WARREN DICKS AND M. J. DUNWOODY,

GROUPS ACTING ON GRAPHS,
CAMBRIDGE STUDIES IN ADVANCED MATHEMATICS 17,
CAMBRIDGE UNIVERSITY PRESS, 1989.

ERRATA
(MAY 4, 2016)

PLACE	**CHANGE**
5^4	Change "(e)" to "(v)" twice.
6^7	Interchange labels "$srse$" and"$srsre$".
9^{1-2}	Change to "repetitions of vertices and no repetitions of edges. Clearly such a path is reduced.".
11_8	Change "EX" to "VX".
11_5	Change boldface subscript "$\boldsymbol{\iota}$" to ordinary subscript "ι".
11_5	Change "*and*" to "and".
12^6	Change "elements 1,1" to "element 1".
13^{11}	Change"$t_e(G(e)$" to "$G(e)^{t_e}$".
17^{13}	Delete "so $G/N \approx \pi(G\backslash T)$".
18_{11}	Change "$EX^{\pm 1}$" to "$ET^{\pm 1}$".
27^1	Interchange "$G_{\tau e} = G_{\{p,p'\}}$" and "$G_e$".
29_5	Interchange "V" and "E".
32_{12}	Change "u_1" to "g_1".
33^{13}	Change "$\alpha(e)(\alpha_{\tau e}(g^{t_e})u)$" to "$\alpha(e)(\alpha_{\bar{\tau} e}(g^{t_e})(u))$".
35_9	Change "$\mathop{*}\limits_{v\in V} G(v)$" to "$G = \mathop{*}\limits_{v\in V} G(v)$".
39^{10}	Change "69" to "71".
39_{10}	Change "$e = EY_0$" to "$e \in EY_0$".
40^7	Delete one "meet any".
41_{17}	Change "thdn" to "then".
41_{19}	Change "$g \cdots$" to "$g_2 \cdots$".
44	Stallings (1991) uses similar techniques to prove many other results.
45^1	Change "G" to "$*_{i\in I} G_i$".
45^7	Insert Corollary: If $\alpha : F \to G$ is a homomorphism of free groups then there exist subgroups F_1 and F_2 of F such that $F = F_1 * F_2$, and α is injective on F_1, and α is trivial on F_2. (Herbert Federer and Bjarni Jónsson, Some properties of free groups, Trans. Amer. Math. Soc., 63 (1950), 1-27.)
45_{10}	Change "take" to "takes".
45_3	Change "Gerardin" to "Gérardin".

PLACE	CHANGE
46^{10-12}	Change "Theorem 8.3 seems to have been first stated explicitly in Serre (1977), but is essentially contained in Reidemeister (1932), Section 4, 20." to "Theorem 8.3 is due to Serre (1977). Reidemeister (1932) came close to discovering it."
$46_{6,5}$	Delete "Serre ... by".
46_3	Change "Wagner (1957)," to "Grushko (1940) for the case where F has finite rank, and to Wagner (1957) for the general case,"
50_{10}	Change "(v, v')" to "(v', v)".
53^5	Change "$= v(e^*)$" to "$= v(e)^*$".
54_{18}	Change "$s(v) = s(w)$ then $e(v) = e(w)$ for all $e \in E$" to "$e(v) = e(w)$ for all $e \in E$ then $s(v) = s(w)$".
54_3	After "$\delta(ss') \subseteq \delta s$" insert "$\cup \delta s'$".
55^2	Change "$s'(v)$" to "$s(v')$".
55_{11}	Add "and not containing 0,1" after "E_{n-1}".
$57_{13,3}$	Change "$E' \cup E$" to "$E \cup E'$".
$61^{17,23}$	Change "$\iota s, \tau s = \tau s*, \iota s*$" to "$\iota s = \iota s^*, \tau s, \tau s^*$" twice.
71_{10}	Change"Fredenthal" to "Freudenthal".
