April 9, 2019

《物理の英語》(3235)　　2019 年度　Syllabus

日時:前期, 火曜日, 第 4 時限(14:45-16:15)
場所:理学部6号館 301 講義室
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講義の概要：物理学で用いられる英語について、作文力を高めるための文法･表現法を系統的に学ぶとともに、物理学の教材を用いて聴解能力の向上をめざした実習も行う。

授業計画と内容：15 回の授業は主に次の 6 つの内容から構成される：

（1）「物理の英語（前野）」の配布物に沿って，物理学で用いられる英語の記述・表現法を学ぶ。
毎週の講義内容を復習するための小テスト(Quiz)を 10 回程度行う。
（2）数式の読み方について音声録音（Doyle 教授）を利用して学ぶ。
（3）ファインマンによる講義の録音を用いて，聴き取り・ノート取りの練習を行う。
（4）最近の物理科学の話題を教材として、表現法を学ぶ。
原子力発電, 高温超伝導, 重力波, トポロジカル相, 先端光学など。
（5）エッセイの基本的構成を学び、科学英語のエッセイ課題について実習を行う。
（6）留学試験 TOEFL (Test of English as a Foreign Language) や GRE (Graduate Record Examination) の概要を体験する。類似の形式での物理科学関係の練習問題を用いた中間試験を行う。

・その他、留学経験者や留学生をゲストに招き、体験談やアドバイスを聞く。
・成績は小テスト(約 50%)、エッセイ課題(約 10%)、中間試験(約 10%)、期末試験(約 30%) の合計点をもとに評価する。
・アナウンスや教材ダウンロードは HP から: **http://www.ss.scphys.kyoto-u.ac.jp/butsurinoeigo/index.html**

#	Dates (2019)	「物理の英語」(Maeno)	数式	Feynman	Special Topics
1	4/9	講義説明　配布･解説 1-1	JN-3		TA:Hiraoka (自己紹介), TOEFL 説明
2	4/16	Quiz 1　解説 1-2　配布・解説 2	Doyle		留学の話、脳の話,
3	4/23	文法試験（TOEFL ITP 式）	Doyle		
	4/30	休講			
	5/7	（月曜授業）			
4	5/14	Quiz 2　解説 1-3　配布・解説 3	JN16		IYPT2019: Elementouch
5	5/21	Quiz 3　解説 1-4　配布・解説 4	Doyle	F-1	Superconductivity at 200 K
6	5/28	Quiz 4　配布・解説 5		F-2	Nuclear reactors
7	6/4	Quiz 5　配布・解説 6		F-3	Essay structure, Essay 課題
8	6/11	Quiz 6　配布・解説 7		F-4	Gravitational wave
9	6/18	(創立記念日:演習型授業)			Essay 作成、Essay 提出締切: 6/19
10	6/20 (Thu)	(火曜授業) Quiz 7　配布・解説 8		F-5	GRE General
11	6/25	文法試験（TOEFL ITP 式）			Video (Optics)
12	7/2	Quiz 8　配布・解説 9			GRE Physics
13	7/9	Quiz 9　配布・解説 10			2018 期末試験配布・解説
14	7/16	まとめ	Doyle	F-6	Essay 解説
15	7/23	期末試験			

物理の英語 (Maeno)
1. 物理の基本用語 Glossary
2. 科学論文の構成と図表、数式 Scientific papers
3. 名詞・代名詞 Nouns
4. 動詞　Verbs
5. 形容詞・副詞・比較級 Adjective, adverb
6. 動名詞と分詞 Gerund and participle
7. 前置詞　Prepositions
8. 冠詞　　Article
9. 文のつなぎ方 Conjunction
10. 修辞法　Rhetoric

Judy Noguchi:
耳から学ぶ科学英語（講談社, 1995）より
3. Fractions and decimal numbers
16. Element names

R.P. Feynman:
The Very Best of the Feynman Lectures
(Basic Books, 2005),
http://www.feynmanlectures.info/より：
"Deuteron and ^{2}He", "Size of an atom",
"Superconductivity"

物理の英語　References

April 9, 2019

WEB 辞書

1. Merriam-Webster Online　http://www.m-w.com/　など多数

物理学辞典

①. Valerie Illingworth (ed.): *The Penguin Dictionary of Physics*, 4th ed.
(Penguin Books, 2009). Amazon ¥1,890
授業で頻繁に用いる以外に、物理学の学習全般にも役立つ。

参考書　（講義ノート作成に参考にしたもの等）

① 日本物理学会編：科学英語論文のすべて、第 2 版（丸善，1999）．特に 2, 3, 4 章.
② 原田豊太郎：理系のための英語論文執筆ガイド（講談社ブルーバックス B1346，2002）．
科学技術論文一般に対する表現法.
③ 原田豊太郎：間違いだらけの英語科学論文（講談社ブルーバックス B1448，2004）．日本人に多い誤用を類型化.
4. 原田豊太郎：科学技術英語の書き方入門（アグネ，1985）．
5. グレン・パケット：科学論文の英語用法百科 第 1 編（京都大学学術出版会，2004）．よく誤用される単語と表現.
⑥ 野口ジュディー：耳から学ぶ科学英語（講談社，1995）．同著者の科学英語書籍は多いが、講義ではこれを使う。
⑦ R.P. Feynman: *The Very Best of the Feynman Lectures* (Basic Books, October 2005),
6 CDs: Total playing time: Approx. 6 hours. Amazon ¥2,953
http://www.feynmanlectures.info/
8. R.A. Hilke 他：コンピューター方式対応　TOEFL パーフェクト模試（東進ブックス, 2001）．
9. 松谷偉弘, R. Hilke, and P. Wadden: はじめての TOEFL テスト完全対策（旺文社, 2006）．
10. 田地野彰、金丸敏幸、ETS: TOEFL ITP テスト（研究社, 2012）．
11. 木村哲也：全問正解する TOEFL-ITP TEST 文法問題 580 問（語研, 2013）．
12. 小野義正：科学英語論文の書き方（丸善, 2016）．

読み物、他

1. Steven Weinberg: *The First Three Minutes* (Basic Books, 1993).
② 鈴木陽一：DUO 3.0 CD 復習用（ICP, 2001）．
現代英語の重要単語 1600+熟語 1000 を重複なしで 560 本の基本例文に凝縮。
3. 京大英語学術語彙研究グループ・研究者：京大 基本英単語 1110 (2009).
これに含まれていない物理の基本語彙を講義で紹介。
4. Jorge Cham: *Piled Higher and Deeper* (Piled Higher and Deeper Publishing, 1997 and 2005).
5. Arthur Bloch: *Murphy's Law: The 26th Anniversary Edition* (Perigee Trade, 2003).

WEB

1. TOEFL ITP
http://www.ets.org/toefl_itp/content/sample_questions/　Sample questions
2. GRE Physics
http://www.ets.org/gre/subject/about/content/physics/　You can download practice questions.
3. Criterion
http://www.cieej.or.jp/toefl/criterion/user.html

4. Physics for the 21st Century (Harvard-Smithsonian Center for Astrophysics, 2010)
http://www.learner.org/courses/physics/index.html
An excellent introduction to the current physics with videos, text PDFs, and more.
5. The Feynman Lectures on Physics
http://www.feynmanlectures.info/
6. The Nobel Prize in Physics
https://www.nobelprize.org/prizes/physics/
7. On Fukushima Nuclear Disaster: NHK World News - CNN - YouTube (3:07)
http://www.youtube.com/watch?v=BdbitRlbLDc&feature=related
8. On STAP: NHK World News - YouTube (2:26, 2014/12/19)
https://www.youtube.com/watch?v=4faAHQEd9_g#t=68

	Category	単語	Words	Definitions/descriptions
1	General	電磁気学	electricity and magnetism	
2	General	量子力学	quantum mechanics	
3	General	統計力学	statistical mechanics	
4	General	卒業論文	senior thesis	
5	General	大学院生	graduate student	
6	General	学部生	undergraduate student	
7	General	理学研究科	Graduate School of Science	
8	General	理学部	Faculty of Science	
9	General	前期/後期	first semester/ second semester	
10	General	経験則	empirical rule	A rule derived from experiments or observations rather than theory.
11	Matter	分子	molecule	The smallest unit into which any substance is divided into without losing its chemical nature, usually consisting of a group of atoms.
12	Matter	原子	atom	The smallest part of an element that can exist, consisting of a small dense nucleus of protons and neutrons surrounded by orbiting electrons.
13	Matter	原子核	nucleus (pl. nuclei)	The most massive part of an atom, consisting of protons and neutrons.
14	Matter	核子	nucleon	A collective term for a proton or neutron, i.e. for a constituent of an atomic nucleus.
15	Matter	陽子	proton	A positively charged nucleon.
16	Matter	中性子	neutron	An elementary particle with zero charge and with rest mass nearly equal to that of a proton. A charge-neutral nucleon.
17	Matter	電子	electron	A stable elementary particle whose negative charge $-e$ defines an elementary unit of charge.
18	Matter	光子	photon	A quantized particle of electromagnetic radiation (light).
19	Matter	水素	hydrogen	An element whose atom consists of one proton and one electron.
20	Matter	元素の周期表	periodic table of the elements	A table of chemical elements arranged in order of their atomic numbers.
21	Math	足し算	addition	The mathematical operation represented by a plus symbol (+).
22	Math	引き算	subtraction	The mathematical operation represented by a minus symbol (−).
23	Math	整数	integer	A whole number, i.e. does not contain a fraction.
24	Math	偶数	even number	A number that can be written as $2n$, where n is an integer.
25	Math	奇数	odd number	A number that can be written as $2n+1$, where n is an integer.
26	Math	分数	fraction	A number expressed as p over q (p/q).
27	Math	小数	decimal	A fraction whose denominator is a power of ten and whose numerator is expressed by figures placed to the right of a decimal point.
28	Math	分子	numerator	The number above the line in a fraction.
29	Math	分母	denominator	The number below the line in a fraction.
30	Math	積分	integration	The process of finding an integral, i.e. the function for which the derivative is the given function. The integral can express the area under the graph of the given function.
31	Math	近似	approximation	Something that is similar but not exactly equal to something else. E.g. an approximate value for some quantity can be used if the true value is too difficult to calculate, or an approximate model can be used if the true model is too complicated.
32	Mechanics	精度	precision	A measure of the smallness of random deviation from the mean value.
33	Mechanics	確度	accuracy	A measure of the smallness of systematic deviation from the true value.
34	Math	行列	matrix (*pl.* matrices)	An m n matrix is a rectangular array of numbers (do not have to be numbers) set out in m rows and n columns.
35	Math	円筒	cylinder	A geometric shape with parallel sides and circular cross-section.
36	Math	球	sphere	A solid object that is completely round, with every point on its surface at an equal distance from the center.

	Category	単語	Words	Definitions/descriptions
37	Math	立方体	cube	A three-dimensional object bounded by six equal squares, with neighbouring squares perpendicular to each other.
38	Math	四角形	rectangle	A four-sided shape with four straight lines joined at right angles. Unlike a square, the sides do not all have to be of equal length.
39	Math	平行四辺形	parallelogram	A two-dimensional shape with opposite sides parallel and equal in length. The three-dimensional counterpart of a parallelogram is a parallelepiped.
40	Math	台形	trapezoid	A two-dimensional shape with 4 straight sides that has a pair of opposite sides parallel.
41	Math	正三角形	equilateral triangle	A triangle in which all three sides are equal.
42	Math	二等辺三角形	isosceles triangle	A triangle that has two sides of equal length.
43	Math	半径	radius (*pl.* radii)	The distance from the center of a circle (or sphere) to its circumference.
44	Math	直径	diameter	A straight line going from one side of a circle to the other side, passing through the center of the circle.
45	Math	表面積	surface area	The total area of the faces or curved surfaces of a solid object.
46	Math	体積	volume	The amount of three-dimensional space occupied by a body or enclosed by a closed boundary.
47	Math	直角	a right angle	An angle of 90°
48	Math	平行	parallel	The relationship between two lines (or planes) that never meet.
49	Math	垂直	perpendicular	The relationship between lines or surfaces that intersect at right angles.
50	Math	直交	orthogonal	Orthogonality is an extension of the idea of perpendicularity to higher dimensions and non-geometric objects.
51	Math	原点	origin	A fixed point from which coordinates are measured.
52	Math	対数関数	logarithm	The power to which a fixed number (the base) must be raised in order to recover a given number.
53	Math	指数関数	exponential	The function e^x, which is equal to its own derivative. (e=2.7182818 …)
54	Math	平均	mean	For the set of numbers a_1, a_2, a_3,… a_n, the value given by $(a_1+a_2+a_3+...+a_n)/n$. Also commonly known as the average.
55	Math	桁数	an order of magnitude	A power of 10. The value of physical quantities are often given to an order of magnitude. For example, 2.3 10^5 and 6.9 10^5 are of the same order of magnitude.
56	Math	次元	dimension	(1) Combinations for any physical quantities that can be expressed in terms of base units (such as meter, kg and second) of fundamental physical quantities (such as length, mass and time). (2) In geometry, the dimension of the space is the minimum number of coordinates required to specify any point within the space.
57	Math	複素数	complex number	A number that can be expressed as $a + ib$, where i is the imaginary unit satisfying $i^2 = -1$ and a and b are real numbers.
58	Math	実数	real number	A number with no imaginary part. This can be expressed as $a + 0i$
59	Math	虚数	imaginary number	A number with no real part. This can be expressed as $0 + ib$
60	Math	円筒座標	cylindrical coordinate system	A three dimensional coordinate system in which a position is specified by radial distance ρ, azimuthal angle φ, and axial distance z.
61	Math	球座標	spherical coordinate system	A three dimensional coordinate system in which a position is specified by distance r from the origin, polar angle θ, and azimuthal angle φ.
62	Math	極角	polar angle, θ	In two dimensions, the polar angle is measured counterclockwise from the x-axis to a line drawn from the origin to some given point in the x-y plane. In three dimensions, the polar angle is measured from the z-axis to a line drawn from the origin to some given point in the 3-dimensional space.
63	Math	方位角	azimuthal angle, φ	In three dimensions, after projection of the vector between the origin and some given point of interest onto the x-y plane, the azimuthal angle is the angle measured counterclockwise from the x-axis to this projected line.

