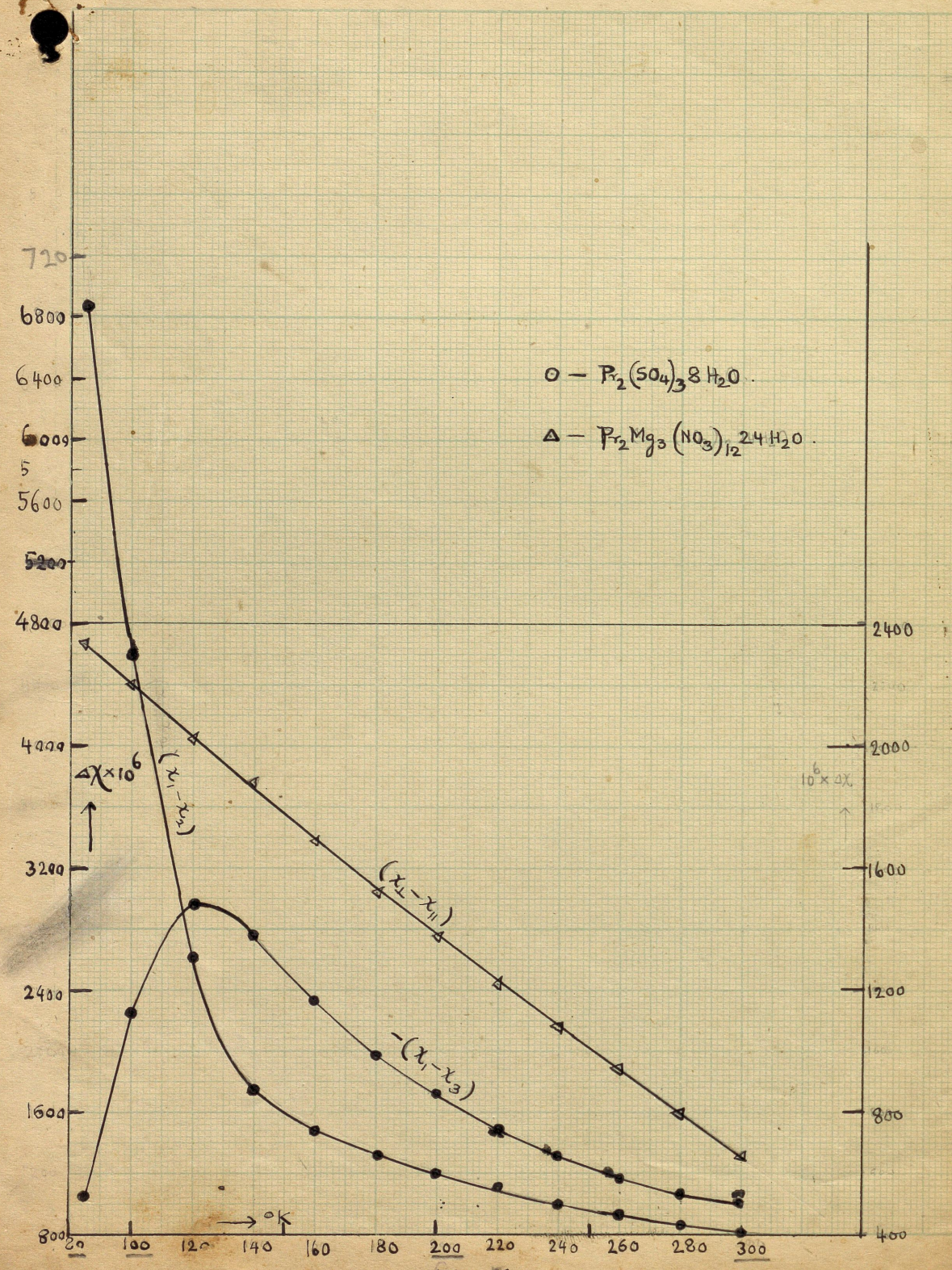

O — $Pr_2(SO_4)_3 8H_2O$.
Δ — $Pr_2Mg_3(NO_3)_{12} 24H_2O$.
$\Delta\chi \times 10^6$
$10^6 \times \Delta\chi$
$(\chi_1 - \chi_2)$
$(\chi_1 - \chi_{11})$
$-(\chi_1 - \chi_3)$
°K
720
6800
6400
6000
5600
5200
4800
4400
4000
3200
2400
1600
800
2400
2000
1600
1200
800
400
20
100
120
140
160
180
200
220
240
260
280
300

Fig. 5.

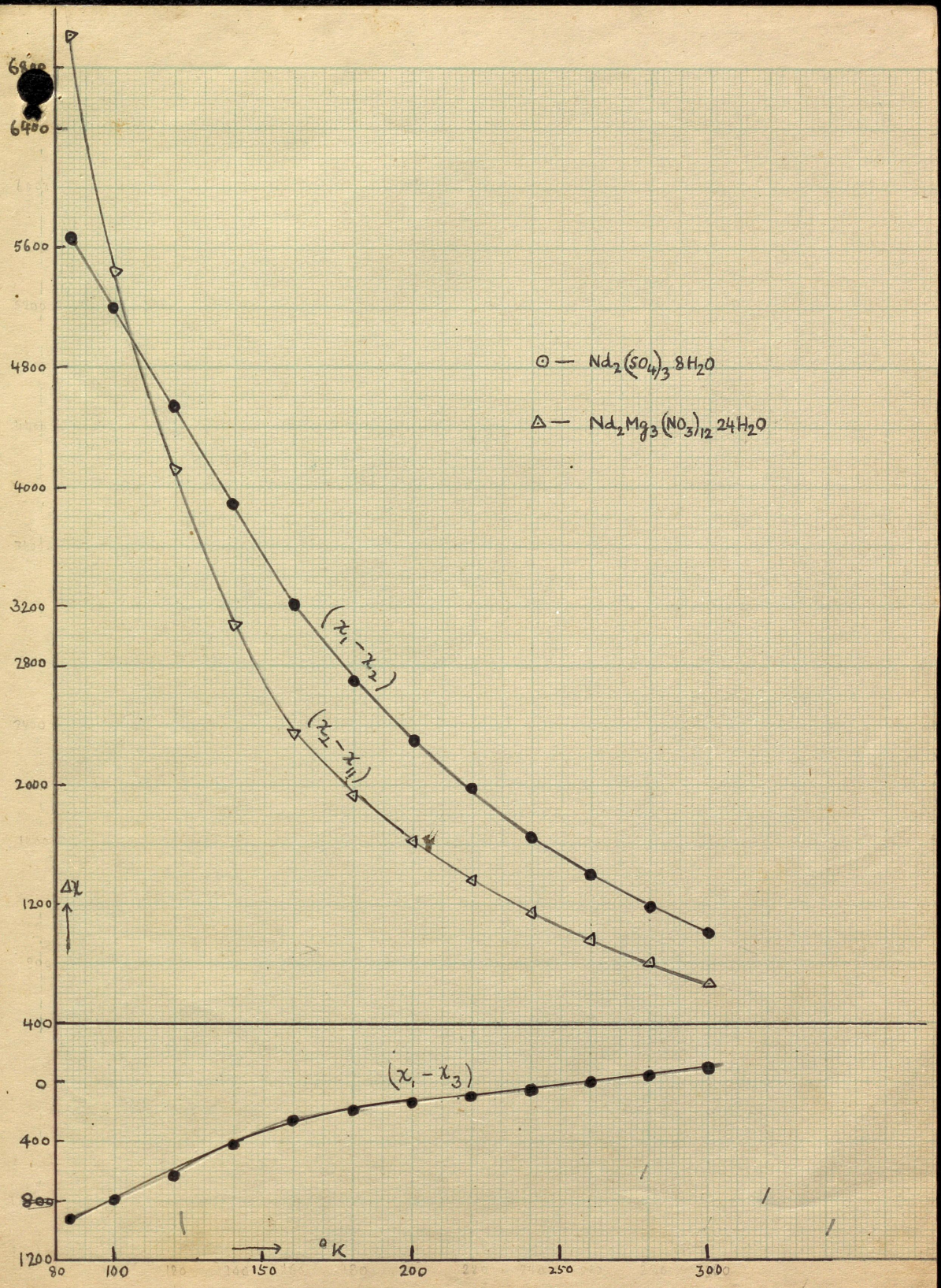

6400
5600
4800
4000
3200
2800
2000
1200
400
0
400
800
1200
80
100
150
200
250
300
°K
Δχ
⊙ — Nd2(SO4)3 8H2O
△ — Nd2Mg3(NO3)12 24H2O
(χ1 − χ2)
(χ2 − χ||)
(χ1 − χ3)

