Title: **HUMIDITY MEASURMENT**
Ref Number: **5**
Location: **NATIONAL COLLEGE LABORATORY**
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Team Size: **~4**
Environment: **INDOORS**

OBJECTIVE

To determine the reliability and accuracy of various instruments for determining the amount of water vapour in the atmosphere.

APPARATUS

1. Assmann psychrometer, standard equipment.
2. Mason hygrometer
3. Wet and dry Thermojunctions
4. Thermohygrograph
5. Sling psychrometer
6. De-point apparatus
7. Desk Fan
8. Galvanometer for use with (3) and (6).
9. Thermohygrometer

THEORY

1. Regnault's method of determining the relative humidity and dew-point from readings of dry and wet bulb thermometers involves the determination of the vapour pressure from an equation, such as:

$P_s = P_{ss} - A*b*(t-t^1)$

where P_s = vapour pressure under conditions of observation
P_{ss} = saturation vapour pressure at the temperature of the wet bulb
b = barometric pressure
t = dry bulb temperature
t^1 = wet bulb temperature
A = Psychrometric constant

The numerical value of A depends on the speed of air past the wet bulb, the value of the latent heat evaporation and the scale used for the measurement temperature.

This relationship forms the basis for the Psychrometric tables and charts from which moisture content, percentage saturation etc can be obtained.

2. Assmann showed that for accurate determination of humidity from dry bulb and wet bulb temperatures one had to maintain an air current over the wet bulb in excess of about 2m/s since the depression of the wet bulb does not vary at speeds of 2m/s to 30m/s. He

designed a psychrometer in which provision was made for drawing air over the wet and dry bulbs of the thermometers at a rate exceeding 2m/s and he also drew up suitable tables.

3. In the USA a "Sling psychrometer" is used as a standard instrument for determining the temperature and humidity of the air. The tables prepared by the Smithsonian Institution for use with these instruments agree very closely with those compiled by Assmann for the Assmann Psychrometer.

4. Such tables do not apply to determinations of humidity for readings of thermometers exposed in the open air in louvred screens of the Stevenson type. Hygrometric tables including those published by IHVE are available for such readings but they are not suitable for use with thermometers exposed indoors in factories or other buildings unless precautions are taken to ventilate the thermometers by fans or otherwise.

5. Some thoughts should be given to the correct choice of IHVE Guide table to be used for aspirated and non-aspirated wet bulb temperatures.

PROCEDURE

1. Check that all wet bulb reservoirs are filled with distilled water.
2. Measure the dry and wet bulb temperatures with the Assmann psychrometer after following carefully the instructions given in the operation of the instrument. Read the thermometers to the nearest 0.1 degree.
3. Measure the dry and wet bulb temperatures with instruments (2) and (3) under two conditions viz:
    a) in calm air
    b) Ventilated with the desk fan.
4. Measure the dry bulb temperature and the relative humidity with the thermohyrograph in calm air when ventilated with desk fan.
5. Measure the dry and wet bulb temperatures with sling psychrometer.
6. Measure the dewpoint with the apparatus supplied. Proceed as follows:-
    a) Fill rear chamber with ether to a level covering the thermojuction attached to the mirrior.
    b) Draw a sample of air into the front chamber and seal off.
    c) Evaporate the ether slowly and note the temperature at which dew begins to form on the mirror (t_1)
    d) Allow the temperature of the air to rise and note the temperature at which dew disappears (t_2)
    e) Take the mean of t_1 and t_2 as the true dewpoints.
    f) Compare with dew point determined from psychrometric tables using the headings from Assman. If error is large continue taking reading until reasonable agreement is obtained.

RESULTS

Interpolating from Section C1 of the IHVE Guide tabulated results under the following headings:

Dry bulb temperature, wet bulb temperature, percentage saturation, relative humidity, moisture content, dew-point; noting whether sling or screen wet bulb was used to obtain remaining values.

