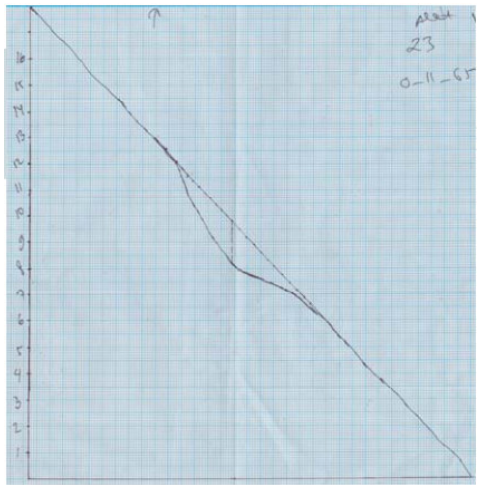
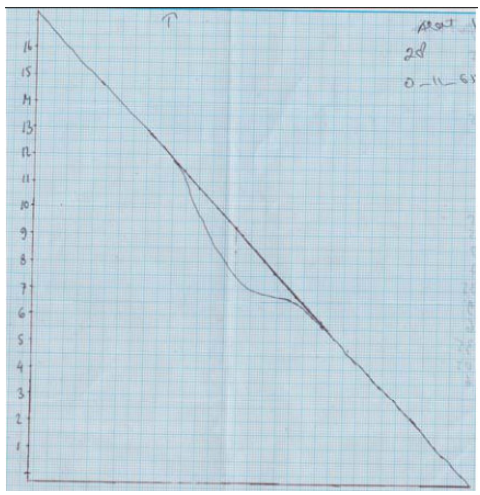
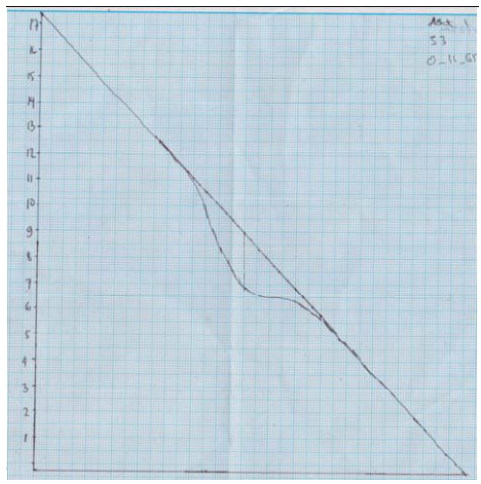
Determination of Refractive Index Gradient and Diffusion Coefficient of Salt Solution from Laser Deflection Measurement (10 points)

A. Measurement of Refractive Index Gradient of Salt Water Solution (4.5 points)

Question	Answer	Marks
A1. **(1.2 pts)**		Deflectogram of C_0 = 23 g/150 mL Centred Depth of dip: 1.5 - 1.6 cm (0.4 pts) -0.4 -0.05 -0.05 -0.05 -0.1
	No dip No reference line Deflectogram (DL) not at the centre (+- 5mm) but the depth of dip still in 1.5 - 1.6 cm range DL at the centre, the depth of dip $<$ 1.5 cm or $>$ 1.6 cm DL not at the centre, the depth of dip $<$ 1.5 cm or $>$ 1.6 cm	
		Deflectogram of C_0 = 28 gr/150 mL Centred Deep of dip: 1.7 - 1.9 cm (0.4 pts) -0.4 -0.05 -0.05 -0.05 -0.1
	No dip No reference line Deflectogram (DL) not at the centre (+- 5mm) but the depth of dip still in 1.7 cm - 1.9 cm range DL at the centre, the depth of dip $<$ 1.7 cm or $>$ 1.9 cm DL not at the centre, the depth of dip $<$ 1.7 cm or $>$ 1.9 cm	



Deflectogram of C_0 = 33 g/150 mL
Deep of dip: 1.9 - 2.3 cm
(0.4 pts)
-0.4 pts
-0.05 pts
- 0.05 pts
- 0.05 pts
-0.1

No dip
No reference line
Deflectogram (DL) not at the centre (+-5mm) but the depth of dip still in 1.9 - 2.3 cm range
DL at the centre, the depth of dip $<$ 1.9 cm or $>$ 2.3 cm
DL not at the centre, the depth of dip $<$ 1.9 cm or $>$ 2.3 cm