	Category	単語	Words	Definitions / descriptions
1	Mechanics	並進	translation	The movement of a body or system in such a way that all points are moved in parallel directions through equal distances.
2	Mechanics	運動方程式	an equation of motion	Equation that describes the motion or evolution of a system as a function of time.
3	Mechanics	位置	position	The location of an object relative to the origin of an arbitrary set of coordinates.
4	Mechanics	速度	velocity	The rate of change of position with time.
5	Mechanics	加速度	acceleration	The rate of change of velocity with time.
6	Mechanics	質量	mass	A measure of a body's inertia, i.e. its resistance to acceleration: $a = F/m$. Can also be defined in terms of the gravitational attraction between two bodies.
7	Mechanics	運動量	momentum (*pl.* momenta)	The product of the mass and the velocity of a particle.
8	Mechanics	角速度	angular velocity	The rate at which a body rotates about an axis.
9	Mechanics	慣性モーメント	moment of inertia	The resistance of an object to changes of its angular velocity.
10	Mechanics	角運動量	angular momentum	The product of the angular velocity of a body and its moment of inertia about the axis of rotation.
11	Mechanics	位置エネルギー	potential energy	The energy associated with the position of objects in a system.
12	Mechanics	運動エネルギー	kinetic energy	The energy associated with the motion of a system.
13	Mechanics	摩擦	friction	Force opposing the sliding of one surface over another.
14	Mechanics	重力	gravity	The attractive force between two bodies which is proportional to the product of their masses.
15	Mechanics	振動	oscillation	A regular movement between one position and another or between one amount and another.
16	Mechanics	調和振動子	a harmonic oscillator	An oscillator which has sinusoidal like motion.
17	Mechanics	共鳴	resonance	A condition in which a vibrating system responds with maximum amplitude to an alternating driving force, which occurs when the driving frequency coincides with the natural frequency of the system.
18	Mechanics	振幅	amplitude	The peak value of an alternating quantity in either the positive or negative direction.
19	Mechanics	位相	phase	The state of development of a periodic quantity, specifically the fraction of the whole period that has elapsed.
20	E&M	電荷	charge	A property of an elementary particle that determines the force it experiences in the presence of an electric or magnetic field. Usually measured in units of the magnitude of the negative charge of the electron, *e*.
21	E&M	引力	attractive force	e.g. The force between positive and negative charges is attractive.
22	E&M	斥力	repulsive force	e.g. The force between two positive or two negative charges is repulsive.
23	E&M	クーロン力	Coulomb force	The force between two charged particles.
24	E&M	周波数	frequency	The rate of repetition of a regular event, e.g. the number of cycles of an oscillation per second.
25	E&M	周期	period	The time it takes to complete one cycle of an oscillation.
26	E&M	電流	current	A flow of electric charge through a substance.
27	E&M	電圧	voltage	The difference in the electric potential between two points in a circuit that gives rise to a force on charged particles, thus inducing a current. The induced current is related to the resistance of the circuit through Ohm's law: $I = V/R$.
28	E&M	オシロスコープ	oscilloscope	An instrument used to provide a visual image of electrical signals, i.e. their amplitude and time evolution.
29	E&M	抵抗	resistance	A measure of a substances' opposition to the flow charge when a voltage (potential difference) is applied. It is related to the voltage and current via Ohm's law as $R = V/I$.
30	E&M	並列	in parallel	Two capacitors connected in this way give a total capacitance that is the sum of the two.
31	E&M	直列	in series	Two resistors connected in series give a total resistance that is the sum of the two.
32	E&M	エックス線回折	X-ray diffraction	The diffraction of X-rays by a crystal whose atomic separations are comparable in size to the wavelength of X-rays. (Diffraction is the spreading or bending of waves as they pass through an aperture (or series of apertures as in the case of the crystal) or round the edge of a barrier.)
33	E&M	反射	reflection	The return of all or part of a beam of particles or waves when it encounters a boundary between two media.
34	E&M	屈折率	index of refraction	The parameter that characterizes the change in direction of a wave when it enters another medium.
35	E&M	干渉	interference	The interaction between two or more wave motions affecting the same part of a medium such that the total disturbance is the vector sum of the disturbances resulting from each of the individual waves.

	Category	単語	Words	Definitions/descriptions
1	QM	不確定性原理	the uncertainty principle	The fundamental principle often expressed by the relation $\Delta x \bullet \Delta p \gtrsim h$.
2	QM	パウリの排他律	the Pauli exclusion principle	The rule stating that no two identical Fermions can be in the same quantum state.
3	QM	量子化	quantization	The procedure involved in transforming from a classical to a quantum understanding of physical phenomena whereby variables that are continuous in the classical theory become quantized, i.e. can only take on certain discrete values.
4	QM	スピン	spin	The intrinsic angular momentum of an elementary particle.
5	QM	対称性	symmetry	The property of a system that leaves the system unchanged after a certain transformation.
6	QM	束縛状態	bound state	A state in which a particle is subject to a potential such that the particle has a tendency to remain localised in one or more regions of space.
7	QM	基底状態	the ground state	The lowest stable energy state of a system.
8	QM	励起状態	excited state	An unstable state of a system whose energy is greater than that of the ground state.
9	QM	励起エネルギー	activation energy	The height of the energy barrier separating two minima of potential energy.
10	QM	縮退	degeneracy	A situation in which two or more distinct states have the same energy.
11	QM	摂動	perturbation	A small deviation from a known or solved reference system.
12	QM	消滅（生成）演算子	annihilation (creation) operator	In the context of quantum mechanics, where the energy levels of a system are discretised, an annihilation (creation) operator can be considered as an operator that decreases (increases) the number of particles in a given energy state by one.
13	Stat. Mech.	エントロピー	entropy	An extensive variable in thermodynamics which gives a measure of the microscopic disorder of a system.
14	Stat. Mech.	断熱膨張	adiabatic expansion	A thermodynamic expansion process in which no heat enters or leaves a system.
15	Stat. Mech.	分配関数	partition function	A summation which describes how the probabilities are divided among the different microstates, based on their individual energies: it counts the (weighted) number of states a system can occupy.
16	Stat. Mech.	熱平衡	thermal equilibrium	The condition of a system in which the net rate of exchange of heat between its components is zero.
17	Stat. Mech.	平均自由行程	mean free path	The average distance travelled between collisions by the molecules in a gas, photons in a plasma etc
18	Stat. Mech.	揺らぎ	fluctuation	An irregular increase or decrease in a quantity derived from many identical random processes.
19	Stat. Mech.	飽和	saturation	A situation in which the response or output of a system becomes substantially constant and independent of the increasing external field or input.
20	Stat. Mech.	ヒステリシス	hysteresis (*pl.* hystereses)	The dependence of a system not only on its current environment but also on its past environment, e.g. in a ferromagnetic material.
21	Stat. Mech.	アニーリング （焼きなまし）	annealing	The process of heating a substance at a certain temperature below its melting temperture, maintaining it for a cetain time, and cooling it slowly so that the substance reaches a state closer to its thermal equilibrium at ambient tempearatue.

	Category	単語	Words	Definitions/descriptions
1	Condensed Matter	金属	metal	A material with high electrical conductivity (low resistance).
2	Condensed Matter	絶縁体	insulator	A material with very low electrical conductivity (high resistance) because of the energy gap between the valence band and conduction band.
3	Condensed Matter	超伝導	superconductivity	A phenomenon in which the electrical resistance of a metal disappears completely below a certain temperature.
4	Condensed Matter	相転移	phase transition	The transformation of a thermodynamic system from one state of matter to another.
5	Condensed Matter	走査型トンネル顕微鏡	STM (scanning tunneling microscope)	A type of an electron microscope based on the tunnel effect for imaging surfaces at the atomic level. (When a fine conducting tip is held close to the surface of a sample with an electric potential, electrons tunnel between the sample and the tip, producing a small current. The tip is slowly moved across the surface and raised and lowered so as to keep the electrical current constant. In this way, the profile of the surface based on its local density of electron states can be determined.)
6	Condensed Matter	核磁気共鳴	NMR (nuclear magnetic resonance)	A resonant absorption of radio-frequency radiation when its frequency coincides with the difference in energy between two states of a nucleus with a spin in a magnetic field.
7	Condensed Matter	レーザー	Laser	A beam of coherent, monochromatic light, or a device that emits such a beam. The light is produced by stimulated emission of electromagnetic radiation.
8	Condensed Matter	発光ダイオード	LED (light-emitting diode)	A semiconductor pn-junction diode which emits light by recombination of electrons with holes. The color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.
9	Particles and Cosmology	微細構造定数	fine-structure constant	A dimensionless quantity, denoted by α, which serves as a convenient measure of the strength of the electromagnetic interaction.
10	Particles and Cosmology	核融合	nuclear fusion	A reaction between light nuclei in which a heavier nucleus is formed with the release of energy.
11	Particles and Cosmology	核分裂	nuclear fission	The splitting of a heavy nucleus of an atom into two or more fragments of comparable size.
12	Particles and Cosmology	宇宙	universe	All the matter, energy and space that exists.
13	Particles and Cosmology	銀河	galaxy	A large gravitationally bound cluster of stars, gas, and dust.
14	Particles and Cosmology	太陽系	the solar system	The system made up of the sun, its orbiting planets and their natural satellites (moons).
15	Particles and Cosmology	宇宙線	cosmic ray	High-energy charged particles which enter the earth’s atmosphere from outer space.
16	Particles and Cosmology	重力波	gravitational wave	Disturbance in the curvature of spacetime, generated by accelerated masses, that propagates as a wave outward from their source at the speed of light.
17	Particles and Cosmology	特殊相対論	the special theory of relativity	The theory developed by Einstein in 1905 which leads to the equivalence of energy and mass: $E = mc^2$.
18	Particles and Cosmology	一般相対論	general relativity (The general theory of relativity)	The theory developed by Einstein which provides a unified description of gravity as a geometric property of space and time, or spacetime. (In particular, the curvature of spacetime is directly related to the energy and momentum of whatever matter and radiation are present.)

第 2 章　科学論文の構成と図表式

§2-1 科学論文の構成

物理学の論文に限らず，また英語論文であれ日本語解説文であれ，科学論文ではおおよそ次に述べるような構成がとられる．ここでは，「課題演習」や「課題研究」のレポートへの適用も想定して，その一般的注意点について述べる．

基本ルール・型を知る→ variations

A. 表題　(Title)

B. 著者名　(Author Names)

C. 所属と連絡先　(Affiliation and Address)

D. 抄録　(Abstract)

どういう方法で，何を調べて，何がわかったかを手短に（例えば英文 100 語程度）に書く．

E. 本文　(Main Text)

1. 序論 (Introduction)

目的・背景・動機 (purpose, background and motivation),
および本研究の重要性 (significance).
論文の内容についての見通し (outline).

2. 実験 (Experiment, Experimental, Experimental Procedure)

実験の原理，装置の詳細など．
主な数式には続き番号をいれ，文中では「第 1 式，　Eq.(1) 」などと引用する．

理論の論文の場合は「実験」のかわりに,

2’. 理論 (Theory)

3. 結果 (Results)

結果を図や表も使ってまとめる．
図や表には，続き番号（図 1，第 1 図，Fig. 1 など）とタイトルのみ，またはタイトルと簡単な説明文 (captions) を（図の下に, 表の上に）付ける．
データを整理したものは「結果」.「考察」では結果に対するより深い意味付けを行う．

4. 考察 (Discussion)

結果の意味や正当性，解析結果の意味付けなどを図や表も使ってまとめる．
他の研究結果との関連についても述べる．
否定的な結果や技術上の問題点についても明記する．（ただし，こればかり強調するのは考えもの．）
明記した上で推論 (Speculation) を含んでもよい．

5. 結論 (Conclusion)

結果と考察から導かれたことを，普遍的な形で短く（例えば 150 語程度で）表現する．今後の課題・展望についても述べる．
摘要 (Summary) の形をとることもある．

2-4 については，テーマごとの「縦割り」の構成をとることもある．
また，あらわに章立てをとらない場合でも，内容の流れは上のような構成にする．

F. 謝辞　(Acknowledgements)

「課題演習」レポートの場合は共同実験者に対する感謝の言葉など．

G. 引用文献　(References)

本文での引用順に番号を付けて，それをリストする．引用文献の表記方法はすぐ下で述べる．本文中の引用箇所にも番号を付ける．

H. 付録　(Appendices)

通常は不要．本文中にあると論理の流れを乱すが，論文中に是非含めたいものをまとめる．式の導出過程の詳細など.「課題演習」レポートの場合は，測定生データを整理したものや，回路図，開発したコンピュータプログラムなどにも利用できる．

引用文献の表記方法

決まった表記スタイルがある．ただし，アメリカ式，ヨーロッパ式で若干異なる．以下ではアメリカ式（例えば Journal of the Physical Society of Japan や Physical Review のスタイル）について説明する．

A. 学術雑誌の場合

番号) 著者名，雑誌略称 **巻(太字)**, 開始頁または論文番号--頁 (発行年). **最後にピリオド**

1) J. G. Bednorz and K. A. Müller, Z. Phys. B **64**, 189 (1986).
2) B. P. Abbott *et al.*, Phys. Rev. Lett. **116**, 061102--1-16 (2016).

B. 単行本の場合

番号）著者名，書名(英語は斜体)[, ed. 編者](出版社，発行年) 章 or 頁.

2) C. Kittel, *Introduction to Solid State Physics*, 8th ed. (Wiley, 2004) Chap. 12.
3) 潮田資勝, 科学英語論文のすべて，第 2 版，日本物理学会編（丸善，1999）第 2 章.

§2-2 図

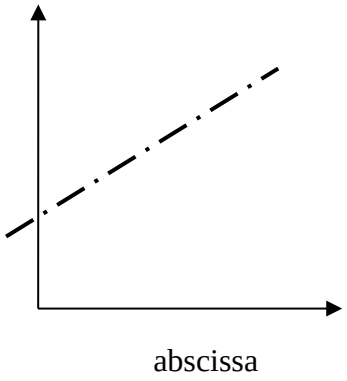
① 上・右の枠にも必ず目盛り(**graduations**)を入れる.

② 物理量記号は斜体(***italic***), 単位記号は立体(**roman**).
これは SI （国際単位系）のきまり.

③ **Caption** は図の下.
④ Caption の初めにタイトルを名詞句で示す.
⑤ その後に説明文を続ける.（説明文は省略することもある.）

⑥ 本文中での図の説明によく使う表現：
Figure 1 shows ..., ... is shown in Fig. 1.
Figure 2 displays ..., indicates ..., represents..., illustrates..., depicts ..., compares ..., demonstrates ..., etc.
現在形であることに注意!

Glossary:
origin
intercept
slope
ordinate
abscissa
solid line
broken line ‐ ‐ ‐ ‐ ‐ 破線
dotted line ····· 点線
dash-dotted line
extrapolation, interpolation
symbols: open circle, solid (closed) triangle
a guide to the eye
arbitrary units (arb. units)



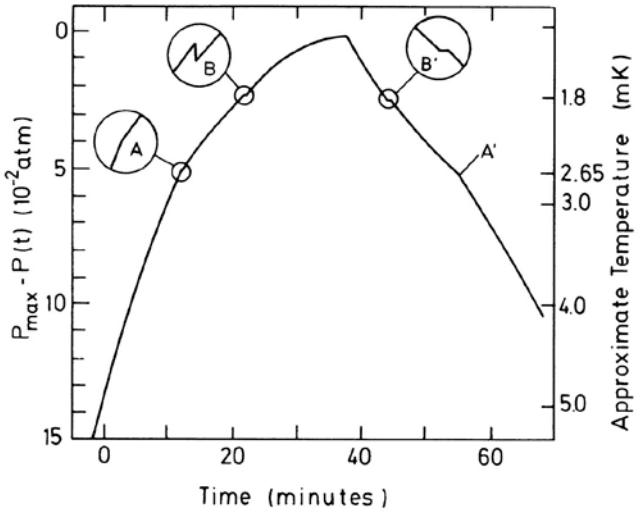


Figure 4.1 Pressure versus time trace when the volume in a Pomeranchuk cell was changed at a constant rate. The signatures A and B, shown magnified in the inserts, indicate the occurrence of two phase transitions in ^{3}He. (After Osheroff *et al.* (1972a).)

