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Dew point of a Gas/ Gas mixture

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What is a dew point of a Gas/ Gas Mixture ?

Definition

' Gas Saturation'

This is a point at which the enclosed Gas the evaporation is equal to total moisture content in gas at constant pressure

"Dew Point" is defined as the temperature to which a given volume of air must be cooled at constant pressure and constant water vapour content in order for saturation to occur. If the air is cooled further, some of the moisture will condense.

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Relationship between Dew Point and Moisture Content
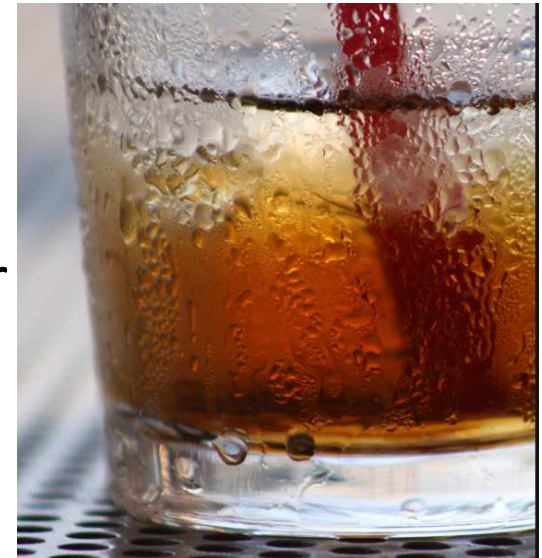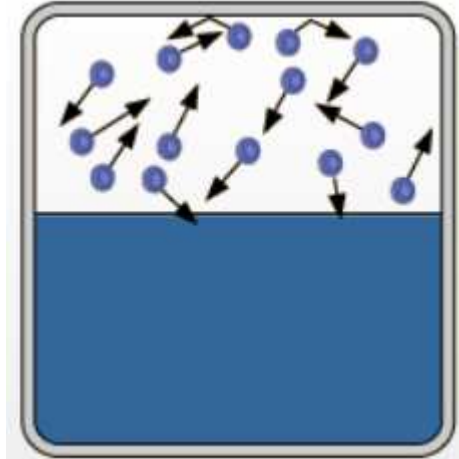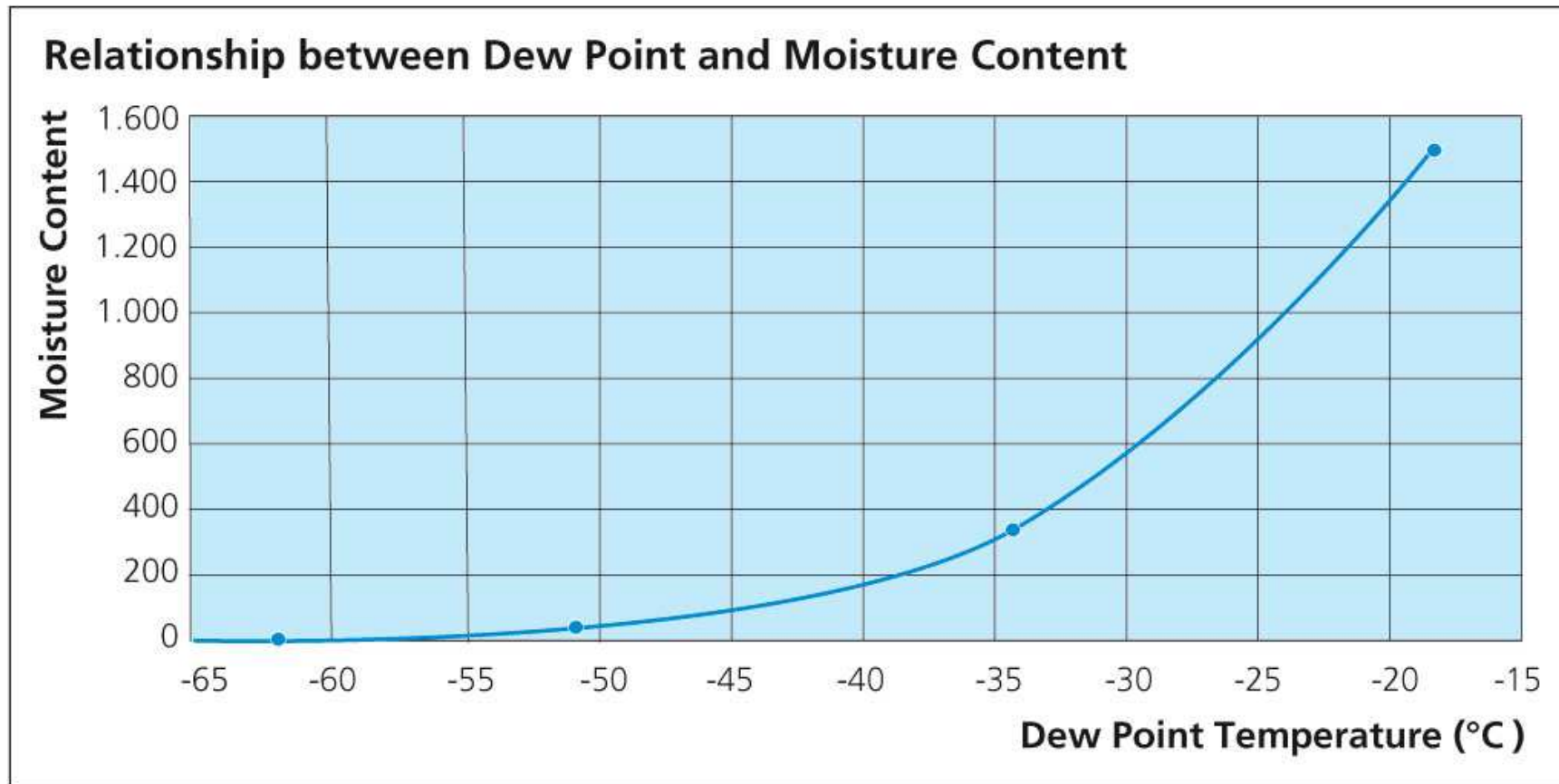
Moisture content is directly α to Dew point temperature of a Gas/ Gas mixture

