```
LISTFC LUDWIG     6/ 8/93    Page  1    XTAL3.0 SEP90/UNX

>>> copy master bdf  ludwig.000 -->  ludwig.aa1


********************
*** Begin LISTFC ***
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LISTFC CONTROL PARAMETERS
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ITEMS TO BE LISTED                1    1701    1800    1305
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ITEMS HAVE BEEN SCALED         1.00   10.00   10.00   10.00
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FREL AND SIGF SCALE(S)            1   .1220
```

IRWIN & PETERSON
FOR DEPOSIT

0,0,L

| | | | |
|---|---|---|---|
| 1 | 943 | 939 | 0 |
| 2 | 224 | 1919 | 6 |
| 3 | 410 | 411 | 2 |
| 4 | 859 | 873 | 2 |
| 5 | 245 | 247 | 2 |

0,2,L

| | | | |
|---|---|---|---|
| 0 | 276 | 267 | 0 |
| 1 | 378 | 373 | 1 |
| 2 | 159 | 166 | 1 |
| 3 | 211 | 216 | 2 |
| 4 | 81 | 81 | 1 |
| 5 | 106 | 102 | 1 |

0,4,L

| | | | |
|---|---|---|---|
| 0 | 323 | 311 | 1 |
| 1 | 563 | 542 | 1 |
| 2 | 156 | 156 | 2 |
| 3 | 350 | 349 | 2 |
| 4 | 111 | 109 | 1 |
| 5 | 181 | 184 | 2 |

0,6,L

| | | | |
|---|---|---|---|
| 0 | 68 | 61 | 0 |
| 1 | 31 | 28 | 1 |
| 2 | 29 | 23 | 2 |
| 3 | 33 | 14 | 3 |
| 4 | 18 | 11 | 8 |
| 5 | 17 | 1 | 11 |

0,8,L

| | | | |
|---|---|---|---|
| 0 | 1103 | 1068 | 2 |
| 1 | 707 | 703 | 2 |
| 2 | 777 | 771 | 2 |
| 3 | 420 | 415 | 2 |
| 4 | 425 | 425 | 3 |
| 5 | 249 | 254 | 3 |

0,10,L

| | | | |
|---|---|---|---|
| 0 | 277 | 270 | 2 |
| 1 | 74 | 66 | 0 |
| 2 | 221 | 222 | 2 |
| 3 | 62 | 59 | 1 |
| 4 | 127 | 123 | 1 |

0,12,L

| | | | |
|---|---|---|---|
| 0 | 172 | 178 | 2 |
| 1 | 217 | 219 | 2 |
| 2 | 145 | 148 | 1 |
| 3 | 156 | 157 | 2 |
| 4 | 100 | 102 | 2 |

0,14,L

| | | | |
|---|---|---|---|
| 0 | 230 | 245 | 2 |
| 1 | 423 | 419 | 2 |
| 2 | 184 | 185 | 2 |
| 3 | 296 | 294 | 3 |
| 4 | 106 | 98 | 2 |

0,16,L

| | | | |
|---|---|---|---|
| 0 | 175 | 175 | 2 |
| 1 | 295 | 300 | 2 |
| 2 | 155 | 153 | 2 |
| 3 | 222 | 227 | 2 |

0,18,L

| | | | |
|---|---|---|---|
| 0 | 302 | 305 | 3 |
| 1 | 179 | 179 | 2 |
| 2 | 265 | 268 | 3 |
| 3 | 157 | 157 | 2 |

0,20,L

| | | | |
|---|---|---|---|
| 0 | 50 | 49 | 2 |
| 1 | 139 | 138 | 1 |
| 2 | 50 | 43 | 2 |

0,22,L

| | | | |
|---|---|---|---|
| 0 | 78 | 73 | 2 |

1,1,L

| | | | |
|---|---|---|---|
| 1 | 289 | 288 | 1 |
| 2 | 101 | 101 | 1 |
| 3 | 152 | 157 | 2 |
| 4 | 50 | 48 | 2 |
| 5 | 75 | 71 | 2 |

1,2,L

| | | | |
|---|---|---|---|
| 1 | 92 | 115 | 0 |
| 2 | 474 | 481 | 1 |
| 3 | 154 | 152 | 2 |
| 4 | 235 | 237 | 2 |
| 5 | 92 | 90 | 2 |

1,3,L

| | | | |
|---|---|---|---|
| 1 | 318 | 322 | 1 |
| 2 | 53 | 37 | 0 |
| 3 | 217 | 216 | 2 |
| 4 | 0 | 3 | 121 |
| 5 | 99 | 96 | 2 |

1,4,L

| | | | |
|---|---|---|---|
| 1 | 117 | 112 | 1 |
| 2 | 187 | 182 | 2 |
| 3 | 81 | 79 | 1 |
| 4 | 97 | 97 | 1 |
| 5 | 50 | 48 | 2 |

1,5,L

| | | | |
|---|---|---|---|
| 1 | 179 | 184 | 1 |
| 2 | 205 | 197 | 2 |
| 3 | 101 | 100 | 1 |
| 4 | 106 | 103 | 1 |
| 5 | 58 | 55 | 2 |

1,6,L

| | | | |
|---|---|---|---|
| 1 | 543 | 541 | 2 |
| 1 | 551 | 541 | 1 |
| 1 | 554 | 541 | 1 |
| 2 | 498 | 489 | 2 |
| 3 | 297 | 295 | 2 |
| 4 | 261 | 261 | 2 |
| 5 | 173 | 171 | 2 |

1,7,L

| | | | |
|---|---|---|---|
| 1 | 1002 | 960 | 2 |
| 2 | 183 | 181 | 2 |
| 3 | 507 | 504 | 2 |
| 4 | 82 | 80 | 1 |
| 5 | 263 | 254 | 3 |

1,8,L

| | | | |
|---|---|---|---|
| 1 | 414 | 415 | 2 |
| 2 | 310 | 314 | 2 |
| 3 | 243 | 244 | 2 |
| 4 | 184 | 179 | 2 |

1,8,L

| | | | |
|---|---|---|---|
| 5 | 148 | 145 | 2 |

1,9,L

| | | | |
|---|---|---|---|
| 1 | 48 | 51 | 1 |
| 2 | 209 | 208 | 2 |
| 3 | 35 | 32 | 2 |
| 4 | 113 | 111 | 1 |

1,10,L

| | | | |
|---|---|---|---|
| 1 | 246 | 240 | 2 |
| 2 | 147 | 143 | 2 |
| 3 | 162 | 160 | 2 |
| 4 | 96 | 93 | 2 |

1,11,L

| | | | |
|---|---|---|---|
| 1 | 377 | 379 | 2 |
| 2 | 39 | 38 | 2 |
| 3 | 231 | 230 | 2 |
| 4 | 43 | 39 | 2 |

1,12,L

| | | | |
|---|---|---|---|
| 1 | 497 | 503 | 2 |
| 2 | 311 | 308 | 2 |
| 3 | 347 | 348 | 3 |
| 4 | 205 | 206 | 2 |

1,13,L

| | | | |
|---|---|---|---|
| 1 | 146 | 141 | 1 |
| 2 | 198 | 201 | 2 |
| 3 | 105 | 100 | 1 |
| 4 | 127 | 126 | 2 |

1,14,L

| | | | |
|---|---|---|---|
| 1 | 216 | 213 | 2 |
| 2 | 160 | 157 | 2 |
| 3 | 160 | 158 | 2 |
| 4 | 113 | 110 | 2 |

1,15,L

| | | | |
|---|---|---|---|
| 1 | 307 | 309 | 2 |
| 2 | 76 | 74 | 1 |
| 3 | 222 | 223 | 2 |
| 4 | 59 | 56 | 2 |

1,16,L

| | | | |
|---|---|---|---|
| 1 | 303 | 305 | 3 |
| 2 | 144 | 145 | 1 |
| 3 | 238 | 239 | 2 |

1,17,L

| | | | |
|---|---|---|---|
| 1 | 63 | 61 | 2 |
| 2 | 12 | 6 | 12 |
| 3 | 41 | 41 | 2 |