fig 6

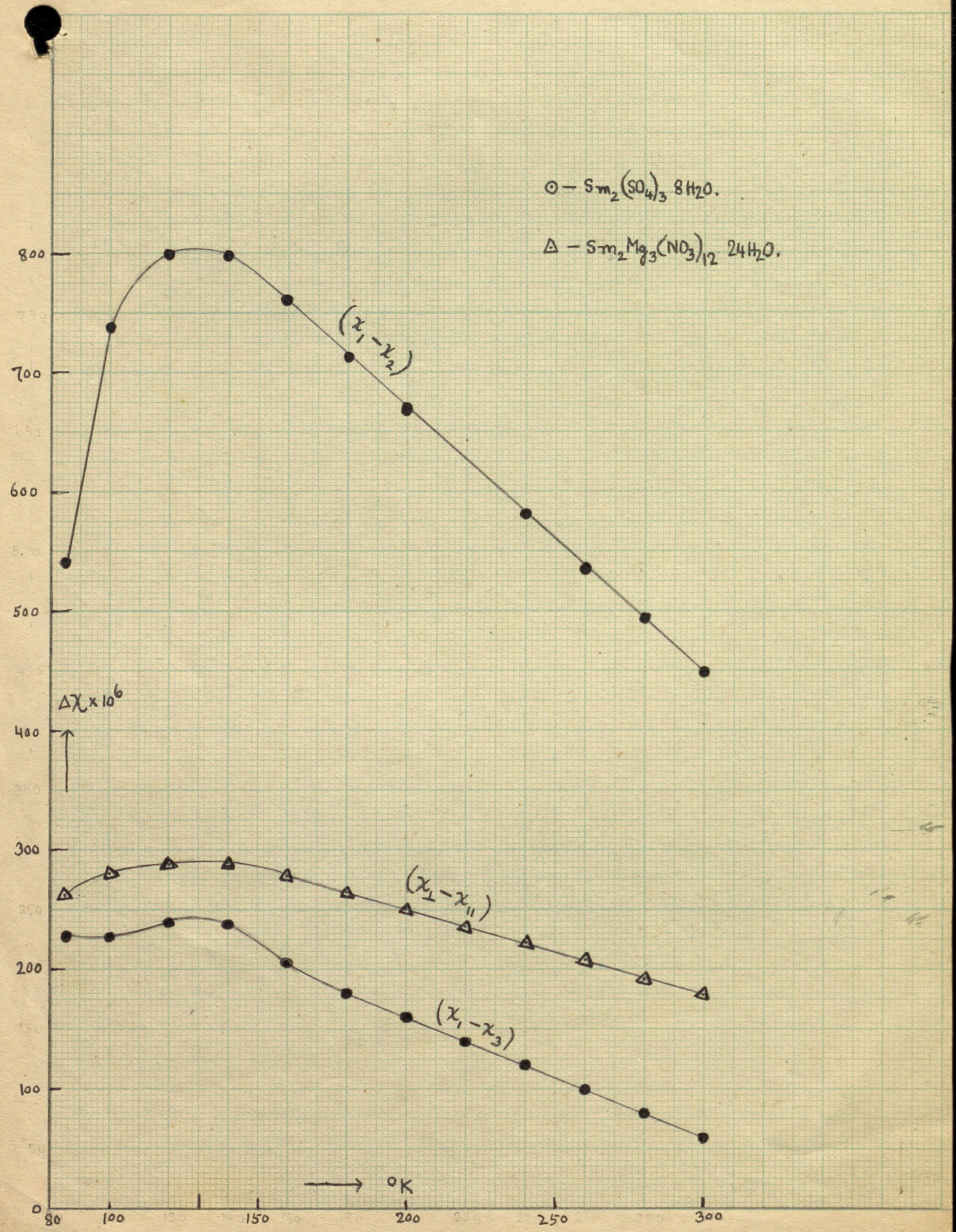

⊙ – $Sm_2(SO_4)_3\ 8H_2O$.
△ – $Sm_2Mg_3(NO_3)_{12}\ 24H_2O$.
$(\chi_1 - \chi_2)$
$(\chi_1 - \chi_{11})$
$(\chi_1 - \chi_3)$
$\Delta\chi \times 10^6$
°K
800
700
600
500
400
300
200
100
0
80
100
150
200
250
300

fig7

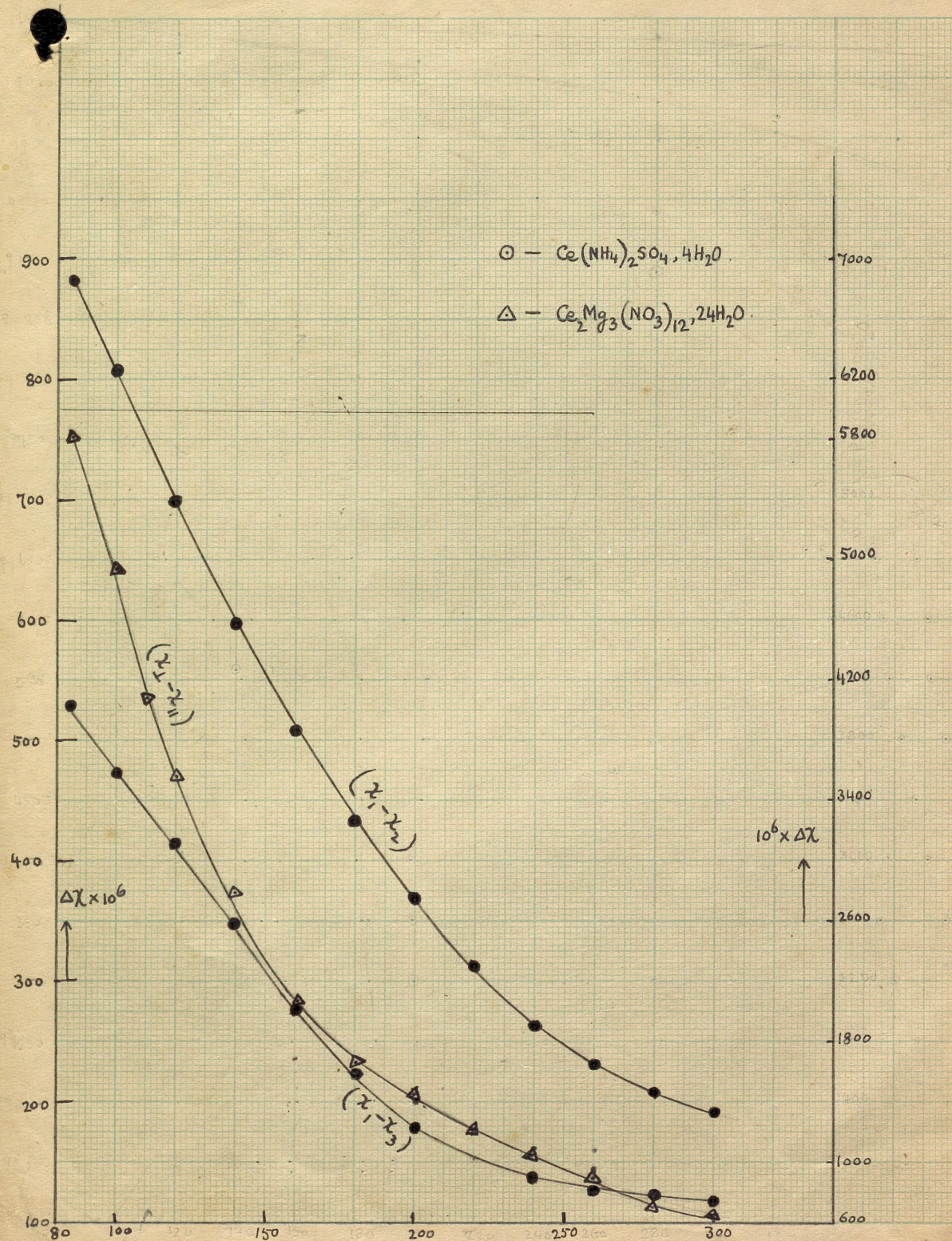
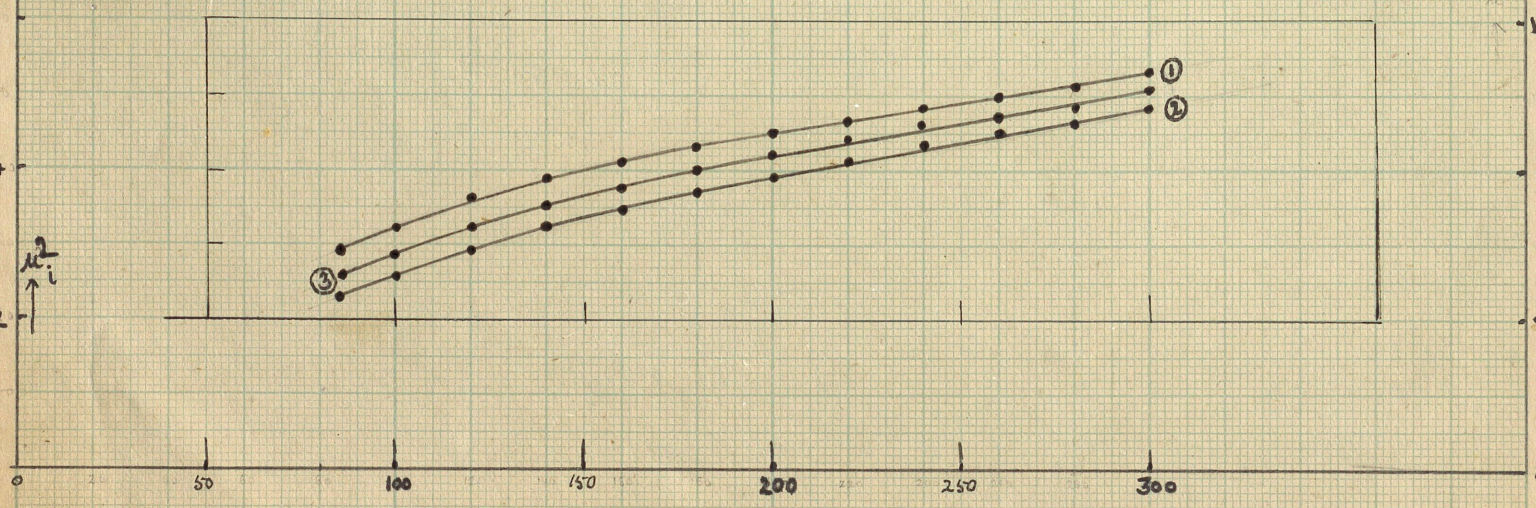