Composition of various gas Atmosperes

Gas constituent	Percentage (based on natural gas)	Percentage (based on propane)
N_2	40.9%	40.9%
CO	19.6%	23.3%
CO_2	0.4%	0.1%
H_2	38.9%	35.5%
CH_4	0.2%	0.2%
Dew point	+20/+50°F **+7.5to +11.25degC**	-10/-15°F **-26.25 to-29degC**
(Air/gas) ratio	2.6:1	7.8:1

Table 1. Typical compositional ranges for endothermic gas

Composition of Exothermic Gas

Table 1. Atmosphere composition from methane combustion and exogas generation	$\%H_2$	$\%H_2O$	$\%CO_2$	$\%CO$	$\%N_2$	Dew pt, °C
Hot burner gas (1120°C)	14.1	13.3	4.2	9.5	58.8	52
Exogas (1050°C)	13.6	4.6	2.4	13.0	66.4	20

PSA Nitrogen generation
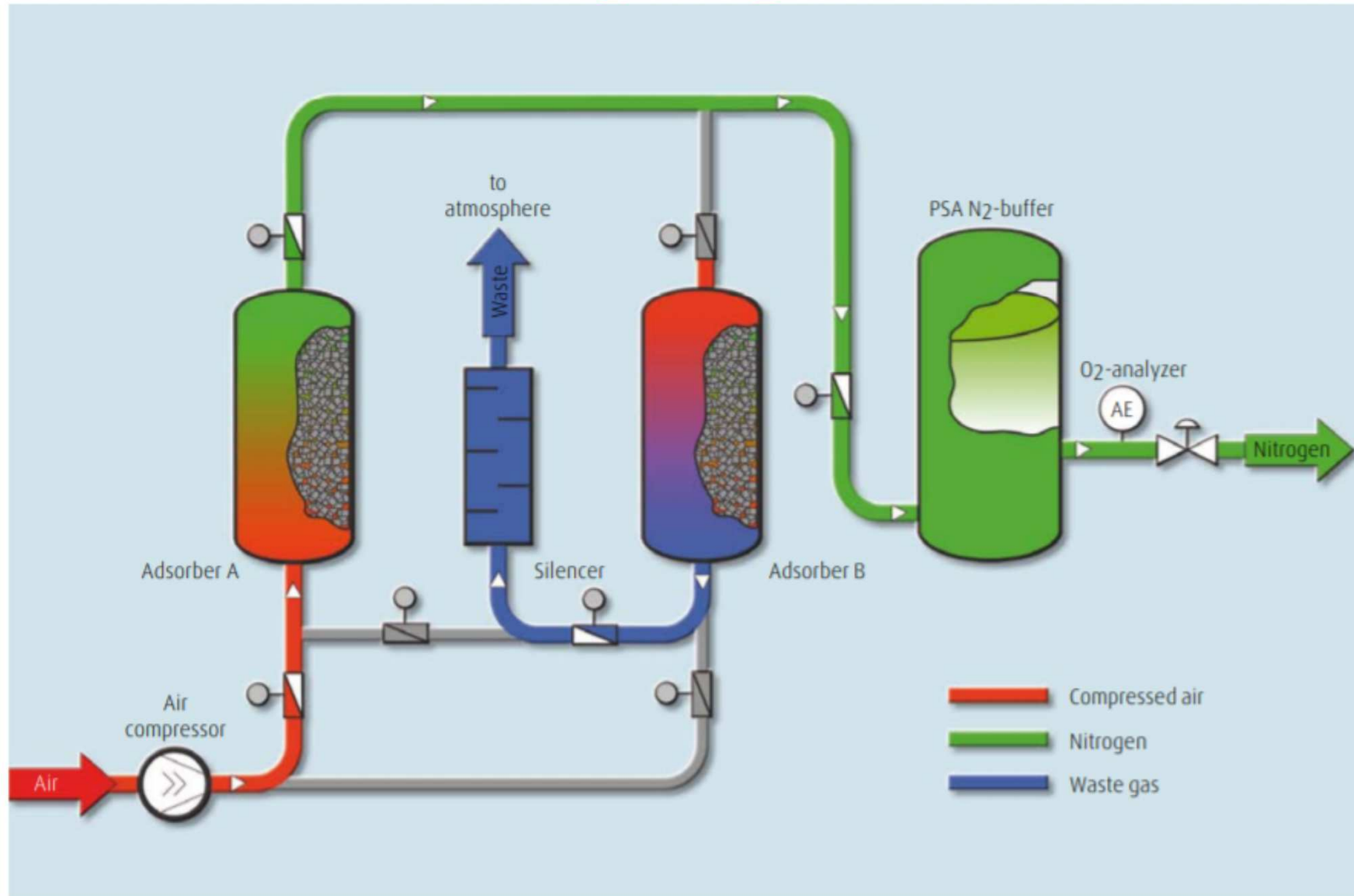
Typical specification of PSA Nitrogen Gas

a) Purity of the gas: 99.999 %

b) Typical impurity levels: Oxygen < 2ppm

H_2O <2ppm

$CO+CO_2$: < 0.5 ppm

Total Hydrocarbons: < 0.5 ppm

c) Typical Nitrogen gas pressure of 140 Kg/cm^2 (approx.)

d. Dew point : - 40 ^{0} C @ 6-7 bar pressure

Gas Automisation

IS : 1747 - 1972

3. REQUIREMENTS

3.1 The gas, when tested according to the methods prescribed in Appendix A, shall conform to the requirements given in Table 1. Reference to the relevant clauses of Appendix A is given in col 5 of the table.