1,18,L

| | | | |
|---|---|---|---|
| 1 | 103 | 98 | 1 |
| 2 | 112 | 107 | 1 |
| 3 | 82 | 80 | 2 |

1,19,L

| | | | |
|---|---|---|---|
| 1 | 124 | 123 | 1 |
| 2 | 58 | 57 | 2 |

1,20,L

| | | | |
|---|---|---|---|
| 1 | 351 | 357 | 3 |
| 2 | 269 | 271 | 3 |

1,21,L

| | | | |
|---|---|---|---|
| 1 | 207 | 208 | 2 |

2,0,L

| | | | |
|---|---|---|---|
| 0 | 148 | 151 | 0 |
| 1 | 1353 | 1275 | 5 |
| 2 | 61 | 52 | 0 |
| 3 | 624 | 636 | 2 |
| 4 | 61 | 64 | 1 |
| 5 | 315 | 314 | 3 |

2,1,L

| | | | |
|---|---|---|---|
| 1 | 139 | 131 | 1 |
| 2 | 27 | 22 | 1 |
| 3 | 48 | 43 | 1 |
| 4 | 17 | 12 | 5 |
| 5 | 24 | 22 | 3 |

2,2,L

| | | | |
|---|---|---|---|
| 0 | 86 | 92 | 0 |
| 1 | 362 | 348 | 1 |
| 2 | 49 | 49 | 0 |
| 3 | 179 | 179 | 2 |
| 4 | 27 | 25 | 2 |
| 5 | 86 | 83 | 2 |

2,3,L

| | | | |
|---|---|---|---|
| 1 | 318 | 302 | 1 |
| 2 | 56 | 56 | 0 |
| 3 | 121 | 126 | 1 |
| 4 | 29 | 28 | 2 |
| 5 | 63 | 63 | 2 |

2,4,L

| | | | |
|---|---|---|---|
| 0 | 1483 | 1392 | 1 |
| 1 | 571 | 557 | 1 |
| 2 | 980 | 976 | 2 |
| 3 | 325 | 319 | 2 |
| 4 | 501 | 488 | 2 |
| 5 | 205 | 202 | 2 |

2,5,L

| | | | |
|---|---|---|---|
| 1 | 223 | 216 | 1 |
| 2 | 477 | 485 | 2 |
| 3 | 90 | 91 | 1 |
| 4 | 223 | 219 | 2 |
| 5 | 48 | 45 | 2 |

2,6,L

| | | | |
|---|---|---|---|
| 0 | 554 | 547 | 1 |
| 1 | 451 | 441 | 2 |
| 2 | 372 | 377 | 2 |
| 3 | 248 | 248 | 2 |
| 4 | 195 | 191 | 2 |
| 5 | 141 | 138 | 2 |

2,7,L

| | | | |
|---|---|---|---|
| 1 | 107 | 107 | 1 |
| 2 | 42 | 41 | 1 |
| 3 | 60 | 58 | 1 |
| 4 | 28 | 23 | 3 |
| 5 | 35 | 33 | 3 |

2,8,L

| | | | |
|---|---|---|---|
| 0 | 164 | 160 | 2 |

2,8,L

| | | | |
|---|---|---|---|
| 1 | 442 | 440 | 2 |
| 2 | 131 | 126 | 1 |
| 3 | 274 | 275 | 2 |
| 4 | 96 | 97 | 1 |
| 5 | 162 | 162 | 2 |

2,9,L

| | | | |
|---|---|---|---|
| 1 | 226 | 238 | 2 |
| 2 | 114 | 119 | 1 |
| 3 | 138 | 138 | 1 |
| 4 | 68 | 64 | 2 |

2,10,L

| | | | |
|---|---|---|---|
| 0 | 157 | 161 | 2 |
| 1 | 155 | 149 | 2 |
| 2 | 119 | 116 | 1 |
| 3 | 95 | 92 | 1 |
| 4 | 60 | 52 | 2 |

2,11,L

| | | | |
|---|---|---|---|
| 1 | 23 | 25 | 2 |
| 2 | 79 | 83 | 1 |
| 3 | 19 | 20 | 6 |
| 4 | 51 | 51 | 2 |

2,12,L

| | | | |
|---|---|---|---|
| 0 | 438 | 446 | 2 |
| 1 | 452 | 463 | 2 |
| 2 | 359 | 360 | 2 |
| 3 | 318 | 319 | 3 |
| 4 | 235 | 238 | 2 |

2,13,L

| | | | |
|---|---|---|---|
| 1 | 10 | 12 | 8 |
| 2 | 96 | 95 | 1 |
| 3 | 17 | 10 | 6 |
| 4 | 64 | 61 | 2 |

2,14,L

| | | | |
|---|---|---|---|
| 0 | 599 | 602 | 2 |
| 1 | 144 | 144 | 1 |
| 2 | 491 | 497 | 2 |
| 3 | 121 | 120 | 1 |
| 4 | 325 | 320 | 3 |

2,15,L

| | | | |
|---|---|---|---|
| 1 | 71 | 70 | 1 |
| 2 | 59 | 58 | 2 |
| 3 | 52 | 49 | 2 |

2,16,L

| | | | |
|---|---|---|---|
| 0 | 92 | 94 | 1 |
| 1 | 34 | 32 | 2 |
| 2 | 80 | 81 | 1 |
| 3 | 22 | 16 | 5 |

2,17,L

| | | | |
|---|---|---|---|
| 1 | 73 | 74 | 1 |
| 2 | 19 | 19 | 6 |
| 3 | 60 | 55 | 2 |

2,18,L

| | | | |
|---|---|---|---|
| 0 | 43 | 41 | 2 |
| 1 | 212 | 219 | 2 |
| 2 | 34 | 24 | 2 |
| 3 | 165 | 169 | 2 |

2,19,L

| | | | |
|---|---|---|---|
| 1 | 89 | 87 | 2 |
| 2 | 17 | 17 | 9 |

2,20,L

| | | | |
|---|---|---|---|
| 0 | 86 | 88 | 2 |
| 1 | 140 | 143 | 1 |
| 2 | 80 | 80 | 2 |

2,21,L

| | | | |
|---|---|---|---|
| 1 | 15 | 14 | 10 |

2,22,L

| | | | |
|---|---|---|---|
| 0 | 290 | 301 | 3 |

3,1,L

| | | | |
|---|---|---|---|
| 1 | 651 | 642 | 1 |
| 2 | 262 | 253 | 2 |
| 3 | 315 | 320 | 2 |
| 4 | 131 | 133 | 1 |
| 5 | 161 | 160 | 2 |

3,2,L

| | | | |
|---|---|---|---|
| 1 | 1059 | 1058 | 1 |
| 2 | 387 | 377 | 2 |
| 2 | 386 | 377 | 2 |
| 2 | 364 | 377 | 2 |
| 2 | 379 | 377 | 2 |
| 2 | 379 | 377 | 2 |
| 2 | 375 | 377 | 2 |
| 2 | 364 | 377 | 2 |
| 2 | 350 | 377 | 2 |
| 2 | 374 | 377 | 2 |
| 3 | 491 | 501 | 2 |
| 4 | 198 | 200 | 2 |
| 5 | 267 | 267 | 3 |

3,3,L

| | | | |
|---|---|---|---|
| 1 | 770 | 753 | 1 |
| 1 | 762 | 753 | 1 |
| 1 | 763 | 753 | 1 |
| 2 | 68 | 65 | 0 |
| 3 | 355 | 355 | 2 |
| 4 | 28 | 31 | 3 |
| 5 | 174 | 165 | 2 |

3,4,L

| | | | |
|---|---|---|---|
| 1 | 245 | 243 | 2 |
| 2 | 91 | 86 | 0 |
| 3 | 131 | 132 | 1 |
| 4 | 57 | 55 | 2 |
| 5 | 75 | 73 | 2 |

3,5,L

| | | | |
|---|---|---|---|
| 1 | 99 | 103 | 1 |
| 2 | 268 | 269 | 2 |
| 3 | 53 | 46 | 1 |
| 4 | 128 | 124 | 1 |
| 5 | 26 | 24 | 6 |

3,6,L

| | | | |
|---|---|---|---|
| 1 | 562 | 554 | 2 |
| 2 | 317 | 315 | 2 |
| 3 | 316 | 314 | 2 |
| 4 | 181 | 177 | 2 |
| 5 | 188 | 185 | 2 |