D. Vollhardt and P. Wolfle, *The Superfluid Phase of Helium 3* (Taylor and Francis, 1990) p.96.

§2-3 表

① 表に**タテ枠は入れない**.

② Caption は表の上.
③ Caption の初めにタイトルを名詞句で示す.
④ その後に説明文を続ける.（説明文は省略することもある.）

⑤ 本文中での表の説明によく使う表現：
Table 1 shows ...,　.... is shown in Table 1.
Table 2 displays ..., summarizes ...,
represents..., compares ..., etc.
現在形！

Glossary:
column, row

Table 1 Typical style of table and names of the items appearing in the table.

列 (columns)	第2列	第3列	……	列の見出し (column headings)
行(rows)				
第2行 ⟶	−2.53	0.25 ±0.08		
第3行 ⟶	31.5	0.2 ±0.1		
第4行 ⟶	>0.25[a]	$0.256^{+0.025}_{-0.015}$		
⋮				
表の見出し (table texts)				

a. Lower limit obtained by the attenuation method in ref. 3.

Table 3
SM Higgs boson cross sections (in pb) at $\sqrt{s} = 8$ (7) TeV for $m_H = 125$ GeV. The total values as well as the contributions from the individual production modes are listed. The branching ratios to the final-state channels considered in this Letter are also given (where ℓ stands for electron or muon), together with their relative uncertainty. Up-to-date theoretical calculations are used [14–16,89,35,36].

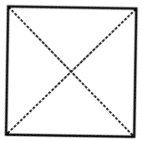
Cross section (pb) at $\sqrt{s} = 8$ (7) TeV		Branching ratio (relative uncertainty)	
ggF	19.52 (15.32)	$H \to WW^* \to \ell\nu\ell\nu$	0.010 (±5%)
VBF	1.58 (1.22)	$H \to \gamma\gamma$	2.28×10^{-3} (±5%)
WH	0.70 (0.57)	$H \to ZZ^* \to 4\ell$	1.25×10^{-4} (±5%)
ZH	0.39 (0.31)		
$t\bar{t}H$	0.13 (0.09)		
Total	22.32 (17.51)		

SM: Standard Model

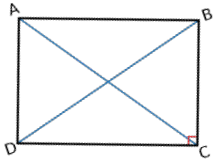
ATLAS Collaboration, "*Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC*", Physics Letters B **726**, 88-119 (2013).

§2-4 図形 Geometrical Figures

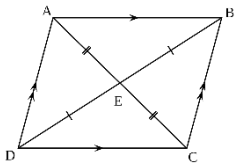
正方形　square



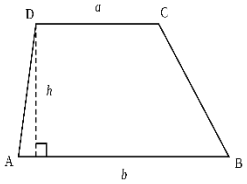
長方形　rectangle



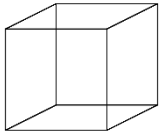
平行四辺形　parallelogram



台形　trapezoid

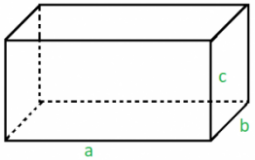


立方体　cube

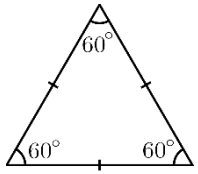


直方体

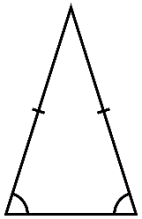
rectangular parallelepiped



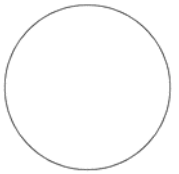
正三角形　equilateral triangle



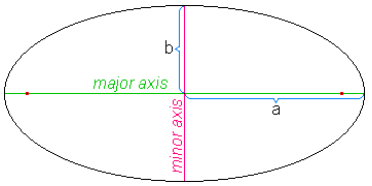
二等辺三角形　isosceles triangle



円　circle

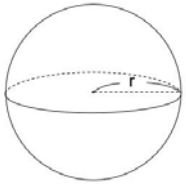


楕円　ellipse

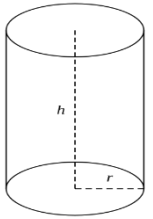


oval: There is no precise mathematical definition of an oval. All ellipses are ovals but not all ovals are ellipses.

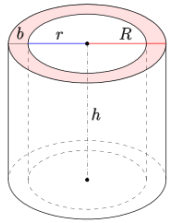
球　sphere



円柱　cylinder

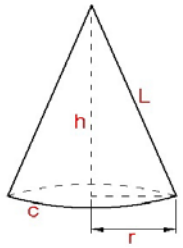


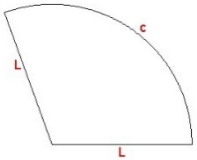
円筒　hollow cylinder



円錐　cone

A three-dimensional geometric shape that tapers smoothly from a flat base (frequently, though not necessarily, circular) to a point called the apex or vertex.





https://brilliant.org/wiki/surface-area-of-a-cone/

(出典: Wikipedia, etc.)

§2-5 式の読み方：How to Read Equations

1. $a^n = b^n + c^n$

2. $\quad {}_nC_r = \frac{n!}{(n-r)!\,r!}$

3. $\int_0^\infty e^{-x^2} dx = \sqrt{\pi}/2$

4. $\boldsymbol{\nabla} \times \boldsymbol{H} = \boldsymbol{j} + \frac{\partial \boldsymbol{D}}{\partial t}$

5. $F = -k_{\mathrm{B}} T \ln Z\,; \quad Z = \sum_{n=0}^{\infty} e^{-E_n/k_{\mathrm{B}}T}$

6. $\frac{1}{2m_{\mathrm{e}}}(-i\hbar\boldsymbol{\nabla} + e\boldsymbol{A})^2\Psi = E\,\Psi$

1. Fermat's Last Theorem

As conjectured (and perhaps proven) by Fermat and recently proven by Andrew Wiles, for any integer *n* greater than or equal to 3, there is no set of three integers *a*, *b* and *c* for which *a* to the *n*-th power equals *b* to the *n*-th power plus *c* to the *n*-th power holds.

2. The combination of *n* choose *r*

The number of ways of choosing *r* elements from a group of *n* elements is denoted by sub *n* capital *C* sub *r*, which is equal to *n* factorial divided by open parentheses *n* minus *r* close parentheses factorial times *r* factorial.

3. Gaussian integral

The integral over *x* from 0 to infinity of the exponential of minus *x* squared is equal to the square root of π over 2.

4. One of Maxwell's equations

The curl of the vector ***H*** is equal to the vector ***j*** plus the partial derivative of the vector ***D*** with respect to *t*.
*In both the USA and UK, "curl" is commonly used instead of "rotation".

5. Partition function

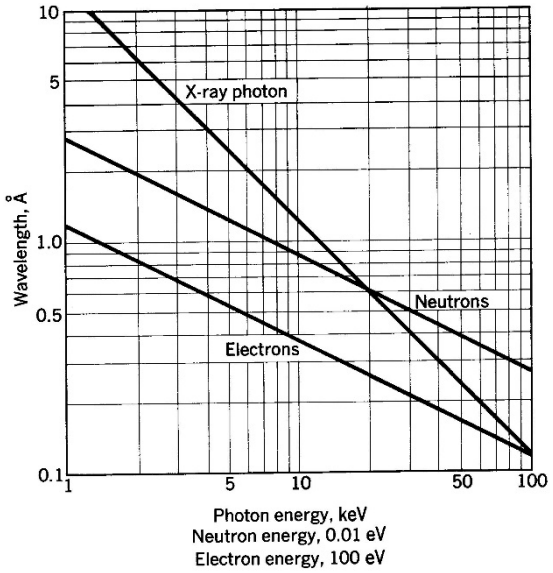
The Helmholtz free energy *F* is given by minus *k* sub B times *T* times the natural logarithm of *Z*, where *Z* is the partition function given by the sum over *n* from *n* equals 0 to infinity of *e* to the minus *E* sub *n* over *k* sub B times *T*.

6. Schrödinger equation example

The Schrödinger equation for an electron with the charge minus *e* in a magnetic field is one over two *m* sub e times open parentheses minus *i h* - bar gradient plus *e* times the vector potential *A* close parentheses squared psi equals the energy *E* times psi.

(Exercise 2-1)

1. 図の説明文(caption)は図の上に書くべきか？下に書くべきか？
2. 下の図は、光子、中性子、電子の各粒子線について、ドブロイ波長(de Broglie wavelengths)のエネルギー依存性を示す。下の図の説明文(caption)を論文の様式に従って英語で作れ。図の番号は「図 2」とし、波長のエネルギー依存性（何乗に逆比例？）の違いによって、グラフの勾配が 2 種類ある理由についても簡単に述べる説明文にせよ。



C. Kittel, *Introduction to Solid State Physic*s (8th ed., John Wiley& Sons, 2005) p. 24.

(Exercise 2-2) Read the following equations and write down how to read them.

1. $H_0 = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 x^2$

2. $\int_{-\infty}^{\infty} e^{-\alpha x^2} dx = \sqrt{\frac{\pi}{\alpha}}$

3. $\frac{\partial \rho}{\partial t} + \boldsymbol{\nabla} \cdot (\rho \boldsymbol{v}) = 0$

第 3 章　名詞 (Nouns)

§3-1 特殊な複数形

	SINGULAR	PLURAL	
1.	formula	formulae	式
2.	phenomenon	phenomena	現象
3.	nucleus		
4.	maximum		
5.	hypothesis		
6.	matrix		

(Exercise 3-1) 複数形を書け。

1. spectrum	2. analysis
3. quantum	4. parenthesis
5. momentum	6. thesis
7. medium	8. axis
9. minimum	10. criterion
11. radius	12. supernova

特殊な複数形のパターンは限られている.

略称や数字の複数表記：単に s をつける。紛らわしい場合は 's を付ける。

・*His family name is spelled with two is.*→ His family name is spelled with two i's.

・1980s (1980's)　in the 1980s (in the 1980's:　see §3-7)

・Some numbers with a sequence of 3's followed a 1, such as 31, 331, 3331 and 333331, are prime numbers.

・LEDs

§3-2 小数の場合の単数・複数形

0.1 mm (zero point one millimeter),　1.1 mm (one point one millimeters)
数字が 1 を超えたら複数。1 以下なら単数扱い。（Judy Noguchi, 井口道生）

1 以外はすべて複数形という用法もある。
English also tends to use the plural with decimal fractions, even if less than one, as in *0.3 metres, 0.9 children.* (Wikipedia)

§3-3 数えられない名詞(Uncountable Nouns)関連

★[U] と [C] の表記のない辞書は使うな!

(1) 決して"s"を付けない名詞：[U]

1. Information [U]

W: ** *Many informations were obtained.*** ← 文法上の誤り
R1:　A lot of information was obtained.
R2: (not common) Much information was obtained.
R3: (not common) Many items of information were obtained.

(補足) "a lot of" は　a lot of *n*([C], ***必ず pl.***),　a lot of *n*([U]) 両方使える.
A lot of inelastic events were recorded.　非弾性事象

(比較) "a variety of" も同様。 a variety of *n*([C], ***必ず pl.***), a variety of *n*([U])

2. Equipment [U]

W: ** *Several equipments were installed.***
R:　Several pieces of equipment were installed.
R:　Many items of equipment were installed.
R:　A lot of equipment was installed.

Apparatus, instrument, machine などは, 普通[C]である.
(補足) apparatus は複数形も apparatus (or apparatuses).

3. Data [U] cf. datum

W: ** *Many datas were obtained.***

R: A lot of data was obtained.

W: ** *Several of the datas are shown in Fig. 3.***

R: Several of the data are shown in Fig. 3.

Data はすでに複数形であるので，“s”を付けることはできない(単数形は datum)．しかし，複数形であるのに関わらず最近では This data **was** analyzed by computer.のように単数的にも，あるいは These data **are** very interesting.のように複数的にも扱うことができる．各自の好みに応じてよいが，文中全体で一貫した扱いをするべきである．

(補足)以下の文を比較せよ．

This data was analyzed **by** computer.

This data was analyzed **with a** personal computer.

4. The following [U]

W: ** *The followings were assumed.***

R: The following was assumed: The following were assumed:

R: The following assumptions were made:

W: ** *The plasma parameters were the followings.***

R: The plasma parameters are as follows.

“The following”には決して”s”は付かない．“The following”は The + *adj.* で名詞的に使っている．この場合､内容によって単数･複数どちらの扱いでも可.

5. Evidence [U]

W: ***The evidences for the broken symmetry are as follows.***

R: The evidence for *the broken symmetry* is as follows.

R: There are many pieces of evidence to support this conjecture.

6. Literature [U] 文献

W: ***The literatures offer evidence to support these results.***

R: The literature offers evidence to support these results.

7. Behavior

W: ***The research of EuSe clarifies a complex magnetic behavior.***

R: The research of EuSe clarifies complex magnetic behavior.

次のような場合，うっかりと “behaviors”としやすいので注意．

R: Likewise this ease of oxidation is shown in the chemical behavior of 1 and 2.

★最近は複数形 behaviors の使用も増えてきている。

8. Dependence

W: ***The dependences of the conductivity on the temperature, pressure, and frequency were measured.***

R: The dependence of the conductivity on the temperature, pressure, and frequency was measured.

（日本物理学会編：科学英語論文のすべて（丸善，1999）第 3 章．）

(補足) **behavior [U] と dependence [U] は、場合によっては複数形**でも用いられることがある．その場合でも、[U]としての原形で置き換えてもよい場合が多い．（原田豊太郎：理系のための英語論文執筆ガイド（講談社，2002） pp. 37-42.）自分で文を書く場合は必ず単数形で使う方が無難.

(2)　本来［U］だがしばしば複数形

R:　The material is paramagnetic at low **temperatures**, and diamagnetic at high **temperatures**.

低温で何点もデータ･ポイントがある場合などに, 各点を別々の temperature として数えている．Energy, conductivity, specific heat なども同様.

R:　The electrical **conductivities** of the two samples are completely different.

(3) 一般概念には必ず複数(plural, *pl.*)をとる名詞：[C]

features, properties, aspects, characteristics, circumstances.

これらの名詞は，一般的概念 を意味するときは複数形．一つの特別な 性質などをさすときにのみ単数形.

Let us examine　[the properties/ some features/ various aspects/ the characteristics]　of this problem.

