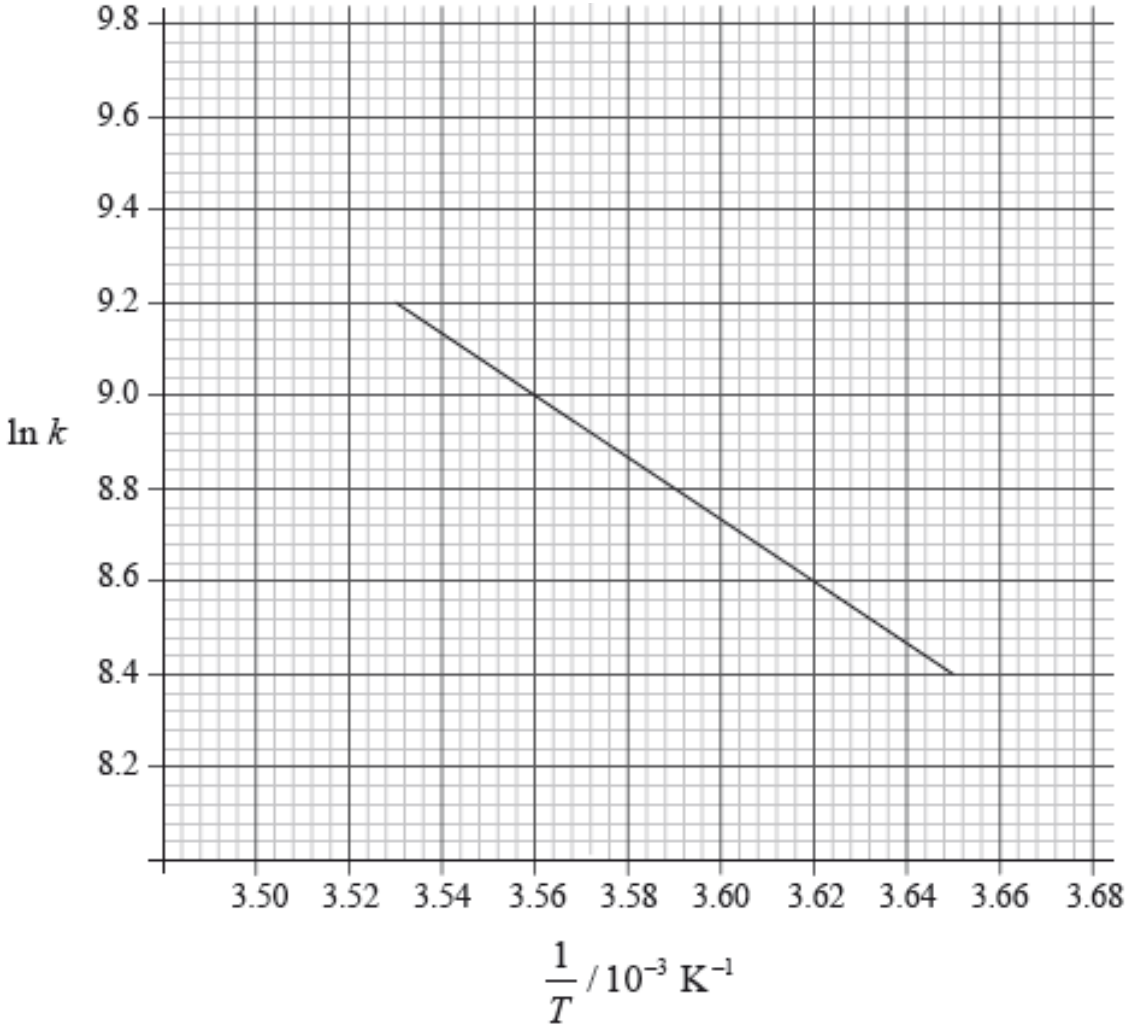
Topic 16.2 Rate Expressions & Mechanisms

Past Exam Questions (Paper 2)

1a. *[2 marks]*

Consider the following graph of lnk against $\frac{1}{T}$ for the first order decomposition of N_2O_4 into NO_2. Determine the activation energy in $kJ\ mol^{-1}$ for this reaction.