3,7,L

| | | | |
|---|---|---|---|
| 1 | 330 | 327 | 2 |

### 3,7,L

| | | | |
|---|---|---|---|
| 2 | 119 | 118 | 1 |
| 3 | 212 | 208 | 2 |
| 4 | 43 | 40 | 2 |
| 5 | 99 | 102 | 2 |

### 3,8,L

| | | | |
|---|---|---|---|
| 1 | 197 | 195 | 2 |
| 2 | 205 | 202 | 2 |
| 3 | 138 | 133 | 1 |
| 4 | 128 | 127 | 1 |

### 3,9,L

| | | | |
|---|---|---|---|
| 1 | 149 | 145 | 1 |
| 2 | 311 | 311 | 2 |
| 3 | 99 | 97 | 1 |
| 4 | 178 | 175 | 2 |

### 3,10,L

| | | | |
|---|---|---|---|
| 1 | 312 | 320 | 2 |
| 2 | 333 | 338 | 2 |
| 3 | 206 | 209 | 2 |
| 4 | 210 | 204 | 2 |

### 3,11,L

| | | | |
|---|---|---|---|
| 1 | 347 | 354 | 2 |
| 2 | 218 | 228 | 2 |
| 3 | 215 | 219 | 2 |
| 4 | 129 | 126 | 1 |

### 3,12,L

| | | | |
|---|---|---|---|
| 1 | 136 | 134 | 1 |
| 2 | 266 | 266 | 2 |
| 3 | 104 | 104 | 1 |
| 4 | 187 | 182 | 2 |

### 3,13,L

| | | | |
|---|---|---|---|
| 1 | 38 | 39 | 2 |
| 2 | 42 | 42 | 2 |
| 3 | 20 | 26 | 6 |
| 4 | 17 | 24 | 8 |

### 3,14,L

| | | | |
|---|---|---|---|
| 1 | 148 | 148 | 2 |
| 2 | 169 | 167 | 2 |
| 3 | 114 | 112 | 1 |
| 4 | 121 | 120 | 2 |

### 3,15,L

| | | | |
|---|---|---|---|
| 1 | 111 | 110 | 1 |
| 2 | 81 | 80 | 1 |
| 3 | 76 | 75 | 2 |

### 3,16,L

| | | | |
|---|---|---|---|
| 1 | 173 | 171 | 2 |
| 2 | 323 | 327 | 3 |
| 3 | 143 | 138 | 1 |

### 3,17,L

| | | | |
|---|---|---|---|
| 1 | 272 | 276 | 3 |
| 2 | 130 | 131 | 1 |
| 3 | 213 | 209 | 2 |

### 3,18,L

| | | | |
|---|---|---|---|
| 1 | 86 | 88 | 1 |
| 2 | 62 | 64 | 2 |
| 3 | 70 | 71 | 2 |

### 3,19,L

| | | | |
|---|---|---|---|
| 1 | 59 | 62 | 2 |
| 2 | 79 | 79 | 2 |

### 3,20,L

| | | | |
|---|---|---|---|
| 1 | 131 | 132 | 1 |
| 2 | 206 | 206 | 2 |

### 3,21,L

| | | | |
|---|---|---|---|
| 1 | 152 | 151 | 1 |

### 4,0,L

| | | | |
|---|---|---|---|
| 0 | 614 | 625 | 1 |
| 1 | 367 | 365 | 1 |
| 2 | 587 | 576 | 2 |
| 3 | 235 | 237 | 2 |
| 4 | 332 | 322 | 2 |
| 5 | 167 | 164 | 2 |

### 4,1,L

| | | | |
|---|---|---|---|
| 1 | 20 | 1 | 2 |
| 2 | 66 | 57 | 0 |
| 3 | 13 | 11 | 10 |
| 4 | 24 | 25 | 5 |
| 5 | 13 | 7 | 12 |

### 4,2,L

| | | | |
|---|---|---|---|
| 0 | 199 | 203 | 1 |
| 1 | 559 | 556 | 1 |
| 1 | 553 | 556 | 1 |
| 1 | 550 | 556 | 1 |
| 2 | 139 | 142 | 1 |
| 3 | 284 | 290 | 2 |
| 4 | 79 | 77 | 1 |
| 5 | 146 | 145 | 1 |

### 4,3,L

| | | | |
|---|---|---|---|
| 1 | 104 | 104 | 1 |
| 2 | 115 | 111 | 1 |
| 3 | 58 | 57 | 1 |
| 4 | 59 | 58 | 2 |
| 5 | 36 | 34 | 3 |

### 4,4,L

| | | | |
|---|---|---|---|
| 0 | 125 | 116 | 1 |
| 1 | 934 | 929 | 2 |
| 2 | 57 | 61 | 1 |
| 3 | 515 | 521 | 2 |
| 4 | 27 | 11 | 3 |
| 5 | 284 | 279 | 3 |

### 4,5,L

| | | | |
|---|---|---|---|
| 1 | 237 | 240 | 2 |
| 2 | 81 | 82 | 1 |
| 3 | 116 | 114 | 1 |
| 4 | 41 | 38 | 2 |
| 5 | 69 | 63 | 2 |

### 4,6,L

| | | | |
|---|---|---|---|
| 0 | 134 | 140 | 1 |
| 1 | 18 | 8 | 4 |
| 2 | 88 | 91 | 1 |
| 3 | 21 | 0 | 5 |
| 4 | 42 | 41 | 2 |
| 5 | 11 | 3 | 16 |

### 4,7,L

| | | | |
|---|---|---|---|
| 1 | 115 | 116 | 1 |

4,7,L

| | | | |
|---|---|---|---|
| 2 | 98 | 100 | 1 |
| 3 | 71 | 72 | 1 |
| 4 | 61 | 57 | 2 |
| 5 | 42 | 44 | 3 |

4,8,L

| | | | |
|---|---|---|---|
| 0 | 715 | 702 | 2 |
| 1 | 388 | 388 | 2 |
| 2 | 553 | 541 | 2 |
| 3 | 269 | 261 | 2 |
| 4 | 323 | 325 | 3 |

4,9,L

| | | | |
|---|---|---|---|
| 1 | 27 | 29 | 2 |
| 2 | 106 | 107 | 1 |
| 3 | 25 | 21 | 3 |
| 4 | 65 | 65 | 2 |

4,10,L

| | | | |
|---|---|---|---|
| 0 | 812 | 817 | 2 |
| 1 | 333 | 347 | 2 |
| 2 | 631 | 631 | 2 |
| 3 | 229 | 228 | 2 |
| 4 | 381 | 376 | 3 |

4,11,L

| | | | |
|---|---|---|---|
| 1 | 128 | 131 | 1 |
| 2 | 99 | 100 | 1 |
| 3 | 93 | 91 | 1 |
| 4 | 69 | 68 | 2 |

4,12,L

| | | | |
|---|---|---|---|
| 0 | 150 | 149 | 2 |
| 1 | 18 | 12 | 5 |
| 2 | 127 | 128 | 1 |
| 3 | 22 | 20 | 6 |
| 4 | 88 | 90 | 2 |

4,13,L

| | | | |
|---|---|---|---|
| 1 | 17 | 10 | 3 |
| 2 | 44 | 45 | 2 |
| 3 | 10 | 5 | 7 |
| 4 | 24 | 30 | 6 |

4,14,L

| | | | |
|---|---|---|---|
| 0 | 9 | 7 | 12 |
| 1 | 147 | 147 | 1 |
| 2 | 17 | 18 | 6 |
| 3 | 104 | 105 | 1 |
| 4 | 37 | 34 | 3 |

4,15,L

| | | | |
|---|---|---|---|
| 1 | 39 | 33 | 2 |
| 2 | 50 | 51 | 2 |
| 3 | 28 | 27 | 3 |

4,16,L

| | | | |
|---|---|---|---|
| 0 | 189 | 194 | 2 |
| 1 | 286 | 291 | 3 |
| 2 | 174 | 170 | 2 |
| 3 | 222 | 222 | 2 |