A2.
(1.5 pts)

i	δ_i (cm)	ξ_i (cm)	Z_o (cm)	d(cm)	Z (cm)
1	0.05	11.55	10.4 ± 0.1	0.8 ± 0.1	53.4 ± 0.1
2	0.35	11.3			
3	0.6	11.05			
4	0.9	10.85			
5	1	10.65			
6	1.1	10.35			
7	1.3	10.15			
8	1.4	9.85			
9	1.45	9.7			
10	1.5	9.45			
11	1.6	9.25			
12	1.5	8.95			
13	1.4	8.65			
14	1.2	8.35			
15	1	8.05			
16	0.8	7.75			
17	0.7	7.55			
18	0.5	7.25			
19	0.3	6.95			
20	0.2	6.65			
21	0.05	6.4			

Table 1 of C_0 = 23 g/150 mL
Optimum Z and Z_0
data = 20
(0.5 pts)
-0.05 pts
-0.05 pts
-0.15 pts
-0.3 pts
-0.45 pts

Correct data point must be extracted from deflectogram
correct data points >= 20, but not all observable (Z, Z0, d) are written
Incorrect d
15<= # correct data points<20,
10<# correct data points<15
#correct data points<10

A2.

i	δ_i (cm)	ξ_i (cm)	Z_o (cm)	d(cm)	Z (cm)
1	0.05	11.65	10.4 ± 0.1	0.8 ± 0.1	53.4 ± 0.1
2	0.25	11.4			
3	0.4	11.2			
4	0.8	11			
5	1	10.75			
6	1.2	10.4			
7	1.4	10.2			
8	1.5	10			
9	1.6	9.8			
10	1.7	9.5			
11	1.75	9.25			
12	1.7	8.95			
13	1.65	8.7			
14	1.5	8.4			
15	1.25	8.05			
16	0.9	7.6			
17	0.6	7.3			
18	0.4	7.05			
19	0.25	6.75			
20	0.05	6.3			

Table 1 of C_0 = 28 g/150 mL
Optimum Z and Z_0
data = 20 (0.5 pts)
-0.05 pts
-0.05 pts
-0.15 pts
-0.3 pts
-0.45 pts

Correct data point must be extracted from deflectogram
correct data points >= 20, but not all observable (Z, Z0, d) are written
Incorrect d
15<= # correct data points<20,
10<# correct data points<15
#correct data points<10

A2.

i	δ_i (cm)	ξ_i (cm)	Z_o (cm)	d(cm)	Z (cm)
1	0.05	11.6	10.4 ± 0.1	0.8 ± 0.1	53.4 ± 0.1
2	0.15	11.4			
3	0.35	11.1			
4	0.65	10.85			
5	1.1	10.6			
6	1.3	10.4			
7	1.5	10.2			
8	1.7	10			
9	1.85	9.7			
10	2	9.5			
11	2.1	9.25			
12	2	9			
13	1.8	8.6			
14	1.5	8.3			
15	1.25	8.05			
16	1	7.8			
17	0.75	7.45			
18	0.55	7.15			
19	0.4	6.8			
20	0.2	6.4			
21	0.05	6.1			

Table 1 of C_0 = 33 g/150 mL
data point >= 20
(0.5 pts)
-0.05 pts
-0.05 pts
-0.15 pts
-0.3 pts
-0.45 pts

Correct data point must be extracted from deflectogram
correct data points >= 20, but not all observable (Z, Z0, d) are written
Incorrect d
15<= # correct data points<20,
10<# correct data points<15
#correct data points<10

