

## Answer to Some Selected Problems

### UNIT 1

- 1.17  $\sim 15 \times 10^{-4} \text{ g}$ ,  $1.25 \times 10^{-4} \text{ m}$
- 1.18 (i)  $4.8 \times 10^{-3}$  (ii)  $2.34 \times 10^5$  (iii)  $8.008 \times 10^3$  (iv)  $5.000 \times 10^2$   
(v) 6.0012
- 1.19 (i) 2 (ii) 3 (iii) 4 (iv) 3  
(v) 4 (vi) 5
- 1.20 (i) 34.2 (ii) 10.4 (iii) 0.0460 (iv) 2810
- 1.21 (a) law of multiple proportion (b) (i) Ans : ( $10^6 \text{ mm}$ ,  $10^{15} \text{ pm}$ )  
(ii) Ans : ( $10^{-6} \text{ kg}$ ,  $10^6 \text{ ng}$ )  
(iii) Ans : ( $10^{-3} \text{ L}$ ,  $10^{-3} \text{ dm}^3$ )
- 1.22  $6.00 \times 10^{-1} \text{ m} = 0.600 \text{ m}$
- 1.23 (i) B is limiting (ii) A is limiting  
(iii) Stoichiometric mixture –No (iv) B is limiting  
(v) A is limiting
- 1.24 (i)  $2.43 \times 10^3 \text{ g}$  (ii) Yes  
(iii) Hydrogen will remain unreacted;  $5.72 \times 10^2 \text{ g}$
- 1.26 Ten volumes
- 1.27 (i)  $2.87 \times 10^{-11} \text{ m}$  (ii)  $1.515 \times 10^{-11} \text{ m}$  (iii)  $2.5365 \times 10^{-2} \text{ kg}$
- 1.30  $1.99265 \times 10^{-23} \text{ g}$
- 1.31 (i) 3 (ii) 4 (iii) 4
- 1.32  $39.948 \text{ g mol}^{-1}$
- 1.33 (i)  $3.131 \times 10^{25}$  atoms (ii) 13 atoms (iii)  $7.8286 \times 10^{24}$  atoms
- 1.34 Empirical formula CH, molar mass  $26.0 \text{ g mol}^{-1}$ , molecular formula  $\text{C}_2\text{H}_2$
- 1.35  $0.94 \text{ g CaCO}_3$
- 1.36  $8.40 \text{ g HCl}$

### UNIT 2

- 2.1 (i)  $1.099 \times 10^{27}$  electrons (ii)  $5.48 \times 10^{-7} \text{ kg}$ ,  $9.65 \times 10^4 \text{ C}$
- 2.2 (i)  $6.022 \times 10^{24}$  electrons  
(ii) (a)  $2.4088 \times 10^{21}$  neutrons (b)  $4.0347 \times 10^{-6} \text{ kg}$   
(iii) (a)  $1.2044 \times 10^{22}$  protons (b)  $2.015 \times 10^{-5} \text{ kg}$
- 2.3 7,6: 8,8: 12,12: 30,26: 50, 38
- 2.4 (i) Cl (ii) U (iii) Be
- 2.5  $5.17 \times 10^{14} \text{ s}^{-1}$ ,  $1.72 \times 10^6 \text{ m}^{-1}$
- 2.6 (i)  $1.988 \times 10^{-18} \text{ J}$  (ii)  $3.98 \times 10^{-15} \text{ J}$