4,17,L

| | | | |
|---|---|---|---|
| 1 | 15 | 13 | 6 |
| 2 | 14 | 0 | 12 |
| 3 | 19 | 10 | 8 |

4,18,L

| | | | |
|---|---|---|---|
| 0 | 525 | 537 | 3 |
| 1 | 94 | 93 | 1 |
| 2 | 469 | 464 | 3 |

4,19,L

| | | | |
|---|---|---|---|
| 1 | 80 | 78 | 2 |
| 2 | 102 | 102 | 2 |

4,20,L

| | | | |
|---|---|---|---|
| 0 | 25 | 21 | 3 |
| 1 | 7 | 1 | 20 |

4,21,L

| | | | |
|---|---|---|---|
| 1 | 49 | 47 | 2 |

5,1,L

| | | | |
|---|---|---|---|
| 1 | 102 | 107 | 1 |
| 2 | 91 | 88 | 0 |
| 3 | 52 | 54 | 1 |
| 4 | 45 | 45 | 2 |
| 5 | 24 | 16 | 6 |

5,2,L

| | | | |
|---|---|---|---|
| 1 | 791 | 808 | 1 |
| 2 | 449 | 447 | 2 |
| 3 | 418 | 419 | 2 |
| 4 | 243 | 245 | 2 |
| 5 | 247 | 242 | 2 |

5,3,L

| | | | |
|---|---|---|---|
| 1 | 832 | 845 | 2 |
| 2 | 36 | 37 | 2 |
| 3 | 466 | 465 | 2 |
| 4 | 44 | 39 | 2 |
| 5 | 249 | 245 | 3 |

5,4,L

| | | | |
|---|---|---|---|
| 1 | 216 | 217 | 2 |
| 2 | 130 | 130 | 1 |
| 3 | 125 | 128 | 1 |
| 4 | 78 | 76 | 2 |
| 5 | 77 | 74 | 2 |

5,5,L

| | | | |
|---|---|---|---|
| 1 | 244 | 251 | 2 |
| 2 | 393 | 392 | 2 |
| 3 | 153 | 159 | 2 |
| 4 | 222 | 219 | 2 |
| 5 | 99 | 96 | 2 |

5,6,L

| | | | |
|---|---|---|---|
| 1 | 294 | 292 | 2 |
| 2 | 252 | 246 | 2 |
| 3 | 193 | 187 | 2 |
| 4 | 153 | 150 | 1 |

5,7,L

| | | | |
|---|---|---|---|
| 1 | 156 | 150 | 2 |
| 2 | 107 | 105 | 1 |
| 3 | 83 | 82 | 1 |
| 4 | 50 | 51 | 2 |

5,8,L

| | | | |
|---|---|---|---|
| 1 | 185 | 188 | 2 |

5,8,L

| | | | |
|---|---|---|---|
| 2 | 128 | 127 | 1 |
| 3 | 129 | 130 | 1 |
| 4 | 87 | 87 | 2 |

5,9,L

| | | | |
|---|---|---|---|
| 1 | 59 | 55 | 1 |
| 2 | 126 | 122 | 1 |
| 3 | 33 | 35 | 2 |
| 4 | 64 | 63 | 2 |

5,10,L

| | | | |
|---|---|---|---|
| 1 | 362 | 363 | 2 |
| 2 | 330 | 327 | 2 |
| 3 | 249 | 248 | 2 |
| 4 | 219 | 216 | 2 |

5,11,L

| | | | |
|---|---|---|---|
| 1 | 543 | 565 | 2 |
| 2 | 79 | 76 | 1 |
| 3 | 368 | 370 | 3 |
| 4 | 36 | 34 | 3 |

5,12,L

| | | | |
|---|---|---|---|
| 1 | 111 | 109 | 1 |
| 2 | 169 | 170 | 2 |
| 3 | 86 | 87 | 2 |
| 4 | 120 | 120 | 2 |

5,13,L

| | | | |
|---|---|---|---|
| 1 | 171 | 173 | 2 |
| 2 | 157 | 158 | 2 |
| 3 | 128 | 127 | 1 |
| 4 | 106 | 110 | 2 |

5,14,L

| | | | |
|---|---|---|---|
| 1 | 123 | 123 | 1 |
| 2 | 141 | 140 | 1 |
| 3 | 97 | 97 | 2 |

5,15,L

| | | | |
|---|---|---|---|
| 1 | 149 | 150 | 1 |
| 2 | 23 | 17 | 5 |
| 3 | 107 | 102 | 2 |

5,16,L

| | | | |
|---|---|---|---|
| 1 | 262 | 264 | 2 |
| 2 | 314 | 313 | 3 |
| 3 | 210 | 210 | 2 |

5,17,L

| | | | |
|---|---|---|---|
| 1 | 144 | 144 | 1 |
| 2 | 12 | 6 | 9 |
| 3 | 113 | 106 | 2 |

5,18,L

| | | | |
|---|---|---|---|
| 1 | 78 | 79 | 2 |
| 2 | 61 | 60 | 2 |

5,19,L

| | | | |
|---|---|---|---|
| 1 | 57 | 56 | 2 |
| 2 | 86 | 87 | 2 |

5,20,L

| | | | |
|---|---|---|---|
| 1 | 94 | 98 | 2 |

6,0,L

| | | | |
|---|---|---|---|
| 0 | 151 | 146 | 1 |
| 1 | 406 | 404 | 2 |
| 2 | 79 | 86 | 0 |
| 3 | 265 | 265 | 2 |
| 4 | 19 | 4 | 8 |
| 5 | 145 | 149 | 2 |

6,1,L

| | | | |
|---|---|---|---|
| 1 | 91 | 95 | 0 |
| 2 | 67 | 67 | 1 |
| 3 | 51 | 52 | 1 |
| 4 | 49 | 34 | 2 |
| 5 | 35 | 34 | 3 |

6,2,L

| | | | |
|---|---|---|---|
| 0 | 50 | 21 | 0 |
| 1 | 240 | 239 | 2 |
| 2 | 12 | 17 | 8 |
| 3 | 138 | 139 | 1 |
| 4 | 19 | 12 | 8 |
| 5 | 76 | 69 | 2 |

6,3,L

| | | | |
|---|---|---|---|
| 1 | 25 | 15 | 2 |
| 2 | 88 | 88 | 1 |
| 3 | 20 | 20 | 3 |
| 4 | 53 | 51 | 2 |
| 5 | 18 | 15 | 9 |

6,4,L

| | | | |
|---|---|---|---|
| 0 | 1226 | 1260 | 2 |
| 1 | 427 | 431 | 2 |
| 2 | 904 | 901 | 2 |
| 3 | 281 | 281 | 2 |
| 4 | 521 | 509 | 3 |

6,5,L

| | | | |
|---|---|---|---|
| 1 | 26 | 25 | 2 |
| 2 | 256 | 264 | 2 |
| 3 | 18 | 15 | 6 |
| 4 | 151 | 147 | 1 |

6,6,L

| | | | |
|---|---|---|---|
| 0 | 273 | 278 | 2 |
| 1 | 228 | 230 | 2 |
| 2 | 211 | 214 | 2 |
| 3 | 150 | 151 | 2 |
| 4 | 128 | 124 | 1 |

6,7,L

| | | | |
|---|---|---|---|
| 1 | 116 | 115 | 1 |
| 2 | 137 | 136 | 1 |
| 3 | 81 | 78 | 1 |
| 4 | 88 | 84 | 2 |

6,8,L

| | | | |
|---|---|---|---|
| 0 | 85 | 84 | 1 |
| 1 | 277 | 282 | 2 |
| 2 | 82 | 78 | 1 |
| 3 | 190 | 188 | 2 |
| 4 | 65 | 69 | 2 |

6,9,L

| | | | |
|---|---|---|---|
| 1 | 121 | 116 | 1 |
| 2 | 130 | 133 | 1 |
| 3 | 77 | 73 | 2 |

6,9,L

| | | | |
|---|---|---|---|
| 4 | 87 | 85 | 2 |

6,10,L

| | | | |
|---|---|---|---|
| 0 | 34 | 23 | 2 |
| 1 | 296 | 306 | 2 |
| 2 | 14 | 13 | 10 |
| 3 | 207 | 203 | 2 |
| 4 | 6 | 7 | 13 |

