Similar equations with other numerical constants apply to other types of glass or glass areas in other arrangements. (Heat-absorbing glass or glass in multiple layers, for example).

Equation 12 may be clarified further by explanations of the numerical constants involved:

1.04 = Over-all unit conductance for heat transfer under *summer* conditions, Btu per (hour) (square foot) (Fahrenheit degree). (Note that this is the transmittance U taken at 1.13 for winter conditions in Chapter 6.)

0.022 = Fraction of I_d which is absorbed and then transferred to the indoor space from the indoor glass surface, dimensionless. (Note that, of the total absorption, part goes inside and part goes outside.)

0.0165 = Fraction of I_s which is absorbed and then transferred to the indoor space from the indoor glass surface, dimensionless.

0.778 = transmissivity of the glass for sky radiation, dimensionless.

Magnitudes of the quantities I_d, I_s and t_o entering into Equation 12 would depend upon the time of the day, time of the year, atmospheric conditions, latitude of the receiving surface, and the orientation of the receiving surface. Principles and data needed for the calculation of I_d and I_s have been given previously in this chapter. Weather data, such as the sol-air temperatures in Tables 10 and 11, give data on t_o throughout a design day.

Table 15 has been prepared to expedite practical calculations of the heat gain through glass areas; tabulated values are magnitudes of the sum ($0.022\ I_d + 0.0165\ I_s + \tau_d I_d + 0.778\ I_s$) from Equation 12 for a solar declination of 18 deg. This declination corresponds to a nominal August 1 design day, although the values tabulated may be used with safety to represent average conditions from July 15th to August 15th.

It is possible to use the heat-gain data of Table 15 for other single-thickness glass materials than common window glass through the introduction of approximate correcting factors. Table 16 gives such factors. The range of transmissivities in Table 16 extends from high-transmission crystal-like glass to low-transmission heat-absorbing glass. The transmissivity of 0.87 is that of common window glass.

By using two or more layers of glass separated by air spaces, the absorptivity is increased and the transmissivity decreased. Values for some combinations appear in the literature [11]. A rough approximation which holds fairly well until the angle of incident radiation becomes large is that the transmissivity of the combination is the product of the transmissivities of the component layers, while the absorptivity of the combination is the absorptivity of the outer glass plus the product of the absorptivity of the inner glass and the transmissivity of the outer.

Heat-gain quantities from Table 15 may also be used for other times of the year than August 1 if a correction is made for solar declination. Solar heating calculation for glass areas can also be based upon these data. Table 17 gives solar declinations for various times of the year. The rule for procedure is the following:

To find the radiation heat gain for some declination of the sun other than 18 deg use the latitude in Table 15 equal to that of the locality in question plus (18 deg—solar declination involved).

For example, consider that the instantaneous heat gain is required for Philadelphia in the middle of June. The latitude of Philadelphia is 40 deg North. The solar declination in mid-June is about 23.5 deg. The section of Table 15 to be used is then that for a latitude of 40 + (18 − 23.5) = 34.5 deg; say 35 deg.

Caution: This method gives only approximate values and its use should be limited. It may be used for Eastern and Western exposures for all hours 8:00 a.m. to 4:00 p.m.

TABLE 15. INSTANTANEOUS RATES OF HEAT GAIN DUE TO SOLAR AND SKY RADIATION FOR SINGLE SHEETS OF UNSHADED COMMON WINDOW GLASS [a, b]

Computed for Solar Declination of 18 Deg—August 1

Note: *To determine the total instantaneous rate of heat gain add the term 1.04 (t_o-t_i) to the values shown in the table (see Equation 12).*

Sun Time	Solar Altitude β Deg	Instantaneous Rate of Heat Gain, Btu per Hour for Each Square Foot of Unshaded Glass								
		N	NE	E	SE	S	SW	W	NW	Horizontal
					25 Deg North Latitude					
6 a.m.	7.5	19	77	84	40	3	3	3	3	12
7	20.5	26	146	173	98	10	10	10	10	68
8	34.0	18	148	193	121	13	13	13	13	143
9	47.5	15	118	172	120	16	15	15	15	205
10	61.5	16	67	124	95	22	16	16	16	252
11	74.5	16	25	57	57	25	16	16	16	282
12	83.0	16	16	16	25	28	25	16	16	293
1 p.m.	74.5	16	16	16	16	25	57	57	25	282
2	61.5	16	16	16	16	22	95	124	67	252
3	47.5	15	15	15	15	16	120	172	118	205
4	34.0	18	13	13	13	13	121	193	148	143
5	20.5	26	10	10	10	10	98	173	146	68
6	7.5	19	3	3	3	3	40	84	77	12
					30 Deg North Latitude					
6 a.m.	9.0	22	88	97	47	4	4	4	4	15
7	21.5	23	146	176	105	11	11	11	11	74
8	34.5	16	140	194	130	14	14	14	14	144
9	47.5	15	104	171	133	20	15	15	15	205
10	60.0	16	53	126	112	33	16	16	16	248
11	72.0	16	19	56	74	42	16	16	16	277
12	78.0	16	16	16	34	45	34	16	16	288
1 p.m.	72.0	16	16	16	16	42	74	56	19	277
2	60.0	16	16	16	16	33	112	126	53	248
3	47.5	15	15	15	15	20	133	171	104	205
4	34.5	16	14	14	14	14	130	194	140	144
5	21.5	23	11	11	11	11	105	176	146	74
6	9.0	22	4	4	4	4	47	97	88	15
					35 Deg North Latitude					
6 a.m.	10.0	21	97	109	53	4	4	4	4	19
7	22.5	19	143	179	110	11	11	11	11	79
8	34.5	14	133	194	140	15	14	14	14	144
9	46.5	15	90	170	144	28	15	15	15	200
10	58.5	16	38	126	128	47	16	16	16	243
11	68.5	16	16	56	91	62	17	16	16	269
12	73.0	16	16	16	45	68	45	16	16	279
1 p.m.	68.5	16	16	16	17	62	91	56	16	269
2	58.5	16	16	16	16	47	128	126	38	243
3	46.5	15	15	15	15	28	144	170	90	200
4	34.5	14	14	14	14	15	140	194	133	144
5	22.5	19	11	11	11	11	110	179	143	79
6	10.0	21	4	4	4	4	53	109	97	19
					40 Deg North Latitude					
5 a.m.	1.5	7	18	17	6	1	1	1	1	2
6	11.5	23	106	120	62	5	5	5	5	24
7	23.0	15	141	181	118	11	11	11	11	82
8	34.5	14	122	194	147	19	14	14	14	145
9	45.5	15	76	172	156	42	15	15	15	196
10	56.0	16	30	125	144	66	16	16	16	235
11	64.5	16	16	53	110	85	22	16	16	261
12	68.0	16	16	16	62	94	62	16	16	269
1 p.m.	64.5	16	16	16	22	85	110	52	16	261
2	56.0	16	16	16	16	66	144	125	30	235
3	45.5	15	15	15	15	42	156	172	76	196
4	34.5	14	14	14	14	19	147	194	122	145
5	23.0	15	11	11	11	11	118	181	141	82
6	11.5	23	5	5	5	5	62	120	106	24
7	1.5	7	1	1	1	1	6	17	18	2