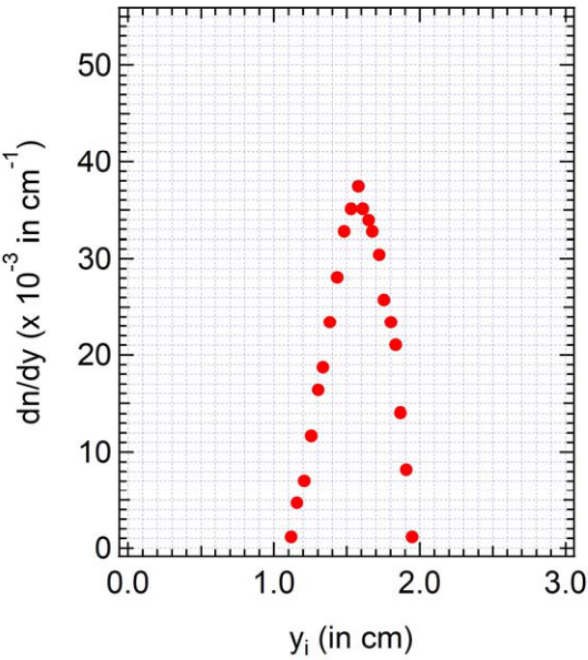
A3.
(1.5 pts)

i	Y_i (cm)	dn/dY
1	1.85944	0.00117
2	1.81919	0.00819
3	1.77894	0.01404
4	1.74674	0.02106
5	1.71455	0.02340
6	1.66625	0.02574
7	1.63405	0.03043
8	1.58575	0.03277
9	1.56161	0.03394
10	1.52136	0.03511
11	1.48916	0.03745
12	1.44086	0.03511
13	1.39257	0.03277
14	1.34427	0.02809
15	1.29597	0.02340
16	1.24767	0.01872
17	1.21548	0.01638
18	1.16718	0.01170
19	1.11888	0.00702
20	1.07058	0.00468
21	1.03034	0.00117

Table 2 of C_0 = 23 g/150 mL.
data = 20
(0.25 pts)
- 0
- 0.05 pts
- 0.25pts

Jury must check the data in table
wrong data point < 3
3<# wrong data point < 6
wrong data point > 6

A3.



Plot dn/dY vs Y
C_0 = 23 g/150 mL.
"Gaussian-Like" shape
(0.25 pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.05 pts
-0 pts
-0.25 pts

No x-axis label
No x-axis unit
Without x-axis unit
No y-axis label
No y-axis unit
Without y-axis unit
Ordinate axis represented in 2 digid behind point
Ordinate axis represented in 3 digid behind point
Random shape

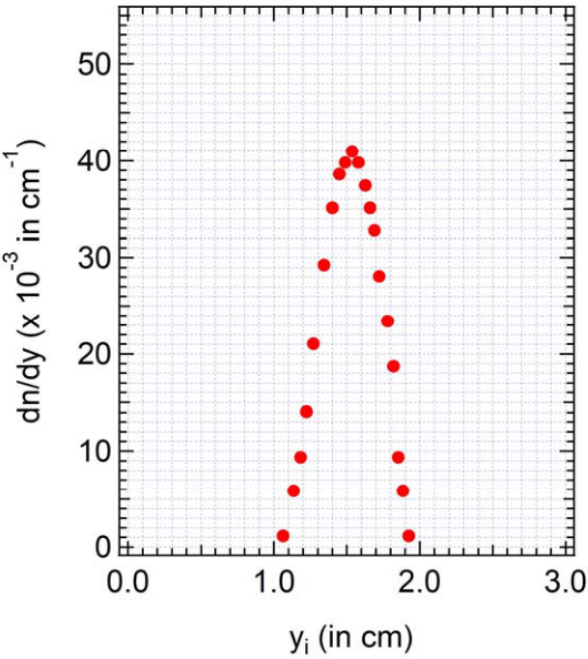
A3.

i	Y_i (cm)	dn/dY
1	1.87554	0.00117
2	1.83529	0.00585
3	1.80309	0.00936
4	1.77089	0.01872
5	1.73065	0.02340
6	1.67430	0.02809
7	1.64210	0.03277
8	1.60990	0.03511
9	1.57770	0.03745
10	1.52941	0.03979
11	1.48916	0.04096
12	1.44086	0.03979
13	1.40061	0.03862
14	1.35232	0.03511
15	1.29597	0.02926
16	1.22352	0.02106
17	1.17523	0.01404
18	1.13498	0.00936
19	1.08668	0.00585
20	1.01424	0.00117

Table 2 of
C_0 = 28 g/150 mL.
data = 20
(0.25 pts)
- 0
- 0.05 pts
- 0.25pts

Jury must check the data in table
wrong data point < 3
3<# wrong data point < 6
wrong data point > 6

A3.