- 2.7  $6.0 \times 10^{-2} \text{ m}$ ,  $5.0 \times 10^9 \text{ s}^{-1}$  and  $16.66 \text{ m}^{-1}$
- 2.8  $2.012 \times 10^{16}$  photons
- 2.9 (i)  $4.97 \times 10^{-19} \text{ J}$  (3.10 eV); (ii) 0.97 eV (iii)  $5.84 \times 10^5 \text{ m s}^{-1}$
- 2.10  $494 \text{ kJ mol}^{-1}$
- 2.11  $7.18 \times 10^{19} \text{ s}^{-1}$
- 2.12  $4.41 \times 10^{14} \text{ s}^{-1}$ ,  $2.91 \times 10^{-19} \text{ J}$
- 2.13 486 nm
- 2.14  $8.72 \times 10^{-20} \text{ J}$
- 2.15 15 emission lines
- 2.16 (i)  $8.72 \times 10^{-20} \text{ J}$  (ii) 1.3225 nm
- 2.17  $1.523 \times 10^6 \text{ m}^{-1}$
- 2.18  $2.08 \times 10^{-11} \text{ ergs}$ , 950 Å
- 2.19 3647 Å
- 2.20  $3.55 \times 10^{-11} \text{ m}$
- 2.21 8967 Å
- 2.22  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ; Ar,  $\text{S}^{2-}$  and  $\text{K}^+$
- 2.23 (i) (a)  $1s^2$  (b)  $1s^2 2s^2 2p^6$ ; (c)  $1s^2 2s^2 2p^6$  (d)  $1s^2 2s^2 2p^6$
- 2.24  $n = 5$
- 2.25  $n = 3$ ;  $l = 2$ ;  $m_l = -2, -1, 0, +1, +2$  (any one value)
- 2.26 (i) 29 protons
- 2.27 1, 2, 15
- 2.28 (i)  $l$   $m_l$   
           0       0  
           1       -1, 0, +1  
           2       -2, -1, 0, +1, +2  
 (ii)  $l = 2$ ;  $m_l = -2, -1, 0, +1, +2$   
 (iii) 2s, 2p
- 2.29 (a) 1s, (b) 3p, (c) 4d and (d) 4f
- 2.30 (a), (c) and (e) are not possible
- 2.31 (a) 16 electrons (b) 2 electrons
- 2.33  $n = 2$  to  $n = 1$
- 2.34  $8.72 \times 10^{-18} \text{ J}$  per atom
- 2.35  $1.33 \times 10^9$
- 2.36 0.06 nm
- 2.37 (a)  $1.3 \times 10^2 \text{ pm}$  (b)  $6.15 \times 10^7 \text{ pm}$
- 2.38 1560
- 2.39 8
- 2.40 More number of K-particles will pass as the nucleus of the lighter atoms is small, smaller number of K-particles will be deflected as a number of positive charges is less than on the lighter nuclei.
- 2.41 For a given element the number of protons is the same for the isotopes, whereas the mass number can be different for the given atomic number.
- 2.42  $^{81}_{35}\text{Br}$

- 2.43  $^{37}_{17}\text{Cl}^{-1}$
- 2.44  $^{56}_{26}\text{Fe}^{3+}$
- 2.45 Cosmic rays > X-rays > amber colour > microwave > FM
- 2.46  $3.3 \times 10^6 \text{ J}$
- 2.47 (a)  $4.87 \times 10^{14} \text{ s}^{-1}$  (b)  $9.0 \times 10^9 \text{ m}$  (c)  $32.27 \times 10^{-20} \text{ J}$   
(d)  $6.2 \times 10^{18}$  quanta
- 2.48 10
- 2.49  $8.28 \times 10^{-10} \text{ J}$
- 2.50  $3.45 \times 10^{-22} \text{ J}$
- 2.51 (a) Threshold wave length 652.46 nm (b) Threshold frequency of radiation  $4.598 \times 10^{14} \text{ s}^{-1}$   
(c) Kinetic energy of ejected photoelectron  $9.29 \times 10^{-20} \text{ J}$ , Velocity of photoelectron  $4.516 \times 10^5 \text{ ms}^{-1}$
- 2.52 530.9 nm
- 2.53 4.48 eV
- 2.54  $7.6 \times 10^3 \text{ eV}$
- 2.55 infrared, 5
- 2.56 434 nm
- 2.57 455 pm
- 2.58  $494.5 \text{ ms}^{-1}$
- 2.59 332 pm
- 2.60  $1.516 \times 10^{-38} \text{ m}$
- 2.61 Cannot be defined as the actual magnitude is smaller than uncertainty.
- 2.62 (v) < (ii) = (iv) < (vi) = (iii) < (i)
- 2.63 4p
- 2.64 (i) 2s (ii) 4d (iii) 3p
- 2.65 Si
- 2.66 (a) 3 (b) 2 (c) 6  
(d) 4 (e) zero
- 2.67 16

## UNIT 5

- 5.1 2.5 bar
- 5.2 0.8 bar
- 5.4 70 g/mol
- 5.5  $M_B = 4M_A$
- 5.6 203.2 mL
- 5.7  $8.314 \times 10^4 \text{ Pa}$
- 5.8 1.8 bar
- 5.9  $3 \text{ g/dm}^3$
- 5.10  $1249.8 \text{ g mol}^{-1}$
- 5.11 3/5
- 5.12 50 K