⊙ — $Ce(NH_4)_2SO_4, 4H_2O$
△ — $Ce_2Mg_3(NO_3)_{12}, 24H_2O$
$\Delta\chi \times 10^6$
$10^6 \times \Delta\chi$
$(\chi_1 - \chi_2)$
$(\chi_1 - \chi_3)$
$(\chi_2 - \chi_3)$
900
800
700
600
500
400
300
200
100
7000
6200
5800
5000
4200
3400
2600
1800
1000
600
80
100
150
200
250
300

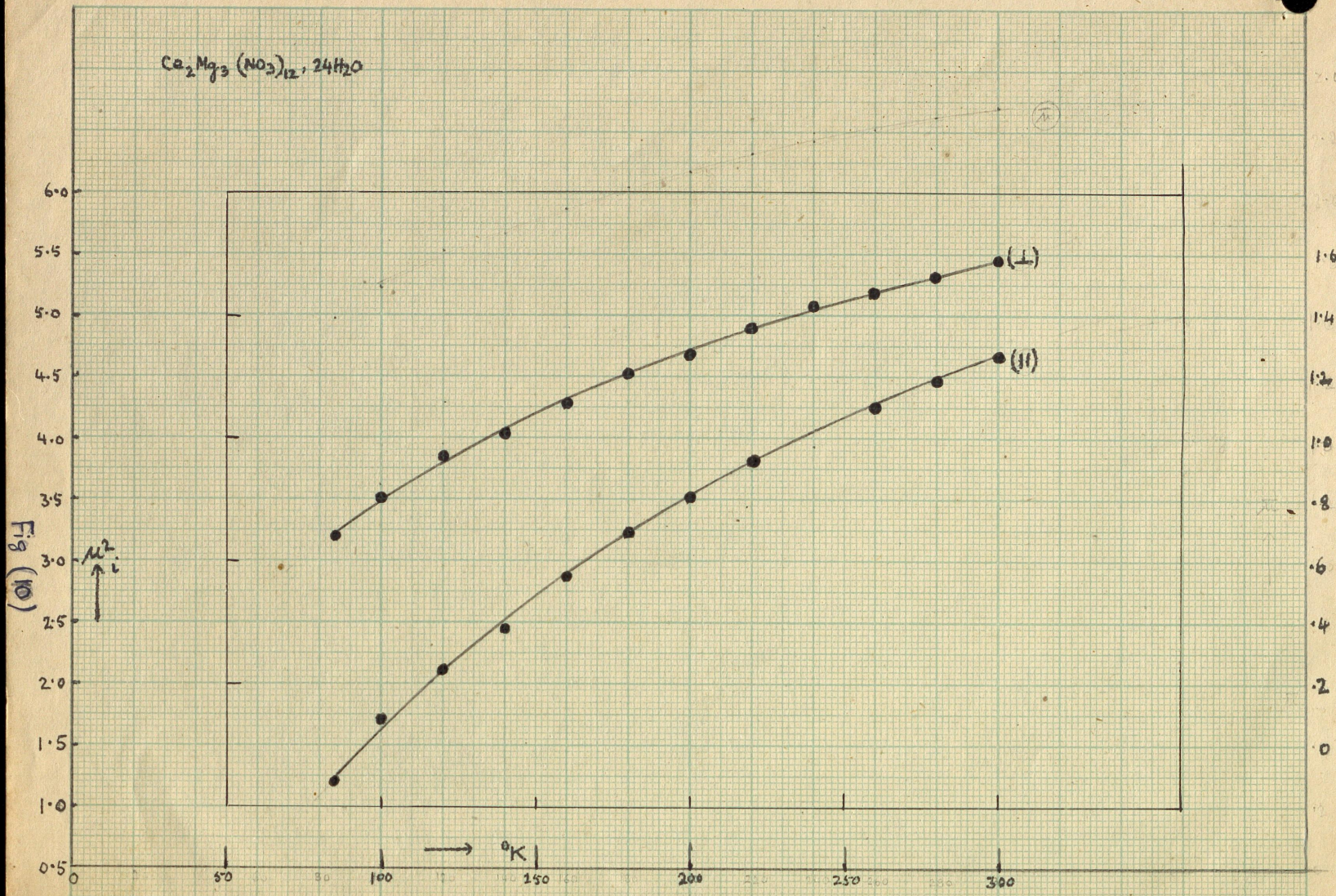
fig. 8

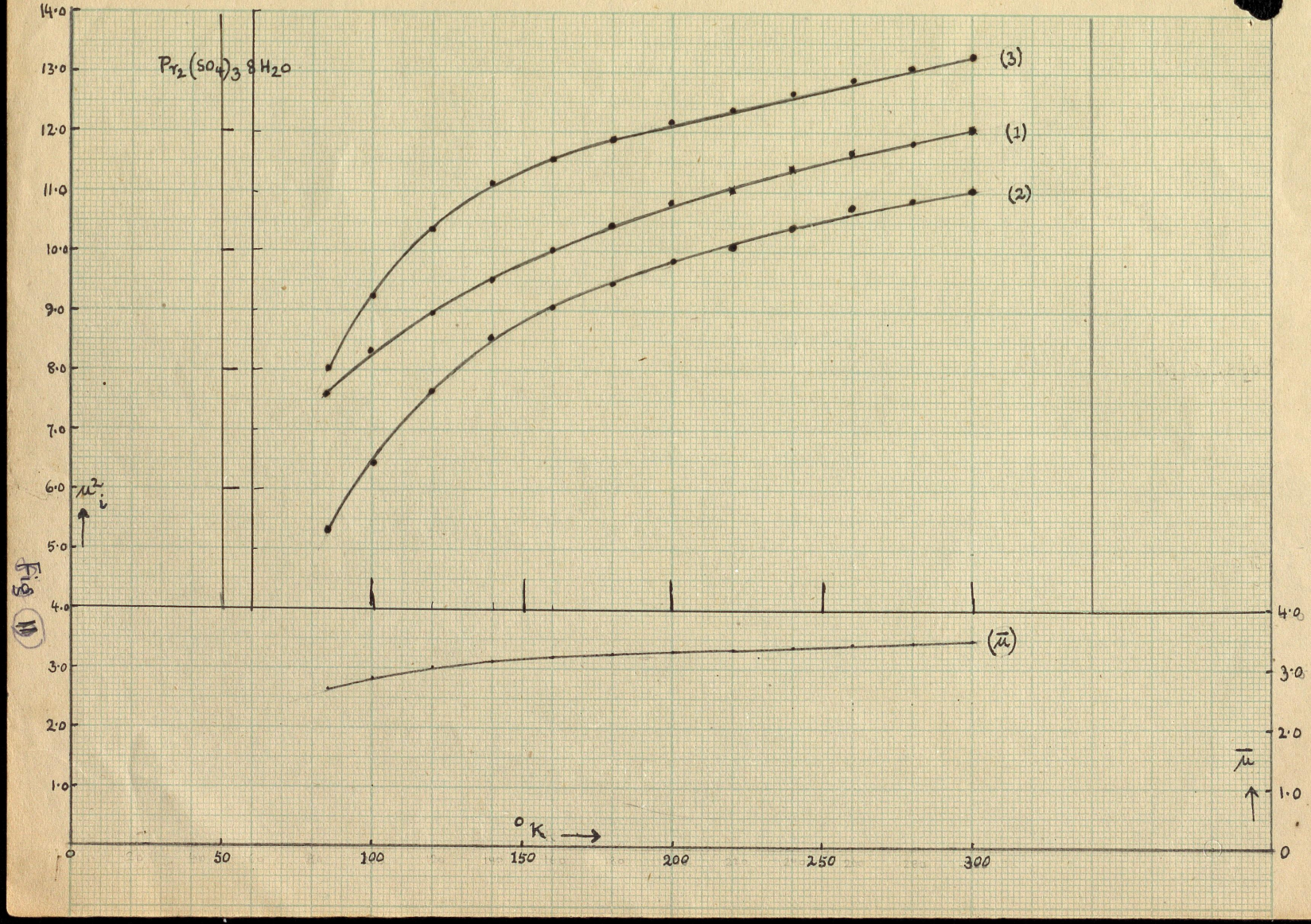
Temperature Variation of the square of the effective moment.

