kJ}$) at $3.7\,\mathrm{V}$ ($32.9\,\mathrm{W\,h}$)
- iPad conversion example: $32.9\,\mathrm{W\,h} \approx 8827\,\mathrm{mA\,h} * 3.7\,\mathrm{V} * (1\,\mathrm{A}/1000\,\mathrm{mA})$
- iPad conversion example: $118\,\mathrm{kJ} \approx 32.9\,\mathrm{W\,h} * (3600\,\mathrm{s}/1\,\mathrm{h}) * (1\,\mathrm{kJ}/1000\,\mathrm{J})$
- (WARN) Voltage in a mobile phone circuit: $0.5\,\mathrm{V}$ to $1\,\mathrm{V}$
- (WARN) Current in a mobile phone circuit: $100\,\mathrm{mA}$ to $180\,\mathrm{mA}$

Appliance	Power Consumption
Light bulb	$2\,\mathrm{W}$ to $120\,\mathrm{W}$
Desktop	$250\,\mathrm{W}$ to $720\,\mathrm{W}$
Laptop	$250\,\mathrm{W}$
(WARN) Coffee maker	$800\,\mathrm{W}$
(WARN) Microwave	$600\,\mathrm{W}$ to $1500\,\mathrm{W}$
(WARN) Dishwasher	$1200\,\mathrm{W}$ to $1500\,\mathrm{W}$
(WARN) Washing machine	$300\,\mathrm{W}$ to $500\,\mathrm{W}$
(WARN) Iron	$1000\,\mathrm{W}$
(WARN) Air conditioner	$2000\,\mathrm{W}$ to $5000\,\mathrm{W}$
(WARN) Ceiling fan	$10\,\mathrm{W}$ to $50\,\mathrm{W}$
(WARN) TV	$150\,\mathrm{W}$
(WARN) Oven	$3000\,\mathrm{W}$

9 Electromagnetic Spectrum

Type	Wavelength	Frequency	Energy	Reference
Radio	$1 \times 10^{3}\,\mathrm{m}$	$1 \times 10^{4}\,\mathrm{Hz}$		
Microwave	$1 \times 10^{-2}\,\mathrm{m}$	$1 \times 10^{10}\,\mathrm{Hz}$		
Infared	$1 \times 10^{-5}\,\mathrm{m}$	$1 \times 10^{13}\,\mathrm{Hz}$		
Visible	$5 \times 10^{-7}\,\mathrm{m}$	$1 \times 10^{15}\,\mathrm{Hz}$		
Ultraviolet	$1 \times 10^{-8}\,\mathrm{m}$	$1 \times 10^{16}\,\mathrm{Hz}$		
X-ray	$1 \times 10^{-10}\,\mathrm{m}$	$1 \times 10^{18}\,\mathrm{Hz}$		
Gamma	$1 \times 10^{-12}\,\mathrm{m}$	$1 \times 10^{20}\,\mathrm{Hz}$		

Colour	Wavelength		Frequency		Energy	Reference
Violet	380×10^{-9} m	to	668×10^{12} Hz	to		
	450×10^{-9} m		789×10^{12} Hz			
Blue	450×10^{-9} m	to	606×10^{12} Hz	to		
	495×10^{-9} m		668×10^{12} Hz			
Green	495×10^{-9} m	to	526×10^{12} Hz	to		
	570×10^{-9} m		606×10^{12} Hz			
Yellow	570×10^{-9} m	to	508×10^{12} Hz	to		
	590×10^{-9} m		526×10^{12} Hz			
Orange	590×10^{-9} m	to	484×10^{12} Hz	to		
	620×10^{-9} m		508×10^{12} Hz			
Red	620×10^{-9} m	to	400×10^{12} Hz	to		
	750×10^{-9} m		484×10^{12} Hz			

9.1 Other Facts

- Wifi: 2.4 GHz to 5 GHz
- Cellular frequencies: 900 MHz in Europe and Asia; 1900 MHz in the USA

10 Demographics

Location	Population	Known For
Canada	35.16 million	
USA	313.9 million	
Europe	739.2 million	
China	1.36 billion	
India	1.24 billion	
Indonesia	238 million	
Brazil	201 million	
Russia	144 million	
Japan	127 million	
Mexico	118 million	
Vietnam	90.4 million	
Germany	80.5 million	
France	65.8 million	
Great Britain	63.7 million	
Italy	59.9 million	
South Africa	53.0 million	
South Korea	50.2 million	
Spain	46.7 million	
Kenya	44.3 million	
Argentina	40.1 million	
Poland	38.5 million	
Malaysia	29.9 million	
Taiwan	23.4 million	
Australia	23.3 million	
Netherlands	16.8 million	
Belgium	11.2 million	
Greece	10.8 million	
Portugal	10.6 million	
Czech Republic	10.5 million	
Sweden	9.63 million	
Austria	8.50 million	
UAE	8.26 million	
Israel	8.09 million	
Hong Kong	7.18 million	
Denmark	5.62 million	
Singapore	5.40 million	

Scotland	5.30 million
Ireland	4.59 million

10.1 Todo

- population density
- population history
- cities, provinces, states

11 Geography

Location	Area	Width	Diagonal	Height
Canada	$9.98 \times 10^6\,\mathrm{km}^2$	4800 km (3000 miles)		
USA	$9.83 \times 10^6\,\mathrm{km}^2$	4180 km	4500 km (2800 miles)	
Russia	$17.1 \times 10^6\,\mathrm{km}^2$			
China	$9.71 \times 10^6\,\mathrm{km}^2$			
France	$675 \times 10^3\,\mathrm{km}^2$			
Spain	$503 \times 10^3\,\mathrm{km}^2$			
Japan	$378 \times 10^3\,\mathrm{km}^2$			
Germany	$357 \times 10^3\,\mathrm{km}^2$			
UK	$224 \times 10^3\,\mathrm{km}^2$			

11.1 Todo

- cities, provinces, states

12 Technology

Hmmmmm.

13 Economy

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14 Animals

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18 Related rates

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19 Chemical properties

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20 History

Period	Begin	End
Ancient Greek (archaic)	900 BC	500 BC
Ancient Greek (classical)	500 BC	300 BC
Ancient Greek (hellenistic)	300 BC	600 AD
Roman empire (west)	27 BC	476 AD
Roman empire (east)	330	1453
Middle ages/Medieval period	400	1400
Renaissance	1300	1600
Industrial revolution	1760	1830
Baroque period	1590	1725
Classical period	1730	1820
Romantic period	1815	1910
WWI	1914	1918
WWII	1939	1945
Great Depression	1929	Late 1930s, Mid 1940s

Person	Birth	Death	Description
Socrates	469 BC	399 BC	
Aristotle	384 BC	322 BC	
Julius Caesar (roman emperor)	100 BC	44 BC	
Augustus (roman emperor)	63 BC	14 AD	
Nero (roman emperor)	37	68	
Constantine I (roman emperor)	272	337	
Charlemange	740s	814	
Martin Luther	1483	1546	
Queen Elizabeth I	1533	1603	
James Watt	1736	1819	

Event	Date	Description

21 Literature

Hmmmmm.