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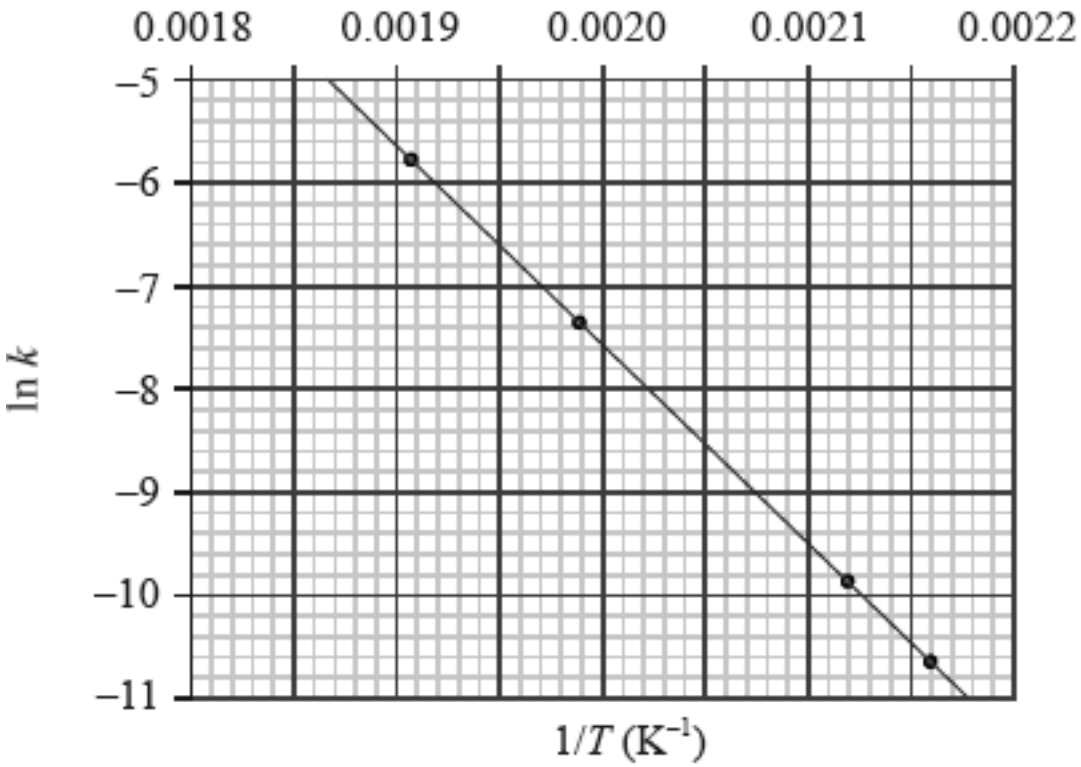
2a. *[1 mark]*

The conversion of CH_3NC into CH_3CN is an exothermic reaction which can be represented as follows.

$CH_3N{\equiv}C \rightarrow transition\ state \rightarrow CH_3C{\equiv}N$

This reaction was carried out at different temperatures and a value of the rate constant, k, was obtained for each temperature. A graph of lnk against $1/T$ is shown below.



Define the term *activation energy*, E_a.

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2b. *[1 mark]*

Describe qualitatively the relationship between the rate constant, k, and the temperature, T.

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2c. *[4 marks]*

Calculate the activation energy, E_a, for the reaction, using Table 1 of the Data Booklet.

