3 This question is about rates of chemical reactions.

(a) Which graph shows a reaction that is zero order with respect to reactant Q?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**
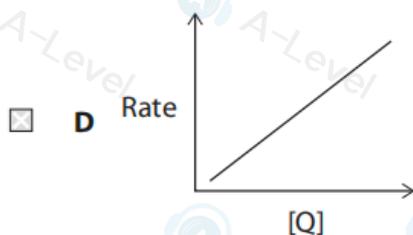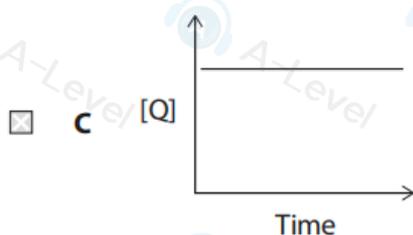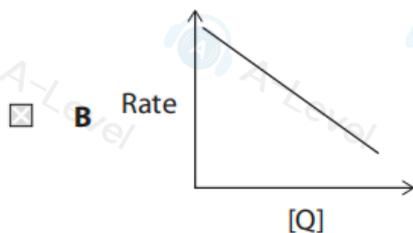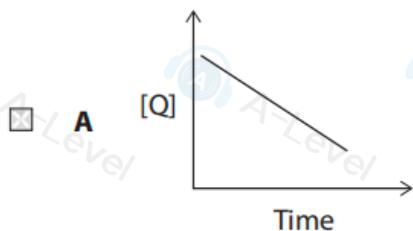
(b) The equation for a gas phase reaction is shown.

$$A(g) \rightarrow B(g) + C(g)$$
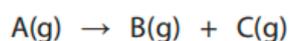
The reaction is first order.
When the initial pressure of A is 2 atm the half-life of the reaction is 20 s.

What is the half-life of the reaction when the initial pressure of A is 4 atm?

(1)

☒ **A** 10 s

☒ **B** 20 s

☒ **C** 40 s

☒ **D** 400 s

(Total for Question 3 = 2 marks)

1 Bromate(V) ions, BrO_3^-, react with bromide ions, Br^-, in aqueous acid.

$$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$$

The rate equation for the reaction is shown.

$$rate = k\,[BrO_3^-]\,[Br^-]\,[H^+]^2$$

(a) Which **continuous** monitoring method could be used to obtain kinetics data for this reaction?

(1)

☒ **A** colorimetry

☒ **B** mass change

☒ **C** titration with sodium thiosulfate

☒ **D** volume of gas evolved

(b) What are the units of the rate constant, k, for this reaction?

(1)