$Co(NH_4)_2SO_4\ 4H_2O$

Fig(9)




$Ce_2Mg_3(NO_3)_{12}, 24H_2O$
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
μ^2
Fig (10)
(⊥)
(∥)
0
50
100
150
200
250
300
°K
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0


$Pr_2(SO_4)_3\,8H_2O$
(3)
(1)
(2)
$(\bar{\mu})$
μ^2_i
$\bar{\mu}$
°K
14·0
13·0
12·0
11·0
10·0
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
0
50
100
150
200
250
300

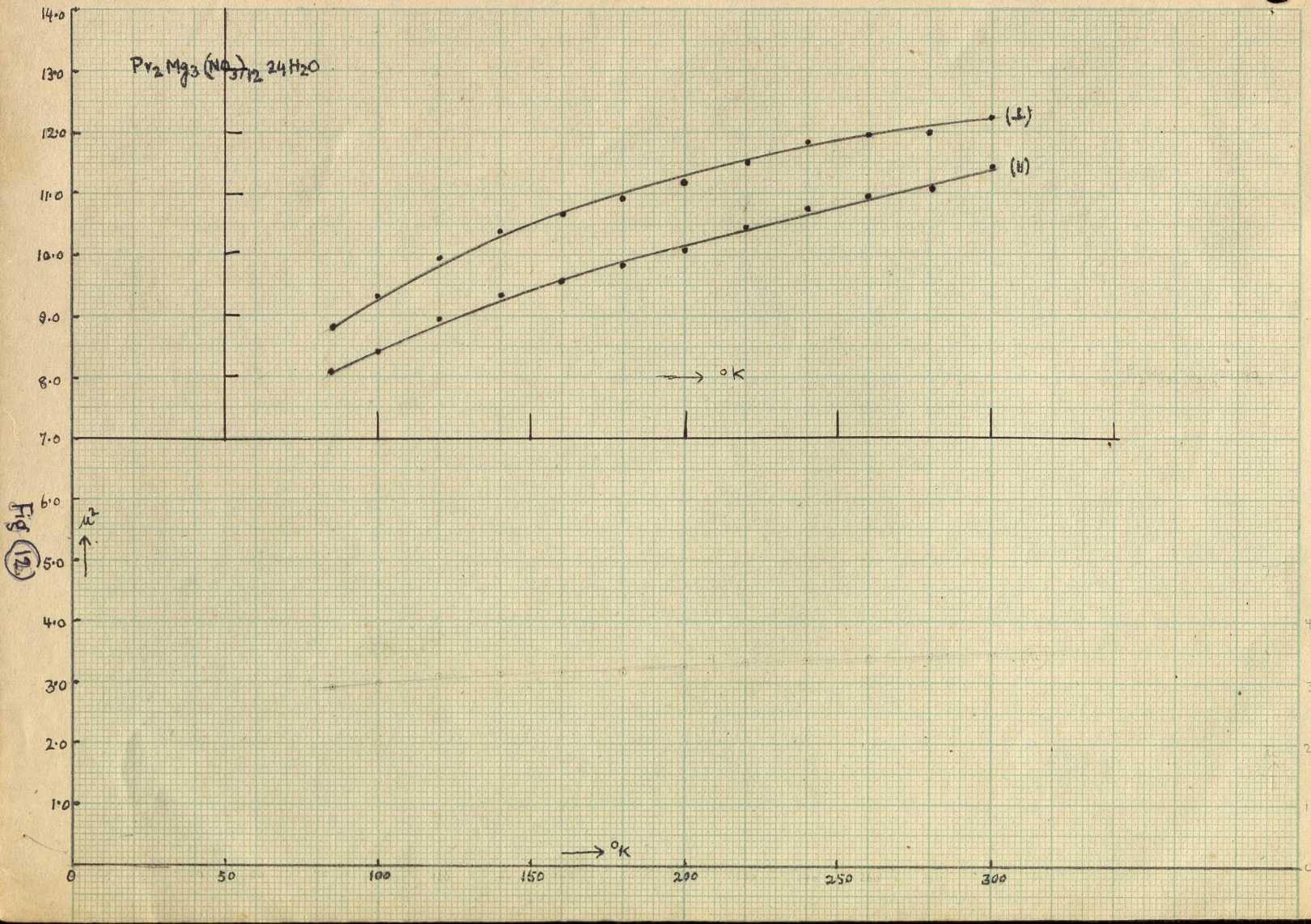
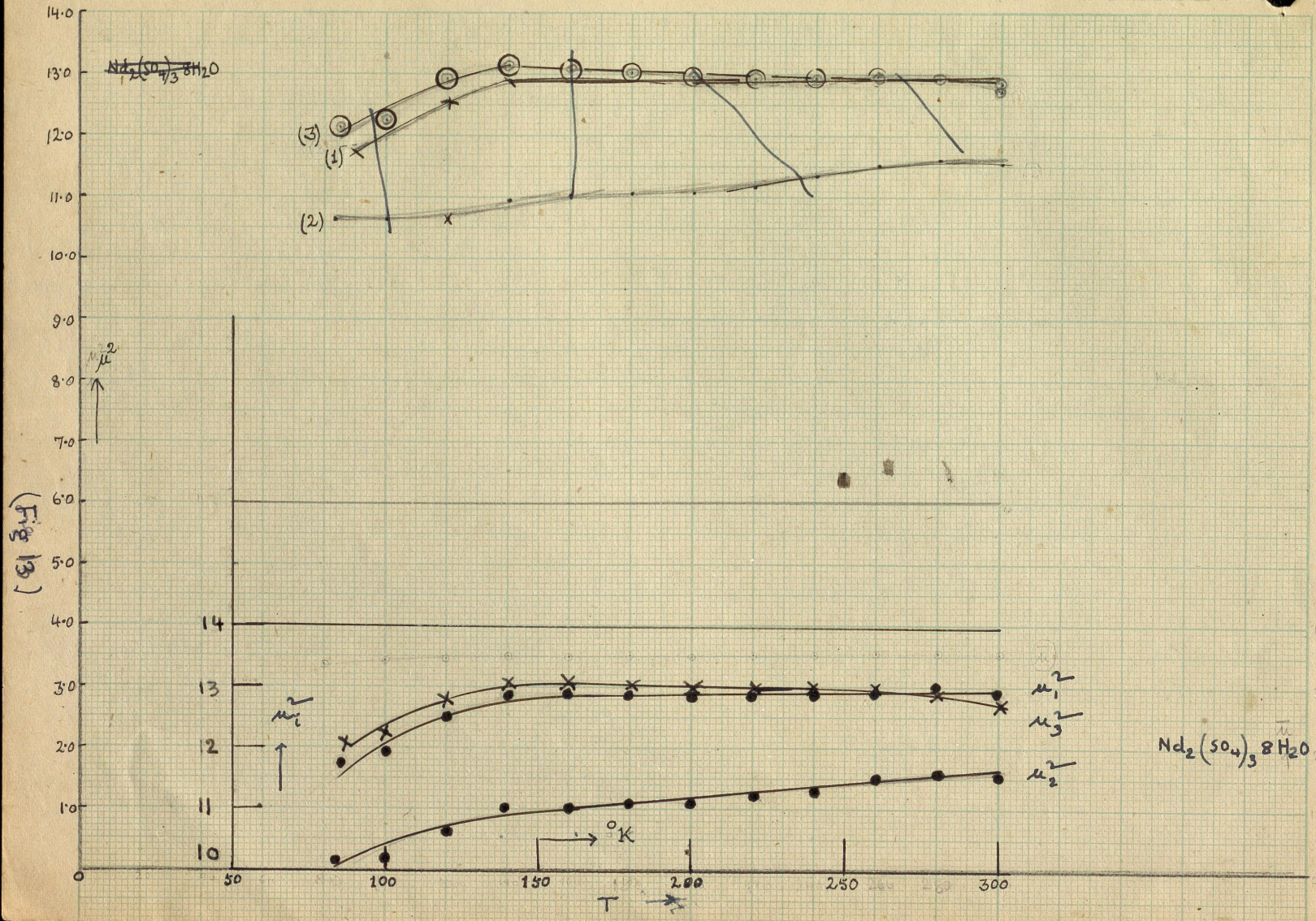

