

総合研究大学院大学先端学術院
加速器科学コース・素粒子原子核コース
5年一貫制博士課程入学試験問題
英 語

令和7年8月20日（水） 11時10分～11時50分

注意

- ☆ 答案用紙の所定の欄に，受験番号，氏名を記入すること.
- ☆ 試験問題（2問）ごとに，異なった答案用紙を使用すること.
- ☆ 各問題に対して，答案用紙は複数使用してよいが，第〇〇問□□枚目というように，所定の欄に，選択した問題の番号及び答案用紙の順番を記入すること.
- 解答できない場合も，受験番号，氏名，問題番号を記入し，提出すること.
- ☆ 答案用紙がさらに必要な場合は，挙手をして監督者に知らせること.

第 1 問

次の文章は、Scientific American 誌の“Carbon Wonderland”というタイトルの記事から、グラフェン (graphene) に関する記述を抜粋したものである。文章を読み、以下の問いに答えなさい。

Consider the humble pencil. It may come as a surprise to learn that the now common writing instrument at one time topped the list of must-have, high-tech gadgets. In fact, the simple pencil was once even banned from export as a strategic military asset. But (1)what is probably more unexpected is the news that every time someone scribes a line with a pencil, the resulting mark includes bits of the hottest new material in physics and nanotechnology: graphene.

Graphene comes from graphite, the “lead” in a pencil: a kind of pure carbon formed from flat, stacked layers of atoms. The tiered structure of graphite was discerned centuries ago, and so it was natural for physicists and materials scientists to try splitting the mineral into its constituent sheets—if only to study a substance whose geometry might turn out to be so elegantly simple. Graphene is the name given to one such sheet. It is made up entirely of carbon atoms bound together in a network of repeating hexagons within a single plane just one atom thick.

Two features of graphene make it an exceptional material. First, despite the relatively crude ways it is still being made, graphene exhibits remarkably high quality—resulting from a combination of the purity of its carbon content and the orderliness of the lattice into which its carbon atoms are arranged. Investigators have so far failed to find a single atomic defect in graphene—say, a vacancy at some atomic position in the lattice or an atom out of place. That perfect crystalline order seems to stem from the strong yet highly flexible interatomic bonds, which create a substance harder than diamond yet allow the planes to bend when mechanical force is applied. The flexibility enables the structure to accommodate a good deal of deformation before its atoms must reshuffle to adjust to the strain.

(2)The quality of its crystal lattice is also responsible for the remarkably high electrical conductivity of graphene. Its electrons can travel without being scattered off course by lattice imperfections and foreign atoms. Even the jostling from the surrounding carbon atoms, which electrons in graphene must endure at room temperature, is relatively small because of the high strength of the interatomic bonds.

The second exceptional feature of graphene is that its conduction electrons, besides traveling largely unimpeded through the lattice, move much faster and as if they had far less mass than do the electrons that wander about through ordinary metals and semiconductors. Indeed, the electrons in graphene—perhaps “electric charge carriers” is a more appropriate term—are curious creatures that live in the weird world where rules analogous to those of relativistic quantum mechanics play an important role. (3)That kind of interaction inside a solid, so far as anyone knows, is unique to graphene. Thanks to this novel material from a pencil, relativistic quantum mechanics is no longer confined to cosmology or high-energy physics; it has now entered the laboratory.

出典 : Andre K. Geim and Philip Kim, "Carbon Wonderland", Scientific American, Vol. 298, No. 4 (2008) 69-75.

【問 1】

下線部(1)を意味が通るように和訳せよ.

【問 2】

下線部(2)を意味が通るように和訳せよ.

【問 3】

下線部(3)を意味が通るように和訳せよ.

【問 4】

グラフェンが例外的な材料である理由として, 2 つの特徴が挙げられている. それぞれを簡潔に述べよ.

第 2 問

あなたは, シカゴ (Chicago) で開催される国際学会に参加する予定であり, 学会期間中に Brown 教授の研究室を訪問したいと希望する電子メールを書こうとしている. 以下の内容を含んだ電子メールの文章を英語で作成しなさい. ただし, あなたの名前は Jun Suzuki とする.

- あなたの名前を名乗り, 総合研究大学院大学 (The Graduate University for Advanced Studies) の博士課程の学生であることを伝えること.
- KEK の田中教授の元で, ビーム物理学に関する研究を行っていること.
- 2025 年 9 月 21 日~27 日にシカゴで開催される国際学会に参加する予定であること.
- この機会を利用して Brown 教授の研究室を訪問し, 私たちの研究についての議論と装置見学をしたいので, 上記期間中の都合を教えてください, と依頼すること.