Essential Pre-Uni Chemistry M3.1

A Level

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

Part A y-intercept

On a plot of $\ln(k)$ against $\frac{1}{T}$, what is the y-intercept?

The following symbols may be useful: `A, E_A, R, T, k`

Part B Units of gradient

Give the units of the gradient of an Arrhenius plot.

- K
- $\mathrm{N\,dm^{-3}}$
- $^{\circ}\mathrm{C}$
- $\mathrm{K\,m^{-2}}$

Part C Gradient

On a plot of $\ln(k)$ against $\frac{1}{T}$, what is the gradient?

The following symbols may be useful: `A, E_A, R, T, k`

Essential Pre-Uni Chemistry M3.2

A Level

$$k = A\mathrm{e}^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

Part A Activation energy

If the gradient of an Arrhenius plot is $-1203\,\mathrm{K}$, find the activation energy. Use $R = 8.3145\,\mathrm{J\,mol^{-1}\,K^{-1}}$.

Part B Activation energy II

If the gradient of an Arrhenius plot is $-4250\,\mathrm{K}$, find the activation energy. Give your answer to 3 significant figures.

Part C Gradient of Arrhenius plot

If a reaction has activation energy of $16.5\,\mathrm{kJ\,mol^{-1}}$, find the expected gradient of an Arrhenius plot.

Part D y-intercept

The pre-exponential factor, A, is found to have a value of $0.6\,\mathrm{s}^{-1}$ for a first-order reaction. Calculate the expected y-intercept of an Arrhenius plot.

Gameboard:

STEM SMART Chemistry Week 34

Essential Pre-Uni Chemistry M3.3

A Level

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

Part A A for a first-order reaction

The y-intercept of an Arrhenius plot for a first-order reaction is at -2.30. Find the pre-exponential factor, A, according to the Arrhenius model.

Part B A for a second-order reaction

The y-intercept of an Arrhenius plot for a second-order reaction is at 3.20. Find the pre-exponential factor, A, according to the Arrhenius model.

Gameboard:
STEM SMART Chemistry Week 34

Essential Pre-Uni Chemistry M3.4

A Level

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

Part A Activation energy

The rate constant, k, for a first-order reaction is found to be $0.0250\,\mathrm{s}^{-1}$ at $290\,\mathrm{K}$. If the pre-exponential factor is $26.0\,\mathrm{s}^{-1}$, find the activation energy.

Part B Pre-exponential factor A

The rate constant, k, for a second-order reaction is found to be $0.050\,\mathrm{dm}^3\,\mathrm{mol}^{-1}\,\mathrm{s}^{-1}$ at $300\,\mathrm{K}$. If the activation energy is $2.50\,\mathrm{kJ\,mol}^{-1}$, find the value of the pre-exponential factor, A.

Gameboard:
STEM SMART Chemistry Week 34

Essential Pre-Uni Chemistry M3.6

A Level

P P P

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

If a reaction has activation energy $14.0\,\mathrm{kJ\,mol^{-1}}$, and a pre-exponential factor of $120\,\mathrm{s^{-1}}$, find the temperature at which the rate constant is equal to $2.00\,\mathrm{s^{-1}}$.

Gameboard:

STEM SMART Chemistry Week 34

Essential Pre-Uni Chemistry M3.7

A Level

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

A reaction is found to have a rate constant of $1.25 \times 10^{-3}\,\mathrm{dm^6\,mol^{-2}\,s^{-1}}$ at $400\,\mathrm{K}$ and $1.60 \times 10^{-3}\,\mathrm{dm^6\,mol^{-2}\,s^{-1}}$ at $500\,\mathrm{K}$.

Part A E_A

Find the activation energy.

Part B A

Find the pre-exponential factor, A.

Part C Order of the reaction

Give the overall order of reaction.

Essential Pre-Uni Chemistry M3.8

A Level

$$k = Ae^{-E_A/RT}$$

An Arrhenius plot is a graph of $\ln(k)$ against $\frac{1}{T}$ in K^{-1}.