$Pr_2Mg_3(NO_3)_{12}\,24H_2O$
(I)
(II)
°K
μ^2
14·0
13·0
12·0
11·0
10·0
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
0
50
100
150
200
250
300

Fig (12)


14·0
13·0
12·0
11·0
10·0
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
0
μ²
(BM)²
(3)
(1)
(2)
14
13
12
11
10
μᵢ²
50
100
150
200
250
300
T
°K
μ₁²
μ₃²
μ₂²
Nd₂(SO₄)₃ 8H₂O

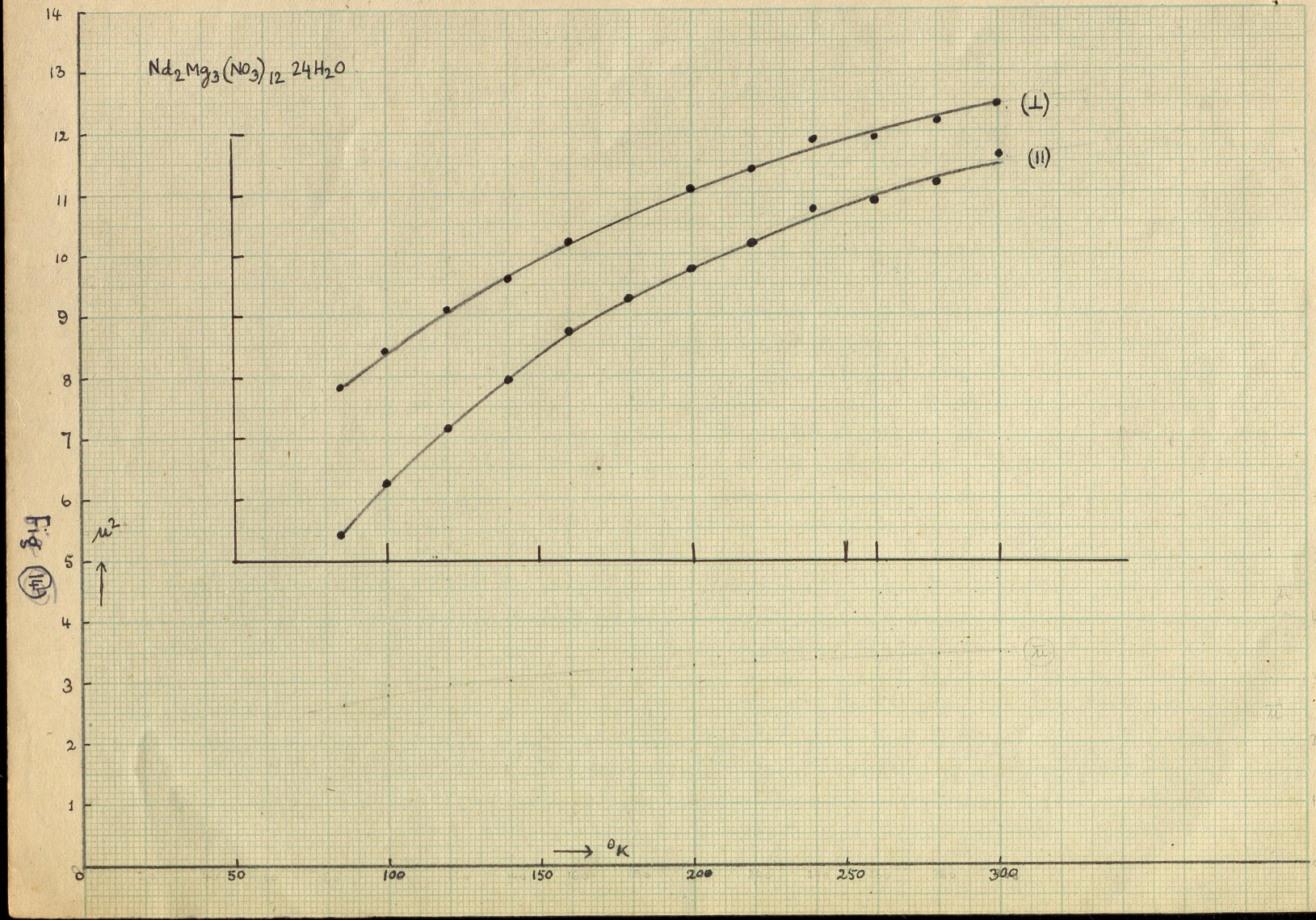
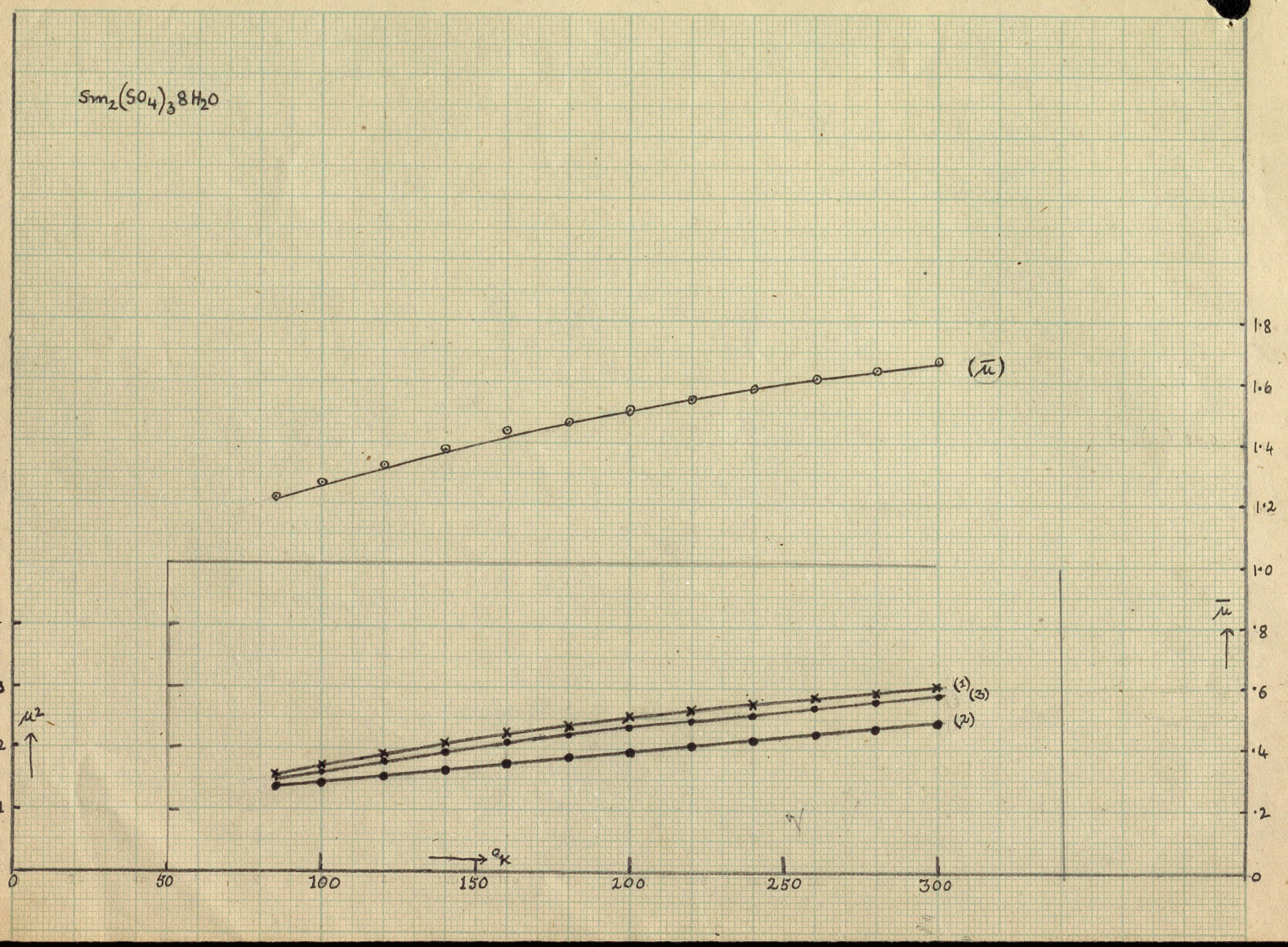
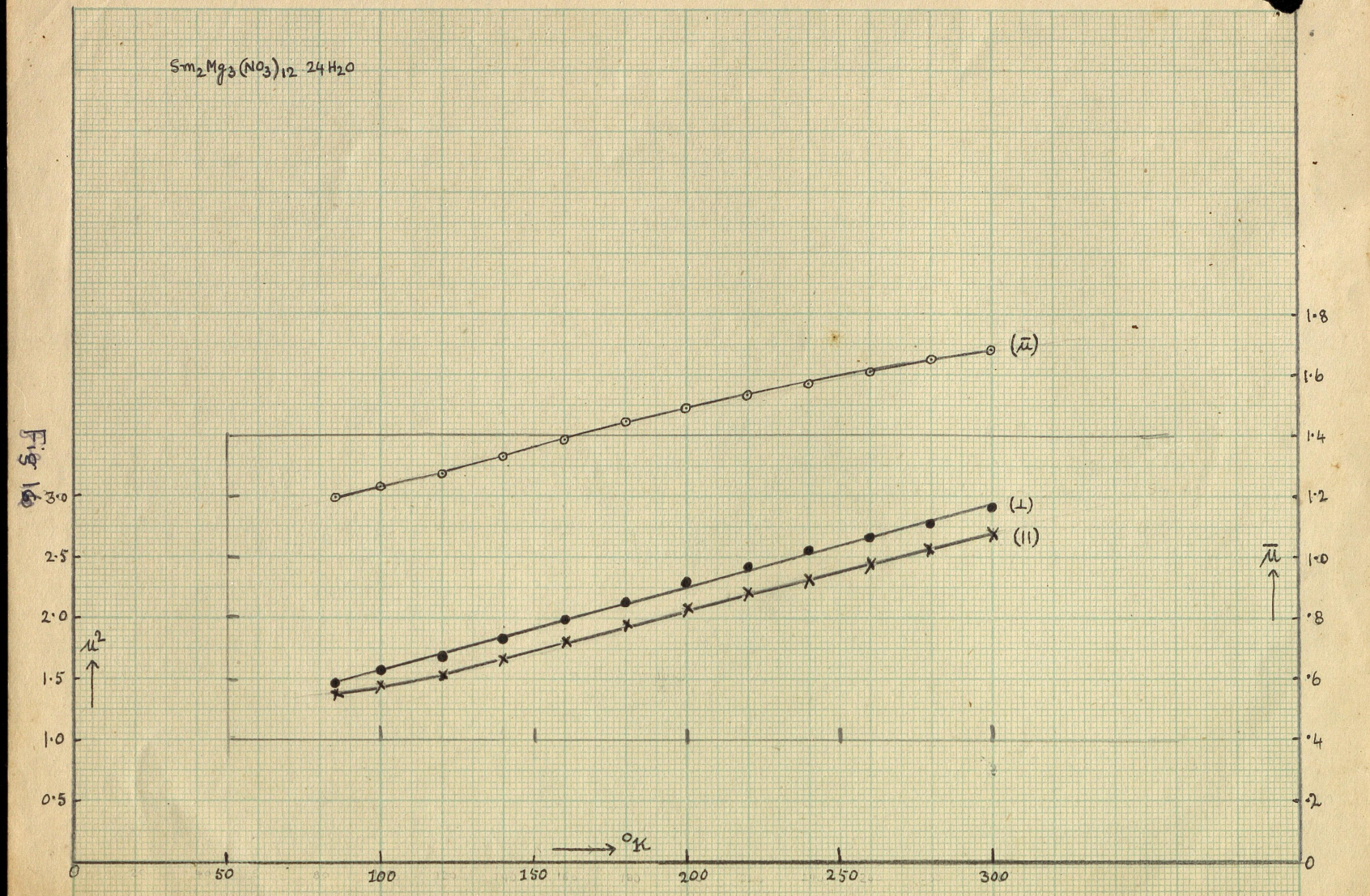

