

TEST OF CHEMISTRY

Department of Chemistry

化 学 専 攻

November 24, 2009 (平成 21 年 11 月 24 日) 9 : 00 a.m. ~ 11 : 00 a.m.

General Directions (注 意 事 項)

1. Answer all the problems in English or in Japanese. (すべての問題に英語または日本語で解答せよ。)
2. Check the number of sheets. (以下の用紙の枚数を確認せよ。)

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|-----------------------|-----|
| Problem Sheets (問題用紙) | 3 枚 |
| Answer Sheets (解答用紙) | 3 枚 |
3. Write your name and number on all three answer sheets. (3枚すべての解答用紙に氏名と受験番号を記せ。)

[I] Answer the following problems (a) – (c). (以下の問(a) ~ (c)に答えよ。)

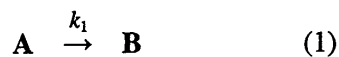
(a) Although the nuclear charge of beryllium is larger than that of lithium, the electron affinity of beryllium is much smaller than that of lithium. Explain the reason. (ベリリウム原子の核電荷は、リチウム原子の核電荷より大きいにもかかわらず、電子親和力はベリリウムの方が小さい。理由を説明せよ。)

(b) Draw the stereochemical structure of the SF₄ molecule. Give an explanation. (SF₄分子の立体構造を描き、そう考えた理由を説明せよ。)

(c) List the bases F⁻, I⁻, and NH₂⁻ in the order of increasing proton affinity (using the inequality sign (<)). Give an explanation. (F⁻, I⁻ と NH₂⁻ イオンについて、プロトン親和性の順番を不等号 (<) を使って並べ、そう考えた理由を説明せよ。)

[II] Answer the following problems (a) and (b). (以下の問(a)と(b)に答えよ。)

(a) Answer the following problems on first-order consecutive reactions involving two steps: (2段階からなる逐次1次反応に関して次の間に答えよ。)



where k_1 and k_2 are the rate constants for step (1) and (2), respectively. Assume that the initial concentration of A at $t = 0$ is $[A(0)]$ and those of B, C at $t = 0$ are $[B(0)] = [C(0)] = 0$.

(ここで k_1 と k_2 はそれぞれステップ(1)と(2)の反応速度定数である。Aの初期濃度を $[A(0)]$, B, Cの初期濃度を $[B(0)] = [C(0)] = 0$ とする。)

(i) Show the differential equations for the rates of change of the concentrations of A, B, and C. (A, B, Cの濃度の時間変化を表す微分方程式を示せ。)

(ii) Applying the steady-state approximation to the concentration of B, derive the concentration of C as a function of t . (Bの濃度に定常状態近似を用い, Cの濃度の時間変化を表す式を求めよ。)

(iii) Specify the rate-determining step in the above case (ii) and explain your answer. (問(ii)の場合, どちらのステップが律速段階か, 理由とともに示せ。)

(b) Answer the following problems. (以下の間に答えよ。)

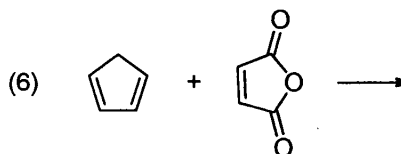
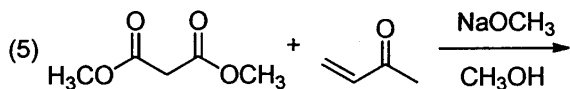
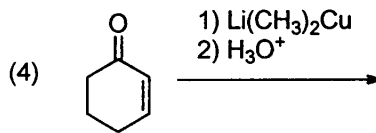
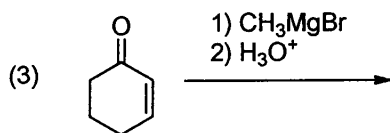
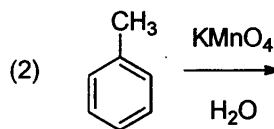
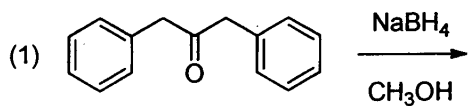
(i) Predict the relative magnitudes of the molecular dipole moments for the following methyl halides: CH_3Br , CH_3Cl , and CH_3I . Explain your answer. (次のハロゲン化メチル (CH_3Br , CH_3Cl , CH_3I) の双極子モーメントの相対的な大きさを予測せよ。理由を説明せよ。)

(ii) The dipole moment of chlorobenzene is 5.2×10^{-30} C m. Draw the structure of 1,3-dichlorobenzene and show the resultant dipole moment by vectorial addition of two chlorobenzene dipole moments. Estimate the dipole moment of 1,3-dichlorobenzene. (クロロベンゼンの双極子モーメントは 5.2×10^{-30} C m である。1,3-ジクロロベンゼンの分子構造にベクトル合成から得られる双極子モーメントを示せ。1,3-ジクロロベンゼンの双極子モーメントを推算せよ。)

[III] Answer the following problems (a) and (b). (以下の問(a)と(b)に答えよ)。

(a) Draw the structural formulas of the major product in each of the following reactions

(1) - (6). (次の反応(1)~(6)に示した反応の主生成物の構造を記せ。)



(b) Indicate which of the nitrogen atoms, N¹ or N², in compound **1** is more basic than the other.

Explain the reason. (化合物 **1** の窒素原子 N¹ と窒素原子 N² のうち塩基性が強いのはどちらか、そう考えた理由とともに答えよ。)