6,11,L

| | | | |
|---|---|---|---|
| 1 | 160 | 161 | 2 |
| 2 | 104 | 103 | 1 |
| 3 | 116 | 118 | 1 |
| 4 | 75 | 72 | 2 |

6,12,L

| | | | |
|---|---|---|---|
| 0 | 294 | 300 | 2 |
| 1 | 338 | 344 | 2 |
| 2 | 252 | 248 | 2 |
| 3 | 255 | 252 | 2 |
| 4 | 178 | 176 | 2 |

6,13,L

| | | | |
|---|---|---|---|
| 1 | 50 | 52 | 2 |
| 2 | 101 | 101 | 1 |
| 3 | 30 | 38 | 5 |

6,14,L

| | | | |
|---|---|---|---|
| 0 | 350 | 354 | 2 |
| 1 | 119 | 118 | 1 |
| 2 | 296 | 296 | 3 |
| 3 | 108 | 105 | 2 |

6,15,L

| | | | |
|---|---|---|---|
| 1 | 210 | 207 | 2 |
| 2 | 164 | 162 | 2 |
| 3 | 166 | 161 | 2 |

6,16,L

| | | | |
|---|---|---|---|
| 0 | 71 | 70 | 1 |
| 1 | 18 | 24 | 6 |
| 2 | 61 | 61 | 2 |
| 3 | 17 | 12 | 10 |

6,17,L

| | | | |
|---|---|---|---|
| 1 | 97 | 100 | 1 |
| 2 | 64 | 67 | 2 |

6,18,L

| | | | |
|---|---|---|---|
| 0 | 76 | 76 | 2 |
| 1 | 241 | 245 | 2 |
| 2 | 62 | 60 | 2 |

6,19,L

| | | | |
|---|---|---|---|
| 1 | 58 | 60 | 2 |
| 2 | 144 | 144 | 1 |

6,20,L

| | | | |
|---|---|---|---|
| 0 | 110 | 105 | 1 |
| 1 | 154 | 154 | 2 |

7,1,L

| | | | |
|---|---|---|---|
| 1 | 349 | 349 | 2 |
| 2 | 216 | 223 | 2 |
| 3 | 222 | 228 | 2 |
| 4 | 136 | 138 | 1 |

7,2,L

| | | | |
|---|---|---|---|
| 1 | 166 | 156 | 2 |
| 2 | 424 | 436 | 2 |
| 3 | 115 | 117 | 1 |
| 4 | 251 | 257 | 2 |

7,3,L

| | | | |
|---|---|---|---|
| 1 | 116 | 114 | 1 |
| 2 | 242 | 243 | 2 |
| 3 | 62 | 58 | 1 |
| 4 | 143 | 134 | 1 |

7,4,L

| | | | |
|---|---|---|---|
| 1 | 131 | 137 | 1 |
| 2 | 153 | 158 | 2 |
| 3 | 88 | 91 | 1 |
| 4 | 99 | 94 | 2 |

7,5,L

| | | | |
|---|---|---|---|
| 1 | 123 | 122 | 1 |
| 2 | 43 | 43 | 2 |
| 3 | 82 | 81 | 1 |
| 4 | 37 | 35 | 3 |

7,6,L

| | | | |
|---|---|---|---|
| 1 | 212 | 207 | 2 |
| 2 | 237 | 229 | 2 |
| 3 | 146 | 142 | 2 |
| 4 | 156 | 151 | 2 |

7,7,L

| | | | |
|---|---|---|---|
| 1 | 671 | 685 | 2 |
| 2 | 73 | 73 | 1 |
| 3 | 443 | 444 | 3 |
| 4 | 70 | 65 | 2 |

7,8,L

| | | | |
|---|---|---|---|
| 1 | 224 | 223 | 2 |
| 2 | 199 | 197 | 2 |
| 3 | 158 | 158 | 2 |
| 4 | 129 | 129 | 2 |

7,9,L

| | | | |
|---|---|---|---|
| 1 | 206 | 203 | 2 |
| 2 | 295 | 295 | 2 |
| 3 | 148 | 149 | 1 |
| 4 | 191 | 189 | 2 |

7,10,L

| | | | |
|---|---|---|---|
| 1 | 242 | 238 | 2 |
| 2 | 183 | 184 | 2 |
| 3 | 179 | 175 | 2 |
| 4 | 128 | 128 | 2 |

7,11,L

| | | | |
|---|---|---|---|
| 1 | 297 | 304 | 2 |
| 2 | 36 | 35 | 2 |
| 3 | 201 | 201 | 2 |
| 4 | 10 | 14 | 19 |

7,12,L

| | | | |
|---|---|---|---|
| 1 | 324 | 328 | 2 |
| 2 | 134 | 133 | 1 |
| 3 | 252 | 246 | 2 |

7,13,L

| | | | |
|---|---|---|---|
| 1 | 10 | 12 | 13 |

7,13,L

| | | | |
|---|---|---|---|
| 2 | 55 | 53 | 2 |
| 3 | 7 | 12 | 21 |

7,14,L

| | | | |
|---|---|---|---|
| 1 | 158 | 162 | 2 |
| 2 | 98 | 96 | 1 |
| 3 | 127 | 127 | 1 |

7,15,L

| | | | |
|---|---|---|---|
| 1 | 276 | 277 | 3 |
| 2 | 120 | 118 | 1 |
| 3 | 214 | 207 | 2 |

7,16,L

| | | | |
|---|---|---|---|
| 1 | 355 | 355 | 3 |
| 2 | 156 | 157 | 2 |
| 3 | 287 | 287 | 3 |

7,17,L

| | | | |
|---|---|---|---|
| 1 | 128 | 130 | 1 |
| 2 | 41 | 35 | 2 |

7,18,L

| | | | |
|---|---|---|---|
| 1 | 74 | 74 | 2 |
| 2 | 79 | 80 | 2 |

7,19,L

| | | | |
|---|---|---|---|
| 1 | 124 | 122 | 1 |

8,0,L

| | | | |
|---|---|---|---|
| 0 | 1200 | 1219 | 2 |
| 1 | 255 | 263 | 2 |
| 2 | 924 | 945 | 2 |
| 3 | 191 | 193 | 2 |
| 4 | 546 | 544 | 3 |

8,1,L

| | | | |
|---|---|---|---|
| 1 | 193 | 194 | 2 |
| 2 | 167 | 171 | 2 |
| 3 | 118 | 117 | 1 |
| 4 | 103 | 103 | 1 |

8,2,L

| | | | |
|---|---|---|---|
| 0 | 129 | 135 | 1 |
| 1 | 230 | 221 | 2 |
| 2 | 102 | 103 | 1 |
| 3 | 142 | 145 | 1 |
| 4 | 67 | 66 | 2 |

8,3,L

| | | | |
|---|---|---|---|
| 1 | 116 | 114 | 1 |
| 2 | 107 | 110 | 1 |
| 3 | 77 | 78 | 1 |
| 4 | 67 | 70 | 2 |

8,4,L

| | | | |
|---|---|---|---|
| 0 | 103 | 106 | 1 |
| 1 | 392 | 390 | 2 |
| 2 | 95 | 92 | 1 |
| 3 | 258 | 260 | 2 |
| 4 | 86 | 84 | 2 |

8,5,L

| | | | |
|---|---|---|---|
| 1 | 185 | 197 | 2 |
| 2 | 12 | 14 | 8 |
| 3 | 128 | 128 | 1 |
| 4 | 15 | 8 | 12 |

8,6,L

| | | | |
|---|---|---|---|
| 0 | 17 | 20 | 6 |
| 1 | 60 | 61 | 1 |
| 2 | 17 | 14 | 7 |
| 3 | 41 | 36 | 2 |
| 4 | 13 | 3 | 11 |

8,7,L

| | | | |
|---|---|---|---|
| 1 | 162 | 161 | 2 |
| 2 | 122 | 117 | 1 |
| 3 | 116 | 114 | 1 |
| 4 | 83 | 81 | 2 |