Plot dn/dY vs Y
C_0 = 28 g/150 mL.
"Gaussian-Like" shape
(0.25 pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.05 pts
-0 pts
-0.25 pts

without x-axis label
without x-axis unit
wrong x-axis unit
without y-axis label
without y-axis unit
wrong y-axis unit
Ordinate axis represented in 2 digid behind point
Ordinate axis represented in 3 digid behind point
Random shape of the curve

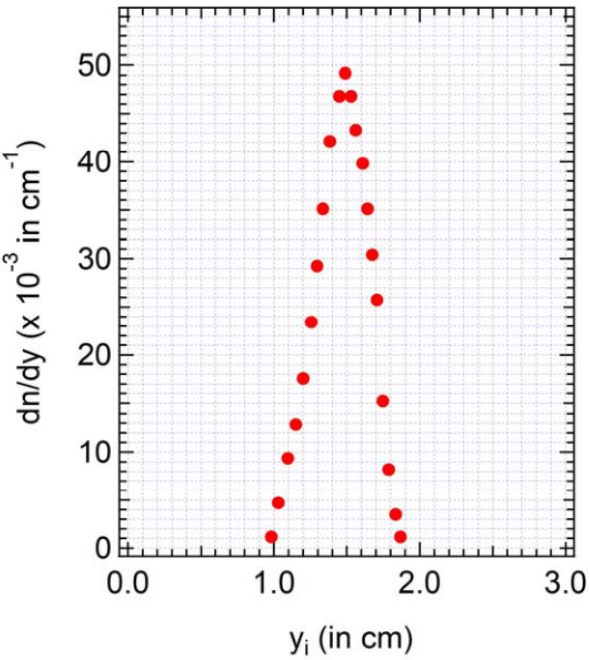
A3.

i	Y_i (cm)	dn/dY
1	1.86749	0.00117
2	1.83529	0.00351
3	1.78699	0.00819
4	1.74674	0.01521
5	1.70650	0.02574
6	1.67430	0.03043
7	1.64210	0.03511
8	1.60990	0.03979
9	1.56161	0.04330
10	1.52941	0.04681
11	1.48916	0.04915
12	1.44891	0.04681
13	1.38452	0.04213
14	1.33622	0.03511
15	1.29597	0.02926
16	1.25572	0.02340
17	1.19938	0.01755
18	1.15108	0.01287
19	1.09473	0.00936
20	1.03034	0.00468
21	0.98204	0.00117

Table 2 of
C_0 = 33 g/150 mL.
data = 20
(0.25 pts)
- 0
- 0.05 pts
- 0.25pts

Jury must check the data in table
wrong data point < 3
3<# wrong data point < 6
wrong data point > 6

A3.



Plot dn/dY vs Y C_0 = 33 g/150 mL. (0.25 pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.05 pts
-0 pts
-0.25 pts

without x-axis label
without x-axis unit
wrong x-axis unit
without y-axis label
without y-axis unit
wrong y-axis unit
Ordinate axis represented in 2 digid behind point
Ordinate axis represented in 3 digid behind point
Random shape of the curve

A4. **(0.3 pts)**	h for 23 g/ 150 mL = (1.5 ± 0.1) cm	0.1 pts
	h for 28 g/ 150 mL = (1.5 ± 0.1) cm	0.1 pts
	h for 33 g/ 150 mL = (1.5 ± 0.1) cm	0.1 pts
	If h is correctly determined from graph A3 for each concentration	- 0
	If h is not correctly determined from graph A3 for each concentration	-0.1

B : Determination of Diffusion Coefficient (4.2 points)

Question	**Answer**	**Marks**
B1. **(0.9 pts)**	**Linear form of eq.(3)**	0.9 pt -0.9 pts

$$\ln\left(\frac{dn}{dY}\right) \approx m(h-Y)^2 + C \qquad \text{(b1)}$$

$$m = -\frac{1}{4D_e t}$$

Constant : $C = \ln\left(\left(\frac{dn}{dc}\right)\left(\frac{C_0}{2\sqrt{\pi D_e t}}\right)\right)$
Other than (b1)