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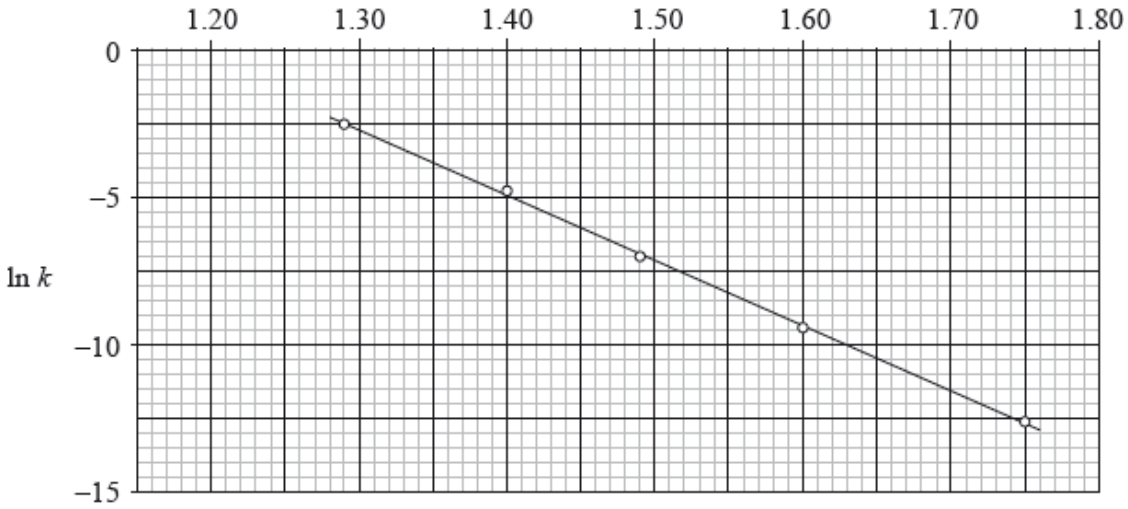
3a. *[4 marks]*

HI(g) decomposes into $H_2(g)$ and $I_2(g)$ according to the reaction below.

$$2HI(g) \rightarrow H_2(g) + I_2(g)$$

The reaction was carried out at different temperatures and a value of the rate constant, k, was obtained for each temperature. A graph of lnk against $\frac{1}{T}$ is shown below.

$\frac{1}{T}/10^{-3}\ K^{-1}$



Calculate the activation energy, E_a, for the reaction using these data and Table 1 of the Data Booklet showing your working.

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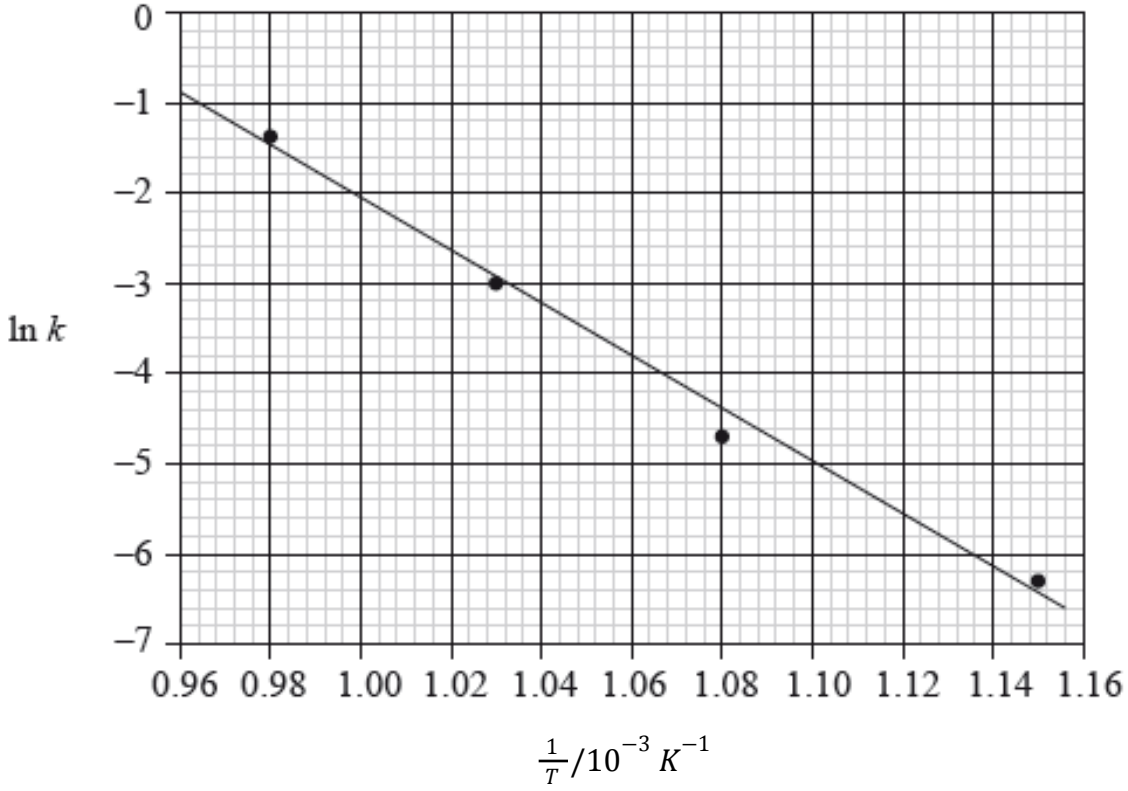
4a. *[1 mark]*