The solution (2.8) has the peculiar　[property/ feature/ characteristic]　of being invariant under the interchange of *x* and *y*.
A disturbing aspect of this situation is that ...
The unfortunate circumstance that *f* diverges makes it impossible to ...

(補足) feature を future と間違って発音する日本人が多いのはなぜだろう?
The new model features the future technology of remote sensing.

property: ．．．に関する性質 →*pl.*
．．．という性質→ →*sg.*
transformation properties,
Hermitian property,
symmetry properties (対称でも非対称でもよい、対称性に関する性質)
the symmetric property (対称であるという性質)

(Exercise 3-2) 次の 2 つの違いを吟味せよ.
1. the magnetic properties of copper
2. the magnetic (ferromagnetic) property of iron

§3-4 抽象名詞

★抽象名詞・動詞化 で明解な文になる.

日本人は英語を書くとき, 動詞より名詞を好んで用いる傾向がある．これは「英訳」すべき「和文」がそのようになっているからかもしれない．しかし，名詞を多用しすぎると冗漫でだらだらした文になってしまう.

1. **This results in a high reduction of the resistance.** ☜スタイルの誤り
（これが抵抗の大幅な 減少 をもたらす．）
→　This drastically reduces the resistance.

“－ion”で終わる名詞は特に致命的 である.
2.**The rotation of the sample was done.***（試料の回転を行った．）
→　The sample was rotated.
3.**We can use this formula for the purpose of the estimation of the density.***
→　We can use this formula to estimate the density.

(Exercise 3-3)　次の文を改善せよ.
1. **The temperature stability of the sample was achieved in this way.***
（試料温度の 安定化 は．．．）
2. **The oxidation of the iron was performed.***
3. **Utilization of synchrotron radiation is usually made in this way.***

§3-5 複合名詞

a neutron detector = a detector of neutrons （中性子検出器）
名詞 (*n.*) の形容詞 (*adj.*) 的な用法.

★ハイフンが必要になる場合：
次のように形容詞で修飾された名詞を合わせて形容詞的に使う場合はハイフンが必要.

a high-energy particle = a particle of high energy
the fine-structure constant

(補足) 形容詞の結合でもハイフン必要.

a two-dimensional system	This system is two dimensional.
a 1-cm diameter disc	The diameter of the disc is 1 cm.

(補足) 十分よく使われた語句は一語に結合してしまう場合がある.

wavelength, eigenvalue (これはドイツ語起源だから)
しかし: mean free path (平均自由行程)

★三つ以上の名詞の結合は好ましくない.

The sample temperature control unit is shown in Fig. 1.
→The unit for controlling the sample temperature is shown in Fig. 1.

§3-6 代名詞

W: ** *The electrical resistivity of sample 1 is approximately the same as sample 2.***
R: The electrical resistivity of sample 1 is approximately the same as that of sample 2.
R: The resistivity of sample 1 is quite different from that of sample 2.
R: The resistivity values of sample 1 and sample 2 are quite different.
R: This method of measuring conductivity is as versatile as the one described in reference 1.

§3-7 所有格 's か 定冠詞 the か

アポストロフィー 's を伴う場合、それだけで特定する働きがあるので、定冠詞 the はつけない.

Maxwell's equations （the Maxwell equations） one of Maxwell's equations
Ohm's law

the Maxwell distribution
the Pauli exclusion principle (cf. *principal* axis)
a Feynman diagram
a Poisson ratio

(Exercise 3-4)
Underline grammatically incorrect words and write down the correct words.
以下の文中で文法的に誤った部分に下線を引き、正しい語句を示せ.

1. ***Many evidences for an unusual nonlinear behavior have been found in a variety of physical property.***

2. ***These phenomenon can be experimentally studied using these two equipments and theoretically analyzed in terms of a product of two matrix.***

第 4 章　動詞 (Verbs)

§4-1 主語と動詞の呼応

主語と動詞が正しく呼応しないことは，日本人科学者が英語を書く際に，最も多くみられる文法上の誤りである．

W: ** *Classical condensation theory are used to explain these phenomena.***
←文法上の誤り
R: Classical condensation theory is used to explain these phenomena.
（古典的な凝縮理論）

W: ***The difference between the two cases are discussed in the next section.***
R: The difference between the two cases is discussed in the next section.

(Exercise 4-1) 次の文のなかで，主語と動詞の呼応に誤りがあれば正せ．

1. The activation energy of the free carriers are estimated as 27 meV.
2. The diameter and (the) length of the tungsten wire were 0.1 mm and 5 mm, respectively.
   普通，”The diameter and the length of ...” としないことに注意．
3. The distribution of *B* in these cases is shown in Fig. 2.
4. The current modulation rate were kept at about 2% for the two signals.
5. The capacitance of the other parts was kept constant.

この種の誤りは次の例でもわかるように，単数主語と動詞との間に複数形の名詞が存在する場合に，最も多くみられるものである．

W: ** *The current density in the laser tubes are rather high.***
R: The current density in the laser tubes is rather high.

主語が何であるかを見極めれば，この種の誤りは避けられるはずである．

(Exercise 4-2) 次の文の主語に下線を引き，動詞の呼応に誤りがあれば正せ．

1. The ratio *a/b* for protons and electrons are, however, independent of the potential.
2. The dependence of the capacitance values of these ceramics on temperature is given by the following equation.
3. The above considerations on the space charge effect leads to the conclusion that the results in our previous report was not representative of the intrinsic behavior.
4. A total of 21 values were obtained.
5. A series of unexpected events was recorded.

（補足）a series of …の次には複数名詞がくるが，全体で単数扱い．

§4-2 単数か複数か

1. a **number** of + [C] *pl.* + **are** ...　　（= many，たくさんの）
a large number of ... are ...

W: ** *A number of topics relating to this subject has already been fully reviewed in a recent article.***
R: A number of topics relating to this subject have already been fully reviewed in a recent article.
主語は “a number of topics” で，複合的に複数扱い．

個数を意味する “number” は単数．
R: The number of particles entering the chamber per unit time was measured by the method described earlier.

2. an **amount** of + [U] + **is** ...　量を表す

R:　A large amount of information was obtained by this experiment.
W: ** *The amount of atoms in the sample space increases with pressure.* **
R:　The number of atoms in the sample space increases with pressure.

（補足）多数・多量両方の意味で使える　a lot of …,　a variety of ….（第 3 章）は，多数[C]*pl.*の場合複数扱い、多量[U]の場合単数扱い。尚，a lot of ….はやや口語的であり，科学論文になじまない場合もある。

3. each of +[C] *pl.* + **is** ...

R:　Each of these electron-doped specimens was examined with a scanning electron microscope. (SEM: 走査型電子顕微鏡）
every ... も同様に単数扱い.

4. or ⇒ 動詞は近くの主語に呼応

R:　Two conventional detectors or a single new detector provides sufficient sensitivity.

W: ** *This is especially true when x or y are very small.* **
R:　This is especially true when *x* or *y* is very small..

R:　If **either** *a* **or** *b* exceeds the limit, the second solution is applicable.
R:　**Neither** a drop in voltage **nor** a change in temperature affects the response.

5. as well as

語法　(1) A as well as B　では A の方に意味上の重点が置かれ，それを主語とする述語動詞の数は A と一致する: John, as well as his friends, was injured in the accident.

cf. **Not only B but (also) A**　では**動詞は　A　と呼応**する.
(2) ときには　A　と　B　が意味上対等な重みで併置されることがある: In theory as well as in practice, the idea was unsound.
（新英和中辞典，第 6 版（研究社，1994）.）

6. 計量値の主語　・見かけは複数形でも単数主語

R:　Five grams of NaCl was added to the solution.

§4-3 時制

現在形：科学的真理　「いつ誰がやってもそうなること」
(present tense)　文中の図表の説明にも使う.

過去形：実験の行為の説明
(past tense)　実験結果の記述

現在完了形：　最新の結果を強調
(present perfect tense)　（過去の時点が明記されておれば過去形）

R:　Bednorz and Müller discovered superconductivity in the Ba-La-Cu-O system in 1986.

R:　Bednorz and Müller have **recently** discovered superconductivity in the Ba-La-Cu-O system.

(Exercise 4-3) 次の文における時制の誤りを正せ.
1. A much improved LED is recently developed.
2. A pulsar has been discovered in 1957.
3. The numerical solution of Eq. 16 has schematically been shown in Fig. 3.

§4-4 他動詞か自動詞か

	他動詞 (*v.t.*, transitive verb)	自動詞 (*v.i.*, intransitive verb)
目的語	必要	伴わない
受動態	できる	できない

(1) 他動詞

1. discuss (*v. t.*)

W: ** *Let us discuss about the validity of this approximation.***
R: Let us discuss the validity of this approximation.
前置詞 “about” は不要である．話し言葉において特に間違えやすい.

2. consider (*v. t.*)

W: ** *We considered about this possibility thoroughly.”*
R: We considered this possibility thoroughly.
discuss と同様 “(誤) *consider about …*” の誤用が多い。

3. equal (*v. t.*)

“A equals B.” (*v. t.)* または *“A is equal to B.” (adj.)*
これらの用法を混同しないように.
W: ** *The product of the secondary voltage and current equals to that of the primary voltage and current.”*
R: The product of the secondary voltage and current equals that of the primary voltage and current.”
R: The product of the secondary voltage and current is equal to that of the primary voltage and current.”

4. enter (*v. t.*)

W: ** *Both of these impurity elements enter into the A site.”*
R: Both of these impurity elements enter the A site.
「...に入る」は日本語では自動詞であるが，英語では他動詞.

他動詞 ”enter” には「入力する，記入する」という意味もある.
R: Complete your application by entering your student ID number here.

自動詞の”enter”は物理の英語ではほとんど用いない.

似た例として visit などもあげられる．（*v.i.*の用法もある．）
W: ** *I will visit to your university this summer.”*
R: I will visit your university this summer.

5. approach (*v. t.*)

W: ** *As x approaches to unity, f (x) diverges.***
R: As *x* approaches unity, *f (x)* diverges.
（*x* が 1 に漸近すると，...）

他動詞 “approach” に前置詞 “to” は不要である.
自動詞の”approach”は物理の英語ではあまり用いない.

6. substitute (*v.t.*)

強磁性
W: ** *We substituted copper by iron in order to induce ferromagnetism.* **
R: We substituted iron <u>for</u> copper in order to induce ferromagnetism.
R: We replaced copper <u>with</u> iron in order to induce ferromagnetism.
A で *B* を置換する: *A* が “substitute”の目的語になる。

7. attribute (*v. t.*)

"(We) attribute A **to** B." (*v. t.)*
If you **attribute** something **to** an event or situation, you think that it was caused by that event or situation.　(WEB 上の英英辞典が便利:
http://www.collinsdictionary.com/dictionary/english-cobuild-learners.)
★ A と B の論理関係（B が原因）に注意 *!*

同義語に **ascribe** A **to** B がある.
R: We therefore attribute this discrepancy to the crude approximation made in Eq. (3).
R: Therefore, this discrepancy **is attributed to** the crude approximation made in Eq. (3).
R: Therefore, this discrepancy **is attributable to** the crude approximation made in Eq. (3).

8. raise (*v. t.*)
raise (*v.t.*) と rise (*v.i.*) の混用に注意.

R: The quantity of heat that raises the temperature of the whole bulk of a substance by 1 K is called its heat capacity.
R: The intensity of the light rose again at higher scattering angles.

(2) 自動詞

1. result (*v. i.*)

ふたつの用法がある.　(1) A results in B: A→B.
(2) B results from A: B ←A.
R: Fifty percent of the traffic accidents result in head injuries.
（補足）percent の複数形は percent.

result は自動詞であるから、次のように「過去分詞」を形容詞的に用いることはもちろんできない.
W: ** *The resulted particles have diameters ranging from 2□μm to 5□μm .***
R: The resulting (resultant) particles have diameters ranging from 2 μm to 5 μm.

2. remain (*v. i.*)
W: ** *The remained question is how to reach the quantum limit of detection.***
R: The remaining question is how to reach the quantum limit of detection.

W: ** *The inelastic contribution from spin scattering remains a large value.***
R: The inelastic contribution from spin scattering remains large.
R: The inelastic contribution from spin scattering **retain**s a large value.

3. occur (*v. i.*)

W: ** *The temperature rise occurred a drop in voltage.***
R: The temperature rise caused a drop in voltage.
R: A drop in voltage occurred with the temperature rise.
(温度上昇が電圧の降下を引き起こした．)

スペルに注意：occurs, occu**rr**ed, occu**rr**ing, occu**rr**ence

4. consist (*v. i.*)

"A consists of B."（A は B からなる．B は A の構成要素である．）
W: ** *We used a solvent consisted of 60 wt% toluene and 40 wt% ethanol.***
R: We used a solvent which consists of 60 wt% toluene and 40 wt% ethanol.
R: We used a solvent consisting of 60 wt% toluene and 40 wt% ethanol.

consist は進行形には出来ない．上の例文の consisting は分詞.
W: ** *This review is consisting of five chapters.***
R: This review paper consists of five chapters.

(Exercise 4-4) 次の文のなかで，動詞の用法に誤りがあれば正せ.

1. *Magnetic oscillations are resulted from the quantization of energy levels.*
2. *The apparatus is consisted of three parts.*
3. *CP violation is occurred in the kaon decay.*
4. *We have already discussed in detail concerning the nonlinear effects.*
5. *The relativistic effect is attributed to the long lifetime of the muons.*
6. *X-ray was irradiated to the sample for two hours.*
7. *The temperature of the sample raised to promote the reaction.*

§4-5 能動態と受動態

☆なるべく能動態を使うことが望ましい．受動態は文章の明確さを弱める.

能動態： *s* + *v.t.* + *o.*
受動態：*s* (もとの *o*) + be (の諸形)+ *v.t.* (過去分詞)
+ **by** + “agent” （動作主，もとの *s*).
動作主が道具などの場合は
+ **with** + “agent” （**道具**，もとの *s*).

☆受動態を不必要に二重に用いるのは悪文*！*

* *The discrepancy is considered to be caused by the crude approximation.**
← スタイルの誤り

R: The discrepancy is attributed to the crude approximation in Eq. (3).

(Exercise 4-5) 能動態で書かれている次の文を受動態に書き改めよ.

1. An electron microscope can resolve the atomic configuration.
2. We have successfully substituted iron for copper.
3. Most of the previous authors have ascribed this phenomenon to adiabatic softening.
4. Equation 1 permits us to calculate the magnetic flux density inside.

(Exercise 4-6) 受動態で書かれている次の文を能動態に書き改めよ.

1. Laser processing is featured in the 2015 models.
2. The origin of attraction between electrons is attributed to the electron-phonon interaction.
3. There were a number of diffraction peaks which were not identified.

(補足) 科学英語における動詞の用法については、以下の解説が詳しい：
原田豊太郎：英語論文執筆ガイド（講談社ブルーバックス B1364，2002）
ポイント 6-10, pp. 116-185.