77^{18}	Change"*and*" to "and".
83^{10}	Change "S'" to"E'".
83^{11}	Change "{e}" to "$\{e\}$".
92^{16}	Delete "$\tilde{T}_1$ to a path of".
99_7	Change "succesor" to "successor".
100_{11}	Change "H-H" to "G-H".
101_3	Change "amost" to "almost".
102_5	Change "$<$" to "$\leq$".
103^{9-13}	Change to "If $(p, q, r) = (2, 3, 6)$ then acb, bac generate a free abelian subgroup of rank two and index 6; see Magnus (1974),p.69."
105^{19}	Bass (1993) gives a (short) proof that G has a free subgroup of index n.
107_9	Change "G indexed by A" to "A indexed by G".
107_5	Change"of AG" to "of (G, A)".
115^{14}	Change "Theorem 3.1" to "Theorem 3.13".
134_9	Change "(1968)" to "(1971)".
132_{14}	Change "B" to"R".
134_5	Change to "Theorem 6.12 is due to Hopf for G finitely generated, and the general case is new".
134_3	Change "Theorem 4.12" to "Theorem 4.11".
136^9	Change the first "P" to "G".
136^{10}	Change "H^*" to "H_*" and "H^i" to "H_i".
134^2	After "Brown(1982)" add "and Zimmerman (1981)".
136^{12}	Change "H_*" to "H^*" and "H_i" to "H^i".
140_2	Change "he" to "the".
142_{13}	Change "P" to "Q" and "P'" to "Q'".
142_{12}	Change "P" to "Q".
142_{11}	Change "$P \to P'$" to "$Q \to Q'$".

PLACE	CHANGE
142_{10}	Change "$P \to P'$" to "$Q \to Q'$".
142_7	Change "Q" to "B" twice.
143^{11-13}	Change "P" to "Q", "P'" to "Q'","P''" to "Q''", twice each.
143_3	Change "moduls" to "modules".
$144_{3,2}$	Change the seven occurrences of "P" to "Q".
$146^{2,3}$	Change "$\partial(p \otimes q) = \partial_P p \otimes q + (-1)^{\deg\ q} p \otimes \partial_q q$" to "$\partial(p \otimes q) = (-1)^{\deg\ q} \partial_P p \otimes q + p \otimes \partial_q q$".
146_{10-4}	Should read "$(\partial_{P\otimes Q} x) \cap \phi$ $= [(-1)^{\deg\ q} \partial_P p \otimes q + p \otimes \partial_Q q] \cap \phi$ $= (-1)^{\deg\ q} \partial_P p \otimes \phi q + p \otimes \phi \partial_Q q$ $= (-1)^{\deg\ q} \partial_{P\otimes C}(p \otimes \phi q) + [(p \otimes q) \cap \phi \partial_Q]$ $= (-1)^{\deg\ q} \partial_{P\otimes C}[(p \otimes q) \cap \phi] + [(p \otimes q) \cap \partial_{\mathrm{Hom}(Q,C)} \phi]$ $= (-1)^{\deg\ q} \partial_{P\otimes C}(x \cap \phi) + (x \cap \partial_{\mathrm{Hom}(Q,C)} \phi)$ If, further, ϕ is homogeneous, then either $\partial_{P\otimes C}(x \cap \phi) = 0$ or $\deg \phi = -\deg q$, and in both cases we can write (4) $\qquad (\partial_{P\otimes Q} x) \cap \phi = ((-1)^{\deg\ \phi} \partial_{P\otimes C}(x \cap \phi)) + x \cap \partial_{\mathrm{Hom}(Q,C)} \phi$".
148^{13}	In 2.16 Proposition, in the display change "$\mathrm{Ext}_R(B, C)$" to "$\mathrm{Ext}_R^n(B, C)$" twice, and after the display change "commutes" to "commutes with sign $(-1)^n$".