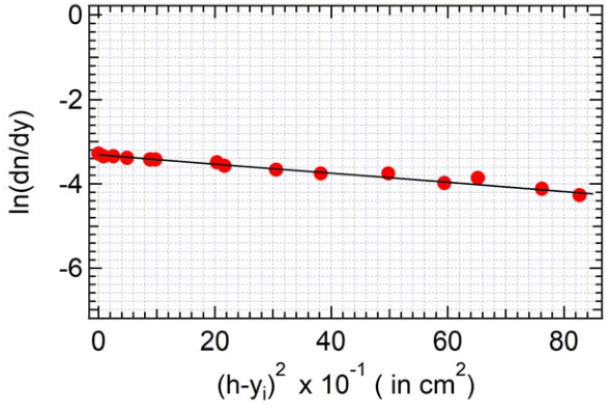
B2.
(1.8 pts)

i	$(h\text{-}y_i)^2$	$\ln(dn/dy)$
1	0.06592	-3.86003
2	0.050423	-3.75467
3	0.031065	-3.65936
4	0.020752	-3.4923
5	0.00917	-3.41819
6	0.005128	-3.3831
7	0.000984	-3.3492
8	6.99E-07	-3.28466
9	0.002414	-3.3492
10	0.009493	-3.41819
11	0.021237	-3.57235
12	0.037646	-3.75467
13	0.05872	-3.97781

Table 3 of C_0 = 23 g /150 mL.
data = 10
(0.3 pts)
-0 pts
-0.05 pts
-0.3 pts
- 0
- 0.05 pts
- 0.25 pts

Jury must check the data in table
# of data point > 10
3 <= # of data point < 10
# of data point < 3
wrong data point < 3
3<# wrong data point < 6
wrong data point >6

B2



Plot of Table 3
C_0 = 23 g/150 mL
data = 10
(0.3pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0 pts
-0.05 pts
-0.25 pts
-0.3 pts

Using linear regression of eq. (B1.1), we obtain
m (slope) = -10 cm^{-2} till -8.8 cm^{-2}
without x-axis label
without x-axis unit
wrong x-axis unit
without y-axis label
without y-axis unit
wrong y-axis unit
# of data point in linear range > 10
3 <= # of data point in linear range < 10
# of data point in linear range < 3 or random shape of curve
m is out of range

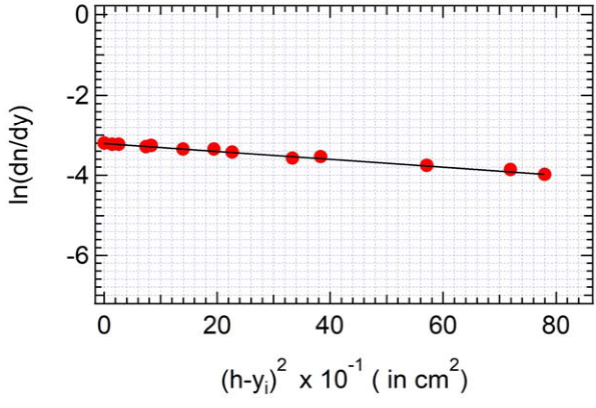
B2.

i	$(h\text{-}y_i)^2$	$\ln(dn/dy)$
1	0.057912	-3.75467
2	0.033968	-3.57235
3	0.023136	-3.41819
4	0.014378	-3.3492
5	0.007693	-3.28466
6	0.001553	-3.22404
7	6.99E-07	-3.19505
8	0.002414	-3.22404
9	0.007989	-3.25389
10	0.018955	-3.3492
11	0.037646	-3.53152
12	0.071007	-3.86003
13	0.099079	-4.26549

Table 3 of C_0 = 28 g /150 mL.
data = 10
(0.3 pts)
-0 pts
-0.05 pts
-0.3 pts
- 0
- 0.05 pts
- 0.25 pts

Jury must check the data in table
# of data point > 10
3 <= # of data point < 10
# of data point < 3
wrong data point < 3
3<# wrong data point < 6
wrong data point >6

B2.