(補足：動詞のアクセント) 物理の口頭発表等で，日本人の中には次のような動詞にも，誤って第 1 音節（the first syllable）にアクセントをつけるクセの人が多い.

動詞: （誤）*réport, íncrease, óccur, résult* など
（**正**）repórt, increase, occúr, result

第一音節で（正） díffer

The origin of “Murphy’s Law” マーフィーの法則

In 1949 at Edwards Air Force Base, Captain* Ed Murphy, a development engineer from Wright Field Aircraft Lab, remarked by referring to the technician who had wired the strain gauge bridges:
“If there is any way to do it wrong, he will”,

Arthur Bloch: Murphy’s Law: 26th Anniversary Edition
(A Perigee Book, 1993).

*Captain:（空軍）大尉

第 5 章　形容詞・副詞・比較表現
（Adjectives, Adverbs, and Comparison ）

§5-1 形容詞 (Adjectives, *adj*.)

用法 1：補語（叙述用法）

This compound is metallic. (*s* + *v* + *c*)

用法 2：名詞を修飾（限定用法）

This is a metallic compound. (*adj*. + *n*.)

It melts at a temperature similar to that of aluminum. (*n*. + *adj*.句)

用法に注意を要する形容詞

1. similar / same / identical

W: ** *We used a similar apparatus as used in our previous experiment.***

R: We used an apparatus similar to that of Smith and Jones.

R: We used the same apparatus as (that) in our previous experiment.

R: For this particular quantity, the classical mechanics and the quantum mechanics give the identical result.

"similar to"（類似の）と"the same as"（同一の）は意味が異なる．前者は類似しているが同一ではない場合，後者は同じものである場合に用いる．
"the identical to"は「全く同一の」という意味を特別に強調したいときにのみ用いる。

2. able to

W: ** *These values are able to be fitted to the experimental curve.***

R: These values can be fitted to the experimental curve.

"*are able to be*" は奇異に聞こえるので，"can be"を用いるべきである．
"A is capable of *n.* (or ...ing)."という用法もある．

3. applicable to

W: ** *Equation 1 can be applicable to this device.* ** （素子）

R: Equation 1 can be applied to this device.

R: Equation 1 is applicable to this device.

"can"と"able"はともに可能なことを意味するから，間違いの例では類語の反復になっている．

4. negligible

W: ** *The effect of this distortion can be negligible.* **

R: The effect of this distortion can be neglected.

R: The effect of this distortion is negligible.

ひとつ前の例と同様．

5. dependent on

W: ** *The current is independent on the voltage.* **

R: The current is independent of the voltage.

R: The current depends on the voltage.

R: The current is dependent on the voltage.

"dependent on"と"independent of"を混同しないように．
"independent *from*" は誤用

6. determined

W: ** *The unit cell was determined to be face-centered cubic.* **

R: The unit cell was found to be face-centered cubic.

R: It was determined that the unit cell was body-centered cubic.
（面心立方晶，体心立方晶）

“be determined (*adj.*) to do”は「（人が）...することを決心している」という意味で用いる.

7. 複合語の形容詞的用法（名詞を修飾）⇒ ハイフン (hyphen) **でまとめる.**
（§3-4 でも述べた。）

R: We used a 5-g sample for the neutron spectroscopy. (gram)
R: Finally, 6 g of the sample was purified. (grams)

R: Such behavior is characteristic of a two-dimensional system.
R: The spin dynamics of this system is two dimensional.

In Millikan’s oil-drop experiment, the electric charge carried by each oil drop was found to be a multiple of a unit.

“The method of least squares” （最小二乗法）は “the least-squares method” とも言い, “-squares”はあくまで複数形にする.

signal-to-noise ratio: 信号雑音比、S/N 比
mean free path: 平均自由行程 （mean は”free path”を修飾）

Murphy’s Law:
If anything can go wrong, it will.

Murphy’s law of thermodynamics:
Things get worse under pressure.

Murphy’s constant:
Matter will be damaged in direct proportion to its value.

§5-2 副詞 (Adverb, *adv.*)

v., adj., adv., 文全体などを修飾. （cf. *n.*を修飾するのは *adj.*）

(1) 副詞の位置

簡単な原則はない.
文全体を修飾する場合は文頭が普通.
形容詞，副詞，句，節を修飾する場合，その直前におくのが普通.
動詞を修飾する場合は,
自動詞なら動詞の直後,
他動詞なら動詞の直前（または目的語の後）におくのが普通.
動詞と目的語の間に副詞を入れないこと.

R: The temperature rise occurred unexpectedly.

W: ** *”This article covers completely the topics.* **
R: This article **completely** covers the topics.

助動詞がある場合は, （最初の）助動詞の直後.
この場合は原則がはっきりしている.
We will **qualitatively** discuss the behavior.
These problems should **first** be considered separately.
The signal corresponding to the E_3 structure has **always** been observed.

(2) 用法に注意を要する副詞

1. almost

W: ** *Almost the dislocations were annihilated.***
R: Almost all the dislocations were annihilated.

量や数を示すときには”almost all”を用い，程度を表すときには”almost”だけで十分である．

R: Almost all the oxygen was absorbed.
R: Almost all the researchers in this field agree with this conclusion.

R: At that point, the crystal almost reached the required temperature.
R: When we closed the valve, the reaction had almost been completed.

2. **enough**

十分強い：strong enough (*enough strong* という誤用が日本人に多い)

When the spins of a pair of nucleons are opposite, the attractive nuclear force is not **strong enough** to bind them together.

3. respectively

W: ** *A=1, B=2, C=3, respectively.***
R: *A*=1, *B*=2 and *C*=3.
R: *A, B* and *C* are 1, 2 and 3, respectively.
(*A,B,C* が長い語句の場合は、視線を大きく左右に移動しなくてはならないので、1,2,3 との対応がわかりづらく△。)

4. firstly

W: ** *Firstly, ... second, ... last, ...***
R: Firstly, ... secondly, ... lastly, ...
R: First, ... second, ... last, ...（最初に，．．．次に，．．．最後に，．．．）
“last”, “lastly” のかわりに “finally”を用いてもよい．
“**At first** (*n.*)” は時間的な順序にのみ用いる．しかも後に最初とは異なる展開があることを暗示して用いる．思考や記述の順番を示す ”First” （「まず第一に」）の代わりに用いるのは誤用である．例えば，

At first, this theory was not widely accepted.

というと「この理論は初めのうちは広くは受け入れられなかったが，今は違う．」というニュアンスがある．

5. hereafter

** *We will abbreviate this to “HTSC” hereafter.***
R: From now on, we will abbreviate this to “HTSC”.
R: We will abbreviate this to “HTSC” here.

文法的には間違いではないが，“hereafter”は”the hereafter”が「死後」を意味するので，何となく気味の悪い感じがする．

(3) 接続副詞

however, hence, thus, therefore, furthermore, accordingly, otherwise など
あくまで副詞である．二つの文をひとつに結合するのには使えない．
接続詞 (because, although, if など) と混同しないように．

“However”の品詞誤用を特によく見かける．

W: ***The results are interesting, however, their interpretation is rather misleading.***
R: The results are interesting. However, their interpretation is rather misleading.
R: Although the results are interesting, their interpretation is rather misleading.

（補足）物理の英語では用いることがないが、接続詞“however”の存在が副詞用法の誤用を生んでいるのかもしれない。

You can act however you wish. 君の好きなように振舞ってよい。

§5−3 比較に関する表現　(Comparison)

Sample B was 10 mm shorter in length than sample A.
Iron has a greater specific gravity than aluminum. (aluminium)
Hydrogen is by far the lightest gas.
Boron nitride is as hard as diamond.
Nickel does not have so high a melting point as tungsten.

用法に注意を要する比較表現

1. compared with (compared to)

W: ** *X is much larger compared with Y.* **
R: *X* is much larger than *Y*.
R: *X* is very large compared with *Y*.
"...er"と"compared with" はともに比較を示すので，類語反復しないこと．

2. different from

W: ** *X is much different from Y.* **
R: *X* is considerably / very different from *Y*.
R: *X* differs greatly from *Y*.

W: ** *The electrode system was different between theirs and ours.* **
R: Their electrode system was different from ours.

3. an order of magnitude ひと桁

R: The transition temperature predicted by the mean field theory is two orders of magnitude smaller than the observation.
R: .... is smaller than the observation **by** two orders of magnitude.

4. by a factor of *N* *N* 倍　　（後の「前置詞句」のところでも触れる．）

R: We have recently improved the sensitivity **by** a factor of twenty.
R: The contribution from higher-order processes is smaller **by** at least a factor of five.

5. unique ただひとつの

R: The differential equation, with the initial condition, has a unique solution.
"ただひとつの"という絶対的な意味があるので，比較級をつくったり，very, rather などの程度を表す副詞で修飾したりはできない．
"common"も同様で，*"more common"*, *"more unique"*とはできない．

(Exercise 5−1)　下線部に注意して全文を英訳せよ．

1. スピン-軌道(orbit)相互作用の効果は無視できる.
2. 金属中の電子の振舞を定性的に議論しよう (We will …).
3. 与えられた体積中の光子の数は温度の 3 乗に比例する (proportional to).
4. 中性子の質量は電子の質量より 3 桁大きい.
5. 弱い相互作用と電磁相互作用の間には深い関係があるのではないかと長きにわたって (副詞 long) 考えられてきた.
6. アインシュタインは宇宙を 4 次元の時空連続体 (space-time continuum) として記述した.
7. この新しい検出技術によって信号雑音比は 5 倍以上改善した。
8. ニュートリノと反ニュートリノは電気的に中性で、ほとんど質量のない粒子であるが、レプトン数はそれぞれ+1 と−1 である.

Fanagle's rule:
Experiments should be reproducible; they should all fail in the same way.

Fanagle's rule:
Teamwork is essential. It allows you to blame someone else.

Futility factor:
No experiment is ever a complete failure; it can always serve as a negative example.

第 6 章　動名詞と分詞
(Gerunds and Participles)

動名詞（gerund）：動詞の　...ing 形　　⇒ **名詞的用法**

分詞（participle）：動詞の　...ing 形（現在分詞形）
または過去分詞形　　⇒ **形容詞的用法**

§6-1 主語としての動名詞

次の二つの文章を比べてみよう．

The substitution of these values into Eq. (1) yields an α of $5 \times 10^{-6}\,K^{-1}$.
Substituting these values into Eq. (1) yields an α of $5 \times 10^{-6}\,K^{-1}$.

抽象名詞を用いた方は，客観的でやや堅い表現になっている．それに対して動名詞を用いた方は動作が直接表現されており，主観的で臨場感がある．（§3-3 でも抽象名詞を動詞化することの優位性を述べた．）

Increasing the temperature to 800℃ did not significantly change the oxidation effects.

§6-2 動詞の後の動名詞（目的語）

他動詞の目的語として不定詞と動名詞のどちらをとるかは，**それぞれの動詞によって異なる**.

W: ** *We have finished to install a new program for the data analysis..* **
←文法上の誤り
R: We have **finished installing** a new program for the data analysis.

動名詞<u>のみ</u>を目的語としてとる他動詞には,
finish, avoid, involve, keep, suggest, resist, postpone などがある.

to+**不定詞 <u>のみ</u>**を伴う他動詞には,
agree, decide, manage, fail　などがある.

（参考）
+目的語＋不定詞　の他動詞：　let,　make
Everything above absolute zero radiates in infrared, **letting** astronomers **see** deep into our galaxy.
しかし受動態では + to +不定詞
You were **made to go** out and get her.　(Hey Jude, the Beatles)

（Exercise 6-1）括弧内の正しい方を選べ.

1. The government postponed (to start / starting) the new nuclear project.
2. Classical mechanics fails (to account,　accounting) for an interference experiment with electrons.
3. I have finished (to write / writing) the report for the student lab.
4. We have finally managed (to repair / repairing) the scintillation counters.
5. I look forward (to meet / to meeting / meeting) you again at the next international conference.
6. We prefer (to use / using) it anyway (rather than to send / to sending) it back to the manufacturer.
7. The temperature inside the chamber finally stopped (to increase / increasing).

§6-3 前置詞の後の動名詞（目的語）

前置詞+動名詞（あるいは接続詞+現在分詞）の形で行為を表すことにより，文が引き締まることが多い．

They first produced various color centers *by irradiation of* the crystal.

They first produced various color centers by irradiating the crystal.

同様に “by measurement of” より “by measuring” の方が，用法は名詞ではあるが本来は動詞であるという動名詞の機能が生かされて，簡潔明快になる．

熟語的に決まった前置詞があるときは，それに続けるには動名詞を用いる．

W: ** *Impurities play an important role to increase metal hardness.”*

R: Impurities play an important role in increasing metal hardness.

“play a part (a role) in”の後には名詞か動名詞．同様の例として “be worth ...ing”, “get rid of ...ing”, “succeed in ...ing” などが挙げられる．

Murphy's law:

If anything can go wrong, it will.

Corollaries（系）:

1. If there is a possibility of several things going wrong, the one that will cause the most damage will be the one to go wrong.
2. It is impossible to make anything foolproof because fools are so ingenious.

§6-4 分詞

分詞：動詞の...ing 形（現在分詞形）または過去分詞形の**形容詞的用法**

A scattering cross section decreases with **increasing ~~the~~** energy of the incident particle.

分詞“increasing”は“energy”を修飾する形容詞なので、“the”は不要．

現在分詞は能動的（能動分詞） a heating filament （加熱用フィラメント）
過去分詞は受動的（受動分詞） a heated substrate （加熱された基板）
☆この過去分詞は時制とは全く無関係

時制の表現は：

能動分詞の完了形は having + 過去分詞

受動分詞の完了形は having been + 過去分詞

（Exercise 6-2）原型の与えられた動詞の分詞をカッコのなかに入れて文を完成せよ．

1. The cable ( ) the electricity is very heavy. [supply]
2. The ( ) gas is discarded before high-purity $^{18}O_2$ gas is introduced into the chamber. [remain]
3. A new composite material ( ) last year is already being produced on a commercial basis. [develop]
4. ( ) the strengths of this new model in the last section, I will now discuss its drawbacks. [emphasize]
5. ( ) in Fig. 10 are some of the simpler Feynman diagrams for electron-electron scattering. [show]

（Exercise 6-3）次の文を分詞を使って書き改めよ．

1. The force that holds the sun and the earth together is gravitation.
2. The mechanical parts which should be repaired immediately are listed below. (“require” を用いて)
3. Hadrons which differ only in their charge can be combined into groups which are called multiplets.

§6-5 分詞構文 (Participial Construction)

分詞を含む副詞節が主文を修飾する構文.

1. A crystal often grows into the shape of a cube or an octahedron, **reflecting** the symmetry of the atomic structure.
2. **Equating** this value to the right-hand side of Eq. 29, we arrive at a self-consistent equation for *k*.
3. **Not having** (= Because we did not have) any electronic calculators at hand, we had difficulty in evaluating the molar weight of the compound.
4. These capacitors can store charge from pulses of current and then release the stored charge between pulses, thereby **producing** a steady current.