8,8,L

| | | | |
|---|---|---|---|
| 0 | 540 | 551 | 2 |
| 1 | 374 | 375 | 2 |
| 2 | 446 | 443 | 2 |
| 3 | 276 | 270 | 3 |
| 4 | 302 | 291 | 3 |

8,9,L

| | | | |
|---|---|---|---|
| 1 | 15 | 1 | 4 |
| 2 | 138 | 134 | 1 |
| 3 | 19 | 2 | 7 |
| 4 | 96 | 89 | 2 |

8,10,L

| | | | |
|---|---|---|---|
| 0 | 266 | 265 | 2 |
| 1 | 105 | 105 | 1 |
| 2 | 220 | 220 | 2 |
| 3 | 89 | 88 | 2 |
| 4 | 147 | 147 | 2 |

8,11,L

| | | | |
|---|---|---|---|
| 1 | 129 | 130 | 1 |
| 2 | 114 | 111 | 1 |
| 3 | 102 | 100 | 2 |

8,12,L

| | | | |
|---|---|---|---|
| 0 | 77 | 76 | 1 |
| 1 | 114 | 114 | 1 |
| 2 | 70 | 68 | 2 |
| 3 | 94 | 93 | 2 |

8,13,L

| | | | |
|---|---|---|---|
| 1 | 65 | 64 | 1 |
| 2 | 19 | 21 | 8 |
| 3 | 54 | 51 | 2 |

8,14,L

| | | | |
|---|---|---|---|
| 0 | 180 | 178 | 2 |
| 1 | 256 | 253 | 2 |
| 2 | 159 | 148 | 2 |
| 3 | 193 | 194 | 2 |

8,15,L

| | | | |
|---|---|---|---|
| 1 | 189 | 188 | 2 |
| 2 | 173 | 172 | 2 |
| 3 | 152 | 150 | 2 |

8,16,L

| | | | |
|---|---|---|---|
| 0 | 126 | 123 | 1 |
| 1 | 205 | 209 | 2 |

8,16,L

| | | | |
|---|---|---|---|
| 2 | 108 | 112 | 2 |

8,17,L

| | | | |
|---|---|---|---|
| 1 | 82 | 88 | 2 |
| 2 | 63 | 65 | 2 |

8,18,L

| | | | |
|---|---|---|---|
| 0 | 250 | 250 | 2 |
| 1 | 140 | 140 | 1 |

8,19,L

| | | | |
|---|---|---|---|
| 1 | 108 | 111 | 2 |

9,1,L

| | | | |
|---|---|---|---|
| 1 | 66 | 68 | 1 |
| 2 | 8 | 12 | 13 |
| 3 | 37 | 33 | 2 |
| 4 | 0 | 14 | 121 |

9,2,L

| | | | |
|---|---|---|---|
| 1 | 216 | 209 | 2 |
| 2 | 181 | 180 | 2 |
| 3 | 150 | 151 | 2 |
| 4 | 125 | 125 | 1 |

9,3,L

| | | | |
|---|---|---|---|
| 1 | 357 | 368 | 2 |
| 2 | 148 | 151 | 1 |
| 3 | 236 | 245 | 2 |
| 4 | 112 | 112 | 2 |

9,4,L

| | | | |
|---|---|---|---|
| 1 | 44 | 39 | 1 |
| 2 | 93 | 94 | 1 |
| 3 | 37 | 30 | 2 |
| 4 | 63 | 62 | 2 |

9,5,L

| | | | |
|---|---|---|---|
| 1 | 302 | 309 | 2 |
| 2 | 284 | 289 | 2 |
| 3 | 217 | 223 | 2 |
| 4 | 189 | 189 | 2 |

9,6,L

| | | | |
|---|---|---|---|
| 1 | 287 | 294 | 2 |
| 2 | 273 | 266 | 2 |
| 3 | 217 | 210 | 2 |
| 4 | 185 | 180 | 2 |

9,7,L

| | | | |
|---|---|---|---|
| 1 | 359 | 368 | 2 |
| 2 | 267 | 267 | 3 |
| 3 | 243 | 234 | 2 |
| 4 | 170 | 170 | 2 |

9,8,L

| | | | |
|---|---|---|---|
| 1 | 191 | 192 | 2 |
| 2 | 168 | 165 | 2 |
| 3 | 142 | 141 | 1 |
| 4 | 121 | 117 | 2 |

9,9,L

| | | | |
|---|---|---|---|
| 1 | 118 | 117 | 1 |
| 2 | 13 | 12 | 11 |
| 3 | 87 | 89 | 2 |
| 4 | 15 | 18 | 6 |

9,10,L

| | | | |
|---|---|---|---|
| 1 | 147 | 147 | 1 |
| 2 | 75 | 72 | 2 |
| 3 | 113 | 115 | 2 |

9,11,L

| | | | |
|---|---|---|---|
| 1 | 143 | 140 | 1 |
| 2 | 15 | 3 | 10 |
| 3 | 96 | 96 | 2 |

9,12,L

| | | | |
|---|---|---|---|
| 1 | 244 | 245 | 2 |
| 2 | 233 | 231 | 2 |
| 3 | 194 | 192 | 2 |

9,13,L

| | | | |
|---|---|---|---|
| 1 | 190 | 189 | 2 |
| 2 | 233 | 230 | 2 |
| 3 | 155 | 151 | 2 |

9,14,L

| | | | |
|---|---|---|---|
| 1 | 123 | 123 | 1 |
| 2 | 113 | 113 | 1 |
| 3 | 103 | 100 | 2 |

9,15,L

| | | | |
|---|---|---|---|
| 1 | 121 | 124 | 1 |
| 2 | 28 | 27 | 3 |

9,16,L

| | | | |
|---|---|---|---|
| 1 | 129 | 132 | 1 |
| 2 | 114 | 113 | 2 |

9,17,L

| | | | |
|---|---|---|---|
| 1 | 13 | 3 | 9 |

9,18,L

| | | | |
|---|---|---|---|
| 1 | 62 | 56 | 2 |

10,0,L

| | | | |
|---|---|---|---|
| 0 | 39 | 30 | 1 |
| 1 | 613 | 628 | 2 |
| 2 | 19 | 10 | 4 |
| 3 | 431 | 424 | 2 |
| 4 | 24 | 19 | 3 |

10,1,L

| | | | |
|---|---|---|---|
| 1 | 126 | 125 | 1 |
| 2 | 147 | 145 | 1 |
| 3 | 91 | 87 | 1 |
| 4 | 97 | 97 | 2 |

10,2,L

| | | | |
|---|---|---|---|
| 0 | 36 | 37 | 2 |
| 1 | 143 | 139 | 1 |
| 2 | 32 | 30 | 2 |
| 3 | 94 | 94 | 1 |
| 4 | 21 | 21 | 6 |