TABLE 1 REQUIREMENTS FOR NITROGEN

SL No.	CHARACTERISTIC	REQUIREMENT		METHOD OF TEST (REF TO CL No. Of APPENDIX A)
		Pure Grade	Terh Grade	
(1)	(2)	(3)	(4)	(5)
i)	Oxygen, percent by volume, *Max*	0.001	0.5	A-1 and A-2
ii)	Hydrogen, parts per million, *Max*	5	—	A-3
iii)	Carbon dioxide, parts per million, *Max*	5	—	A-4
iv)	Other carbon compounds, determined as CO_2, parts per million, *Max*	5	—	A-5
v)	Carbon monoxide, parts per million, *Max*	Nil	—	A-6
vi)	Moisture, g/m^3, at 21 kg/cm^2, *Max*	0.01	—	A-7

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Influence on Gas Carburizing atmosphere

Atmosphere used presently : Nitrogen and Acetone

DECARBURIZING ELEMENTS IN ATMOSPHERE

Water / moisture content (H_2O) and (CO_2) Carbon dioxide

CARBURIZING ELEMENTS
Carbon Monoxide (CO) and Methane (CH_4)

Nitrogen is Neutral Reactive Gas but the moisture content in the gas effects the carburizing reaction

Acetone (C_3H_6O) which cracks to form
1. Methane (CH_4)
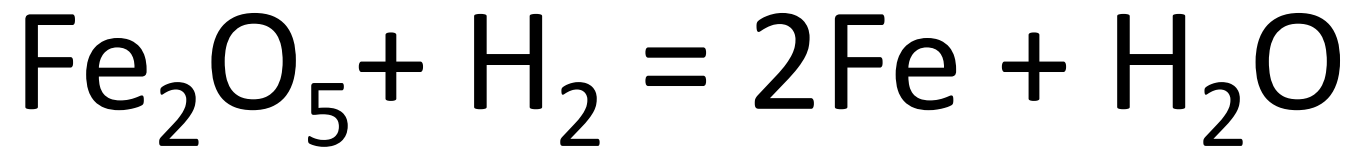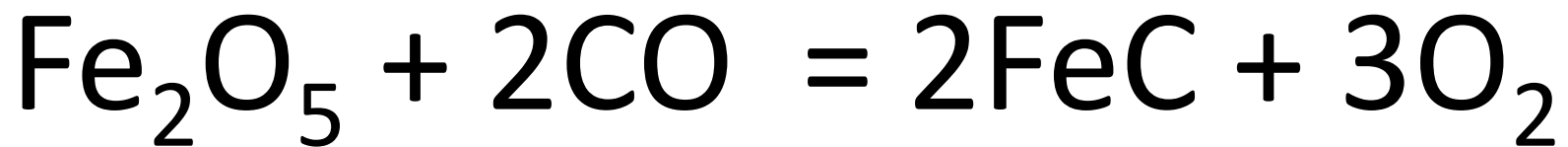2. Carbon Monoxide (CO)
3. moisture content (H_2O)