$Nd_2Mg_3(NO_3)_{12}\,24H_2O$
(⊥)
(||)
μ^2
^0K
0
50
100
150
200
250
300
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Fig 8

$Sm_2(SO_4)_3 8H_2O$




$Sm_2Mg_3(NO_3)_{12}\ 24H_2O$
Fig 1a
μ^2
3·0
2·5
2·0
1·5
1·0
0·5
0
50
100
150
200
250
300
°K
$(\bar{\mu})$
(⊥)
(||)
$\bar{\mu}$
1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
0

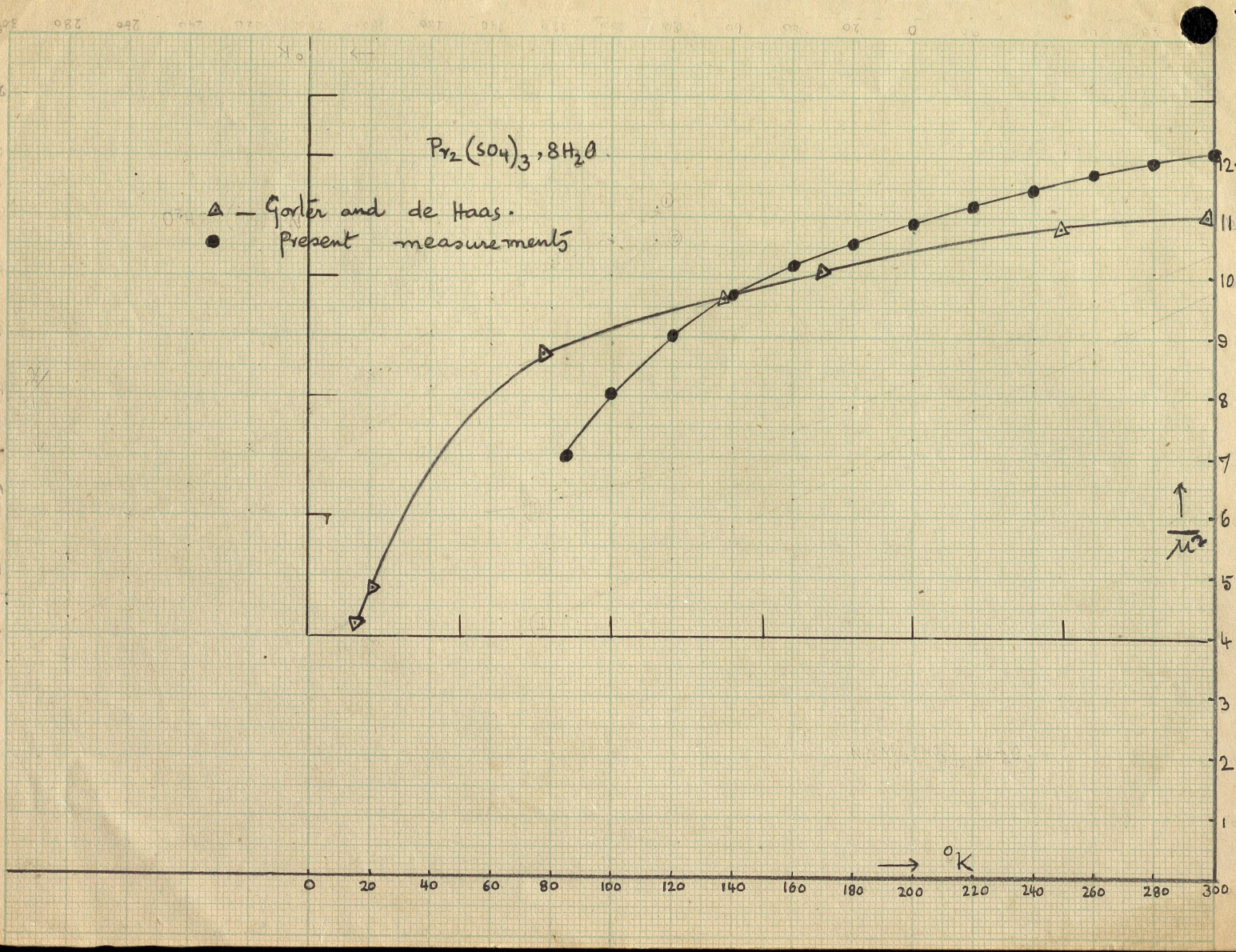

$Pr_2(SO_4)_3, 8H_2O$
△ — Gorter and de Haas.
● Present measurements
$\overline{\mu^2}$
^0K
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
1 2 3 4 5 6 7 8 9 10 11 12

Fig. (17)