10,3,L

| | | | |
|---|---|---|---|
| 1 | 223 | 229 | 2 |
| 2 | 99 | 101 | 1 |

| | | | |
|---|---|---|---|
| | 10,3,L | | |
| 3 | 161 | 164 | 2 |
| 4 | 73 | 73 | 2 |
| | 10,4,L | | |
| 0 | 412 | 421 | 2 |
| 1 | 171 | 171 | 2 |
| 2 | 332 | 337 | 2 |
| 3 | 140 | 139 | 1 |
| 4 | 219 | 217 | 2 |
| | 10,5,L | | |
| 1 | 52 | 50 | 1 |
| 2 | 147 | 149 | 1 |
| 3 | 37 | 35 | 2 |
| 4 | 105 | 101 | 2 |
| | 10,6,L | | |
| 0 | 285 | 284 | 2 |
| 1 | 262 | 253 | 2 |
| 2 | 242 | 239 | 2 |
| 3 | 191 | 185 | 2 |
| 4 | 166 | 164 | 2 |
| | 10,7,L | | |
| 1 | 169 | 167 | 2 |
| 2 | 139 | 137 | 1 |
| 3 | 132 | 129 | 1 |
| 4 | 100 | 99 | 2 |
| | 10,8,L | | |
| 0 | 38 | 33 | 2 |
| 1 | 192 | 191 | 2 |
| 2 | 40 | 35 | 2 |
| 3 | 146 | 146 | 1 |
| | 10,9,L | | |
| 1 | 13 | 20 | 5 |
| 2 | 109 | 104 | 1 |
| 3 | 12 | 15 | 13 |
| | 10,10,L | | |
| 0 | 104 | 101 | 1 |
| 1 | 14 | 6 | 10 |
| 2 | 83 | 79 | 2 |
| 3 | 16 | 3 | 9 |
| | 10,11,L | | |
| 1 | 111 | 110 | 1 |
| 2 | 155 | 155 | 2 |
| 3 | 89 | 90 | 2 |
| | 10,12,L | | |
| 0 | 251 | 254 | 2 |
| 1 | 240 | 241 | 2 |
| 2 | 222 | 221 | 2 |
| 3 | 193 | 190 | 2 |
| | 10,13,L | | |
| 1 | 29 | 30 | 4 |
| 2 | 40 | 35 | 2 |
| | 10,14,L | | |
| 0 | 467 | 469 | 3 |
| 1 | 104 | 102 | 1 |
| 2 | 419 | 407 | 3 |
| | 10,15,L | | |
| 1 | 111 | 109 | 1 |
| 2 | 105 | 106 | 2 |
| | 10,16,L | | |
| 0 | 54 | 47 | 2 |
| 1 | 39 | 38 | 2 |
| | 10,17,L | | |
| 1 | 0 | 2 | 121 |
| | 11,1,L | | |
| 1 | 352 | 355 | 2 |
| 2 | 206 | 205 | 2 |
| 3 | 259 | 259 | 2 |
| 4 | 145 | 145 | 2 |
| | 11,2,L | | |
| 1 | 347 | 347 | 2 |
| 2 | 134 | 134 | 1 |
| 3 | 260 | 259 | 3 |
| 4 | 98 | 97 | 2 |
| | 11,3,L | | |
| 1 | 126 | 128 | 1 |
| 2 | 96 | 93 | 1 |
| 3 | 80 | 77 | 2 |
| 4 | 56 | 60 | 2 |
| | 11,4,L | | |
| 1 | 59 | 57 | 1 |
| 2 | 29 | 24 | 2 |
| 3 | 45 | 42 | 2 |
| | 11,5,L | | |
| 1 | 96 | 94 | 1 |
| 2 | 9 | 9 | 8 |
| 3 | 75 | 75 | 2 |
| | 11,6,L | | |
| 1 | 346 | 351 | 2 |
| 2 | 230 | 226 | 2 |
| 3 | 273 | 265 | 3 |
| | 11,7,L | | |
| 1 | 301 | 298 | 3 |
| 2 | 36 | 36 | 4 |
| 3 | 218 | 218 | 2 |
| | 11,8,L | | |
| 1 | 67 | 70 | 2 |
| 2 | 101 | 98 | 1 |
| 3 | 55 | 57 | 2 |
| | 11,9,L | | |
| 1 | 195 | 192 | 2 |
| 2 | 280 | 271 | 3 |
| 3 | 157 | 155 | 2 |
| | 11,10,L | | |
| 1 | 80 | 78 | 1 |
| 2 | 150 | 147 | 1 |
| 3 | 69 | 67 | 2 |
| | 11,11,L | | |
| 1 | 124 | 125 | 1 |

11,11,L

| | | | |
|---|---|---|---|
| 2 | 99 | 96 | 2 |
| 3 | 87 | 87 | 2 |

11,12,L

| | | | |
|---|---|---|---|
| 1 | 72 | 72 | 2 |
| 2 | 173 | 168 | 2 |

11,13,L

| | | | |
|---|---|---|---|
| 1 | 76 | 70 | 2 |
| 2 | 70 | 71 | 2 |

11,14,L

| | | | |
|---|---|---|---|
| 1 | 93 | 91 | 1 |
| 2 | 113 | 109 | 2 |

11,15,L

| | | | |
|---|---|---|---|
| 1 | 92 | 91 | 2 |

11,16,L

| | | | |
|---|---|---|---|
| 1 | 37 | 28 | 2 |

12,0,L

| | | | |
|---|---|---|---|
| 0 | 391 | 390 | 2 |
| 1 | 151 | 149 | 2 |
| 2 | 321 | 326 | 2 |
| 3 | 133 | 130 | 1 |

12,1,L

| | | | |
|---|---|---|---|
| 1 | 74 | 75 | 1 |
| 2 | 11 | 8 | 9 |
| 3 | 58 | 59 | 2 |

12,2,L

| | | | |
|---|---|---|---|
| 0 | 69 | 71 | 1 |
| 1 | 199 | 198 | 2 |
| 2 | 63 | 62 | 2 |
| 3 | 147 | 147 | 1 |

12,3,L

| | | | |
|---|---|---|---|
| 1 | 120 | 121 | 1 |
| 2 | 158 | 158 | 2 |
| 3 | 99 | 98 | 2 |

12,4,L

| | | | |
|---|---|---|---|
| 0 | 157 | 159 | 2 |
| 1 | 188 | 192 | 2 |
| 2 | 129 | 125 | 1 |
| 3 | 140 | 139 | 1 |

12,5,L

| | | | |
|---|---|---|---|
| 1 | 209 | 204 | 2 |
| 2 | 74 | 73 | 2 |
| 3 | 163 | 158 | 2 |

12,6,L

| | | | |
|---|---|---|---|
| 0 | 5 | 5 | 31 |
| 1 | 79 | 75 | 1 |
| 2 | 11 | 7 | 6 |
| 3 | 65 | 59 | 2 |

12,7,L

| | | | |
|---|---|---|---|
| 1 | 161 | 163 | 2 |
| 2 | 155 | 154 | 2 |
| 3 | 126 | 130 | 2 |

12,8,L

| | | | |
|---|---|---|---|
| 0 | 283 | 279 | 3 |
| 1 | 131 | 122 | 1 |
| 2 | 248 | 240 | 3 |
| 3 | 105 | 103 | 2 |

12,9,L

| | | | |
|---|---|---|---|
| 1 | 16 | 11 | 10 |
| 2 | 120 | 112 | 2 |
| 3 | 13 | 11 | 13 |

12,10,L

| | | | |
|---|---|---|---|
| 0 | 310 | 303 | 3 |
| 1 | 132 | 130 | 1 |
| 2 | 269 | 262 | 3 |

12,11,L

| | | | |
|---|---|---|---|
| 1 | 201 | 196 | 2 |
| 2 | 156 | 158 | 2 |

12,12,L

| | | | |
|---|---|---|---|
| 0 | 65 | 61 | 2 |
| 1 | 9 | 8 | 19 |
| 2 | 58 | 56 | 2 |

12,13,L

| | | | |
|---|---|---|---|
| 1 | 27 | 21 | 3 |
| 2 | 66 | 66 | 2 |

12,14,L

| | | | |
|---|---|---|---|
| 0 | 71 | 67 | 2 |
| 1 | 178 | 171 | 2 |

13,1,L

| | | | |
|---|---|---|---|
| 1 | 105 | 105 | 1 |
| 2 | 184 | 184 | 2 |
| 3 | 92 | 89 | 2 |

13,2,L

| | | | |
|---|---|---|---|
| 1 | 220 | 221 | 2 |
| 2 | 229 | 228 | 2 |
| 3 | 177 | 174 | 2 |

13,3,L

| | | | |
|---|---|---|---|
| 1 | 375 | 365 | 3 |
| 2 | 74 | 74 | 2 |
| 3 | 286 | 285 | 3 |

13,4,L

| | | | |
|---|---|---|---|
| 1 | 34 | 36 | 2 |
| 2 | 35 | 32 | 2 |
| 3 | 28 | 31 | 3 |

13,5,L

| | | | |
|---|---|---|---|
| 1 | 173 | 173 | 2 |
| 2 | 259 | 254 | 3 |
| 3 | 139 | 143 | 2 |

13,6,L

| | | | |
|---|---|---|---|
| 1 | 132 | 128 | 1 |
| 2 | 189 | 183 | 2 |
| 3 | 106 | 105 | 2 |

