```
.include    <m2560def.inc>
.equ    C4H     = high(15289)   ; delay count for creating 261.63-Hz tone
.equ    C4L = low(15289)
.equ    C4SH    = high(14431)   ; delay count for creating 277.18-Hz tone
.equ    C4SL    = low(14431)
.equ    D4FH    = high(14431)   ; 277.18 Hz
.equ    D4FL    = low(14431)
.equ    D4H     = high(13621)   ; 293.66 Hz
.equ    D4L = low(13621)
.equ    D4SH    = high(12856)   ; 311.13 Hz
.equ    D4SL    = low(12856)
.equ    E4FH    = high(12856)   ; 311.13 Hz
.equ    E4FL    = low(12856)
.equ    E4H = high(12135)   ; 329.63 Hz
.equ    E4L = low(12135)
.equ    F4H = high(11454)   ; 349.23 Hz
.equ    F4L = low(11454)
.equ    F4SH    = high(10811)   ; 369.99 Hz
.equ    F4SL    = low(10811)
.equ    G4FH    = high(10811)   ; 369.99 Hz
.equ    G4FL    = low(10811)
.equ    G4H = high(10204)   ; 392.00 Hz
.equ    G4L = low(10204)
.equ    G4SH    = high(9632)    ; 415.30 Hz
.equ    G4SL    = low(9632)
.equ    A4FH    = high(9632)    ; 415.30 Hz
.equ    A4FL    = low(9632)
.equ    A4H = high(9091)    ; 440.00 Hz
.equ    A4L = low(9091)
.equ    A4SH    = high(8581)    ; 466.16 Hz
.equ    A4SL    = low(8581)
.equ    B4FH    = high(8581)    ; 466.16 Hz
.equ    B4FL    = low(8581)
.equ    B4H = high(8099)    ; 493.88 Hz
.equ    B4L = low(8099)
.equ    C5H = high(7645)    ; 523.25 Hz
.equ    C5L = low(7645)
.equ    C5SH    = high(7215)    ; 554.37 Hz
.equ    C5SL    = low(7215)
.equ    D5FH    = high(7215)    ; 554.37 Hz
.equ    D5FL    = low(7215)
.equ    D5H = high(6810)    ; 587.33 Hz
.equ    D5L = low(6810)
.equ    D5SH    = high(6428)    ; 622.25 Hz
.equ    D5SL    = low(6428)
.equ    E5FH    = high(6428)    ; 622.25 Hz
.equ    E5FL    = low(6428)
.equ    E5H = high(6067)    ; 659.26 Hz
.equ    E5L = low(6067)
.equ    F5H = high(5727)    ; 698.46 Hz
.equ    F5L = low(5727)
.equ    F5SH    = high(5404)    ; 739.99 Hz
.equ    F5SL    = low(5404)
.equ    G5FH    = high(5404)    ; 739.99 Hz
.equ    G5FL    = low(5404)
.equ    G5H = high(5102)    ; 783.99 Hz
.equ    G5L = low(5102)
.equ    G5SH    = high(4816)    ; 830.61 Hz
.equ    G5SL    = low(4816)
.equ    A5FH    = high(4816)    ; 830.61 Hz
```

```
    .equ    A5FL    = low(4816)
    .equ    A5H = high(4545)    ; 880.00 Hz
    .equ    A5L = low(4545)
    .equ    A5SH    = high(4290)    ; 932.33 Hz
    .equ    A5SL    = low(4290)
    .equ    B5FH    = high(4290)    ; 932.33 Hz
    .equ    B5FL    = low(4290)
    .equ    B5H = high(4050)    ; 987.77 Hz
    .equ    B5L = low(4050)
    .equ    ZZH = 0     ; an inaudible note
    .equ    ZZL = 50        ;   "
    .def    dlyHi   = R21       ; delay count high byte
    .def    dlyLo   = R20       ; delay count low byte
    .def    ocCntHi = R4
    .def    ocCntLo     = R3
    .def    tmp     = r19

    .cseg
    .org    0x00
    jmp start
    .org    OC1Aaddr
    jmp oc1AISR
    .org    0xF6
start:  ldi tmp,low(RAMEND) ; initialize the SP
    out SPL,tmp     ;   "
    ldi tmp,high(RAMEND);   "
    out SPH,tmp     ;   "
    lds tmp,DDRB
    ori tmp,0x20    ; configure OC1A/PB5 pin for output
    out DDRB,tmp    ;   "
    ldi tmp,0x40    ; configure TMR1 to operate in normal mode and
    sts TCCR1A,tmp  ; set compare match action to toggle
    ldi tmp,0x01    ; select clk_IO as clock input to Timer 1
    sts TCCR1B,tmp  ;   "
    ldi ZL,low(score<<1)
    ldi ZH,high(score<<1)
    lpm dlyLo,z+
    lpm dlyHi,z+
    lds ocCntLo,TCNT1L  ; read the 16-bit timer 1
    lds ocCntHi,TCNT1H  ;   "
    add ocCntLo,dlyLo
    adc ocCntHi,dlyHi
    sts OCR1AH,ocCntHi  ; start the first OC1A operation to start the song
    sts OCR1AL,ocCntLo  ;   "
    ldi tmp,1<<OCF1A
    sts TIFR1,tmp   ; clear OCF1A flag
    ldi tmp,1<<OCIE1A   ; enable OC1A interrupt locally
    sts TIMSK1,tmp  ;   "
    sei         ; enable interrupt globally
    ldi ZL,low(score<<1)
    ldi ZH,high(score<<1)
songLp: lpm dlyLo,z+    ; read OC delay count low byte
    lpm dlyHi,z+
    cpi dlyHi,0     ; is the lower byte equal to 0?