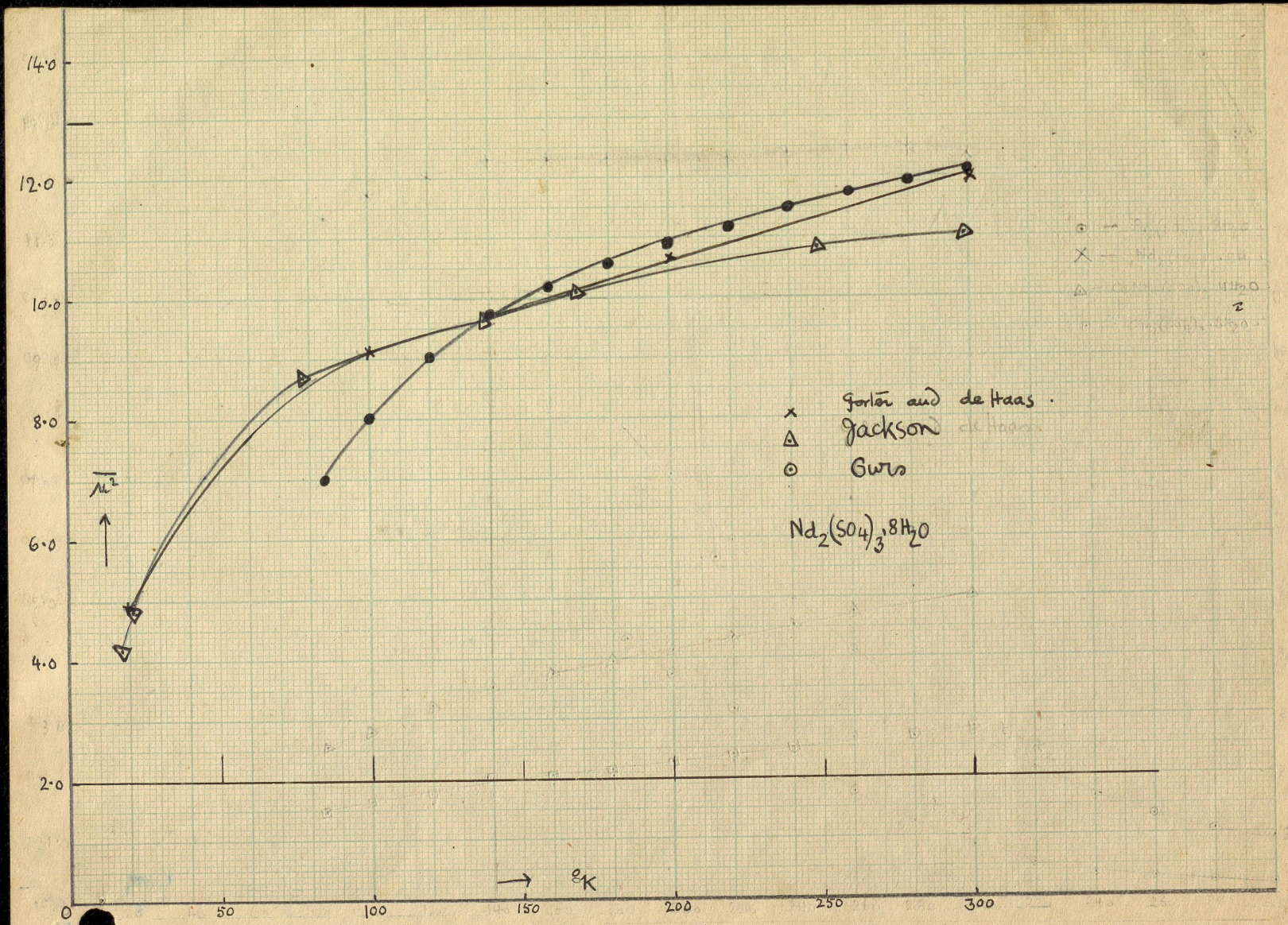

14·0
12·0
10·0
8·0
6·0
4·0
2·0
0
50
100
150
200
250
300
$\overline{\mu^2}$
θ_K
Gorter and de Haas.
Jackson
Gurs
$Nd_2(SO_4)_3 8H_2O$

Fig (18)

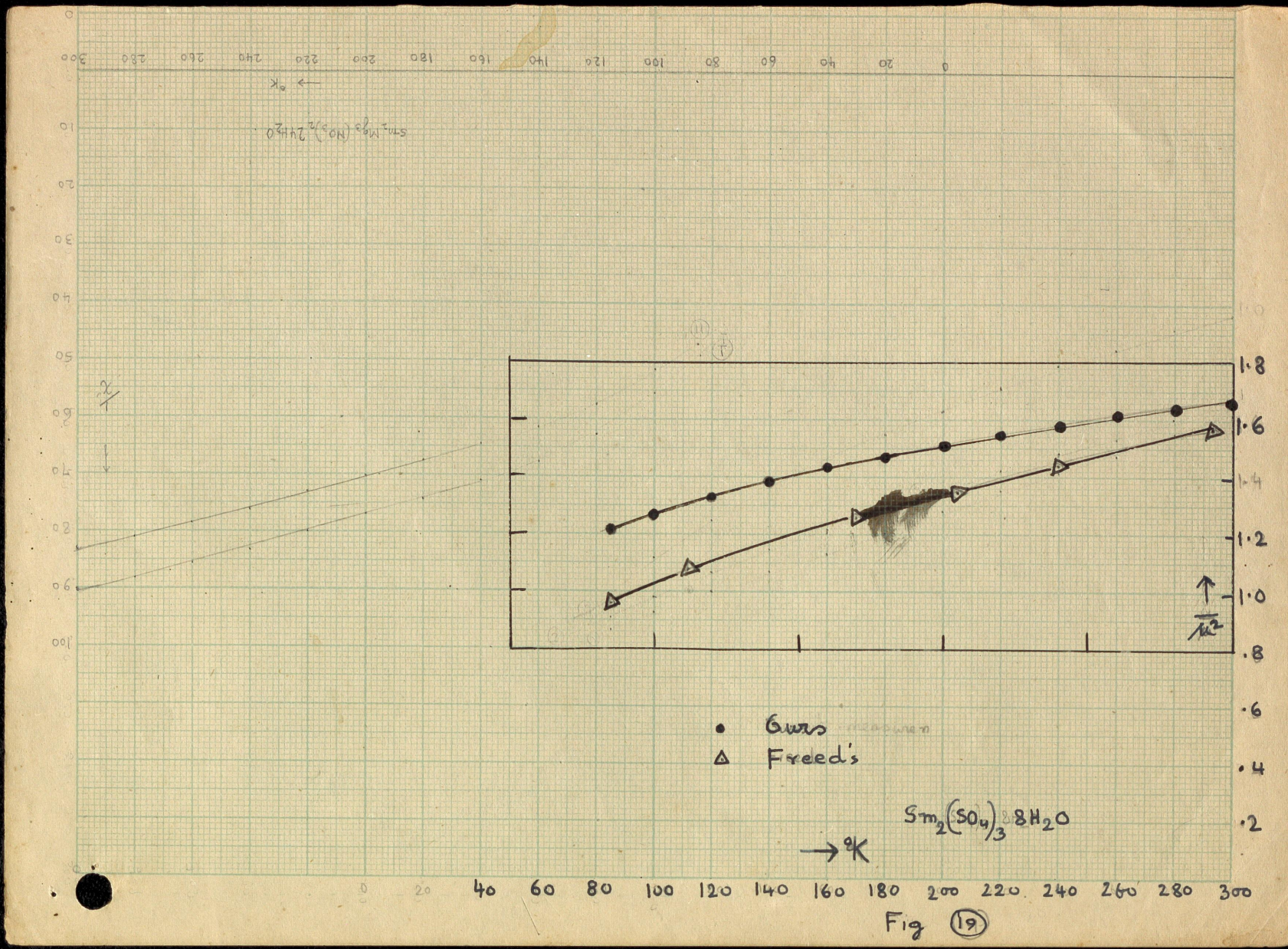

1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
$\frac{1}{\chi_M}$
$\frac{1}{\chi_M^2}$
• Ours
△ Freed's
$Sm_2(SO_4)_3 8H_2O$
→ °K
40 60 80 100 120 140 160 180 200 220 240 260 280 300

Fig (19)