Plot of Table 3
C_0 = 28 g/150 mL
data = 10
(0.3pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0 pts
-0.05 pts
-0.3 pts
-0.3 pts

Using linear regression of eq. (B1.1), we obtain
m (slope) = -10.3 cm^{-2} till -11 cm^{-2}
without x-axis label
without x-axis unit
wrong x-axis unit
without y-axis label
without y-axis unit
wrong y-axis unit
# of data point in linear range > 10
3 <= # of data point in linear range < 10
# of data point in linear range < 3 or random shape of curve
m is out of range

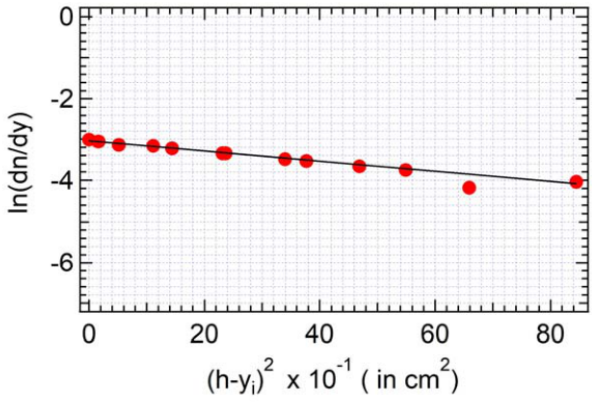
B2.

i	$(h\text{-}y_i)^2$	$\ln(dn/dy)$
1	0.046873	-3.65936
2	0.033968	-3.4923
3	0.023136	-3.3492
4	0.014378	-3.22404
5	0.005128	-3.13948
6	0.001553	-3.06152
7	6.99E-07	-3.01273
8	0.001688	-3.06152
9	0.011126	-3.16688
10	0.023647	-3.3492
11	0.037646	-3.53152
12	0.054884	-3.75467
13	0.08446	-4.04235

Table 3 of C_0 = 33 g /150 mL.
data = 10
(0.3 pts)
-0 pts
-0.05 pts
-0.3 pts
- 0
- 0.05 pts
- 0.25

Jury must check the data in table
# of data point > 10
3 <= # of data point < 10
# of data point < 3
wrong data point < 3
3<# wrong data point < 6
wrong data point >6

B2.



Plot of Table 3
C_0 = 33 g/150 mL
data = 10
(0.3pts)
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.01 pts
-0.3 pts
-0 pts
-0.05 pts
-0.3

Using linear regression of eq. (B1.1), we obtain
m (slope) = -11.3 cm^{-2} till -12.8 cm^{-2}
without x-axis label
without x-axis unit
wrong x-axis unit
without y-axis label
without y-axis unit
wrong y-axis unit
m is out of range
# of data point in linear range > 10
3 <= # of data point in linear range < 10
# of data point in linear range < 3 or random shape of curve

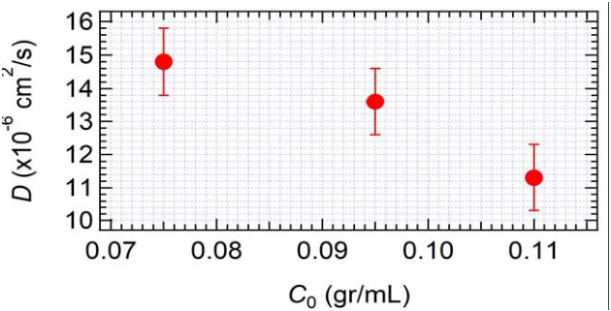
B3
(1.5 pts)

D of 23 g/ 150 mL = (1.38 till 1.58) x 10^{-5} cm^2/s	0.5 pts
D of 28 g/ 150 mL = (1.26 till 1.46) x 10^{-5} cm^2/s	0.5 pts
D of 33 g/ 150 mL = (1.03 till 1.23) x 10^{-5} cm^2/s	0.5 pts-
D is out of range for each concentration	-0.5 pts

C. Nonlinear diffusion (1.3 points)

Question	**Answer**	**Marks**

C1.
(1.3 pts)



Plot D vs. C_0 0.8 pts
-0
-0.4 pts

Without error bars
Value of C not stated in C_0/2

C1. $\frac{d}{dC}D = -4.2 \times 10^{-5}\,\mathrm{cm^2\,mL\,g^{-1}\,s^{-1}}$ till $-15.8 \times 10^{-5}\,\mathrm{cm^2\,mL\,g^{-1}\,s^{-1}}$ 0.5 pts
-0.01 pts
Without or wrong unit -0.5 pts
Out of range