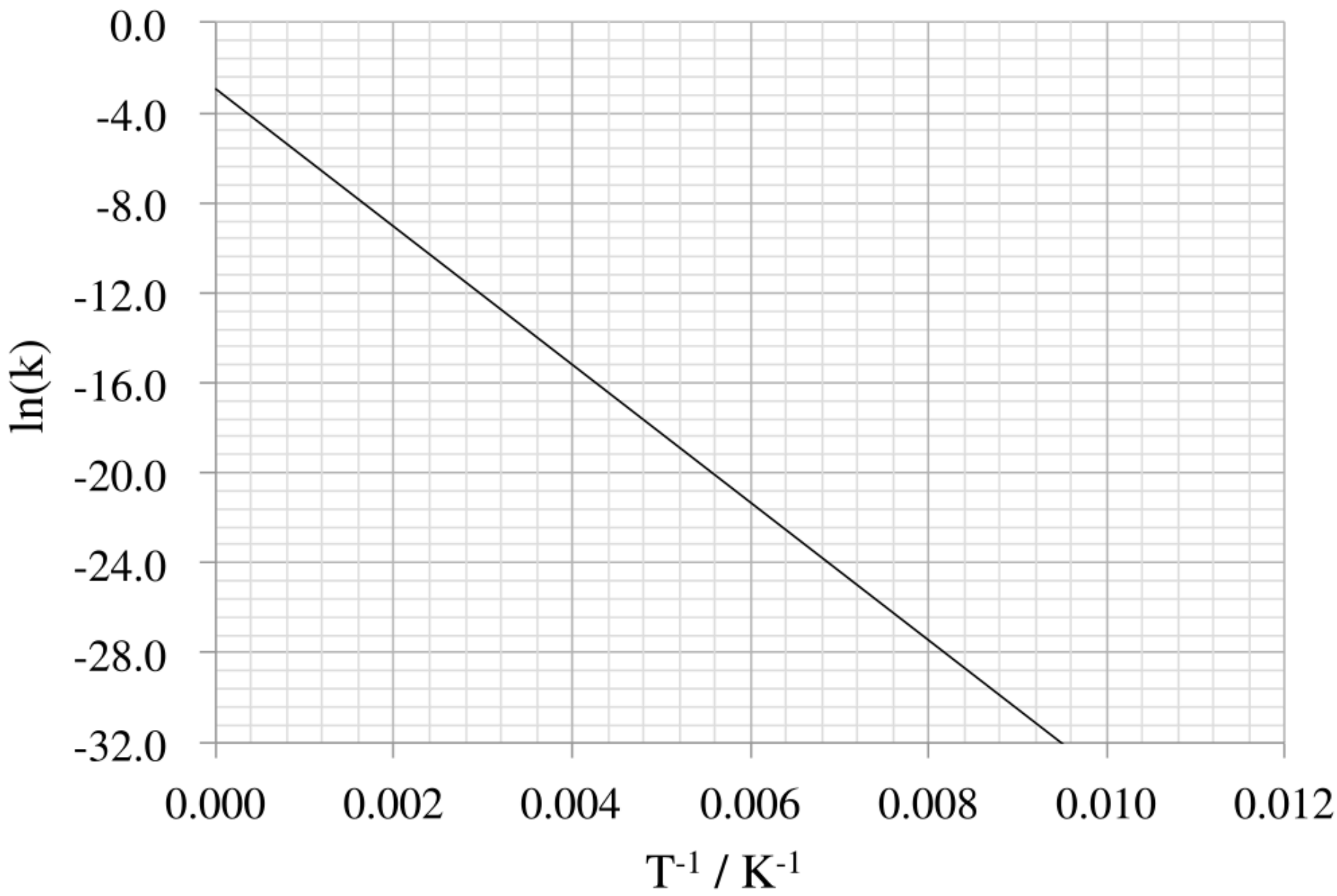

Figure 1: M3.8 Arrhenius Plot

Part A E_A

Using the graph above, find the activation energy. Give your answer to 2 significant figures

Part B A

Using the graph above, find the pre-exponential factor. Give your answer to 1 significant figure

Gameboard:

STEM SMART Chemistry Week 34

Essential Pre-Uni Chemistry M4.1

A Level

The iodination of propanone, $\mathrm{C_3H_6O + I_2 \longrightarrow C_3H_5OI + HI}$, when catalysed in aqueous conditions, obeys the rate law:

$$\mathrm{rate} = k[\mathrm{C_3H_6O}][\mathrm{HCl}]$$

.

Part A Catalyst

Identify the catalyst in this reaction.

Part B Type of catalyst

Is the catalyst homogeneous or heterogeneous?

- heterogeneous
- homogeneous

Part C Concentration of catalyst

If the catalyst has an initial concentration of $0.020\,\mathrm{mol\,dm^{-3}}$, give the concentration of the catalyst when the concentration of propanone has decreased to one quarter of its original value.

Essential Pre-Uni Chemistry M4.6

A Level

Complete the following description of heterogeneous catalysis.

A heterogeneous catalyst works best when it has a large [ ] so that many of its [ ] are exposed to the reactants. In the first stage, reactants are [ ] onto the catalytic surface, weakening internal bonds in the reactant particles. In the second stage, the particles react to form products. The [ ] of the slowest step in this reaction is lower than that of the slowest step in the uncatalysed reaction. The third stage is the [ ], or release, of product particles from the surface. This [ ] the surface ready for further reactions. If the products are not released, or if some contaminant binds to the surface, further catalytic activity is impeded and the catalyst has been [ ].

Items:

mass **desorption** **enthalpy change** **rate** **density** **destruction** **poisoned** **absorbed** **regenerates**

surface area **active sites** **volume** **adsorbed** **activation energy** **corroded**

Gameboard:

STEM SMART Chemistry Week 34

Arrhenius Equation

A Level

The temperature of a sample of hydrogen iodide is raised from $300\,^\circ\mathrm{C}$ to $500\,^\circ\mathrm{C}$. The activation energy for the dissociation of hydrogen iodide ($2\,\mathrm{HI} \longrightarrow \mathrm{H_2} + \mathrm{I_2}$) is $190\,\mathrm{kJ\,mol^{-1}}$.

Part A Rate constants

Calculate the ratio of the rate constants at the two temperatures (as a number greater than 1, to 2 significant figures).

Part B Average velocity

Calculate the ratio of the average velocities of the molecules at the two temperatures (to 2 significant figures).

Part C Activation energy

The enzyme glucose-6-phosphate dehydrogenase catalyses the reaction:

Given the data below and the Arrhenius equation $k = Ae^{-\frac{E_a}{RT}}$, use a graphical method to calculate the activation energy of the reaction, E_a.

T / °C	k / $\mathrm{M^{-1}\,s^{-1}}$
30	1.95
35	2.40
40	2.82
45	3.31
50	3.89

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