Fermi

Adrian

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Contents

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

Force of	Value
Weight of human	$620\,\mathrm{N}$
(WARN) Jump	$2000\,\mathrm{N}$
Gravitational attraction between proton and electron in hydrogen atom	$3.6 \times 10^{-47}\,\mathrm{N}$
Weight of an electron	$8.9 \times 10^{-30}\,\mathrm{N}$
Weight of an E. coli bacterium	$1 \times 10^{-14}\,\mathrm{N}$
Force to break hydrogen bond	$4 \times 10^{-12}\,\mathrm{N}$
Force to break typical noncovalent bond	$1.60 \times 10^{-10}\,\mathrm{N}$
Force to break typical covalent bond	$1.6 \times 10^{-9}\,\mathrm{N}$
Force on an electron in a hydrogen atom	$8.2 \times 10^{-8}\,\mathrm{N}$
Force between two 1 metre long conductors 1 metre apart	$2 \times 10^{-7}\,\mathrm{N}$
Thrust of NSTAR ion engine on NASA's space probe Deep Space 1	$1.9 \times 10^{-2}\,\mathrm{N}$ to $9.2 \times 10^{-2}\,\mathrm{N}$
Weight of an apple	$1\,\mathrm{N}$
Force of human bite at molars	$720\,\mathrm{N}$
Bite force of adult american alligator	$9 \times 10^{3}\,\mathrm{N}$
Bite force of adult great white shark	$1.8 \times 10^{4}\,\mathrm{N}$
Engine of a small car during peak acceleration	$4.5 \times 10^{4}\,\mathrm{N}$
Average force from seatbelt and airbag to a passenger in a car which hits a stationary barrier at $100\,\mathrm{km\,h^{-1}}$	$1 \times 10^{5}\,\mathrm{N}$
Maximum pulling force of a single large diesel-electric locomotive	$8.9 \times 10^{3}\,\mathrm{N}$
Thrust of Space SHuttle Main Engine at lift off	$1.8 \times 10^{6}\,\mathrm{N}$
Weight of largest blue whale	$1.9 \times 10^{6}\,\mathrm{N}$
Thurst of Saturn V rocket at lift off	$3.5 \times 10^{7}\,\mathrm{N}$
Simple estimate of force of sunlight on earth	$5.7 \times 10^{8}\,\mathrm{N}$
Gravitational attraction between earth and moon	$2 \times 10^{20}\,\mathrm{N}$
Gravitational attraction between earth and sun	$3.5 \times 10^{22}\,\mathrm{N}$
Planck force	$1.2 \times 10^{44}\,\mathrm{N}$

6 Mass

Object	Value
Human	$65\,\mathrm{kg}$
Car	$1500\,\mathrm{kg}$
(WARN) Cruise ship	$30 \times 10^{6}\,\mathrm{kg}$ to $220 \times 10^{6}\,\mathrm{kg}$
Empire state building	$330 \times 10^{6}\,\mathrm{kg}$
Ounce	$23.85\,\mathrm{g}$
iPod touch	$0.086\,\mathrm{kg}$
iPod nano	$0.031\,\mathrm{kg}$
iPod shuffle	$0.0125\,\mathrm{kg}$
iPod classic	$0.140\,\mathrm{kg}$
iPhone 5s	$0.112\,\mathrm{kg}$
iPad Air	$0.475\,\mathrm{kg}$
iPad 2	$0.600\,\mathrm{kg}$
iPad mini	$0.330\,\mathrm{kg}$
Macbook air	$1.35\,\mathrm{kg}$
Macbook pro (15 inch)	$2.02\,\mathrm{kg}$
Mac mini	$1.22\,\mathrm{kg}$
Mac (21.5 inch)	$5.68\,\mathrm{kg}$
Mac (27 inch)	$9.54\,\mathrm{kg}$
(WARN) Mac pro	$5\,\mathrm{kg}$

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

- Apple A7 chip: over 1 billion transistors on 102 $102\,\mathrm{mm}^2$ die

13 Economy

13.1 Canada

- Rank: 11th
- GDP: $1.839 trillion
- GDP growth: 2.0%
- GDP per capita: $52300
- Inflation: 1.2%
- Population below poverty line: 9.4%
- Labour force: 18.89 million
- Labour force by occupation: 2% agriculture, 13% manufacturing, 6% construction, 76% services, 3% other
- Unemployment: 6.9
- Main industries: transportation equipment, chemicals, minerals, food products, wood and paper products, fish products, petroleum and natural gas
- Exports: $462.528 billion
- Export goods: motor vehicles and parts, industrial machinery, aircraft, telecommunications equipment, chemicals, plastics, fertilizers, wood pulp, timber, crude petroleum, natural gas, electricity, aluminum
- Export partners: 73.2% USA, 4.6% EU, 4.3% UK, 4.3% China, 3.4% Germany, 3.1% Israel

- Imports: %474.544 billion
- Import goods: machinery and equipment, motor vehicles and parts, crude oil, chemicals, electricity, durable consumer goods
- Import partners: 50.6% USA, 11.0% China, 6.2% UK, 6.2% Japan, 5.5% Mexico, 4.5% South Korea
- Gross external debt: $1.326 trillion
- Public debt: $582.2 billion (33.8% of GDP)
- Budget deficit: $18.9 billion
- Revenues: $682.5 billion
- Expenses: $749.5 billion
- Foreign reserves: $65.82 billion