Carburizing Reactions

- GASEOUS REACTIONS

$$2CO + O_2 = 2CO_2$$

$$CO_2 + 2H_2 = CO + 2H_2O$$

- GAS TO METAL REACTONS

$$Fe_2O_5 + 2CO = 2FeC + 3O_2$$

$$Fe_2O_5 + H_2 = 2Fe + H_2O$$

Carbon vs Dew point

CARBON vs DEW POINT WITH DEGREES C

%CO= 20.0   %H2= 40.0   Af= 1.00

TEMP C→	760	775	790	805	820	835	850	865	880	895	910	925	940	955	970	985	1000	1015	1030	1045	1060
% C ↓	NOTE: DEW POINT IS IN DEGREES CELSIUS																				
0.05	67	64	61	58	55	53	50	48	46	44	41	39	38	36	34	32	31	29	27	26	24
0.10	52	49	47	44	42	39	37	35	33	31	29	27	25	24	22	21	19	17	16	15	13
0.15	44	42	39	37	34	32	30	28	26	24	22	20	19	17	16	14	13	11	10	8	7
0.20	39	36	34	31	29	27	25	23	21	19	17	16	14	12	11	9	8	7	5	4	3
0.25	35	32	30	27	25	23	21	19	17	16	14	12	11	9	7	6	5	3	2	1	0
0.30	31	29	26	24	22	20	18	16	14	13	11	9	8	6	5	3	2	1	-1	-2	-3
0.35	28	26	24	21	19	17	15	14	12	10	8	7	5	4	2	1	0	-2	-3	-4	-5
0.40	26	23	21	19	17	15	13	11	10	8	6	5	3	2	0	-1	-2	-4	-5	-6	-7
0.45	24	21	19	17	15	13	11	9	8	6	4	3	1	0	-2	-3	-4	-6	-7	-8	-9
0.50	22	19	17	15	13	11	9	8	6	4	3	1	0	-2	-3	-5	-6	-7	-8	-9	-11
0.55	20	18	16	13	11	10	8	6	4	3	1	0	-2	-3	-5	-6	-7	-9	-10	-11	-12
0.60	18	16	14	12	10	8	6	4	3	1	0	-2	-3	-5	-6	-7	-9	-10	-11	-12	-13
0.65	17	15	13	10	9	7	5	3	1	0	-2	-3	-5	-6	-7	-9	-10	-11	-12	-13	-14
0.70	15	13	11	9	7	5	4	2	0	-1	-3	-4	-6	-7	-8	-10	-11	-12	-13	-14	-16
0.75	14	12	10	8	6	4	2	1	-1	-3	-4	-5	-7	-8	-10	-11	-12	-13	-14	-16	-17
0.80	13	11	9	7	5	3	1	0	-2	-4	-5	-7	-8	-9	-11	-12	-13	-14	-15	-17	-18
0.85	12	10	8	6	4	2	0	-1	-3	-5	-6	-8	-9	-10	-12	-13	-14	-15	-16	-17	-19
0.90	11	9	6	5	3	1	-1	-2	-4	-6	-7	-9	-10	-11	-13	-14	-15	-16	-17	-18	-19
0.95	10	7	5	4	2	0	-2	-3	-5	-7	-8	-9	-11	-12	-13	-15	-16	-17	-18	-19	-20
1.00	9	6	4	3	1	-1	-3	-4	-6	-7	-9	-10	-12	-13	-14	-15	-17	-18	-19	-20	-21
1.05	8	6	4	2	0	-2	-4	-5	-7	-8	-10	-11	-13	-14	-15	-16	-17	-19	-20	-21	-22
1.10	7	5	3	1	-1	-3	-5	-6	-8	-9	-11	-12	-13	-15	-16	-17	-18	-19	-21	-22	-23
1.15	6	4	2	0	-2	-4	-5	-7	-8	-10	-11	-13	-14	-15	-17	-18	-19	-20	-21	-22	-23
1.20	5	3	1	-1	-3	-5	-6	-8	-9	-11	-12	-14	-15	-16	-17	-19	-20	-21	-22	-23	-24
1.25	4	2	0	-2	-4	-5	-7	-9	-10	-12	-13	-14	-16	-17	-18	-19	-20	-22	-23	-24	-25
1.30	3	1	-1	-3	-4	-6	-8	-9	-11	-12	-14	-15	-16	-18	-19	-20	-21	-22	-23	-24	-25
1.35	2	0	-2	-3	-5	-7	-8	-10	-12	-13	-14	-16	-17	-18	-20	-21	-22	-23	-24	-25	-26
1.40	2	0	-2	-4	-6	-8	-9	-11	-12	-14	-15	-16	-18	-19	-20	-21	-23	-24	-25	-26	-27
1.45	1	-1	-3	-5	-7	-8	-10	-11	-13	-14	-16	-17	-18	-20	-21	-22	-23	-24	-25	-26	-27
1.50	0	-2	-4	-6	-7	-9	-11	-12	-14	-15	-16	-18	-19	-20	-22	-23	-24	-25	-26	-27	-28

