16.2 Activation Energy

Question Paper

Course	DP IB Chemistry
Section	16. Chemical Kinetics (HL only)
Topic	16.2 Activation Energy
Difficulty	Hard

Time allowed: 10

Score: /5

Percentage: /100

Question 1

Which of the following statements about the constant *A* in the Arrhenius equation are correct?

I. It is a steric factor for the fraction of collisions where the particles have the correct mutual orientation
II. It takes into account the energy of the colliding particles
III. It takes into account the number of collisions in a chemical reaction

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

[1 mark]

Question 2

The following information was obtained for the rate constant, *k*, for a reaction at 25 °C.

k	E_a	R
3.46×10^{-8} s^{-1}	96.2 kJ mol^{-1}	8.31 J K^{-1} mol^{-1}

Which expression correctly represents how to calculate the constant, *A*?

A. $A = \frac{(3.46 \times 10^{-8})}{e^{(-96.2\ /\ 8.31\ \times 25)}}$

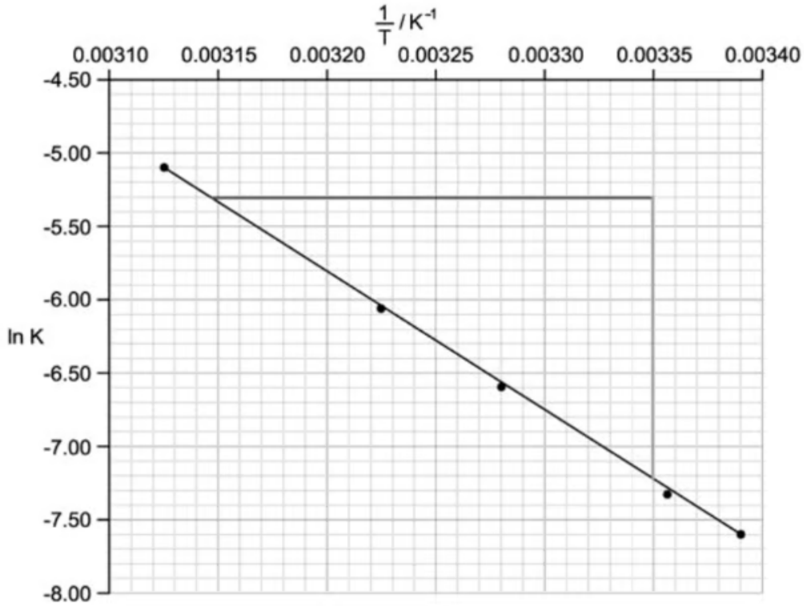
B. $A = \frac{(3.46 \times 10^{-8})}{e^{(-96200\ /\ 8.31\ \times 298)}}$

C. $A = \frac{e^{(-96200\ /\ 8.31\ \times 298)}}{(3.46 \times 10^{-8})}$

D. $A = (3.46 \times 10^{-8}) \times e^{(-96200\ /\ 8.31\ \times 298)}$

[1 mark]

Question 3



Which is the correct expression to calculate the activation energy? (R = 8.31 J K^{-1} mol^{-1})

A. $E_a = \frac{1.90}{0.00020} \times (8.31 \times 10^{-3})$

B. $E_a = \frac{-1.90}{0.00020} \times 8.31$

C. $E_a = \frac{-1.90}{0.00020} \times (8.31 \times 10^{-3})$

D. $E_a = \frac{1.90}{0.00020} \times 8.31$

[1 mark]

Question 4

The rate constant data for a reaction at two different temperatures is shown.

Temperature / °C	Rate constant / $mol^{-1} dm^3 s^{-1}$
5	6.81×10^{-6}
35	6.11×10^{-5}

Using the following equation, which expression is the correct calculation for the activation energy of the reaction, in $kJ\ mol^{-1}$?
($R = 8.31 J K^{-1} mol^{-1}$)

$$\ln\frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

A. $E_a = \dfrac{\ln\dfrac{6.11\times10^{-5}}{6.81\times10^{-6}}\times 8.31}{\left(\dfrac{1}{308} - \dfrac{1}{278}\right)}$

B. $E_a = \dfrac{\ln\dfrac{6.81\times10^{-6}}{6.11\times10^{-5}}\times \left(8.31\times10^{-3}\right)}{\left(\dfrac{1}{278} - \dfrac{1}{308}\right)}$

C. $E_a = \dfrac{\ln\dfrac{6.11\times10^{-5}}{6.81\times10^{-6}}\times 8.31}{\left(\dfrac{1}{278} - \dfrac{1}{308}\right)}$

D. $E_a = \dfrac{\ln\dfrac{6.81\times10^{-6}}{6.11\times10^{-5}}\times \left(8.31\times10^{-3}\right)}{\left(\dfrac{1}{308} - \dfrac{1}{278}\right)}$

[1 mark]

Question 5

When the temperature increases from 25 °C to 55 °C, the rate constant for the reaction increases by a factor of 1.45.

$$\ln\frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Using the equation above, which expression is the correct calculation for the activation energy of the reaction? ($R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$)

A. $E_a = \dfrac{(\ln 1.45) \times (8.31 \times 10^{-3})}{\left(\dfrac{1}{55} - \dfrac{1}{25}\right)}$

B. $E_a = \dfrac{(\ln 1.45) \times (8.31 \times 10^{-3})}{\left(\dfrac{1}{328} - \dfrac{1}{298}\right)}$

C. $E_a = \dfrac{\left(\ln \dfrac{1}{1.45}\right) \times (8.31 \times 10^{-3})}{\left(\dfrac{1}{328} - \dfrac{1}{298}\right)}$

D. $E_a = \dfrac{\left(\ln \dfrac{1.45}{1}\right) \times \left(8.31 \times 10^{-3}\right)}{\left(\dfrac{1}{55} - \dfrac{1}{25}\right)}$

[1 mark]