148_9	In 2.17 Proposition, in the display change "$\mathrm{Ext}_R^n(B', C)$" to "$\mathrm{Ext}_R(B', C)$", and change"$\mathrm{Ext}_R^{n+1}(B'', C)$" to "$\mathrm{Ext}_R(B'', C)$", and after the display delete "with sign $(-1)^{n+1}$".
148_5	Interchange "η" and "ξ".
149^{10}	Change "$\partial_{P\otimes C}(x \cap \phi) - (-1)^{\deg \phi}(x \cap \partial_{\mathrm{Hom}(Q,C)} \phi$" to "$((-1)^{\deg \phi} \partial_{P\otimes C}(x \cap \phi)) + x \cap \partial_{\mathrm{Hom}(Q,C)} \phi$".
$149^{11,12}$	Delete "with sign $-(-1)^{\deg \phi} = (-1)^{n+1}$".
149^{15}	In 2.18 Proposition, in the display change "Ext_R^{n-1}" to "Ext_R^{n+1}".
149^{17}	In 2.18 Proposition, after the display change "commutes with sign $(-1)^n$" to "commutes with sign $(-1)^{n+1}$".
154^{16}	Change the first "is" to "in".
155^1	In top display change "$(-1)^{n+1} \xi \cap -$" to "$\xi \cap -$".
155_1	Change "exact at R" to "exact at RG".
156^5	Change "Theorem I.9.2" to "Corollary I.9.4".
158_4	Change "contractible n-manifold X" to "K-orientable K-acyclic K-homology n-manifold X, as defined in Section 3 of Dicks-Leary (1995)".
$163^{5,7}$	Change "$[1, R_p]$" to "$[2, R_p]$" twice.
163^{13}	Add "and $m_{p,1}$ denotes 1".
170_{13}	Change "Thus H is FP_∞" to "Thus G is FP_∞".
171^{17-19}	Change " notice . . . ." to "notice that the G-action arises by embedding G in $H \wr \mathrm{Sym}_n$ and defining actions of H^n and Sym_n separately.".

PLACE	CHANGE
173^9	Delete "G-finite" after "locally finite".
173_{20-4}	Replace with "Fix a vertex v_0 of Y_0. Consider any $w \in V_0$, and recursively construct an infinite reduced path P_w as follows. Start with the vertex w, thought of as a base vertex, and take the neighbours of w to be the base vertices of their respective components in the forest $Y_0 - \text{star}(w)$. Since $Y_0 - \text{star}(w)$ is infinite and has only finitely many components, one of the components is infinite. Choose one of these infinite components, and if there are more than one, choose one which does not contain v_0. This choice of infinite subtree corresponds to choosing an edge incident to w to be the first edge in our infinite path. We now repeat the same procedure with our chosen infinite subtree with base vertex. In this way, we recursively construct an infinite reduced path P_w which starts at w, and does not contain any edge f such that w lies in an infinite component of $Y_0 - \{f\}$ not containing v_0. Let e be an edge of Y_0. Let $Y_0(v_0, e)$ denote the Y_0-geodesic from v_0 to a vertex of e, but not passing through e. Let $\delta Y_0(v_0, e)$ denote the finite set of edges of Y_0 which have one vertex in $\delta Y_0(v_0, e)$ and the other vertex not in $Y_0(v_0, e)$. Thus e lies in $\delta Y_0(v_0, e)$, and $Y_0(v_0, e)$ forms one of the finite components of $Y_0 - \delta Y_0(v_0, e)$. Let Y_e denote the the subtree of Y_0 generated by the finitely many finite components of $Y_0 - \delta Y_0(v_0, e)$, so Y_e is finite. For $e \in EY_0$, $w \in VY_0$, we claim that if $e \in P_w$ then $w \in Y_e$. Suppose that w does not lie in Y_e, so w lies in an infinite component Y_1 of $Y_0 - \delta Y_0(v_0, e)$. Let f denote the element of $\delta Y_0(v_0, e)$ incident to Y_1. Then f lies between w and $Y_0(v_0, e)$. Hence f lies between w and v_0. Also, Y_1 is an infinite component of $Y_0 - \{f\}$ containing w, so by its construction, P_w stays in Y_1 and does not cross f. Hence P_w does not meet $Y_0(v_0, e)$, so does not contain e. This proves the claim. For any v in V, there is a unique element g of G such that $gv \in V_0$, because G acts freely on V, and we define $P_v = g^{-1}P_{gv}$. Thus P_v is an infinite reduced path in T which begins at v. Consider any edge e of T. We claim that there are only finitely many $v \in V$ such that e belongs to P_v. Suppose then that $v \in V$ such that $e \in P_v$. There is a unique g in G such that $gv \in Y_0$, and then $ge \in gP_v = P_{gv}$. Hence ge lies in Y_0, and gv lies in the finite subtree Y_{ge} of Y_0. Here g is the unique element of G such that $ge \in EY_0$, and we have $v \in g^{-1}Y_{ge}$, so there are only finitely many possibilities for v, as desired.".