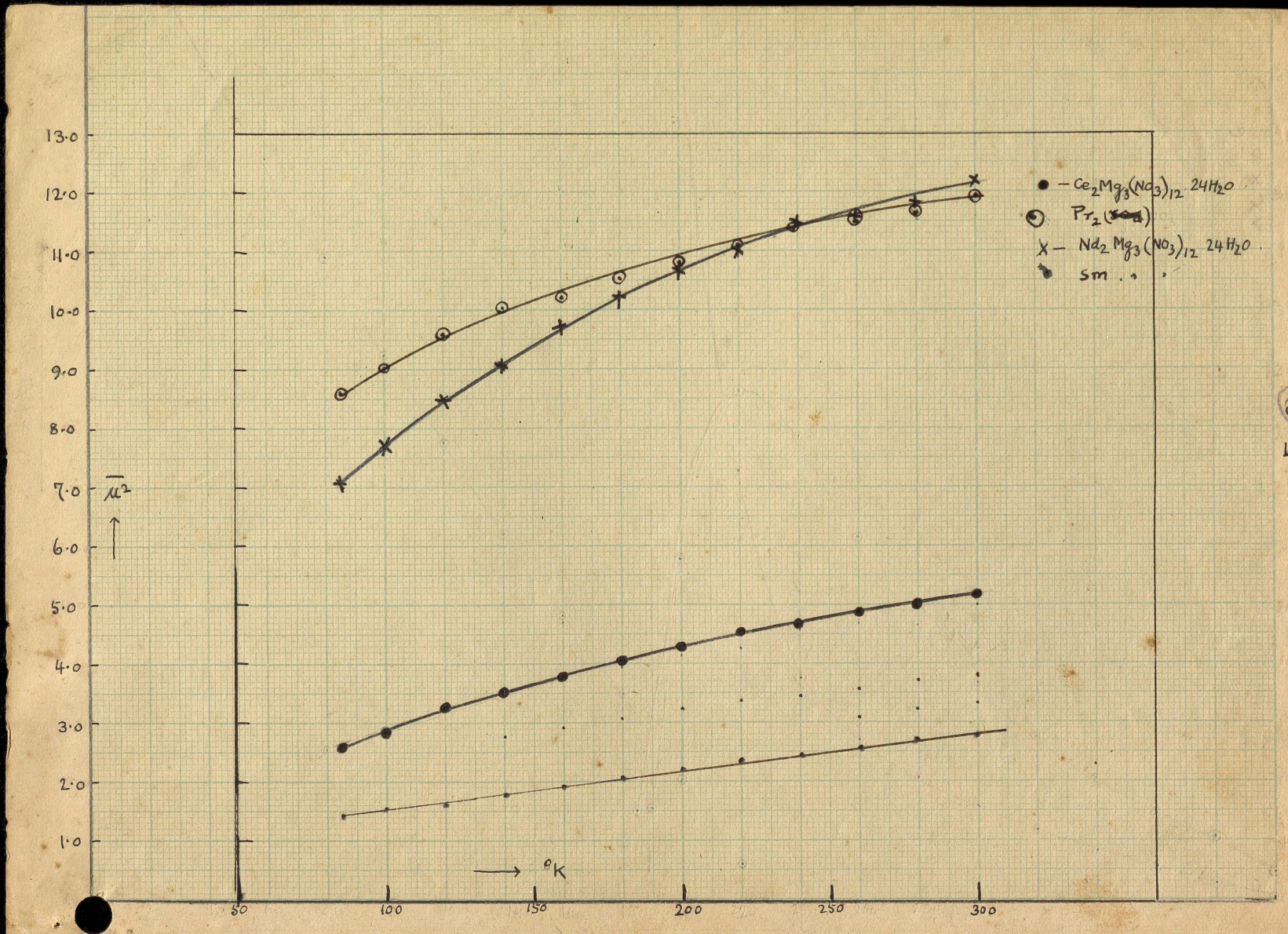

13·0
12·0
11·0
10·0
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
$\overline{\mu}^2$
50
100
150
200
250
300
°K
● – $Ce_2Mg_3(NO_3)_{12}\ 24H_2O$
⊙ Pr_2(
X – $Nd_2Mg_3(NO_3)_{12}\ 24H_2O$
Sm . . .

Fig 20

The observed paramagnetism of many of the salts of the Fe and the Rare Ear. Groups shows that the elem magnets in these ~~solids~~ crystals, namely the metallic ions, are capable of turning round + taking up preferred Orientations in the magc. field. If the elementary mags. were completely free, i.e. free from each other's influence + influence of their environments the per Gram mol would follow the Curie law. But in a crystal, unlike in a gas, this will not be the case: Results considerable deviation from Curie law.

Early days - powdered crystals — deviation attributed to ≠ inner field of the Weiss type mag. proportional to T. Exch int. betw magnetic particles of the same type as in Eqs. above (14).

$$\chi = C/T-\theta$$

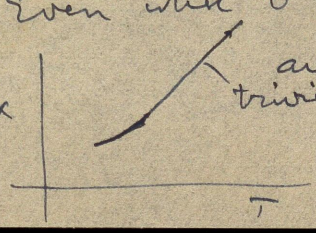
We now know that the observed deviations in crystals can not be attributed to such internal fields.

1) θ appreciable even for magnetically dilute ones. quite indep of dilution 1 atom in 30.
High dilution

2) θ both + + − ve

~~3) Even when $\theta = 0$ μ not correct~~

3) Even when θ log + + ve



$$\chi = \frac{C_1}{T} + \frac{C_2}{T^2} + \cdots$$

$$\frac{C_1}{T-\theta}$$

Large θ associated with large ΔX + Large L

We now know that the local fields which influence the magn. ions are wholly electric due to the ~~+~~ -ve charge atoms surrounding the ion. The theory of paramagn behav. under these fields has been worked out by Kramers, Bethe and in great detail by Van Vleck. The theory presents (many interesting ~~aspects~~ results, some of them quite uncanny) I may hasten to add the Extensive exp. data on single crystal support the theory:

Main features of the theory

Curie law

(2J+1) m states

Actually part of the degeneracy removed.
1) Deviation from Curie law: complicated
2) Local fields asymmetric: Anisotropy:
3) The important part which L plays.

~~+~~ Major divisions. J still a good quantum no. Each multiplet spin.

1) Feeble: Rare earths (2J+1) m. Each with (2J+1) degeneracy

2) Moderately strong ~~&~~ | L.S comp. | El — L
Russell Saunders. | = broken | ES → S. remains. From Salts

3) LS also broken. ~~&~~ complex salts. D. Ferri

C = / T − θ =

1. location of the axes
2. $\Delta\chi$'s describe method
3. χ

Cryostat.

$\chi_i = \frac{C}{T}\left(1 + \frac{\textcircled{H}_i}{T}\right)$ $\qquad \frac{\Delta\chi}{\chi} \sim \frac{\Delta\textcircled{H}}{T}$ $\qquad$ .1° or cm^{-1}

$\chi = \frac{C}{T}$ $\qquad$ Mn Salts Fe^{+++}

Gd $\frac{\Delta\chi}{\chi}$ was 1% Extremely sensitive to impurities

Trombe pre from Sm + Tb
Europium < 0.1 %
only impurity diamagnetic yttrium salt 1.4%.

$\chi_1 - \chi_2 = 36$
$\chi_3 - \chi_1 = 16$

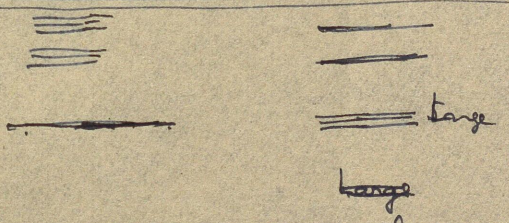
$\frac{\Delta\chi}{\chi} \sim .1\ \%$

$\Delta\textcircled{H} = .3°\ K$
$.2\ cm^{-1}$ overall splitting.

$\Delta\chi \propto \frac{1}{T^2}$ (Mn Gd.)

F state

D $\pm$ ve



Octahedral.
Cr^{+++}

1) Large deviation from Curie law
2) Large " spin value
3) Anisotropy

$NiSO_4 \cdot 6H_2O$ $-330\ cm^{-1}$ Spectr. -335

Fe -340

Ni Am. $-\begin{cases}315\\348\end{cases}$

K 370 / 360

Fluoberyllate BeF_4. 345 / 360.

Crystal field constants same for all of Ni salts

Absolute value. Cr^{+++} $+87\ cm$

Field const:

* mostly cubic but also rhombic

Variation: of ψ small.

Liquid state (solns)

Jahn: Teller

Cs_2CoCl_4 Cs_3CoCl_5 ‖ much closer to spin only value

from mag. meas. $-220\ cm^{-1}$

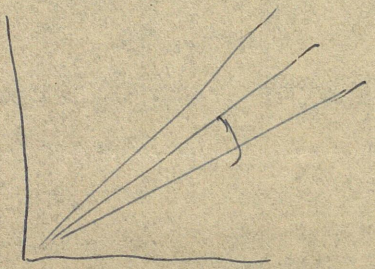
$-180\ cm^{-1}$

Curie law.

Cu

D state

Fe



2 different Curie constants

Co six coordinated ..

Fe.