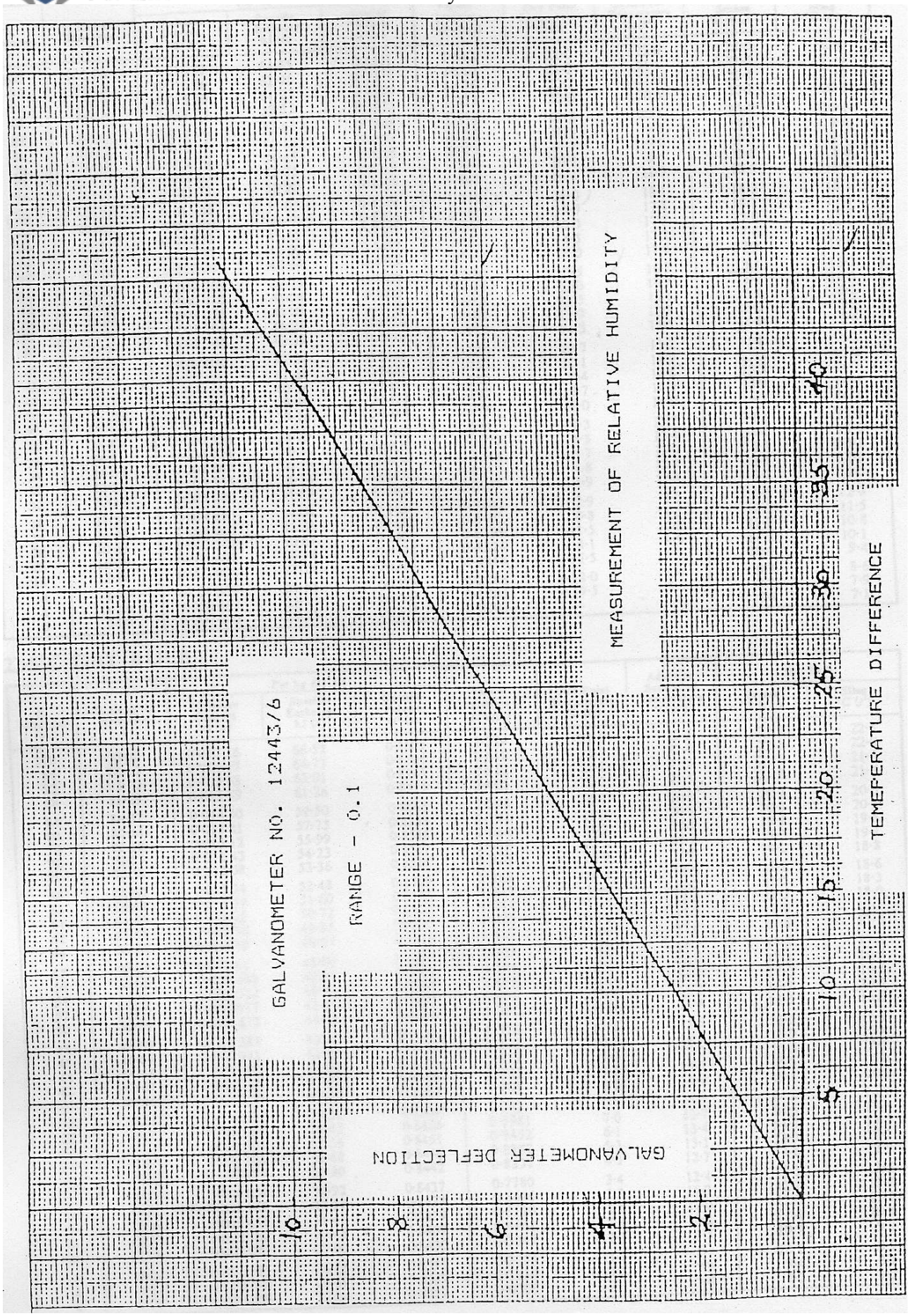
Instrument	*DB (^{O}C)*	*WB (^{O}C)*	*μ (%sat)*	*ϕ (%RH)*	*Moisture Content (kg/kg)*	*Dew-point (^{O}C)*

Note: All results must be in SI units

DISCUSSION

Referring to the theory discuss the results obtained with special reference to the reliability and accuracy of the measurements made taking the percentage sat., relative humidity, moisture content and dewpoint derived from the Assmann psychrometer readings.

Discuss the significance of the sling and screen wet bulb readings in relation to the accuracy of reading obtained from the tables.