174_3	Change "Thus we may assume that $n \geq 1$." to "If $n = 1$ then G has an infinite cyclic subgroup of finite index by Theorem 4.4, and this case is easy. Thus we may assume that $n \geq 2$.".
176_5	Change "K^k" to "H^k.
176_2	Change "Thus in" to "Now let (G, W) be a PD^n pair, so, by ".
177_{11}	Change whole line to"K-orientable K-acyclic K-manifold X of dimension n, whose boundary components are K-acyclic".

PLACE	CHANGE
177_6	Change "ξ°" to "ε°".
178^{20}	Change "Definitions" to "Definition".
183_9	There is a vertical arrow missing on the left of the diagram (1).
185_{12}	In the display that comes two before (7), in the top row, change "$K\omega KE$" to "ωKE".
185_{11}	In the display that comes two before (7), in the label on the rightmost vertical arrow, delete "$(-1)^n$".
185_7	In the display that comes before (7), in the label on the rightmost vertical arrow, delete "$(-1)^n$".
186^{15}	In the display in mid-page, change the two rightmost "$\xi \cap -$" to "$-\xi \cap -$".
186_{12}	In (8) change "$\xi \cap \eta_e$" to "$-\xi \cap \eta_e$".
198^7	Change "$W - Gw$" to "$W - Gw_0$".
198_{15}	Insert "$ET = Ge$" after "G_e is finite".
199^{14}	Insert "$ET = Ge$" after "G_e is finite".
202_{10}	Change "$\sum\limits_{j\in[1,N]}$" to "$\sum\limits_{i,j\in[1,N]}$".
203^{10}	Change "$\|\|a\|\|\,\|\|b\|\| \geq \|\mathrm{tr}\,(\bar{b})\|$" to "$\|\|a\|\|\,\|\|b\|\| \geq \|\mathrm{tr}\,(a\bar{b})\|$".
202_4	Change "then – induces" to "then $\overline{}$ induces".
203_8	Change to "(1) $\quad \|\|a_n e\|\|^2 = \mathrm{tr}(a_n e\overline{a_n e}) = \mathrm{tr}(a_n e\bar{e}\,\overline{a_n}) = \mathrm{tr}(a_n c\overline{a_n}) = \mathrm{tr}(a_n \bar{c}\,\overline{a_n})$.".
$203_{7,6}$	Change "$\mathrm{tr}(a_n\overline{ca_n})$" to "$\mathrm{tr}(a_n\bar{c}\,\overline{a_n})$" twice.
205^8	Change "$P \mapsto KG \otimes_K P$" to "$P \to KG \otimes_K P$".
205^{14}	Change "for all $j \in [1, m]$" to "for all $i \in [1, m]$".
205_{12}	Change "$\sum\limits_{i,g\in G}$" to "$\sum\limits_{i,g}$".