Consider the following graph of lnk against $\frac{1}{T}$ (temperature in Kelvin) for the second order decomposition of N_2O into N_2 and O.

$$N_2O \rightarrow N_2 + O$$



State how the rate constant, k varies with temperature,T.

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4b. *[3 marks]*

Determine the activation energy, E_a, for this reaction.

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5a. *[1 mark]*

Another reaction involving OH^- (aq) is the base hydrolysis reaction of an ester.

$$CH_3COOCH_2CH(aq) + OH^-(aq) \rightarrow CH_3COO^-(aq) + CH_3CH_2OH(aq)$$

Describe **qualitatively** the relationship between the rate constant, *k*, and temperature, *T*.

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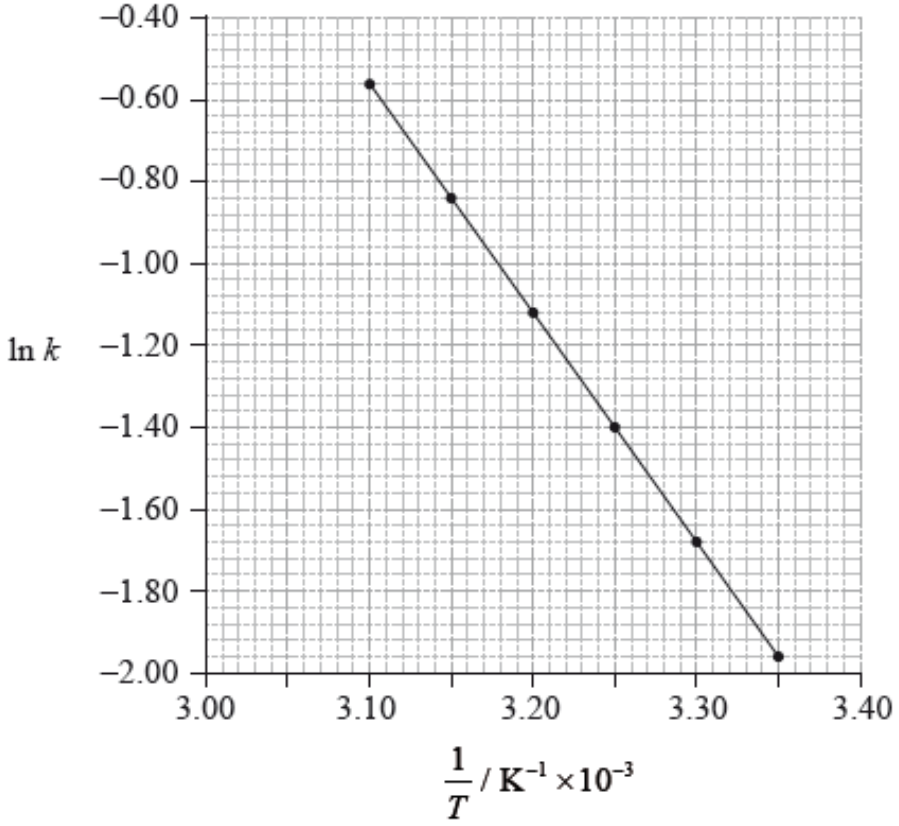
5b. *[4 marks]*

The rate of this reaction was measured at different temperatures and the following data were recorded.



Using data from the graph, determine the activation energy, E_a, correct to **three** significant figures and **state its units**.