MEASUREMENT OF RELATIVE HUMIDITY
TEMEPERATURE DIFFERENCE
GALVANOMETER NO. 12443/6
RANGE - 0.1
GALVANOMETER DEFLECTION
5
10
15
20
25
30
35
40
10
8
6
4
2

22^{0}C Dry Bulb

% Saturation μ	% Relative Humidity ϕ	Per kg dry air: Moisture Content kg (g)	Per kg dry air: Specific Enthalpy kJ (h)	Per kg dry air: Specific Volume m³ (v)	Vapour pressure kPa (p_s)	Dew Point Temperature °C (t_d)	Adiabatic Saturation Temperature °C (t^*)	Wet Bulb: Screen °C (t'_w)	Wet Bulb: Sling °C (t')
100	100·00	0·016 73	64·65	0·8581	2·643	22·0	22·0	22·0	22·0
96	96·10	0·016 06	62·95	0·8572	2·540	21·3	21·5	21·6	21·5
92	92·19	0·015 39	61·25	0·8564	2·436	20·7	21·1	21·1	21·1
88	88·28	0·014 72	59·55	0·8555	2·333	20·0	20·6	20·7	20·6
84	84·36	0·014 06	57·85	0·8546	2·229	19·2	20·1	20·2	20·1
80	80·42	0·013 39	56·15	0·8537	2·125	18·5	19·6	19·8	19·6
76	76·48	0·012 72	54·45	0·8528	2·021	17·7	19·1	19·3	19·1
72	72·53	0·012 05	52·75	0·8519	1·917	16·8	18·6	18·8	18·6
70	70·56	0·011 71	51·90	0·8515	1·865	16·4	18·3	18·6	18·4
68	68·58	0·011 38	51·05	0·8510	1·812	16·0	18·1	18·3	18·1
66	66·60	0·011 04	50·20	0·8506	1·760	15·5	17·8	18·1	17·8
64	64·61	0·010 71	49·35	0·8501	1·707	15·0	17·5	17·9	17·6
62	62·63	0·010 37	48·50	0·8497	1·655	14·5	17·2	17·6	17·3
60	60·64	0·010 04	47·64	0·8492	1·602	14·0	17·0	17·3	17·0
58	58·65	0·009 705	46·79	0·8488	1·550	13·5	16·7	17·1	16·7
56	56·66	0·009 370	45·94	0·8483	1·497	13·0	16·4	16·8	16·5
54	54·66	0·009 036	45·09	0·8479	1·445	12·5	16·1	16·6	16·2
52	52·67	0·008 701	44·24	0·8474	1·392	11·9	15·8	16·3	15·9
50	50·67	0·008 366	43·39	0·8470	1·339	11·3	15·5	16·0	15·6
48	48·67	0·008 032	42·54	0·8465	1·286	10·7	15·2	15·8	15·3
46	46·66	0·007 697	41·69	0·8461	1·233	10·1	14·9	15·5	15·0
44	44·66	0·007 362	40·84	0·8457	1·180	9·4	14·6	15·2	14·7
42	42·65	0·007 028	39·99	0·8452	1·127	8·7	14·3	14·9	14·4
40	40·64	0·006 693	39·14	0·8448	1·074	8·0	14·0	14·7	14·1
38	38·63	0·006 358	38·29	0·8443	1·021	7·3	13·7	14·4	13·8
36	36·62	0·006 024	37·44	0·8439	0·9677	6·5	13·4	14·1	13·5
34	34·60	0·005 689	36·59	0·8434	0·9144	5·7	13·0	13·8	13·2
32	32·58	0·005 354	35·74	0·8430	0·8611	4·8	12·7	13·5	12·8
30	30·56	0·005 020	34·89	0·8425	0·8077	3·9	12·4	13·2	12·5
28	28·54	0·004 685	34·04	0·8421	0·7542	2·9	12·0	12·9	12·2
24	24·49	0·004 016	32·34	0·8412	0·6472	0·8	11·3	12·3	11·5
20	20·43	0·003 346	30·64	0·8403	0·5399	−1·5	10·6	11·7	10·8
16	16·36	0·002 677	28·94	0·8394	0·4324	−4·1	9·9	11·1	10·1
12	12·28	0·002 008	27·24	0·8385	0·3246	−7·5	9·2	10·4	9·4
8	8·20	0·001 339	25·53	0·8376	0·2166	−12·0	8·4	9·8	8·6
4	4·10	0·000 669	23·83	0·8367	0·1084	−19·5	7·6	9·1	7·9
0	0·00	0·000 000	22·13	0·8358	0·0000	—	6·8	8·4	7·1