$206_{12,13}$	Change "$[w_1 \cdots w_q] = [w_2 \cdots w_q w_1]$" to "$\mathrm{Tr}(w_1 \cdots w_q) = \mathrm{Tr}(w_2 \cdots w_q w_1)$".
207^4	Before "invertible" insert "is".
208_{14}	Change "$A *_C X_0$" to "$A *_C x_0$".
209_2	Change "V-term" to "E-term".
211_1	Change "$\to {}_0$" to "$\to P_0$".
212_{22-21}	Change "$= K$ is right annihilated by ωKG" to "$= K = KG/\omega KG$".
212_{20}	Change "$\alpha^*(P^*) \subseteq \omega KG$" to "$\alpha^*(P^*) = \omega KG$".
219^5	After "if" insert "and only if".
219^{15}	Change "$Z_0(K, G)$" to "$\mathrm{Hom}(C_0(K), G)$".
220_4	Change "$\mathbb{Z} \otimes \mathbb{Z}$" to "$\mathbb{Z} \times \mathbb{Z}$".
222_{15}	Change "G" to "K".
224^5	Change "s" to "σ".
224_{14}	One can change "$P \cap \|K\|$" to "P", since $P \subseteq \|K\|$.
224_7	Change "$j(\gamma_i)$" to "$j_P(\gamma_i)$".
225^{11}	Change "h^1" to "h_1".
225_2	After "colouring" insert "with two colours".
229_3	Change "X" to "S".
231^5	Change the second "v_1" to "v_2".
232^{15}	Change "ET" to "VT".

PLACE	CHANGE
232^{16}	Change the second "ET" to "T".
236^{9}	At the end of the line add "Moreover it follows from the thinness of b_2^* or b_1^* that $\nu = \delta$."
240_{13-12}	Change "G, the automorphism group of K, is generated" to "G is the group of automorphisms of K generated".
245^{1-3}	Delete "$H^1(K, \mathbb{Z}_2)$ ... that".
245_3	Change "$H^1(K, \mathbb{Z}_2) = 0$" to "every scc separates M".
272^{7}	Insert in left hand column: "Bass, H. {45, 46, 71} 1993. Covering theory for graphs of groups, *J. Pure and Appl. Algebra* **89**, 3–47. {105≈} ."
272^{7}	In right hand column change the Burns entry to "Burns, R.G. 1971. On the intersection of finitely generated subgroups of a free group, *Math. Z.* **119**, 121–130. {39} "
273_6	In right hand column change "Gerardin" to "Gérardin".
273_5	In left hand column change **"15" to "25".**
273^{16-18}	In right hand column delete the entry.
273^{25}	In right hand column change "Normal Flächen" to "Normalflächen".
273_4	In right hand column change "Raüme" to "Räume".
274_{22}	Delete from left hand column "134,".
274^{20-45}	In the right hand column, interchange lines 20-32 with lines 33-45, to obtain alphabetic order.
274^{27}	In left hand column change "dreidemensionalen" to "dreidimensionalen".
274^{25}	In right hand column change "isomorphismen" to "Isomorphismen".
275^{11}	Insert in right hand column 1991. Foldings of G-trees, pp. 355-368 in *Arboreal Group Theory* (Roger C. Alperin, Editor), MSRI Publications 19, Springer-Verlag, Berlin, 1991. {44≈}
275_7	Change "Räume" to "Räumen".
276^{3}	Insert in left hand column "(-)′".
274_7	Insert in left hand column: "Magnus, W. *Noneuclidean Tesselations and their Groups*, Academic Press, New York, 1974. {103}"
275^{10}	In the right hand column change " {71, 100} " to " {71, 100, 134}".
275_1	In the right hand column add "Zimmerman, B., 1981. Über Homeömorphismen n-dimensionaler Henkelkörper und endliche Erweiterungen von Schottky-Gruppen, *Comm. Math. Helv.* **56**, 474–481. {134}"
276_{12}	The triangle in the right hand column should be unshaded.