- 5.13  $4.2154 \times 10^{23}$  electrons  
 5.14  $1.90956 \times 10^6$  year  
 5.15 56.025 bar  
 5.16 3811.1 kg  
 5.17 5.05 L  
 5.18  $40 \text{ g mol}^{-1}$   
 5.19 0.8 bar

## UNIT 6

- 6.1 (ii)  
 6.2 (iii)  
 6.3 (ii)  
 6.4 (iii)  
 6.5 (i)  
 6.6 (iv)  
 6.7  $q = + 701 \text{ J}$   
 $w = - 394 \text{ J}$ , since work is done by the system  
 $\Delta U = 307 \text{ J}$   
 6.8  $-743.939 \text{ kJ}$   
 6.9  $1.067 \text{ kJ}$   
 6.10  $\Delta H = -7.151 \text{ kJ mol}^{-1}$   
 6.11  $- 314.8 \text{ kJ}$   
 6.12  $\Delta_r H = -778 \text{ kJ}$   
 6.13  $- 46.2 \text{ kJ mol}^{-1}$   
 6.14  $- 239 \text{ kJ mol}^{-1}$   
 6.15  $326 \text{ kJ mol}^{-1}$   
 6.16  $\Delta S > 0$   
 6.17  $2000 \text{ K}$   
 6.18  $\Delta H$  is negative (bond energy is released) and  $\Delta S$  is negative (There is less randomness among the molecules than among the atoms)  
 6.19  $0.164 \text{ kJ}$ , the reaction is not spontaneous.  
 6.20  $-5.744 \text{ kJ mol}^{-1}$   
 6.21  $\text{NO(g)}$  is unstable, but  $\text{NO}_2\text{(g)}$  is formed.  
 6.22  $q_{\text{surr}} = + 286 \text{ kJ mol}^{-1}$   
 $\Delta S_{\text{surr}} = 959.73 \text{ J K}^{-1}$

## UNIT 7

- 7.2 12.229  
 7.3  $2.67 \times 10^4$   
 7.5 (i)  $4.33 \times 10^{-4}$  (ii) 1.90  
 7.6  $1.59 \times 10^{-15}$   
 7.8  $[\text{N}_2] = 0.0482 \text{ molL}^{-1}$ ,  $[\text{O}_2] = 0.0933 \text{ molL}^{-1}$ ,  $[\text{N}_2\text{O}] = 6.6 \times 10^{-21} \text{ molL}^{-1}$