22·5°C DRY BULB

% Saturation μ	% Relative Humidity ϕ	Per kg dry air: Moisture Content kg (g)	Per kg dry air: Specific Enthalpy kJ (h)	Per kg dry air: Specific Volume m³ (v)	Vapour pressure kPa (p_s)	Dew Point Temperature °C (t_d)	Adiabatic Saturation Temperature °C (t^*)	Wet Bulb: Screen °C (t'_w)	Wet Bulb: Sling °C (t')
100	100·00	0·017 26	66·52	0·8603	2·724	22·5	22·5	22·5	22·5
96	96·10	0·016 57	64·77	0·8594	2·618	21·8	22·0	22·1	22·0
92	92·20	0·015 88	63·01	0·8585	2·512	21·2	21·6	21·6	21·6
88	88·29	0·015 19	61·26	0·8575	2·405	20·5	21·1	21·2	21·1
84	84·37	0·014 50	59·50	0·8566	2·298	19·7	20·6	20·7	20·6
80	80·44	0·013 81	57·75	0·8557	2·191	19·0	20·1	20·3	20·1
76	76·50	0·013 12	55·99	0·8548	2·084	18·2	19·6	19·8	19·6
72	72·55	0·012 43	54·23	0·8539	1·976	17·3	19·0	19·3	19·1
70	70·58	0·012 08	53·36	0·8534	1·923	16·9	18·8	19·0	18·8
68	68·60	0·011 74	52·48	0·8529	1·869	16·4	18·5	18·8	18·6
66	66·62	0·011 39	51·60	0·8525	1·815	16·0	18·2	18·5	18·3
64	64·63	0·011 05	50·72	0·8520	1·761	15·5	18·0	18·3	18·0
62	62·65	0·010 70	49·85	0·8516	1·707	15·0	17·7	18·0	17·7
60	60·66	0·010 36	48·97	0·8511	1·653	14·5	17·4	17·8	17·5
58	58·67	0·010 01	48·09	0·8506	1·598	14·0	17·1	17·5	17·2
56	56·68	0·009 668	47·21	0·8502	1·544	13·5	16·8	17·3	16·9
54	54·68	0·009 322	46·33	0·8497	1·490	12·9	16·5	17·0	16·6
52	52·69	0·008 977	45·46	0·8492	1·435	12·4	16·2	16·7	16·3
50	50·69	0·008 632	44·58	0·8488	1·381	11·8	15·9	16·5	16·0
48	48·69	0·008 287	43·70	0·8483	1·326	11·2	15·6	16·2	15·7
46	46·69	0·007 941	42·82	0·8479	1·272	10·5	15·3	15·9	15·4
44	44·68	0·007 596	41·95	0·8474	1·217	9·9	15·0	15·6	15·1
42	42·67	0·007 251	41·07	0·8469	1·163	9·2	14·7	15·3	14·8
40	40·66	0·006 906	40·19	0·8465	1·108	8·5	14·4	15·1	14·5
38	38·65	0·006 560	39·31	0·8460	1·053	7·7	14·1	14·8	14·2
36	36·64	0·006 215	38·43	0·8456	0·9981	7·0	13·7	14·5	13·8
34	34·62	0·005 870	37·56	0·8451	0·9432	6·1	13·4	14·2	13·5
32	32·60	0·005 524	36·68	0·8446	0·8882	5·3	13·1	13·9	13·2
30	30·58	0·005 179	35·80	0·8442	0·8331	4·3	12·7	13·6	12·9
28	28·56	0·004 834	34·92	0·8437	0·7780	3·4	12·4	13·3	12·5
24	24·51	0·004 143	33·17	0·8428	0·6676	1·2	11·7	12·7	11·8
20	20·44	0·003 453	31·41	0·8419	0·5570	−1·1	11·0	12·0	11·1
16	16·37	0·002 762	29·66	0·8409	0·4461	−3·8	10·2	11·4	10·4
12	12·29	0·002 072	27·90	0·8400	0·3349	−7·1	9·5	10·7	9·7
8	8·20	0·001 381	26·15	0·8391	0·2235	−11·7	8·7	10·1	8·9
4	4·11	0·000 690	24·39	0·8382	0·1119	−19·2	7·9	9·4	8·1
0	0·00	0·000 000	22·64	0·8372	0·0000	—	7·0	8·7	7·3