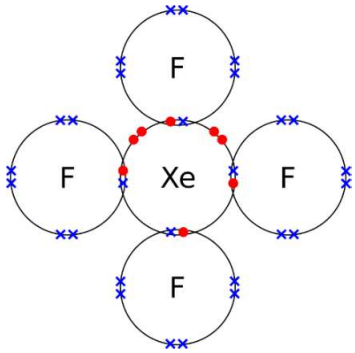
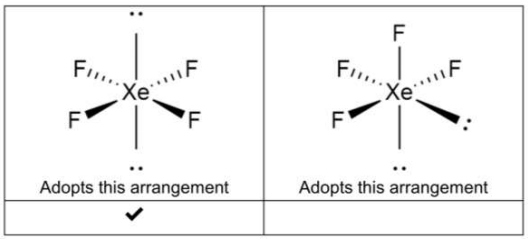
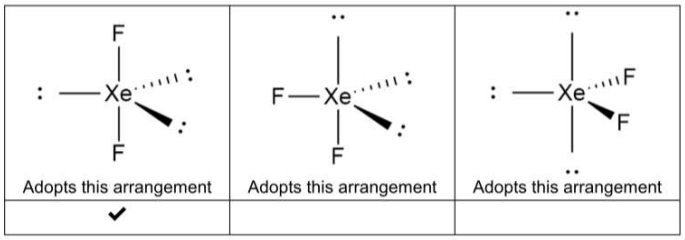
6.	This question is about fluorides of xenon	Mark
(a)	$Xe + 2F_2 \rightarrow XeF_4$ *Must be fully correct for mark. Accept correct fractional coefficients for balancing.*	☑
(b)		☑
(c)	 *One mark for correctly identifiyng both the cis and trans arrangements of the lone pairs and one mark for correctly ticking the trans (square planar) arrangement. The students are not expected to name the arrangements. The square planar arrangement is adopted to maximise the separation between the two lone pairs. Wedges and dashes are not required if shape is clear.*	☑ ☑
(d)	 *The first mark is for drawing at least one arrangement of the correct overall shape (i.e. a trigonal bipyramid). The name of the shape is not required but the shape must be unambiguous from the drawing. The second mark is for having the three correct arrangements (and no additional wrong shapes or duplicates). The third mark is for ticking the linear structure. The students are not expected to name the arrangements. The linear arrangement is adopted to maximise the separation between the three lone pairs. Wedges and dashes are not required if shape is clear.*	☑ ☑ ☑
(e)	$r = k[\text{Xe}]$ or $r = kp_{\text{Xe}}$ *The reaction is first-order with respect to xenon and zeroth-order with respect to fluorine. A correct expression in terms of either concentration, [Xe], or pressure, p_{Xe}, gets one mark.*	☑
(f)	$\frac{k_{\text{cat}}}{k} = \frac{A_{\text{cat}}e^{-E_{cat}/RT}}{Ae^{-E_a/RT}}$ $\boldsymbol{\frac{k_{\text{cat}}}{k} = \frac{A_{\text{cat}}}{A}e^{\Delta E/RT}}$	☑

(g)

$$y = \ln\frac{k_{cat}}{k} = \frac{\Delta E}{RT} + \ln\frac{A_{cat}}{A}$$

$$(y_1) - (y_2) = \frac{\Delta E}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

One mark

$$\Delta E = R\frac{y(T_1) - y(T_2)}{T_1^{-1} - T_2^{-1}}$$

One mark

$$\Delta E = \frac{8.314\ \text{J K}^{-1}\text{mol}^{-1}(\ln 23 - \ln 13)}{(373)^{-1}\text{K}^{-1} - (393)^{-1}\text{K}^{-1}}$$

$= 3.480 \times 10^4$ J mol^{-1} = 34.8 kJ mol^{-1}

Correct answer scores full marks. One mark for eliminating A_{cat}/A, one mark for rearranging for ΔE, one mark for correctly calculating the final answer.

(h)

Collect the temperature-independent constants into a single parameter, c, and then rearrange for E_a:

$$k = c\,T^{\frac{1}{2}}e^{-E_a/RT}$$

One mark for eliminating T-independent constants

$$\ln kT^{-\frac{1}{2}} = -\frac{E_a}{RT} + \ln c$$

$$E_a = -R\frac{\ln k_1T_1^{-1/2} - \ln k_2T_2^{-1/2}}{T_1^{-1} - T_2^{-1}}$$

One mark for rearranging for E_a

Note any two temperatures can be used. Using the data at 50 °C and 170 °C.

$$E_a = -8.314\ \text{J K}^{-1}\text{mol}^{-1} \times \frac{\ln 1.55 \times 10^{-10}(323)^{-1/2} - \ln 2.07 \times 10^{-6}(443)^{-1/2}}{(323)^{-1}\text{K}^{-1} - (443)^{-1}\text{K}^{-1}}$$

E_a = 92.7 kJ mol^{-1} *One mark for correctly calculating the final answer.*

The range for the correct answer is strictly 92.4 kJ mol^{-1} ≤ E_a ≤ 93.0 kJ mol^{-1}. This allows for rounding errors, but ensures that students who have neglected the $T^{½}$ term in their calculation do not get credit, as this gives an E_a = 94.3 kJ mol^{-1}. Correct answer scores full marks by any other method but only if in range specified above.

(i)

The only factor that is affected is the reduced mass μ. Denoting the rate constant for the hypothetical 'light' xenon with k',

$$\frac{k'}{k} = \sqrt{\frac{\frac{1}{28} + \frac{1}{m_F}}{\frac{1}{m_{Xe}} + \frac{1}{m_F}}} = \sqrt{\frac{\frac{1}{28} + \frac{1}{19.00}}{\frac{1}{131.29} + \frac{1}{19.00}}} = 1.211$$

k' = 1.211 × 1.70 × 10^{-8} dm^3 mol^{-1} s^{-1}

= 2.06 × 10^{-8} dm^3 mol^{-1} s^{-1}

Correct answer scores full marks. One mark for an expression that eliminates all the unchanged parameters and one mark for correctly calculating the new rate constant.

Total out of 17 **17**