- 7.9 0.0352mol of NO and 0.0178mol of Br<sub>2</sub>
- 7.10  $7.47 \times 10^{11} \text{ M}^{-1}$
- 7.11 4.0
- 7.12  $Q_c = 2.379 \times 10^3$ . No, reaction is not at equilibrium.
- 7.14 0.44
- 7.15  $0.068 \text{ molL}^{-1}$  each of H<sub>2</sub> and I<sub>2</sub>
- 7.16  $[I_2] = [Cl_2] = 0.167 \text{ M}$ ,  $[ICl] = 0.446 \text{ M}$
- 7.17  $[C_2H_6]_{eq} = 3.62 \text{ atm}$
- 7.18 (i)  $[CH_3COOC_2H_5][H_2O] / [CH_3COOH][C_2H_5OH]$   
 (ii) 3.92 (iii) value of  $Q_c$  is less than  $K_c$  therefore equilibrium is not attained.
- 7.19  $0.02 \text{ molL}^{-1}$  for both.
- 7.20  $[P_{CO}] = 1.739 \text{ atm}$ ,  $[P_{CO_2}] = 0.461 \text{ atm}$ .
- 7.21 No, the reaction proceeds to form more products.
- 7.22  $3 \times 10^{-4} \text{ molL}^{-1}$
- 7.23 0.149
- 7.24 a)  $-35.0 \text{ kJ}$ , b)  $1.365 \times 10^6$
- 7.27  $[P_{H_2}]_{eq} = [P_{Br_2}]_{eq} = 2.5 \times 10^{-2} \text{ bar}$ ,  $[P_{HBr}] = 10.0 \text{ bar}$
- 7.30 b) 120.48
- 7.31  $[H_2]_{eq} = 0.96 \text{ bar}$
- 7.33  $2.86 \times 10^{-28} \text{ M}$
- 7.34  $5.85 \times 10^{-2}$
- 7.35 NO<sub>2</sub><sup>-</sup>, HCN, ClO<sub>4</sub><sup>-</sup>, HF, H<sub>2</sub>O, HCO<sub>3</sub><sup>-</sup>, HS<sup>-</sup>
- 7.36 BF<sub>3</sub>, H<sup>+</sup>, NH<sub>4</sub><sup>+</sup>
- 7.37 F<sup>-</sup>, HSO<sub>4</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup>
- 7.38 NH<sub>3</sub>, NH<sub>4</sub><sup>+</sup>, HCOOH
- 7.41 2.42
- 7.42  $1.7 \times 10^{-4} \text{ M}$
- 7.43  $F^- = 1.5 \times 10^{-11}$ ,  $HCOO^- = 5.6 \times 10^{-11}$ ,  $CN^- = 2.08 \times 10^{-6}$
- 7.44  $[\text{phenolate ion}] = 2.2 \times 10^{-6}$ ,  $\alpha = 4.47 \times 10^{-5}$ ,  $\alpha$  in sodium phenolate =  $10^{-8}$
- 7.45  $[HS^-] = 9.54 \times 10^{-5}$ , in 0.1M HCl  $[HS^-] = 9.1 \times 10^{-8} \text{ M}$ ,  $[S^{2-}] = 1.2 \times 10^{-13} \text{ M}$ , in 0.1M HCl  $[S^{2-}] = 1.09 \times 10^{-19} \text{ M}$
- 7.46  $[Ac^-] = 0.00093$ , pH = 3.03
- 7.47  $[A^-] = 7.08 \times 10^{-5} \text{ M}$ ,  $K_a = 5.08 \times 10^{-7}$ ,  $pK_a = 6.29$
- 7.48 a) 2.52 b) 11.70 c) 2.70 d) 11.30
- 7.49 a) 11.65 b) 12.21 c) 12.57 c) 1.87
- 7.50 pH = 1.88,  $pK_a = 2.70$
- 7.51  $K_b = 1.6 \times 10^{-6}$ ,  $pK_b = 5.8$
- 7.52  $\alpha = 6.53 \times 10^{-4}$ ,  $K_a = 2.35 \times 10^{-5}$
- 7.53 a) 0.0018 b) 0.00018
- 7.54  $\alpha = 0.0054$
- 7.55 a)  $1.48 \times 10^{-7} \text{ M}$ , b) 0.063 c)  $4.17 \times 10^{-8} \text{ M}$  d)  $3.98 \times 10^{-7}$
- 7.56 a)  $1.5 \times 10^{-7} \text{ M}$ , b)  $10^{-5} \text{ M}$ , c)  $6.31 \times 10^{-5} \text{ M}$  d)  $6.31 \times 10^{-3} \text{ M}$
- 7.57  $[K^+] = [OH^-] = 0.05 \text{ M}$ ,  $[H^+] = 2.0 \times 10^{-13} \text{ M}$

- 7.58  $[\text{Sr}^{2+}] = 0.1581\text{M}$ ,  $[\text{OH}^-] = 0.3162\text{M}$ ,  $\text{pH} = 13.50$
- 7.59  $\alpha = 1.63 \times 10^{-2}$ ,  $\text{pH} = 3.09$ . In presence of  $0.01\text{M HCl}$ ,  $\alpha = 1.32 \times 10^{-3}$
- 7.60  $K_a = 2.09 \times 10^{-4}$  and degree of ionization =  $0.0457$
- 7.61  $\text{pH} = 7.97$ . Degree of hydrolysis =  $2.36 \times 10^{-5}$
- 7.62  $K_b = 1.5 \times 10^{-9}$
- 7.63  $\text{NaCl}$ ,  $\text{KBr}$  solutions are neutral,  $\text{NaCN}$ ,  $\text{NaNO}_2$  and  $\text{KF}$  solutions are basic and  $\text{NH}_4\text{NO}_3$  solution is acidic.
- 7.64 (a)  $\text{pH}$  of acid solution =  $1.9$  (b)  $\text{pH}$  of its salt solution =  $7.9$
- 7.65  $\text{pH} = 6.78$
- 7.66 a)  $12.6$  b)  $7.00$  c)  $1.3$
- 7.67 Silver chromate  $S = 0.65 \times 10^{-4}\text{M}$ ; Molarity of  $\text{Ag}^+ = 1.30 \times 10^{-4}\text{M}$   
Molarity of  $\text{CrO}_4^{2-} = 0.65 \times 10^{-4}\text{M}$ ; Barium Chromate  $S = 1.1 \times 10^{-5}\text{M}$ ; Molarity of  $\text{Ba}^{2+}$  and  $\text{CrO}_4^{2-}$  each is  $1.1 \times 10^{-5}\text{M}$ ; Ferric Hydroxide  $S = 1.39 \times 10^{-10}\text{M}$ ;  
Molarity of  $\text{Fe}^{3+} = 1.39 \times 10^{-10}\text{M}$ ; Molarity of  $[\text{OH}^-] = 4.17 \times 10^{-10}\text{M}$   
Lead Chloride  $S = 1.59 \times 10^{-2}\text{M}$ ; Molarity of  $\text{Pb}^{2+} = 1.59 \times 10^{-2}\text{M}$   
Molarity of  $\text{Cl}^- = 3.18 \times 10^{-2}\text{M}$ ; Mercurous Iodide  $S = 2.24 \times 10^{-10}\text{M}$ ;  
Molarity of  $\text{Hg}_2^{2+} = 2.24 \times 10^{-10}\text{M}$  and molarity of  $\text{I}^- = 4.48 \times 10^{-10}\text{M}$
- 7.68 Silver chromate is more soluble and the ratio of their molarities =  $91.9$
- 7.69 No precipitate
- 7.70 Silver benzoate is  $3.317$  times more soluble at lower  $\text{pH}$
- 7.71 The highest molarity for the solution is  $2.5 \times 10^{-9}\text{M}$
- 7.72  $2.43$  litre of water
- 7.73 Precipitation will take place in cadmium chloride solution