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6a. *[2 marks]*

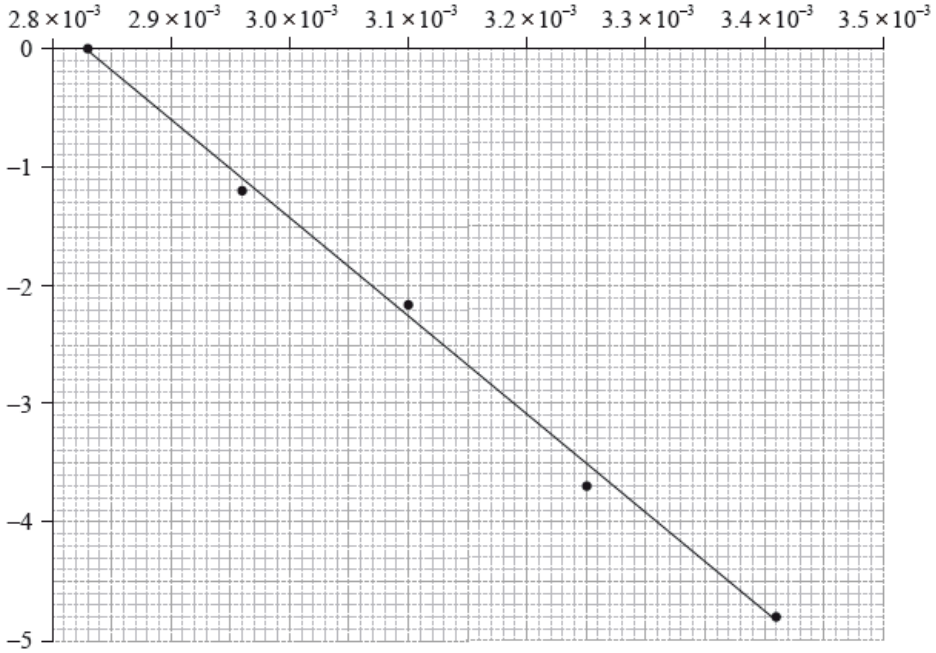
Reaction kinetics can be investigated using the iodine clock reaction. The equations for two reactions that occur are given below.

Reaction A: $H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$

Reaction B: $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

Reaction B is much faster than reaction A, so the iodine, I_2, formed in reaction A immediately reacts with thiosulfate ions, $S_2O_3^{2-}$, in reaction B, before it can react with starch to form the familiar blue-black, starch-iodine complex.

The activation energy can be determined using the Arrhenius equation, which is given in Table 1 of the Data Booklet. The experiment was carried out at five different temperatures. An incomplete graph to determine the activation energy of the reaction, based on these results, is shown below.



State the labels for each axis.

x-axis:

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y-axis:

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6b. *[3 marks]*

Use the graph to determine the activation energy of the reaction, in $kJ\ mol^{-1}$, correct to **three** significant figures.

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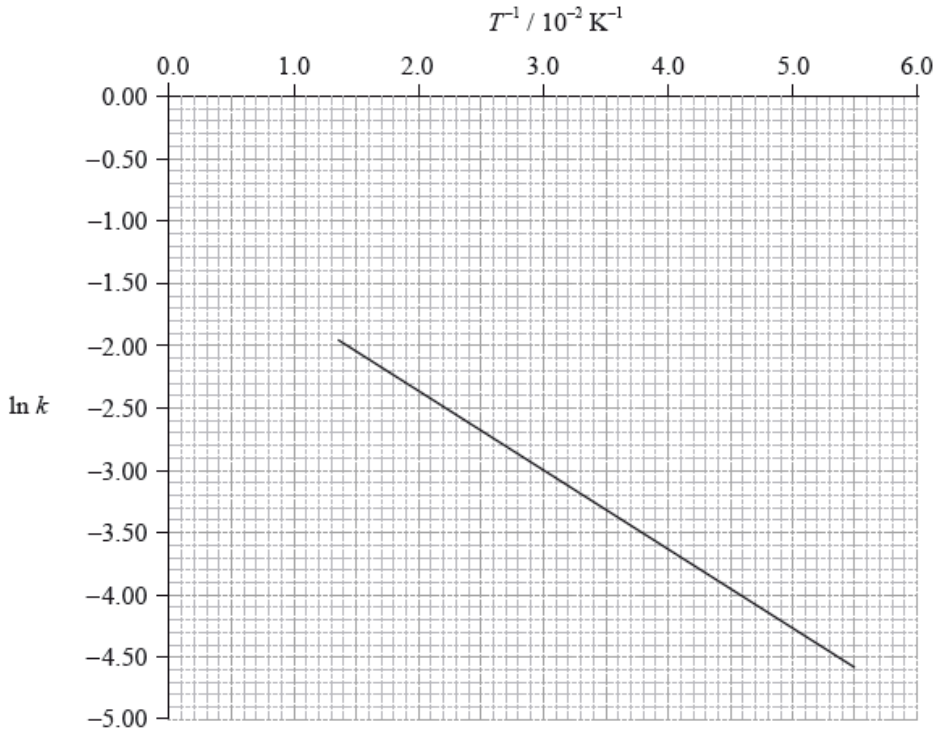
7a. *[1 mark]*