13,7,L

| | | | |
|---|---|---|---|
| 1 | 21 | 26 | 8 |

13,7,L

| | | | |
|---|---|---|---|
| 2 | 49 | 50 | 2 |

13,8,L

| | | | |
|---|---|---|---|
| 1 | 77 | 78 | 2 |
| 2 | 15 | 15 | 11 |

13,9,L

| | | | |
|---|---|---|---|
| 1 | 121 | 119 | 1 |
| 2 | 32 | 29 | 3 |

13,10,L

| | | | |
|---|---|---|---|
| 1 | 157 | 156 | 2 |
| 2 | 140 | 137 | 2 |

13,11,L

| | | | |
|---|---|---|---|
| 1 | 380 | 368 | 3 |
| 2 | 49 | 41 | 2 |

13,12,L

| | | | |
|---|---|---|---|
| 1 | 63 | 59 | 2 |

13,13,L

| | | | |
|---|---|---|---|
| 1 | 188 | 187 | 2 |

14,0,L

| | | | |
|---|---|---|---|
| 0 | 73 | 73 | 2 |
| 1 | 34 | 32 | 2 |
| 2 | 60 | 57 | 2 |

14,1,L

| | | | |
|---|---|---|---|
| 1 | 15 | 5 | 8 |
| 2 | 49 | 52 | 2 |

14,2,L

| | | | |
|---|---|---|---|
| 0 | 12 | 0 | 12 |
| 1 | 86 | 85 | 2 |
| 2 | 13 | 0 | 11 |

14,3,L

| | | | |
|---|---|---|---|
| 1 | 106 | 103 | 1 |
| 2 | 120 | 119 | 1 |

14,4,L

| | | | |
|---|---|---|---|
| 0 | 411 | 407 | 3 |
| 1 | 87 | 83 | 2 |
| 2 | 370 | 360 | 3 |

14,5,L

| | | | |
|---|---|---|---|
| 1 | 93 | 92 | 2 |
| 2 | 5 | 18 | 31 |

14,6,L

| | | | |
|---|---|---|---|
| 0 | 121 | 114 | 1 |
| 1 | 90 | 89 | 2 |
| 2 | 104 | 102 | 2 |

14,7,L

| | | | |
|---|---|---|---|
| 1 | 148 | 149 | 1 |
| 2 | 157 | 157 | 2 |

14,8,L

| | | | |
|---|---|---|---|
| 0 | 0 | 12 | 106 |
| 1 | 70 | 67 | 2 |
| 2 | 16 | 7 | 9 |

14,9,L

| | | | |
|---|---|---|---|
| 1 | 31 | 25 | 3 |

14,10,L

| | | | |
|---|---|---|---|
| 0 | 12 | 2 | 14 |
| 1 | 183 | 175 | 2 |

14,11,L

| | | | |
|---|---|---|---|
| 1 | 198 | 192 | 2 |

14,12,L

| | | | |
|---|---|---|---|
| 0 | 94 | 93 | 2 |

15,1,L

| | | | |
|---|---|---|---|
| 1 | 244 | 241 | 2 |
| 2 | 204 | 201 | 2 |

15,2,L

| | | | |
|---|---|---|---|
| 1 | 76 | 69 | 2 |
| 2 | 204 | 199 | 2 |

15,3,L

| | | | |
|---|---|---|---|
| 1 | 18 | 18 | 6 |
| 2 | 175 | 171 | 2 |

15,4,L

| | | | |
|---|---|---|---|
| 1 | 51 | 52 | 2 |
| 2 | 76 | 73 | 2 |

15,5,L

| | | | |
|---|---|---|---|
| 1 | 124 | 119 | 2 |
| 2 | 82 | 84 | 2 |

15,6,L

| | | | |
|---|---|---|---|
| 1 | 40 | 44 | 3 |

15,7,L

| | | | |
|---|---|---|---|
| 1 | 250 | 239 | 3 |

15,8,L

| | | | |
|---|---|---|---|
| 1 | 54 | 47 | 2 |

16,0,L

| | | | |
|---|---|---|---|
| 0 | 258 | 253 | 3 |
| 1 | 21 | 3 | 6 |

16,1,L

| | | | |
|---|---|---|---|
| 1 | 129 | 124 | 2 |

16,2,L

| | | | |
|---|---|---|---|
| 0 | 60 | 55 | 2 |
| 1 | 86 | 78 | 2 |

16,3,L

| | | | |
|---|---|---|---|
| 1 | 124 | 124 | 2 |

16,4,L

| | | | |
|---|---|---|---|
| 0 | 24 | 27 | 8 |

```
                                1  183  173    2
          16,4,L                                      0   32   31    3
                                     16,6,L
```

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# THE CRYSTAL STRUCTURE OF LUDWIGITE

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## ABSTRACT

We have refined the structure of ludwigite with a crystal taken from the Crestmore quarry, California; it is close to the end member in composition, ideally $Mg_2FeBO_5$. The sample has a formula $Mg_{1.76}Fe_{1.22}Al_{0.02}BO_5$ and unit-cell dimensions *a* 9.2411(6), *b* 12.2948(9), *c* 3.0213(3) Å, *V* 343.27(5) Å$^3$. The structure was refined in space group *Pbam*, to a final $R_w = 0.023$ for 948 observed unique reflections. The very low Al content allows the refinement of the distribution of magnesium and iron in the structure without assumptions as to the location of aluminum.

*Keywords*: ludwigite, vonsenite, pinakiolite group, crystal structure, Crestmore quarry, California.

## SOMMAIRE

Nous avons affiné la structure de la ludwigite avec un cristal provenant de la carrière Crestmore, en Californie, et dont la composition est voisine de la composition idéale, $Mg_2FeBO_5$. La formule est en fait $Mg_{1.76}Fe_{1.22}Al_{0.02}BO_5$, et les paramètres réticulaires sont: *a* 9.2411(6), *b* 12.2948(9), *c* 3.0213(3) Å, *V* 343.27(5) Å$^3$. L'affinement, dans le groupe spatial *Pbam*, a mené à un résidu final $R_w$ de 0.023 pour 948 réflexions uniques observées. La teneur très faible en Al permet un affinement de la distribution du magnésium et du fer dans la structure sans avoir à adresser la question de la distribution de l'aluminium.

(Traduit par la Rédaction)

*Mots-clés*: ludwigite, vonsenite, groupe de la pinakiolite, structure cristalline, carrière Crestmore, Californie.

## INTRODUCTION

We present here the results of a refinement of the crystal structure of ludwigite; in the sample selected, from the Crestmore quarry, California, there is almost no aluminum substituting for $Fe^{3+}$. Ludwigite, with an ideal formula $Mg_2Fe^{3+}BO_5$, is an end-member of the ludwigite–vonsenite ($Fe^{2+}{}_2Fe^{3+}BO_5$) series. Manganese, aluminum and titanium commonly are found to substitute for magnesium and iron. This sample of ludwigite contains only magnesium and iron (with very minor aluminum), and the structure refinement provides information about the structure in the absence of the other substituents.

## BACKGROUND INFORMATION

Takéuchi *et al.* (1950) solved the structure of ludwigite. It belongs to the pinakiolite group of minerals, in which metal ions are octahedrally coordinated by oxygen. The octahedra are linked together by edge-sharing to form what have been described as walls (*e.g.*, Bovin *et al.* 1981). Figure 1 shows the structure of ludwigite viewed down the *c* axis. Swinnea & Steinfink (1983) refined the structure of synthetic vonsenite ($Fe_3BO_5$) and, on the basis of Mössbauer spectroscopy, concluded that ferrous and ferric iron occur in sites *M*2 and *M*4, whereas only ferrous iron occupies *M*1 and *M*3. They suggested that the distance between nearest-neighbor *M*2 and *M*4 sites of 2.79 Å is short enough for electron-hopping to occur. Norrestam *et al.* (1989) studied aluminian ludwigite and concluded, on the basis of site refinement of X-ray data and bond-valence calculations, that Mg occupies all four metal sites. They assumed that the aluminum is evenly distributed over all four sites. Bonazzi & Menchetti (1989) studied three structures in the ludwigite–vonsenite series and described the variation of cell dimensions and bond lengths with composition. Takéuchi & Kogure (1992) described the structure of a specimen of aluminian ludwigite and assigned aluminum to the *M*4 site.

## EXPERIMENTAL

The crystal used is from the Crestmore quarry, Riverside, California, and was provided by the Canadian

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