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## NOTES

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# Logarithms

TABLE I

N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	5	9	13	17	21	26	30	34	38
											4	8	12	16	20	24	28	32	36
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	12	16	20	23	27	31	35
											4	7	11	15	18	22	26	29	33
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	11	14	18	21	25	28	32
											3	7	10	14	17	20	24	27	31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
											3	7	10	13	16	19	22	25	29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	19	22	25	28
											3	6	9	12	14	17	20	23	26
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	9	11	14	17	20	23	26
											3	6	8	11	14	17	19	22	25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	6	8	11	14	16	19	22	24
											3	5	8	10	13	16	18	21	23
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	3	5	8	10	13	15	18	20	23
											3	5	8	10	12	15	17	20	22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	17	19	21
											2	4	7	9	11	14	16	18	21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
											2	4	6	8	11	13	15	17	19
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	6532	6542	6551	6561	6471	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8

# Logarithms

TABLE 1 (Continued)

N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	2	3	4	5	5	6	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	2	3	4	5	5	6	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	2	3	4	5	5	6	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	1	2	3	4	4	5	6	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	1	2	3	4	4	5	6	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	1	2	3	4	4	5	6	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	1	2	3	4	4	5	6	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	1	2	3	3	4	5	6	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	1	2	3	3	4	5	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	1	2	3	3	4	5	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	1	2	3	3	4	5	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	1	2	3	3	4	5	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	1	2	3	3	4	5	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	1	2	3	3	4	4	5	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	1	2	2	3	4	4	5	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	1	2	2	3	4	4	5	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	1	2	2	3	4	4	5	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	1	2	2	3	4	4	5	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	1	2	2	3	4	4	5	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	1	2	2	3	4	4	5	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	1	2	2	3	3	4	5	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	1	2	2	3	3	4	5	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	1	2	2	3	3	4	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	1	2	2	3	3	4	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	1	2	2	3	3	4	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	1	2	2	3	3	4	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	1	2	2	3	3	4	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	1	2	2	3	3	4	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	1	2	2	3	3	4	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	1	2	2	3	3	4	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	1	2	2	3	3	4	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	1	2	2	3	3	4	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	1	2	2	3	3	4	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	1	2	2	3	3	4	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	1	2	2	3	3	4	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	1	2	2	3	3	4	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	1	2	2	3	3	4	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	1	2	2	3	3	4	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	1	2	2	3	3	4	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	1	2	2	3	3	4	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	1	2	2	3	3	4	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	1	2	2	3	3	4	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	1	2	2	3	3	4	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	1	2	2	3	3	4	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9992	9996	0	1	1	2	2	3	3	3	4