    brne    next        ; no, we haven't finished playing the song
    cpi dlyLo,0
    breq    done
next:   lpm r16,z+
    call    delayby10ms ; and place the current note for this duration
    rjmp    songLp      ; continue to the next note
```

```
done:   ldi r16,0       ; stop Timer 1
    sts TCCR1B,r16  ;   "
    rjmp    done
; ---------------------------------------------------------------------------------------------------------------↙
    --------
; The OC1AISR interrupt routine restart a new compare operation to OC1A using
; dlyHi:dlyLo as the delay count.
; ---------------------------------------------------------------------------------------------------------------↙
    --------
oc1AISR: lds    ocCntLo,OCR1AL  ; start the next compare operation for
    lds ocCntHi,OCR1AH  ; channel OC1A
    add ocCntLo,dlyLo   ;   "
    adc ocCntHi,dlyHi   ;   "
    sts OCR1AH,ocCntHi  ;   "
    sts OCR1AL,ocCntLo  ;   "
    reti
; ---------------------------------------------------------------------------------------------------------------↙
    ---------------
; The following subroutine uses Timer3 overflow to create a time delay that is a multiple of
; 10 ms. The multiple is passed in R16.
; ---------------------------------------------------------------------------------------------------------------↙
    ---------------
delayby10ms:
    ldi tmp,0       ; configure Timer 3 to normal mode
    sts TCCR3A,tmp  ; with clock source set to
    ldi tmp,0x02    ; clk_IO / 8
    sts TCCR3B,tmp  ;   "
wp10:   ldi tmp,high(55536) ; Let Timer3 count up from 55536 (65536 - 10000) so that it
    sts TCNT3H,tmp  ; overflows in 10000 clock cycles
    ldi tmp,low(55536)  ;   "
    sts TCNT3L,tmp  ;   "
    ldi tmp,1<<TOV3 ; clear TOV3 flag
    sts TIFR3,tmp   ;   "
wt10:   lds tmp,TIFR3   ; wait until TOV3 flag is set to 1
    sbrs    tmp,TOV3    ;   "
    rjmp    wt10        ;   "
    dec r16
    brne    wp10
    ret

score:  .db F4L,F4H,30, G4L,G4H,10, A4L,A4H,60, B4FL,B4FH,20, ZZL,ZZH,3, B4FL,B4FH,60
    .db C5L,C5H,20, ZZL,ZZH,3, C5L,C5H,60, A4L,A4H,20, ZZL,ZZH,3, A4L,A4H,40
    .db C5L,C5H,40, B4FL,B4FH,60, A4L,A4H,20, B4FL,B4FH,40
    .db G4L,G4H,40, A4L,A4H,120, F4L,F4H,30, G4L,G4H,10
    .db A4L,A4H,60, B4FL,B4FH,20, ZZL,ZZH,3, B4FL,B4FH,60, C5L,C5H,20, ZZL,ZZH,3
    .db C5L,C5H,80, A4L,A4H,40, C5L,C5H,40, B4FL,B4FH,60, A4L,A4H,20, B4FL,B4FH,40
    .db G4L,G4H,40, F4L,F4H,80, ZZL,ZZH,40, C5L,C5H,20
    .db ZZL,ZZH,3, C5L,C5H,20, F5L,F5H,60, E5L,E5H,20, D5L,D5H,60, C5L,C5H,20
    .db C5L,C5H,80, A4L,A4H,40, C5L,C5H,40, B4FL,B4FH,60, A4L,A4H,20, B4FL,B4FH,40
    .db G4L,G4H,40, A4L,A4H,120, C5L,C5H,20, ZZL,ZZH,3, C5L,C5H,20, F5L,F5H,60
    .db E5L,E5H,20, D5L,D5H,60, C5L,C5H,20, ZZL,ZZH,3, C5L,C5H,80, A4L,A4H,40
    .db C5L,C5H,40, C5L,C5H,40, B4FL,B4FH,80, G4L,G4H,40, F4L,F4H,120, ZZL,ZZH,40
    .db C5L,C5H,160, B4FL,B4FH,80, G4L,G4H,80, F4L,F4H,40, ZZL,ZZH,40, G4L,G4H,40
    .db ZZL,ZZH,40, A4L,A4H,80, ZZL,ZZH,40, C5L,C5H,40, F5L,F5H,60, E4L,E4H,20
    .db D5L,D5H,60, C5L,C5H,20, ZZL,ZZH,3, C5L,C5H,80, A4L,A4H,40, C5L,C5H,40
    .db B4FL,B4FH,60, A4L,A4H,20, B4FL,B4FH,40, G4L,G4H,40, F4L,F4H,120,0
```