Table 1 The concentration of $\{Co(NH_3)_5(H_2O)\}^{3+}$ as a function of time at 70 °C

Time/s	$\dfrac{[\{Co(NH_3)_5(H_2O)\}^{3+}]}{mol\ dm^{-3}}$	
0	8.00×10^{-3}	$-3.2153E-7$ J
2 000	7.36×10^{-3}	$-3.1712E-7$
4 000	6.75×10^{-3}	$-2.8676E-7$
6 000	6.21×10^{-3}	$-2.6584E-7$
8 000	5.69×10^{-3}	$-2.3902E-7$
10 000	5.24×10^{-3}	$-2.1645E-5$
12 500	4.71×10^{-3}	$-2.0183E-7$ .008
15 000	4.24×10^{-3}	$-1.7727E-7$
17 500	3.81×10^{-3}	$-1.6937E-7$
20 000	3.44×10^{-3}	

(c) (*3 marks*) Plot a kinetic reaction profile for $\{Co(NH_3)_5(H_2O)\}^{3+}$, using the data in Table 1. A curve should be drawn through the data points and, for convenience, $\{Co(NH_3)_5(H_2O)\}^{3+}$, can be represented by the letter 'A' when labelling the appropriate axis. *Print your kinetic reaction profile, attach it to your answer, and send it to your tutor with your completed assignment.*

(d) Reaction 1 is pseudo first order under the conditions used in the kinetic investigation that produced the data in Table 1. Given just these data:

(i) (*3 marks*) Briefly explain why a preliminary half-life check would not be useful for testing for pseudo-first-order behaviour.

(ii) (*15 marks*) Show how the general approach of the differential method can be used to verify the pseudo-first-order behaviour. Your answer should include a table of the data (including values of *J*) that you use, and an appropriate graph. Your graph should be correctly labelled and *hand-drawn* on graph paper. It should *not* be a print-out from the *Kinetics Toolkit*.

(e) (*4 marks*) A series of experiments was carried out at 70 °C with the same initial concentration of $\{Co(NH_3)_5(H_2O)\}^{3+}$ as in Table 1, but with different initial concentrations of NCS⁻. The variation of the pseudo-first-order rate constant (k_R') as a function of the initial concentration of NCS⁻ is given in Table 2. Use this information to determine the partial order with respect to NCS⁻.

Table 2 Values of the pseudo-first-order rate constant (k_R') at different initial concentrations of NCS⁻ at 70 °C

$[NCS^-]_0$/mol dm⁻³	k_R'/s^{-1}
0.2	4.23×10^{-3}
0.4	8.22×10^{-3}
0.6	1.16×10^{-2}
0.8	1.56×10^{-2}

(f) (*8 marks*) Determine by what factor the initial rate of reaction would decrease if Reaction 1 were to be carried out under the same conditions as those used to collect the data in Table 1, but at the lower temperature of 20 °C. Take the activation energy of Reaction 1 to be 75 kJ mol⁻¹.

Question 2

This question carries 20 per cent of the marks for this assignment, and tests Learning Outcome 4 of Book 5 Part 1, and Learning Outcomes 1, 3, 6 and 8 of Book 5 Part 2.

(a) (*8 marks*) For each of the pairs of reactions (A and B) in (i)–(iii) on p. 3, state which *one* (A or B) will go faster, or whether it is not possible to predict the faster reaction. Briefly give the reasoning behind your answer in each case.

2