# AntiLogarithms

TABLE II

N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	0	1	1	1	1	2	2	2
.01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	0	1	1	1	1	2	2	2
.02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	0	1	1	1	1	2	2	2
.03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	0	1	1	1	1	2	2	2
.04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	1	1	2	2	2	2
.05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	1	1	2	2	2	2
.06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	1	1	2	2	2	2
.07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	1	1	2	2	2	2
.08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	1	1	2	2	2	3
.09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	1	1	2	2	2	3
.10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	1	1	2	2	2	3
.11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	1	1	1	2	2	2	3
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	1	1	1	2	2	2	3
.13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	1	1	1	2	2	2	3
.14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	1	1	1	2	2	2	3
.15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	1	1	1	2	2	2	3
.16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	1	1	1	2	2	2	3
.17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	1	1	1	2	2	2	3
.18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	1	1	1	2	2	2	3
.19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	1	1	1	2	2	2	3
.20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	1	1	1	2	2	2	3
.21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	1	1	1	2	2	2	3
.22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	1	1	1	2	2	2	3
.23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	1	1	1	2	2	2	3
.24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	1	1	1	2	2	2	3
.25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	1	1	1	2	2	2	3
.26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	1	1	1	2	2	2	3
.27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	1	1	1	2	2	2	3
.28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	1	1	1	2	2	2	3
.29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	1	1	1	2	2	2	3
.30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	1	1	1	2	2	2	3
.31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	1	1	1	2	2	2	3
.32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	1	1	1	2	2	2	3
.33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	1	1	1	2	2	2	3
.34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	1	2	2	2	3	3	3	4
.35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	1	2	2	2	3	3	3	4
.36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	1	2	2	2	3	3	3	4
.37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	1	2	2	2	3	3	3	4
.38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	1	2	2	2	3	3	3	4
.39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	1	2	2	2	3	3	3	4
.40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	1	2	2	2	3	3	3	4
.41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	1	2	2	2	3	3	3	4
.42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	1	2	2	2	3	3	3	4
.43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	1	2	2	2	3	3	3	4
.44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	1	2	2	2	3	3	3	4
.45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	1	2	2	2	3	3	3	4
.46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	1	2	2	2	3	3	3	4
.47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	1	2	2	2	3	3	3	4
.48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	1	2	2	2	3	3	3	4
.49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	1	2	2	2	3	3	3	4

# AntiLogarithms

TABLE II (Continued)

N	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
.50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	1	2	3	4	4	5	6	7
.51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	2	3	4	5	5	6	7
.52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	2	3	4	5	5	6	7
.53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	2	3	4	5	6	6	7
.54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	2	3	4	5	6	6	7
.55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	2	3	4	5	6	7	7
.56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	2	3	3	4	5	6	7	8
.57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	2	3	3	4	5	6	7	8
.58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	2	3	4	4	5	6	7	8
.59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	2	3	4	5	5	6	7	8
.60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	2	3	4	5	6	6	7	8
.61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	2	3	4	5	6	7	8	9
.62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	2	3	4	5	6	7	8	9
.63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	2	3	4	5	6	7	8	9
.64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	2	3	4	5	6	7	8	9
.65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	2	3	4	5	6	7	8	9
.66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	2	3	4	5	6	7	9	10
.67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	2	3	4	5	7	8	9	10
.68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	2	3	4	6	7	8	9	10
.69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	2	3	5	6	7	8	9	10
.70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	2	4	5	6	7	8	9	11
.71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	2	4	5	6	7	8	10	11
.72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	2	4	5	6	7	9	10	11
.73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	3	4	5	6	8	9	10	11
.74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	3	4	5	6	8	9	10	12
.75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	3	4	5	7	8	9	10	12
.76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	3	4	5	7	8	9	11	12
.77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	3	4	5	7	8	10	11	12
.78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	3	4	6	7	8	10	11	13
.79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	3	4	6	7	9	10	11	13
.80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	3	4	6	7	9	10	12	13
.81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	3	5	6	8	9	11	12	14
.82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	3	5	6	8	9	11	12	14
.83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	3	5	6	8	9	11	13	14
.84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	3	5	6	8	10	11	13	15
.85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	3	5	7	8	10	12	13	15
.86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	3	5	7	8	10	12	13	15
.87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	3	5	7	9	10	12	14	16
.88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	4	5	7	9	11	12	14	16
.89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	4	5	7	9	11	13	14	16
.90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	4	6	7	9	11	13	15	17
.91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	4	6	8	9	11	13	15	17
.92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	4	6	8	10	12	14	15	17
.93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	4	6	8	10	12	14	16	18
.94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	4	6	8	10	12	14	16	18
.95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	4	6	8	10	12	15	17	19
.96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	4	6	8	11	13	15	17	19
.97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	4	7	9	11	13	15	17	20
.98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	4	7	9	11	13	16	18	20
.99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	5	7	9	11	14	16	18	20