13.2 China

- $18.103 trillion
- GDP per capita: $7583
- GDP growth in 1 year: 7.7%
- Inflation: 2.5%
- GDP by sector: 10.1% agriculture, 45.3% industry, 44.6% services
- Labour force: 795.5 million
- Exports: $2.21 trillion
- Export partners: 17.2% USA, 15.8% Hong Kong, 7.4% Japan, 4.3% South Korea
- Export goods: electrical and machinery, apparel, textiles, iron and steel, optical and medical equipment
- Imports: $1.95 trillion
- Import partners: 9.8% Japan, 9.2% South Korea, 7.1% USA, 5.1% Germany, 4.3% Australia
- Import goods: electrical and machinery, oil and mineral fuels, optical and medical equipment, metal ores, plastic, organic chemicals
- Gross external debt: $697.2 billion
- Public debt: 22.15% of GDP
- Revenues: $1.838 trillion
- Expenses: $2.031 trillion
- Foreign reserves: $3.44 trillion

13.3 Europe

Hmmmmm.

13.4 Russia

Hmmmmm.

13.5 India

Hmmmmm.

13.6 USA

- GDP: $16.66 trillion
- GDP per capita: $49 601
- Population below poverty line: 14.8%
- Labour force: 155.6 million
- Unemployed: 11.26 million
- Unemployment: 7.2%
- Average gross salary: $45 790
- Farming, forestry, fishing: 0.7%
- Manufacturing, extraction, transportation, crafts: 20%
- Managerial, professional, technical: 37%
- Sales, office: 24%
- Other: 18%
- Exports: $1.56 trillion
- Capital goods: 28%
- Industrial supplies and materials (excluding oil fuels): 25%
- Consumer goods (except automotive): 12%
- Automobiles and components: 9.4%
- Food and beverages: 8.6%
- Fuel oil, petroleum products: 7.6%
- Aircraft and components: 6%
- Other: 4%
- Export to Canada: 19%
- Export to Mexico: 14%
- Export to China: 7%
- Export to Japan: 4.5%
- Imports: $2.3 trillion
- Consumer goods (except automotive): 23%
- Capital goods (Except computing): 19%
- Industrial supplies (except crude oil): 18%
- Crude oil: 14%
- Automobiles and components: 13%
- Computers and accessories: 5.4%
- Food and beverages: 4.8%
- Other: 3%
- Import from China: 19%
- Import from Canada: 14%

- Import from Mexico: 12%
- Import from Japan: 6.4%
- Import from Germany: 4.7%
- Public debt: $17.091 trillion (107.2% of GDP)
- Budget deficit: $680 billion
- Revenues: $2.774 trillion
- Individual income tax: 46%
- Social insurance: 35%
- Corporate tax: 24%
- Other: 9.3%
- Expenses: $3.454 trillion
- Social security: 22%
- Defense: 18%
- Medicare: 13%
- Interest: 7.3%
- Medicaid: 7.1%
- Other: 32%

14 Animals

Hmmmmm.

15 Plants

Hmmmmm.

16 Biology

Hmmmmm.

17 Architecture

Hmmmmm.

18 Related rates

Hmmmmm.

19 Chemical properties

Hmmmmm.

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
French Revolution	1789	1799
First Crusade	1096	1099
Hundred Years' War	1337	1453

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	
Isaac Newton	1642	1727	
Gottfried Wilhelm Leibniz	1646	1716	
Albert Einstein	1879	1955	
Carl Friedrich Gauss	1777	1855	
Leonhard Euler	1707	1783	
Pythagoras	570 BC	495 BC	
Pierre de Fermat	1601	1665	
Blaise Pascal	1623	1662	
John Milton	1608	1674	
Shakespeare	1564	1616	
John Donne	1572	1631	
Robert Burns	1759	1796	
William Butler Yeats	1865 - 1939		
J.R.R. Tolkien	1892	1973	
Martin Luther King Jr.	1929	1968	
Captain George Vancouver	1757	1798	
Linus Torvalds	1969	na	
Steve Jobs	1955	2011	
Bill Gates	1955	na	
Larry Page	1973	na	
Sergey Brin	1973	na	
Eric Schmidt	1955	na	
James Gosling	1955	na	
Dennis Ritchie	1941	2011	
Ken Thompson	1943	na	
Bjarne Stroustrup	1950	na	
Guido van Rossum	1956	na	
Yukihiro Matsumoto	1965	na	
Geoffrey Chaucer	1343	1400	
William (I) the Conqueror	1028	1087	
Alexander (III of Macedon) the Great	356 BC	323 BC	

Event	Date	Description
Martin Luther's Ninety-Five Theses	1517 October 31	
American Declaration of Independence	1776 July 4	

21 Literature

Work	Date	Author
Beowulf	975 - 1025	Unknown
Hamlet	1599 - 1602	Shakespeare
King Lear	1603 - 1606	Shakespeare
Macbeth	1603 - 1607	Shakespeare
To a Mouse	1785	Robert Burns
Paradise Lost	1667	Milton
The Second Coming	1919	Yeats
Lord of the Rings	1954 - 1955	Tolkien
The Canterbury Tales	End of 1300s	Chaucer

22 Music

Piece	Date	Composer
Symphony 5	1804 - 1808	Beethoven
The Well Tempered Clavier	1722	Bach
Symphony 9	1824	Beethoven
Eine kleine Nachtmusik	1787	Mozart