物理の英語 (3235) Final Exam（70 分間）

平成 31 年度前期　　担当：前野悦輝　　　　July 23, 2019

A. Write down the words in English that best describe or complete the following statements. (22 points)

A1. (Listen and answer.)

A2. (Listen and answer.)

A3-6. Listen to some element names and write down their symbols.

A7-10. The plural forms (複数形) of the following words.

　A7. axis,　**A8**. percent,　**A9**. radius,　**A10**. supernova.

A11-12. Two capacitors connected in (**A11**) give a total capacitance that is the sum of the two capacitances, while two resistors connected in (**A12**) give a total resistance that is the sum of the two resistances.

A13-14. In nuclear (**A13**), a nucleus is split into two or more lighter nuclei of comparable size. In nuclear (**A14**), in contrast, two or more smaller nuclei combine together, creating a larger, heavier nucleus.

A15-16. A measure of the smallness of random deviation from the mean value is (**A15**), while a measure of the smallness of systematic deviation from the true value is (**A16**).

A17-18. (**A17**) is the number above the line in a fraction and (**A19**) below the line in a fraction.

A19. If a system is in thermal (**A19**), the net rate of exchange of heat between its components is zero.

A20. (**A20**) is the force opposing the sliding of one surface over another.

A21. Seven grams of the sample powder (**A21**) precisely measured. [was/were]

A22. A number of methods (**A22**) known to determine the speed of light. [is/are]

A23. (**A23**) with other theories, the Landau theory gives a much better agreement with the experimental results. [Use "compare".]

A24. The Higgs boson was the last (**A24**) elementary particle predicted by the Standard Model of particle physics. [Use "remain".]

B. Fill in the blanks with the most appropriate prepositions (前置詞) (8 pts.)

1. The red shift is attributed (**B1**) the Doppler shift and gravity.

2. Mercury remains (**B2**) the liquid state even (**B3**) room temperature.

3. The scattering rate is evaluated (**B4**) the method of least squares.

4. We have succeeded (**B5**) stabilizing the reaction pressure (**B6**) this way.

5. The size of an atom is (**B7**) the order (**B8**) 10^{-10} m.

6. This approximation is consistent (**B9**) thermodynamics.

7. A peak of events corresponding (**B10**) the Higgs boson was observed (**B11**) the energy range (**B12**) 120 GeV and 130 GeV.

8. We use general relativity-based models, some (**B13**) which include spin precession.

9. It appears to be one of the few places in physics (**B14**) which there is a rule that can be stated very simply, but (**B15**) which no one has found a simple and easy explanation.

10. The energy released in the annihilation of electrons and positrons temporarily slowed the rate (**B16**) which the universe cooled.

C. Insert suitable articles (a, an, the, or Φ for no article). (9 pts.)

（文頭大文字、空欄なら Φ）

1. The weight of (**C1**) molecule is (**C2**) sum of the weights of all (**C3**) atoms that constitute (**C4**) molecule.

2. (**C5**) fine-structure constant α has (**C6**) interesting physical interpretation.

3. One of (**C7**) Maxwell's equations describes how both current and changing electric fields can give rise to magnetic fields.

4. (**C8**) phenomenon of superconductivity is (**C9**) remarkable example of (**C10**) quantum effects operating on (**C11**) truly macroscopic scale.

5. Kepler's three laws of (**C12**) planetary motion, published around 1610, were (**C13**) results of his pioneering analysis of planetary observations, and laid the groundwork for (**C14**) Newton's great advances. (**C15**) second law, (**C16**) conservation of (**C17**) areal velocity, is (**C18**) general theorem for central force motion.

D. Insert a colon (**:**) or a semicolon (**;**) to complete the sentences. (2 pts)

1. This technique has two clear advantages (D1) the fast time response and the precise phase matching.

2. The first peak corresponds to the Compton scattering (D2) the second one to the pair creation.

3. The uncertainty principle is expressed in the following form (D3) $\Delta x \Delta p \geq \hbar.$

4. The results are interesting (D4) however, the interpretation is rather misleading.

E. Complete the following sentences to show how to read these equations. Some answers may require more than one word. (7 pts.)

$$n! = \int_0^\infty x^n\, e^{-x}\, dx \sim \sqrt{2\pi n}\, \left(\frac{n}{e}\right)^n.$$

Stirling's approximation states that n (**E1**), which is equal to the (**E2**) over x from zero to (**E3**) of x (**E4**) n-th power times (**E5**) of minus x, is approximately equal to the (**E6**) root of 2 pi n times the open (**E7**) n over e close (E7) (E4) n-th power.