☒ **A** $mol\,dm^{-3}\,s^{-1}$

☒ **B** $dm^3\,mol^{-1}\,s^{-1}$

☒ **C** $dm^6\,mol^{-2}\,s^{-1}$
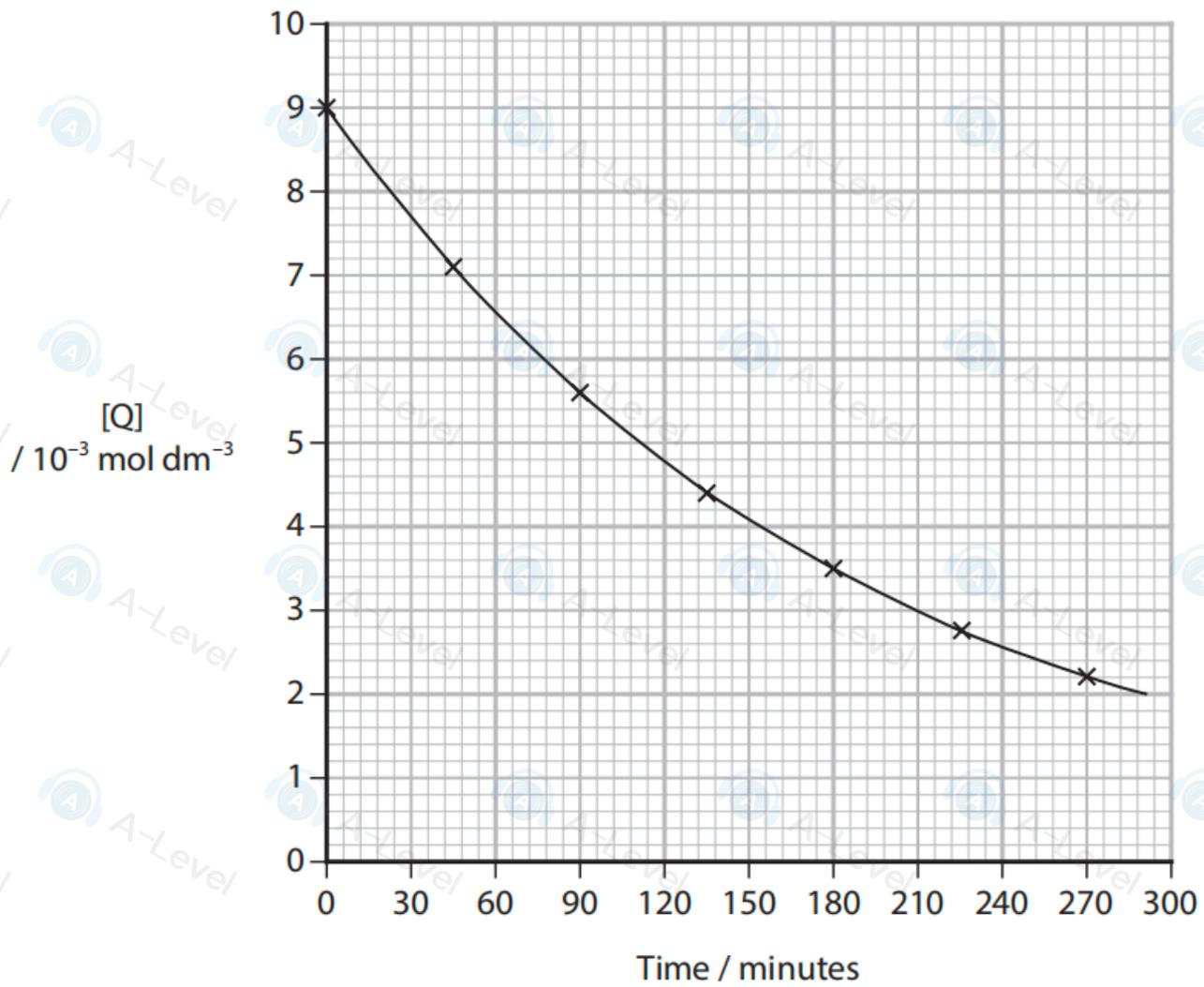
☒ **D** $dm^9\,mol^{-3}\,s^{-1}$

(c) The concentrations of **all** reactants are halved.

By what factor does the rate of reaction change?

(1)

☒ **A** $\dfrac{1}{2}$

☒ **B** $\dfrac{1}{4}$

☒ **C** $\dfrac{1}{8}$

☒ **D** $\dfrac{1}{16}$

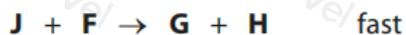**15** A graph of the concentration of Q during decomposition is shown.

What is the half-life for this decomposition?

☒ **A** 93 minutes

☒ **B** 132 minutes

☒ **C** 146 minutes

☒ **D** 291 minutes

3 Two chemicals, **E** and **F**, react to form products **G** and **H**.

$$E + 2F \rightarrow G + H$$

The mechanism for the reaction occurs in two steps via the formation of an intermediate **J**.

$$E + F \rightarrow J \qquad \text{slow}$$

$$J + F \rightarrow G + H \qquad \text{fast}$$

What is the rate equation for the reaction?

- ☒ **A** rate = k[**E**][**F**]
- ☒ **B** rate = k[**E**][**F**]^2
- ☒ **C** rate = k[**F**][**J**]
- ☒ **D** rate = k[**E**][**F**]^2[**J**]

(Total for Question 3 = 1 mark)

2 The half-life of a first order chemical reaction is

- ☒ **A** half the time taken for the reaction to be complete
- ☒ **B** the time taken for the value of the rate constant to halve
- ☒ **C** the time taken for the concentration of a reactant to halve
- ☒ **D** the time taken for the concentration of a product to double

(Total for Question 2 = 1 mark)

2 Nitrogen(V) oxide, N_2O_5, decomposes in a first order reaction.
At 45 °C, the half-life for this reaction is 1400 s.
In an experiment, the initial concentration of nitrogen(V) oxide is 1.0 mol dm^{-3}.

What is the concentration, in mol dm^{-3}, of nitrogen(V) oxide after 4200 s?

- ☒ **A** 0.875
- ☒ **B** 0.500
- ☒ **C** 0.250
- ☒ **D** 0.125

(Total for Question 2 = 1 mark)