懸垂分詞 (Dangling participles)

分詞の意味上の主語と，主文の主語とが異なっている誤用.

分詞構文でもっとも大切なことは，分詞の意味上の主語と，**主文の主語**とを一致させること.

W: ** *Having been kept at 1000℃ for 5 hours, the student took out the samples from the furnace.***

R: After **keeping** the sample at 1000℃ for 5 hours, the student took it out from the furnace.
（正しい文の例では"keeping"は動名詞である．）

W: ** *Seeing from a distance, the particle accelerator looked like a doughnut.***

R: **Seen** from a distance, the particle accelerator looked like a doughnut.

W: ** *Comparing with the data previously obtained, the present results are in excellent agreement with the Landau theory.***

R: **Compared** with the data previously obtained, the present results are in excellent agreement with the Landau theory.

この種の誤用は非常に多くみられる．書き手は see, compare 等の動作を自分あるいは他人が行うというつもりになり能動態（現在分詞）を用いてしまいがちだが, 分詞の主語と主文の主語を一致させるという原則から受動態（過去分詞）をとる必要がある.

一般に分詞構文では，助動詞の being あるいは **having been** は省略されることが多い.

"Using" を除いて懸垂分詞はほとんど例外無く厳禁されていると考えるべき. また considering, regarding, concerning 等のように前置詞として定着している語句は使っても差し支えない.

1. These parameters were obtained using the least-squares method.
2. Strictly speaking, this sentence is not good English.
3. Judging from these results, the experiment was a complete failure.

（Exercise 6-4）次の文を正しく書き改めよ.

1. **Our interest here is to explore its implications, assuming that the same reactions take place in other systems.**
2. **Looking farther back, an endless cycle of expansion and contraction of the universe stretched into the infinite past can be imagined.**

接続詞と分詞の結合

分詞構文では，接続詞を省略した形で「時，原因，理由，手段，結果，条件，譲歩」など様々の付帯事項を付記できる点が便利である．しかし，それだけではどうしても意味が不明になりやすいので時，条件，譲歩などは分詞の前に接続詞を置くことにより，意味を明示することが多い.

1. When using this machine at temperatures above 300 K, you should make sure that adequate arrangements for cooling water are made.
2. While being irradiated with X-rays, the blue crystal faded to gray.
3. Optical glass fibers, if properly fabricated, withstand a tensile stress over 5 GPa.

第７章　前置詞 (Prepositions)

名詞（又は代名詞、動名詞）の前に置く

§7-1 前にある語句との結合

どの前置詞を選ぶかは、後に続く名詞よりもむしろ前にある名詞、動詞、形容詞などによって決まる場合が多い。

（名詞）+（前置詞）

evidence [U] for (of) A
a reason for A
an expression for this interaction
a change in A
the difference between A of B_1 and B_2
an increase (a decrease) in A with B
to play a role (of B) in A
an experiment on A
the data on A
by the analogy of A
an analogy between A and B
the effect of A on B
influence [U] of A on B
B is under the influence of A
an answer to this problem

research in nuclear physics（分野）
research on nuclear fission（限定対象）

(Exercise 7-1)

1. A change (　　) the potential has a remarkable effect (　　) the transmission coefficient.
2. The evidence (　　) superconductivity is as follows.
3. A structural phase transition was the reason (　　) the anomaly (　　) the resistivity.
4. A criterion (　　) the theory is obtained (　　) comparing the dipole moment observed (　　) that calculated.
5. Impurities play an important role (　　) increasing metal hardness.
6. Ohm's law refers (　　) the linear increase (　　) the voltage drop (　　) a resistor (　　) current.
7. New results (　　) neutron scattering experiments (　　) the spin structure (　　) this material has recently been reported.
8. S is equal (　　) the summation (　　) i equals 1 to N (　　) x_i.
9. The difference (　　) the masses (　　) a neutron and a proton is greater (　　) that of an electron.

（動詞）+（前置詞）

to plot y against x
to account for A　原因を説明する　(to take B into account　考慮に入れる)
to substitute A for B　(substitution of A for/into B)
to replace B with/by A
be calculated from A
be estimated from A
to result in A
to succeed in A
to consist of A
to focus on A

to depend on A
(dependent on A, independent of A, dependence of B on A)
to apply A to B: 適用する (to apply for A: 申し込む)
A is attributed to B (We attribute A to B, be attributable to B)
A is ascribed to B
to relate to B, to relate A to (with) B
to correspond to A
be filled with A
be equipped with A
be compared with/to A (be comparable with/to A)
to begin with A
to start with A

take account（考慮に入れる）**の用法**

1. to take account of this fact
2. to take this fact into account
3. to take into account of the fact that ….. (**目的語が長い場合**)

（Exercise 7-2）

1. *X* is very large compared ( ) *Y*.
2. The outer electrode is equipped ( ) a wire mesh.
3. The chamber was filled ( ) helium.
4. The next session will start ( ) 1 p.m. ( ) a plenary lecture.
5. Penetration depth of the ion was calculated ( ) the mean of these values.
6. In Fig. 4 the observed values of electron yield are plotted ( ) the wavelength of stimulating light.
7. The density of states was estimated ( ) the specific heat.
8. We used a solvent consisting ( ) 60 wt. % toluene and 40 wt.% ethanol.
9. This resistivity minimum is attributed ( ) the Kondo effect.
10. The feature corresponding ( ) the energy gap has always been observed.

（形容詞）+（前置詞）

be different from A
(cf. to differ from A, a difference between A_1 and A_2)
be full of A
be characteristic of A (*cf.* a characteristic [C], *pl.* characteristics)
be similar to A
be the same as A
be identical to/with A
be equal to A
be proportional to A
be applicable to A
be consistent with A
be compatible with A

（Exercise 7-3）

1. Our approach ( ) this problem is entirely different ( ) all the previous attempts.
2. The current is independent ( ) the voltage.
3. We used an apparatus similar ( ) that in our previous experiment.
4. Equation 1 is applicable ( ) the relativistic phenomena.
5. Our treatment is consistent ( ) thermodynamics.
6. The period-doubling phenomenon is characteristic ( ) non-linear dynamics.

§7-2 後に続く名詞との結合

at a temperature
at a frequency
at the rate of *R*
for brevity
in a magnetic field
in vacuum
in detail
in principle
in /over a range
in a region
in the right/opposite direction
in this way
in this manner
in this process
in the vicinity of A
on the right/left
with a microscope（道具）
with a standard personal computer
by computer
by this method
by this procedure
by analogy,　by the analogy of A
under these conditions
under the influence of A

(Exercise 7-4)

1. The experiment was carried out (　　) the following conditions.
2. This will be explained (　　) detail (　　) a separate paper.
3. The resolution will be enhanced (　　) up to 50% (　　) this method.
4. The S/N ratio was improved (　　) more than a factor of five (　　) this new receiver.
5. We have succeeded (　　) stabilizing the reaction pressure (　　) this way.
6. Mercury remains (　　) the liquid state even (　　) room temperature.
7. The scattering rate is evaluated (　　) the method of least squares.
8. The Eudora software was designed by Steven Dorner (　　) the University of Illinois in 1988.
9. The crystal was irradiated (　　) X-ray (　　) two hours.

Sattinger 's law:

It works better if you plug it in.

Horner's five-thumb postulate:

Experience varies directly with equipment ruined.

§7-3 前置詞句

いくつかの語を結合して全体として前置詞のはたらき

as well as A
along with A
in addition to A
in accordance with A
in agreement with A
in spite of A (= despite A)
instead of A
in terms of A
on the basis of A　(= based on A)
with respect to A

by a factor of N
on the order of 10^{-3} eV

前置詞句は文を冗長にしがちである.
by means of ...→ by ...
because of the fact that ... → because ...
for the purpose of ... → for ...
in the case of ... → if ...
by the use of ... → by using ...

(Exercise 7-5) 括弧の中にふさわしい前置詞句を書き入れよ。

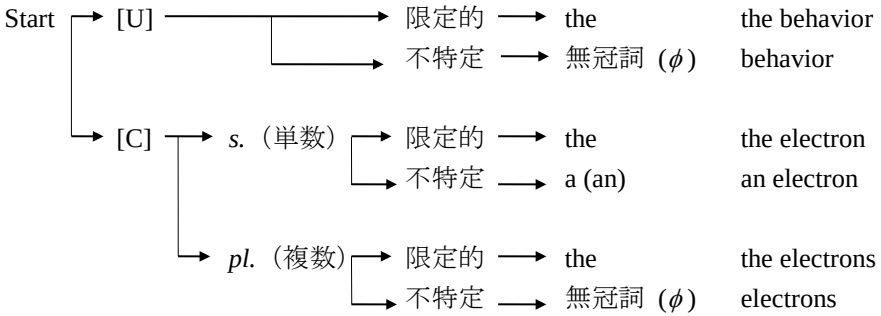
1. The rotation of $\boldsymbol{E}$ equals minus the partial derivative of $\boldsymbol{B}$ (　　) t.
2. (　　) the parameter α, the modified Hamilton's principle can be written by Eq. 1.
3. (　　) his theory, Dirac was led to the conclusion that to each "normal particle," there must exist an "anti-particle" with exactly the same physical properties but the opposite electric charge.
4. The size of an atom is (　　) 10^{-10} m.
5. The signal-to-noise ratio has been improved (　　) five with this new detection technique.

{on the basis of,　based on,　by a factor of ,
in terms of,　with respect to,　on the order of}

第 8 章　冠詞　(Articles)

不定冠詞：a,　定冠詞：the ⇒ 名詞の前に置き，その名詞の概念，適用範囲を明示.

冠詞の選び方（6 種類）
(1) 数えられるか否か？
(2) 単数か否か？
(3) 限定できるか否（不特定）か？



不定冠詞 a の基本的用法
「**読み手から見て不特定**である」と書き手が考えている場合の、可算名詞[C]単数に付ける.

定冠詞 the の基本的用法
(1) 最初に「不特定」として導入された名詞に 2 回目以降に言及するとき.
(2) どのひとつについて言及しているのかはっきりしていて，**読者・聞き手**が間違える可能性のない名詞のとき.
　the sun (= the sun of our solar system)
(3) the *n. of* ... : 名詞が直後の説明で特定される場合
　The area of a circle is equal to πr^2.
(4) 名詞が形容詞の最上級や序数によって限定されている場合.
　the most sensitive detector,　the third law of thermodynamics
(5) the+[C]単数　の形で、種族全体を表す; **「…というものは」**
　The electron has a negative charge.　The brain is extremely complicated.

チェック方法
(1) [C] (a countable noun) なら必ず a か the か、あるいは複数形が必要。
(2) a と the を取り替えてみてチェックする.
　[C] *pl.* や[U]の場合は the を取ったり付けたりしてみる.
(3) this/these, that/those で置き換えられれば the が適当.
(4) a certain を付けてもおかしくなければ a または φ が適当.

A.J. Leggett:「科学英語論文のすべて」第 2 版（丸善，1999）第 4 章.

"**The**" はあなたが話をしている対象がただひとつであることをふつう暗示ししている．一方，"**a**"（あるいは複数の場合に冠詞のないこと）はそれがただ一つでないことを言外に意味している．従って

"**The** solution of (3.9) is given by (3.10)."

は，この解がただ一つしかないことを暗に意味しているが，一方

"**A** solution of (3.9) is given by (3.10)."

は少なくとも他の解がありうることを意味している. 次の「対になった文」を比較してみよう.

f(x) is an analytic function of *x*.
f(x) is the function of *x* defined by (3.11).

f(x) is a Bessel function.　(ベッセル関数は数多くある)
f(x) is the Airy function.　(エアリー関数はただ一つしかない)

（その系が 3 次元系であると仮定して）
Two components of the momentum commute with *H*.
The three components of the momentum commute with *H*.

Very small values of *t* are unphysical.
The very small values of *t* given by Eq. (6) are unphysical.

(Exercise 8-1) カッコのなかに適当な冠詞，またはϕ（無冠詞）を入れよ．

1. The weight of (1) molecule is the sum of the weights of all the atoms that constitute (2) molecule.
2. (3) Internet is (4) phenomenon of the late twentieth century.
3. Pick (5) point on this curve and draw (6) tangent to (7) point.
4. (8) Dirac's theory lead to (9) equation of motion for an electron treated as a point particle.

Heisenberg's uncertainty principle; the uncertainty principle
Maxwell's equations, Ohm's law
the Bohr radius, the Boltzmann constant, the Planck constant

5. Figure 4 shows (10) X-ray diffraction patterns for (11) films prepared at substrate temperatures of 140°C and 400°C.
6. (12) point at which these convex and concave curves meet is called (13) point of inflection.

the convex and the concave curve も可
(the structures and properties of conducting polymers)

7. (14) diagonal of (15) parallelogram divides (16) parallelogram into (17) two congruent triangles.

原田豊太郎：「英語論文執筆ガイド」（講談社, 2002）などより．

(Exercise 8-2) Fill in the parentheses with the most appropriate articles (a, an, the, or ϕ). まずは語感も重視してすばやく解答し，次に上の「選び方」を参考にじっくり検討せよ．

(1) (1) probability of (2) event in (3) ideal experiment is given by (4) square of (5) absolute value of (6) complex number ψ which is called (7) probability amplitude.

P = probability
ψ = probability amplitude
$P = |\psi|^2$.

(2) When (8) event can occur in (9) several alternative ways, (10) probability amplitude for (11) event is (12) sum of (13) probability amplitudes for (14) each way considered separately. There is (15) interference.

$\psi = \psi_1 + \psi_2$
$P = |\psi_1 + \psi_2|^2$.

(3) If (16) experiment is performed which is capable of determining whether (17) one or another alternative is actually taken, (18) probability of (19) event is (20) sum of (21) probabilities for (22) each alternative. (23) interference is lost.

$P = P_1 + P_2$.

From R. P. Feynman, R. B. Leighton, and M. L. Sands: *The Feynman Lectures on Physics* (Addison-Wesley, 1965) Vol. III, Sec. 1-7.

(Exercise 8-3) Complete the following passage by filling in the most appropriate articles (a, an, the, or ϕ).

At about one-hundredth of (1) second, (2) earliest time about which we can speak with (3) any confidence, (4) temperature of (5) universe was about (6) hundred thousand million (10^{11}) degrees Centigrade. This is much hotter than in (7) center of even (8) hottest star, so hot, in (9) fact, that (10) none of (11) components of (12) ordinary matter, (13) molecules, or atoms, or even (14) nucleus of (15) atoms could have held together. Instead, (16) matter rushing apart in this explosion consisted of (17) various types of (18) so-called (19) elementary particles, which are (20) subject of (21) modern high-energy nuclear physics.

From S. Weinberg: *The First Three Minutes* (Basic Books, 1993).

(Exercise 8-4) Complete the following passage by filling in the most appropriate articles (a, an, the, or ϕ).