To determine the activation energy of a reaction, the rate of reaction was measured at different temperatures. The rate constant, k, was determined and lnk was plotted against the inverse of the temperature in Kelvin, T^{-1}. The following graph was obtained.



Define the term *activation energy*, E_a.

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7b. *[2 marks]*

Use the graph to determine the value of the activation energy, E_a, in $kJ\ mol^{-1}$.

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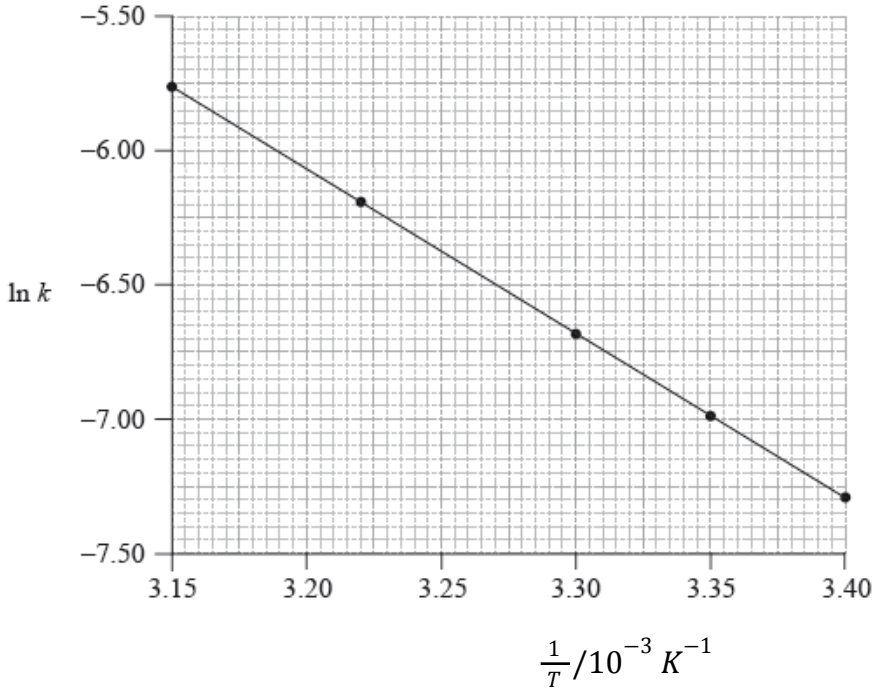
7c. *[1 mark]*

On the graph, sketch the line you would expect if a catalyst is added to the reactants.

8a. *[1 mark]*

Consider the following graph of lnk against $\frac{1}{T}$.



A catalyst provides an alternative pathway for a reaction, lowering the activation energy, E_a.
Define the term *activation energy*, E_a.

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8b. *[1 mark]*

State how the rate constant, k , varies with temperature, T.

8c. *[3 marks]*

Determine the activation energy, E_a, correct to **three** significant figures and state its units.

9a. *[3 marks]*

Suggest how the activation energy, E_a, for a reaction may be determined.