F. Complete the syllogism by providing a sentence [F1] within 30 words in English.（三段論法の形を成すように、2番目の文 [F1] を英文 30 語以内で補え。）(7 pts)

For just two protons to form a bound state in a nucleus, their spins need to parallel because of the spin dependence of the nuclear force. **[F1]** Therefore, helium two (^{2}He) nucleus, consisting of two protons, cannot exist.

G. Answer the following questions **[G1]** to **[G10]**. (28 pts.)

A Unique Pair of Triangles
— Proof of a Simple Theorem Using Abstract Modern Mathematics —

Two graduate students at Keio University have proven a new theorem that states there is only one pair (up to similitude*) of a right triangle **[G1]** and an isosceles triangle **[G2]** for which the lengths of all its sides are integers and which have the same perimeter* and the same area.

The **[G3]** **of, of, and, areas, lines, figures, lengths** are basic geometrical quantities that are indispensable when measuring everything around us. For example, a familiar figure from textbooks is a right triangle with sides of lengths 3, 4, and 5. Moreover, an important question that has been studied since the time of ancient Greece is how many right triangles there are **[G4]** **which, sides, lengths, the, all, for, of** are integers. One field of modern mathematics which has greatly developed in the twentieth century under the influence of this tradition is arithmetic geometry.

The unique pair consists of the right triangle with sides of lengths (377, 352, **[G5]**) and the isosceles triangle with sides of lengths (366, **[G6]**, 132). They proved this theorem by applying the "theory of *p*-adic Abelian integrals" and "descent of rational points" in arithmetic geometry. It is rare that highly abstract modern mathematics has applications to such familiar objects.

* similitude: of a similar shape.
* perimeter: the whole length of the border around an area or shape.

Questions:
G1 and **G2**: Complete simple definitions of these tringles. (6 pts)
G3. Complete the sentence by rearranging all the underlined words into **[G3]**. (3 pts)
G4. Complete the sentence by rearranging all the underlined words into **[G4]**. (3 pts)
G5-G6. Fill in the most appropriate integers. (6 pts)
G7-G8. What are the perimeter and area of each of these triangles? (4 pts)
**G9-G10**. Give schematic drawings of these triangles. (6 pts)

H. The heat capacity of solid argon is shown in the figure below. Answer the following questions in English. (12 pts)

H1. Where should one place the figure caption (説明文), ABOVE or BELOW the figure?

H2. Make a figure caption in the style of a scientific paper within 50 words. Let us call this figure as "Figure 2". After the title of the figure in the caption, add two sentences to describe the figure.

　下の図は、固体アルゴンの低温での熱容量を温度の 3 乗に対してプロットしたものである。この図の caption を論文の様式に従って 50 words 以内の英語で作れ。ただし、図の番号は「図 2」とし、図のタイトルに続いて、以下の内容を説明する二つの文を加えよ。

「この温度領域ではデバイ (Debye) の T^3 の法則 (law) が極めてよく成り立っている。直線の傾き (slope) からデバイ温度 92.0 K が得られる。」
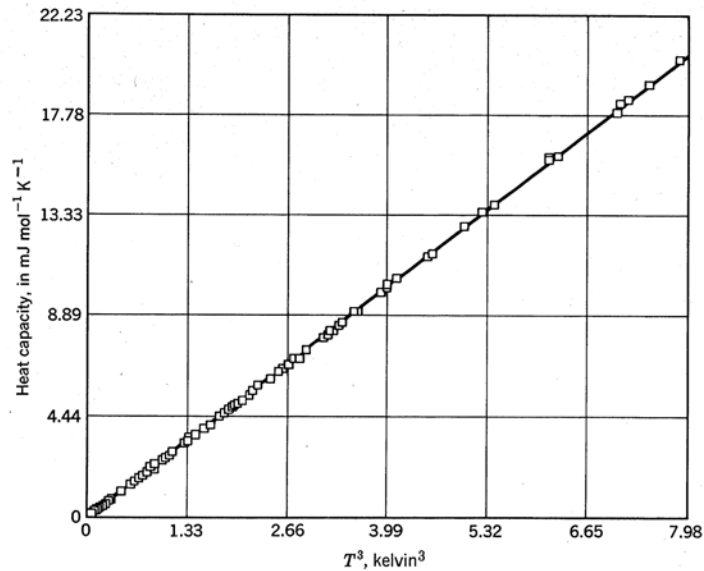
C. Kittel, *Introduction to Solid State Physics*, 8th ed. (Wiley, New York, 2004) Chap.5.