One of (1) most popular beliefs about (2) "strangeness" of (3) quantum mechanics has to do with (4) Heisenberg uncertainty principle, which states that it is impossible to know with (5) total precision both (6) momentum and the position of (7) object at (8) same time. In (9) common understanding, the uncertainty principle is taken for (10) statement that (11) world is unpredictable. Just (12) opposite is true: The uncertainty principle is actually (13) recipe for making (14) measurements with (15) incredible accuracy.

(Exercise 8-5) Complete the following passage by filling in the most appropriate articles (a, an, the, or ϕ).

(1) phenomenon of (2) superconductivity is (3) remarkable example of (4) quantum effects operating on (5) truly macroscopic scale. In (6) superconducting material, (7) finite fraction of (8) electrons are in (9) real sense condensed into (10) "macromolecule" (or "superfluid") which extends over (11) entire volume of (12) system and is capable of (13) motion as (14) whole. At (15) zero temperature (16) condensation is complete and all (17) electrons participate in forming this superfluid, although only those electrons near (18) Fermi surface have their motion appreciably affected by (19) condensation. As (20) temperature is increased, (21) fraction of (22) electrons evaporate from (23) condensate and form (24) weakly interacting gas of (25) excitations (or "normal fluid"), which also extends throughout (26) entire volume of (27) system, interpenetrating (28) superfluid. As (29) temperature approaches (30) critical value T_c, (31) fraction of (32) electrons remaining in (33) superfluid tends to zero and (34) system undergoes (35) second-order phase transition from (36) superconducting to the normal state.

From J. R. Schrieffer, *Theory of Superconductivity*, (Perseus Books, 1964/1999) .

From Prof. Glenn Paquette's lecture (at Kyoto Univ.):

Two rules in choosing proper articles:

1. Countability

   A noun is countable if and only if it has a well-defined boundary.

   （Countable なら 原型に ϕ は不可）

2. Specification

   A noun is specified if and only if the information available to the READER singles out a unique thing.

   （Specified なら the）

   In Fig. 1, we plot $f(x)$ with ( ) open circles.

   ( ) open circles in Fig. 1 represent $f(x)$.

(Exercise 8-6) by Glenn Paquette

Complete the following passage by filling in the most appropriate articles (a, an, the, or ϕ).

1. The quantity $\hbar$ has ( ) interesting physical interpretation.
2. In this case, ( ) operator of this kind does not exist.
3. The above results provide ( ) clear understanding of ( ) resonant behavior.
4. Next, we reduce this set of equations to ( ) system of ( ) simpler equations.
5. We consider ( ) simple equation $d\tau(x)/dx = f(x)$, where $f(x)$ is ( ) second function appearing in (3.4).
6. We plot ( ) coupling strength as ( ) function of y in Fig. 1 (a).
7. However, note here that $F(\gamma; t)$ is not ( ) continuous function of γ.
8. This behavior is described by ( ) following equation: $A = B$.
9. One of ( ) main results is given in the next section.
10. This statement removes most of ( ) ambiguities.
11. This appears to be equivalent to ( ) ordinary second quantization formalism.
12. This treatment is analogous to ( ) standard algebraic treatment of the harmonic oscillator.
13. In this case it is most convenient to use ( ) cylindrical coordinates.
14. Suzuki *et al*. applied unitary analysis to ( ) data obtained in such experiments.
15. Synchronous activity in ( ) brain seems to be generated and maintained by ( ) interactions among neurons.

Vesilind's laws of experimentation:

1. If reproducibility may be a problem, conduct the test only once.
2. If a straight line fit is required, obtain only two data points.

第 9 章　文のつなぎ方　Connecting Sentences

§9-1 関係代名詞

[1] 関係代名詞の限定用法と非限定用法

限定用法（カンマ無し）：その関係詞節が無いと，先行する名詞がどの物や人を指すのかわからなくなる場合.

非限定用法（カンマ有り）：先行詞に対して**付加的な説明**を加える場合.

An experiment which uses a magnetic analyzer is not very reliable.

Brown's experiment, which uses a magnetic analyzer, is not very reliable.

関係詞節を取り除いても意味が変わらないか?

次の文を比べてみよう：

(a) We find the solution of eqs. (8-10) which remains finite as $x \rightarrow 0$.

(b) We find the solution of eqs. (8-10), which remains finite as $x \rightarrow 0$.

文(a) は $x \rightarrow 0$ のときも有限でない他の複数個の解があること（少なくともあり得ること）をほのめかしている．この関係詞節は我々が見つけるべき解がどんな解であるかを示している．他方，文(b)は，解はただ一つ（さもなければ“the”は“a”で置き換えられる）で，さらにそれは有限であると述べている．したがって，文(b)は下のようにも書き換えられる．

We find the solution of eqs. (8-10); this remains finite as $x \rightarrow 0$.

（セミコロンの使い方は §9-3 参照のこと．）

[2] 限定用法に用いる関係代名詞“which”

これは多くの場合不要である。

英語 native speaker の文には関係代名詞はあまり使われない。分詞を使う。

The I-V characteristics which were obtained by this method are shown in Fig. 3.

⇒ The I-V characteristics obtained by this method are shown in Fig. 3.

The method which was described in Section 1 will be used here.

⇒ The method described in Section 1 will be used here.

The equation which describes this behavior is given in Appendix A.

⇒ The equation describing this behavior is given in Appendix A.

[3] 関係代名詞“that”（限定用法のみ）

先行詞が最上級の形容詞を伴っていたり，all, every, any, no, the same, the only, the very, the last, the first など**限定の意味が強い**修飾語を伴っている場合は, that が好まれる．(非限定 .... , that ....は誤用．)

ただし，先行詞が人を指すときは，その場合でも who でよい.

一般に，先行詞が人と物の両方を含む場合は that を用いる.

Table 1 summarizes **all** the previous specific-heat data **that** have been published on this compound.

Law of selective gravity:

An object will fall so as to do the most damage.

Jenning's corollary:

The chance of bread falling with buttered side down is directly proportional to the cost of the carpet.

The Murphy philosophy:

Smile ... tomorrow will be worse.

明日に備えて今日は笑顔で行きましょう.

[4] 関係代名詞の先行詞

関係代名詞がどの名詞（先行詞）を指すか直ちにわかるようになっていること.

(1) 関係代名詞を先行詞の直後に置くのが原則.

One then obtains periodic solutions to the dynamical equations, *which* agree with those found by Jones.

Jones は方程式を見つけたのか，あるいは解を見つけたのか？

⇒ ...equations; **these equations** agree ...

⇒ ...equations; **these solutions** agree ...

(2) 節全体を先行詞とする which の使い方は避ける.

Pauling assumed two kinds of constituent atoms to be set as nearest neighbors, *which* is supported by the fact that ...

⇒ Pauling assumed two kinds of constituent atoms to be set as nearest neighbors. **His assumption** is supported by the fact that ...

[5] 前置詞の目的語としての関係代名詞

However, the extent **to which** Ca influences these properties is still a controversial issue.

(Exercise 9-1) カッコ内に最適な関係代名詞を（必要ならカンマや前置詞加えて）書け.

1. The phase diagrams, (　　) these applications are based, are reviewed in one paper.
2. It appears to be one of the few places in physics (　　) there is a rule (　　) can be stated very simply, but (　　) no one has found a simple and easy explanation.
3. Composite objects, in circumstances (　　) they can be considered as a single object, behave like a Bose particle if they contain an even number of Fermi particles.

§9-2 連結詞

文を論理的につなぐための「**連結詞**」には，**接続詞** (if, and, because など) や **接続副詞** (however, furthermore など) がある.

[1] 連結詞の重要性

次の文はファインマンのある教科書からの引用である．前後の文を論理的に，そして有機的につなぐための語句（太文字）が，頻繁に用いられている．これらの語句が切れ味よい，説得力のある文章を作る上での決め手ともなる.

More surprising is the Meissner effect. If a solid (simply connected) piece of superconducting material is placed in a magnetic field and then cooled below the critical temperature, the magnetic field is pushed out of the superconductor. Technically, some lines might be trapped in the object, because some parts reach the superconducting state before others. Furthermore, if the magnetic field is strong enough, it might not be pushed at all. In such a case, the material does not become superconducting. Its resistance and specific heat are normal. Because of its magnetic domains, iron cannot be cooled into superconductivity.

R.P. Feynman: *Statistical Mechanics*: A Set of Lectures (Benjamin, Reading, Massachusetts, 1972) Chap. 10.

Truman's law: If you cannot convince them, confuse them.
Bumper Sticker: If all else fails, lower your standards.

Cole's law: Thinly sliced cabbage.
Cole's Axiom: (axiom: an established rule or principle 公理)
The sum of the intelligence on the planet is constant; the population is growing.

[2] よく使う連結詞

原因・理由や条件・仮定とその結果を結ぶもの

（接続詞） because, since, if, provided (that)
（副詞） therefore, thus, hence, consequently, accordingly, naturally, obviously, clearly
（副詞句他） as a result, as a consequence, in this way, as long as

同列の内容を結ぶもの

（接続詞） and, or
（副詞） furthermore, moreover, besides, also
first, second, third
（副詞句他） in addition, in particular, as mentioned earlier
not only ... but also ..., at the same time, for example

反対の内容を結ぶもの

（接続詞） but, while, whereas, though, although, even though
（副詞） however, nevertheless, otherwise, conversely
（副詞句他） on the contrary, in contrast, on the other hand,
in spite of, despite （“***despite of ...*** “ **は誤用！**）

注意を要する語句：

1. because, since
“because” は理由をはっきり述べ，因果関係を明らかにする．
“since” は少し軽い感じ. 特に読者も知っているような理由を述べるときに適当．
理由を表す接続詞の “as”, “so”, “for” は用いない方がよい．

2. ***And, But*****： 文頭には用いないこと．**
文を “and”, “but”, “so” で始めないようにしなさい．
“And”の代わりに “moreover” あるいは “further” を使い，
“But” の代わりに “however” あるいは “nevertheless” を使いなさい．
“So” の代わりに “therefore” あるいは “hence” を使いなさい．(A.J. Leggett)

3. then：**文頭で「それゆえ」,「だから」の意味に用いるのは誤り．**
“Then” は時間的順番を表すのに用いる．あるいは条件節を受けて用いる．

“Then” で文を始めることには注意してください. これを “therefore”の意味で使うことは正しくありません．従って例えばつぎのようには書けません．

W:** *“ f(z) is clearly analytic in the upper half-plane.* ***Then*** *we can replace ....” ***
一方つぎのような文は書いてもよろしい．
“ Let us suppose the series converges. Then we can replace ....”
この場合の “then” は “therefore”を意味しません．その意味は
“ When (or If) we have supposed the series to converge, then we can ....”
ということです．(A.J. Leggett)

4. First(ly), ... Second(ly), ... Third(ly), ...
§5-2 (p. 21) でも述べたが “At first” を間違って使う日本人が多い。
“At first”: 時間的順序．しかも後に最初と異なる展開があることを暗示する．
（最初は．．．であったが､後で．．．．となった。）
At first, most of the scientific community believed that his discovery was real.
“First”: 思考や記述の順番．
「まず第一に(First,)」>「次に(Next,)」>「最後に（Last,）」

5. however （接続副詞） §5-2 でも既に取りあげた．
however, hence, thus, therefore, furthermore, accordingly, otherwise などはあくまで副詞である．二つの文を一つに結合するのには使えない．
接続詞 (because, although, if など) と用法を混同しないように．

W: ** *”The results are interesting, however, their interpretation is rather misleading .”***
R: The results are interesting. However, their interpretation is rather

misleading.

R: The results are interesting; however, their interpretation is rather misleading.

セミコロンの用法はすぐ下で解説する.

R: Although the results are interesting, their interpretation is rather misleading.

（接続詞としての “however” は意味が異なる：You can act however you wish.）

6. on the other hand は同じ対象物に関する異なる事象説明に使う。 同じ人物の右手を説明した後、それと異なる左手を説明するような場合に使う。

W: ** *The solution ψ_1 is unstable. On the other hand, the solution ψ_2 is stable.*

“In contrast,”を使うべき

R: This finding can be interpreted as implying the non-physical nature of the solution ϕ_1. On the other hand, it could simply be interpreted as demonstrating the limitations of our method. （Glenn Paquette より引用）

(Exercise 9-2) カッコ内に最適な語句を下の語句群から選んで書きいれよ。

If an atom is exposed to radiation of a frequency much higher than the resonance frequency of (1) its *K* electrons, the dominant processes are Compton effect and photo-ionization. (2), for some purposes one is interested in the coherent scattering, (3) the atom remains in its ground state, (4) the cross section for this is rather small.

語句群： however, although, in which, even,

§9-3 セミコロンとコロン

セミコロンを使おう！

1. **セミコロン** (semicolon ;) は，**ピリオドとカンマの中間程度の区切り**.

二つの文が密接に関係していて別々の文にはしたくないが，一つの文にすると長すぎたり焦点がぼけたりする場合に用いる.

The conference hall was too far to reach on foot; most of us went by bus.

接続副詞と組み合わせて使うのも有効：

A; however B. または A. However B.

セミコロンのあとは小文字で続ける.

2. **コロン** (colon :) は，**説明・列挙**に用いる.

There were two problems in the measurements: the first one was the degradation of the sample crystal at high temperatures and the second one was the distortion of the output signal at high frequencies.

コロンの続きは大文字・小文字いずれでもよい.

The actual behavior of a metal is very complicated: The metal electrons interact with the lattice, with the lattice vibrations, and with one another.

コロンのあとには完結した文章がこなくてもよい.

“the following” や ”as follows” の後には必ずコロン.

(Exercise 9-3) Fill in the parentheses with appropriate colons and semicolons.

1. Despite its remarkable success, the quark model presents us with a great puzzle ( ) it has so far proved impossible to break up any hadron into its constituent quarks.
2. There were two problems in the measurements ( ) we managed to solve both of them.
3. The uncertainty principle is expressed in the following form ( ) $\Delta x \Delta p \geq \hbar$.
4. The results are interesting ( ) however, the interpretation is rather misleading.
5. This brings up an interesting question ( ) Why is it that particles with half-integral spin are Fermi particles whose amplitudes add with the minus sign?
6. The answer is a result of two effects ( ) first, the exclusion principle ( ) and second, the fact that the nuclear forces are somewhat sensitive to the direction of spin.

第 10 章　修辞法 (Rhetoric)

§10-1 並列構造 (Parallelism)

並列関係にある部分は同じ形で表すこと.

日本語に「見たり，聞いたり，試したり」のような語呂のよいことばがある．これを「見たり，聞くこと，試すんだ」では構文がバラバラである．このように内容と機能が似ている表現は，外見上の形も似ていなければならない.

語(word)は当然のことながら，句(phrase)，節(clause)にいたるまで同じ形態の並列構造にする.

Formerly, science was taught by the textbook method, while now the laboratory method is employed.

↓

Formerly, science was taught by the textbook method; now it is taught by the laboratory method.

（Exercise 10-1）次の文を改善せよ.