Dew point vs millivolts

DEW POINT VS. MILLIVOLTS @ TEMPERATURE   @ % H2=   40.0

TEMP F / DEW PT	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000
0	1196	1194	1192	1190	1188	1186	1184	1182	1180	1178	1176	1173	1171	1169	1167
2	1192	1190	1188	1186	1183	1181	1179	1177	1175	1173	1171	1168	1166	1164	1162
4	1188	1186	1184	1181	1179	1177	1175	1172	1170	1168	1166	1163	1161	1159	1157
6	1184	1182	1180	1177	1175	1173	1170	1168	1165	1163	1161	1158	1156	1154	1151
8	1181	1178	1176	1173	1171	1168	1166	1163	1161	1158	1156	1153	1151	1148	1146
10	1177	1174	1172	1169	1167	1164	1161	1159	1156	1154	1151	1149	1146	1143	1141
12	1173	1171	1168	1165	1162	1160	1157	1154	1152	1149	1146	1144	1141	1138	1136
14	1170	1167	1164	1161	1158	1156	1153	1150	1147	1144	1142	1139	1136	1133	1130
16	1166	1163	1160	1157	1154	1151	1149	1146	1143	1140	1137	1134	1131	1128	1125
18	1162	1159	1156	1153	1150	1147	1144	1141	1138	1135	1132	1129	1126	1123	1120
20	1159	1156	1152	1149	1146	1143	1140	1137	1134	1131	1128	1125	1122	1118	1115
22	1155	1152	1149	1146	1142	1139	1136	1133	1130	1126	1123	1120	1117	1114	1110
24	1152	1148	1145	1142	1138	1135	1132	1129	1125	1122	1119	1115	1112	1109	1105
26	1148	1145	1141	1138	1135	1131	1128	1124	1121	1118	1114	1111	1107	1104	1101
28	1145	1141	1138	1134	1131	1127	1124	1120	1117	1113	1110	1106	1103	1099	1096
30	1141	1138	1134	1130	1127	1123	1120	1116	1112	1109	1105	1102	1098	1094	1091
32	1138	1134	1130	1127	1123	1119	1116	1112	1108	1105	1101	1097	1093	1090	1086
34	1134	1131	1127	1123	1119	1115	1112	1108	1104	1100	1097	1093	1089	1085	1081
36	1131	1127	1123	1119	1116	1112	1108	1104	1100	1096	1092	1088	1084	1081	1077
38	1128	1124	1120	1116	1112	1108	1104	1100	1096	1092	1088	1084	1080	1076	1072
40	1124	1120	1116	1112	1108	1104	1100	1096	1092	1088	1084	1080	1076	1071	1067
42	1121	1117	1113	1109	1104	1100	1096	1092	1088	1084	1079	1075	1071	1067	1063
44	1118	1114	1109	1105	1101	1097	1092	1088	1084	1080	1075	1071	1067	1063	1058
46	1115	1110	1106	1102	1097	1093	1089	1084	1080	1076	1071	1067	1062	1058	1054
48	1111	1107	1103	1098	1094	1089	1085	1080	1076	1072	1067	1063	1058	1054	1049
50	1108	1104	1099	1095	1090	1086	1081	1077	1072	1068	1063	1058	1054	1049	1045
52	1105	1101	1096	1091	1087	1082	1077	1073	1068	1064	1059	1054	1050	1045	1040
54	1102	1097	1093	1088	1083	1078	1074	1069	1064	1060	1055	1050	1046	1041	1036
56	1099	1094	1089	1085	1080	1075	1070	1065	1061	1056	1051	1046	1041	1037	1032
58	1096	1091	1086	1081	1076	1071	1067	1062	1057	1052	1047	1042	1037	1032	1027
60	1093	1088	1083	1078	1073	1068	1063	1058	1053	1048	1043	1038	1033	1028	1023

Thank you for your patience

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