1. *Use parallel construction not only to be concise but also clarify.*
2. *This effect was found by Smith and Jones and Suzuki.*
3. *Both quantum mechanics and relativity introduced ideas that seemed outlandish; yet the universe has been made more explicable and predictable by both.*
4. *While we did not observe the expected phase transition, strong frequency dependence indicative of spin freezing was observed in the magnetic susceptibility.*

§10-2 三段論法 (Syllogism)

(1) A = B.　　（本研究でわかった新事実）
(2) Moreover, B = C.　　（よく知られている事実）
(3) Therefore, A = C.　　（本研究における重要な結論）

英語，日本語に限らず，日本人はなぜか (2) を省略してしまうことが多い．主張のポイントとなる事実と結論だけを述べて，その間の論理関係の構築は聞き手，読み手にまかせっぱなしにするような講演や研究発表，論文などをよく見かける．これでは説得力に欠け，自己満足に終わることになる．中村輝太郎氏と A.J. Leggett 氏による次の解説を参考にしよう.

中村輝太郎：「科学英語論文のすべて」
（日本物理学会編，丸善，1984）第 1 章.

論文の中で，三段論法 syllogism がしばしば用いられることは，言うまでもない．三段論法では，まず (1) 大前提 major premise，つぎに (2) 小前提 minor premise，最後に (3) 断案 conclusion を述べる.

(1) フォノン周波数は $\omega\cdot\varepsilon''(\omega)$ のピークの位置によって与えられる.
(2) （しかるに）ラマン散乱強度は $I(\omega) \propto \varepsilon''(\omega)/\omega$ によって与えられる.
(3) （故に）フォノン周波数は $\omega^2\cdot I(\omega)$ のピークの位置から求められる.

(1) The phonon frequency is given by a peak position of the $\omega\cdot\varepsilon''(\omega)$ spectrum;
(2) (but) the Raman intensity is given by $I(\omega) \propto \varepsilon''(\omega)/\omega$;
(3) (therefore) the phonon frequency can be found from the peak position of $\omega^2 I(\omega)$.

このとき，もし大前提がかなり長い文章で，形容詞句，副詞句，形容詞節，副詞節が付いていたりすると，次に小前提を持って来たとき，これが何の目的で現れたかがボンヤリして，インパクトを与えないことがある．このようなとき，大前提はひとまずピリオドを打って終結させ，

“Since (2) the Raman intensity is given by $I(\omega) \propto \varepsilon''(\omega) / \omega$, (3) the phonon frequency can be ·····.”
とすれば，Since で率いられた副文章は，広く認められた真理や，既成の事実など，読者にとって受け入れやすい事柄であることが多いので，読者に十分なインパクトを与えることが出来る．

A. J. Leggett：「科学英語論文のすべて」
（日本物理学会編，丸善，1984）第 4 章.
日本語では，読者にある思考と別の思考との関連を想像して補わせてもとがめられないこともありますが英語では，思考のつながりはいつでも明確になっていなければなりません．日本人の書く英文のひとつの共通した欠陥は，“It is uncertain whether this resonance should be assigned to the (56) or (82) representation, though Jones has suggested that its spin is 1/2.”
（ここで読者は”which, if true, would force us to assign it to the (56) representation”を補充することを任されています）のような文を書くことです．もちろん，あなたが読者に想定している予備知識の程度によってはある程度までは省いても差しつかえません．しかし十分には明確でないよりは，くどいほど明確なほうがはるかに良いのです．ヨーロッパ人読者はときどき日本人の書く英文を簡素を尊ぶ古来の日本画にたとえます．読者は絵の空白部分を自分の鑑賞力で埋めなければなりません．もし読者がこういうことに慣れていれば，もちろんそれは大きな困難を生じませんが，たいていの英語で読み書きする読者はそうではありませんので, その効果は当惑以外の何物でもありません.

（Exercise 10-2）次の文章を改善せよ.
1. We found that this metal melts below 400℃. This metal cannot be pure aluminum.
2. This voltmeter is designed for a power-line frequency of 50 Hz only. Thus you should not use it in Kyoto.

§10-3 循環論法（Circular Reasoning）を避ける

論証すべき結論を潜在的・顕在的に論証の前提とする誤った論証方法。
A logical fallacy in which the reasoner begins with what they are trying to end with

(1) Any object less dense than water will float in water,
because such an object won't sink in water.

The second part assumes that the object floats in water and does not answer the reason for it.
→because the buoyancy force becomes larger than the gravitational force.

(2) Something can't come from nothing.
Thus, the big bang can't have happened.

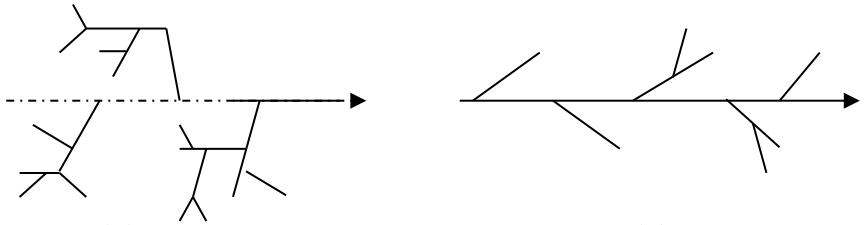
The premise already assumes that the big bang, being something that came from nothing, never happens. Alternatively, the second part implicitly assumes that the big bang happened from nothing.

https://rationalwiki.org/wiki/Circular_reasoning
https://rationalwiki.org/wiki/Big_Bang#How_to_create_a_universe

§10-4 Leggett の樹

日本語では，いくつかの考えを述べるに当たり，それら相互のつながりやある特定の考えの意味が，そのパラグラフ全体あるいは論文全体を読み終えないことには明確にならないようなやり方をしても，許されることが多いように見えます.
だが英語ではそうではありません．それぞれの文章は既に書かれているものだけに照らして完全に理解出来なければなりません．その上，ひとつの考

えと次の考えとの間の関係はそれを読んだときに完全に明確でなければなりません．例えば，もしわき道を探求するために考えの「本筋」からはずれるのなら，このことはわき道の終わるところでなく，始まる点で明確にしなければなりません．このことを図で示すとつぎのようになります．「読む方向」は左から右へです．



(A)　　(B)

英語で読み書きする読者にとっては日本語の形はしばしば(A)のような感じを与えますが，英語では(B)しか許されません．また(B)の木は枝が少ないのにお気付きください．英語では「本筋」からはるかにはなれてさまようことは，普通良いことではありません．

A. J. Leggett：「科学英語論文のすべて」
（日本物理学会編，丸善，1984/1999）第 4 章．)

§10-5 The basic Structure of an Essay

参考:

(1) 鈴木利彦：Criterion®を活用した英語ライティング指導ブック，Vol. 1 (CIEE Japan, 2011).

(2) 門田修平，氏木道人，伊藤佳世子: 英語エッセイ・ライティング，第２版 (コスモピア, 2014).

Title, name, affiliation
Add your Student ID for the essay assignment for this class.
Introductory paragraph
(1) Introduction material, General statements (2) Thesis statement

Body paragraph 1
(1) Topic sentence
(2) Supporting sentences (Concluding sentence)

Body paragraph 2
(1) Topic sentence
(2) Supporting sentences (Concluding sentence)

Body paragraph 3
(1) Topic sentence
(2) Supporting sentences (Concluding sentence)

Body paragraph …

Concluding paragraph
(1) Summary (2) Reformulation of Thesis Statement (3) Reinforcement (4) Final Comment

§10-6 What is Misconduct in Research?

(a) Fabrication

Making up data or research results, etc.

(b) Falsification (Manipulation)

Manipulating research materials, equipment, or processes to change data or results obtained from research activities.

(c) Plagiarism

Appropriating the ideas, analysis, analytical methods, data, research results, research paper(s), or words of other researchers without obtaining the permission of the researchers or giving appropriate credit.

① 捏造（ねつぞう）
存在しないデータ、研究結果等を作成すること。
② 改ざん
研究資料・機器・過程を変更する操作を行い、データ、研究活動によって得られた結果等を真正でないものに加工すること。
③ 盗用（剽窃　ひょうせつ）
他の研究者のアイディア、分析・解析方法、データ、研究結果、論文又は用語を当該研究者の了解又は適切な表示なく流用すること。

From: (1) “Guidelines for Misconduct in Research” (MEXT), pp. 5-6, 11.
http://www.mext.go.jp/english/topics/__icsFiles/afieldfile/2015/07/14/1360017_2.pdfv

(2)「研究活動における不正行為への対応等に関するガイドライン」（文科省, 2016年7月16日） pp. 4,10.
http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu10/siryo/__icsFiles/afieldfile/2014/09/02/1350809_04.pdf

To avoid Plagiarism: Quoting and Paraphrasing

Example:

A paragraph on the persistent current of superconductors（永久電流）

1. Quoting

Example:

“Superconductors are also able to maintain a current with no applied voltage whatsoever, a property exploited in superconducting electromagnets such as those found in MRI machines. Experiments have demonstrated that currents in superconducting coils can persist for years without any measurable degradation. Experimental evidence points to a current lifetime of at least 100,000 years” (Wikipedia “Superconductivity”, https://en.wikipedia.org/wiki/Superconductivity).

2. Paraphrasing

Example:

平易な表現に置き換え：

exploited in → used in, applied to,　degradation → decay

新たな情報も追加：磁気浮上列車

One of the outstanding properties of superconductors is the ability to maintain an electric current with no applied voltage. This property is applied to superconducting magnets such as those used in magnetic resonance imaging (MRI) systems and in magnetic levitation (MAGLEV) trains. It has been demonstrated experimentally that such “persistent current” can be maintained without measurable decay; the estimated decay lifetime exceeds 10^5 years (Wikipedia “Superconductivity”).

Element Names

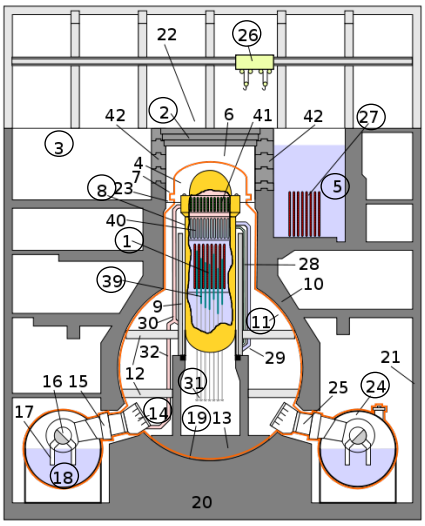
A selection of 45 element names
Underlined Symbols (in red): 26 more frequently used names.

Atomic number	Element symbol	Element name	元素名
1	**H**	hydrogen	
2	**He**	helium	
5	**B**	boron	ホウ素
6	**C**	carbon	
7	**N**	nitrogen	窒素
8	**O**	oxygen	
10	Ne	neon	ネオン
11	**Na**	sodium	ナトリウム
13	**Al**	aluminum （米） (aluminium 英)	アルミニウム
14	**Si**	silicon	
16	**S**	sulfur	硫黄
17	**Cl**	chlorine	塩素
18	Ar	argon	アルゴン
19	**K**	potassium	カリウム
20	Ca	calcium	
22	Ti	titanium	チタン
25	Mn	manganese	マンガン
26	**Fe**	iron	
27	Co	cobalt	コバルト
28	Ni	nickel	ニッケル
29	**Cu**	copper	
30	Zn	zinc	亜鉛
32	**Ge**	germanium	ゲルマニウム
38	Sr	strontium	ストロンチウム
40	Zr	Zirconium	ジルコニウム
41	**Nb**	niobium	ニオブ
44	Ru	ruthenium	ルテニウム
47	**Ag**	silver	
49	In	indium	インジウム
50	**Sn**	tin	錫（すず）
53	**I**	iodine	ヨウ素
54	Xe	xenon	キセノン
55	Cs	cesium	セシウム
56	Ba	barium	バリウム
57	La	lanthanum	ランタン
60	**Nd**	neodymium	ネオジム
74	W	tungsten	タングステン
78	**Pt**	platinum	白金（プラチナ）
79	**Au**	gold	
80	**Hg**	mercury	水銀
82	**Pb**	lead	鉛
92	**U**	uranium	
94	Pu	plutonium	プルトニウム
113	**Nh**	nihonium	ニホニウム (2016 -)
118	Og	oganesson	オガネソン (2016 -)

Glossary on Nuclear Reactors

“Fukushima Nuclear Reactor Problem Explained” (NHK-CNN Video, March 14, 2011) (3:07)
http://www.youtube.com/watch?v=BdbitRlbLDc&feature=related

reactor containment building	原子炉建屋
the Fukushima Daiichi nuclear power plant	福島第一原子力発電所
regular inspection	定期点検
nuclear reactor	原子炉
robust wall	頑丈な壁
uranium	ウラン　U　（発音注意）
fuel rod	燃料棒
nuclear fission	核分裂
meltdown	熔解
control rod	制御棒
power outage	停電
emergency diesel power generator	緊急ディーゼル発電機
safety measures	安全措置
JAEC (Japan Atomic Energy Commission)	原子力委員会（内閣府）
NRA (Nuclear Regulation Authority)	原子力規制委員会（環境省）2012 -
cf. NSCJ (Nuclear Safety Commission of Japan)	原子力安全委員会（内閣府）
NISA (Nuclear and Industrial Safety Agency)	原子力安全・保安院（経産省→2012 より環境省）
IAEA (International Atomic Energy Agency)	国際原子力機関
coolant	冷却材
precaution	用心、警戒
containment vessel	格納容器
cf. pressure vessel	圧力容器
suppression pool,　pressure suppression chamber	圧力抑制室
BWR (Boiling Water Reactor)	沸騰水型炉　→　東京電力など
PWR (Pressurized Water Reactor)	加圧水型炉　→　関西電力など



福島第一原発 1－5 号機の基本構造
Cross-section sketch of a typical BWR Mark I containment, as used in Units 1 to 5. The reactor core (1) consists of fuel rods and moderator rods (39) which are moved in and out by the device (31). Around the pressure vessel (8), there is an outer containment (19) which is closed by a concrete plug (2). When fuel rods are moved in or out, the crane (26) will move this plug to the pool for facilities (3). Steam from the dry well (11) can move to the wet well (24) through jet nozzles (14) to condense there (18). In the spent fuel pool (5), the used fuel rods (27) are stored.
http://en.wikipedia.org/wiki/Fukushima_Daiichi_Nuclear_Power_Plant

Another high-quality video by IRSN (フランス放射線防護原子力安全研究所):
“Understanding the accident of Fukushima Daiichi NPS” (2013/02/02) (13:01)
https://www.youtube.com/watch?v=JMaEjEWL6PU

BWR (Boiling-Water Reactor) 0:48 https://www.youtube.com/watch?v=4bvCDheLm5A
PWR (Pressurized-Water Reactor) 1:03 https://www.youtube.com/watch?v=Qthg5xE196w
By Tennessee Valley Authority (tva.com) 2013/07/25 に公開