```
//OPENING SENTENCE
OPENING,        LDA   StrPTROP              //THEN
                BSA   PrintString
                BUN   Main
NotFirstTime,   LDA   StrOpInput
                BSA   PrintString
Main,           BSA   GetOperator
                LDA   StrPTRNum1
                STA   strTemp
                BSA   PrintString
                BSA   GetSignedInt          //
                STA   Num
                ISZ   FlagLeftOperand       //Left operand was assigned
                LDA   StrPTRNum2
                STA   strTemp
                BSA   PrintString
                BSA   GetSignedInt
                STA   Num2
                BUN   FI

//GetOperator() is a function that will wait for an operator input from the user and determine the input
//accordingly and will change the right operator variable to zero so the main will know which operator
// to continue calculating with.
GetOperator,    HEX   0                     //
                CLA
                BSA   In_char
CheckMul,       CMA
                INC
                ADD   Mul
                SZA
                BUN   CheckPlus
isMul,          STA   Mul
                BUN   GetOperator I
CheckPlus,      LDA   TOperator
                CMA
                INC
                ADD   Plus
                SZA                         //if(TOperator == plus)
                BUN   CheckMinus
isPlus,         STA   Plus                  //THEN
                BUN   GetOperator I
CheckMinus,     LDA   TOperator
                CMA
                INC
                ADD   Minus
                SZA
                BUN   CheckDiv
isMinus,        STA   Minus
                BUN   GetOperator I
CheckDiv,       LDA   TOperator
                CMA
                INC
                ADD   Div
                SZA
                BUN   errIsNotOp
isDiv,          STA   Div
                BUN   GetOperator I
```

```
errIsNotOp,         LDA   cReturn
                    OUT
                    LDA   Cc
                    OUT
                    LDA   StrNotOp
                    BSA   PrintString
                    BUN Reset
//This function will get any number and store it in variable 'Num'
GetSignedInt,       HEX   0
                    CLA
                    STA   TNum
                    LDA   FlagOFF
                    STA   minus_flagRight
                    LDA   OperatorFlag
                    SZA                         //If(operatorFlag == 0)
                    BUN   checkLeftOperand
                    ISZ   OperatorFlag          //THEN
                    BUN   In_char
checkLeftOperand,   LDA   FlagLeftOperand
                    SPA                         //if(FlagLeftOperand > 0)
                    BUN   In_char
                    ISZ   FlagLeftOperand               //THEN
//this function determines between different types of user input to know how to handle the input num
In_char,            HEX   0
                    BSA   Getc
                    STA   Cc
checkX,             ADD   minusX
                    SZA                                 //IF minusX == 0
                    BUN   ContinueCheck
                    HLT                                 //THEN
ContinueCheck,      LDA   operatorFlag
                    SZA
                    BUN   MinusMinus                    //IF OPERATOR START
                    LDA   Cc
                    STA   TOperator
                    LDA   operatorFlag
                    INC
                    STA   operatorFlag
                    LDA   TOperator
                    BUN   In_char I
MinusMinus,         LDA   Cc
                    ADD   minusMinusASCII
                    SZA
                    BUN   operatorFlagCheck
                    LDA   FlagOn                //FlagOn starts with negative number
                    STA   minus_flagRight
                    BSA   Getc
                    STA   Cc
operatorFlagCheck,  LDA   OperatorFlag
                    SZA
                    BUN   getUnsigned     //if operator phase is already executed
                    BUN   GetSignedInt I
getUnsigned,        LDA   Cc
                    ADD   minusCReturn
                    SZA
                    BUN   Convert
                    BUN   End_loop
Convert,            LDA   Cc              // IF Character is not ENTER or Operator
```

```
                        ADD     mASCII_zero     //CONVERT TO the real number - 30
                        STA     Cc
limit0To9,              LDA Cc          //Cc is now an unsigned decimal digit
                        SNA                                             //if(digit < 0)
                        BUN     ContinueLimit0to9
                        BUN errIsNotDigit
ContinueLimit0to9,      LDA     Cc                                      //THEN
                        ADD     minus_nine
                        SPA                             //if(digit < 0 OR digit - 9 > 0)
                        BUN     DigitCase                       //ELSE digit is fine
                        BUN     errIsNotDigit   //THEN digit Cc is NOT ok (between 0 - 9)
DigitCase,              LDA     TNum            // The current whole number we have
                        BSA     MultBy10
                        ADD     Cc              // Cc is currently the original next number
                        STA     TNum            // TNum = (prev digit*10) + currentDigit
                        BUN     In_char
End_loop,               LDA     minus_flagRight
                        SPA
                        BUN     FI_1
                        LDA     TNum
                        CMA
                        INC
                        STA     TNum
FI_1,                   LDA     TNum
                        BUN     GetSignedInt    I
//THE CALCULATION OF THE RESULT
FI,                     HEX  0
SENDTOPLUS,             LDA     Plus
                        SZA
                        BUN     SENDTOMINUS
                        LDA     Num
                        ADD     Num2
                        STA     Res
                        BUN     PRINTRES
SENDTOMINUS,            LDA     Minus
                        SZA
                        BUN     SENDTOMUL
                        LDA     Num2
                        CMA
                        INC
                        ADD     Num
                        STA     Res
                        BUN     PRINTRES
SENDTOMUL,              LDA     Mul
                        SZA                                             //if(mul == 0)
                        BUN     SENDTODIV
PreMul,                 LDA     minus_flagRight                 //THEN
                        ADD     minus_flagLeft
                        STA     resMinusFlag    //IF(resMinusFlag == 1) THEN res = '-num'
gotoLeftOperand,        LDA     minus_flagLeft
                        ADD     Minus1
                        SZA                                             //If(minus_flagLeft) == 1
                        BUN     gotoRightOperand
                        LDA     Num                                     //THEN
                        CMA
                        INC
                        STA     Num
gotoRightOperand,       LDA     minus_flagRight
```

```
                ADD     Minus1
                SZA
                BUN     Multiply
                LDA     Num2
                CMA
                INC
                STA     Num2
Multiply,       LDA     DigitCount      // FOR (each 16 binary digits in multiplier)
                ADD     Digits                  //
                SZA                             //
                BUN     BodyMul                  //
                BUN     PRINTRES                //
//
BodyMul,        LDA     Num2                    // DO
                CIR                             //
                STA     Num2                    //
                SZE                             // IF (digit == 1)
                BUN     THENMUL                 //
                BUN     FI_MUL                  //
THENMUL,        LDA     Res             // THEN result = result + multiplicand;
                ADD     Num                     //
                STA     Res                     //
FI_MUL,         LDA     Num                     // FI;
                CIL                     // Shift(multiplicand) 1 place to left;
                STA     Num                     //
                ISZ     DigitCount              // DigitCount++;
                BUN     Multiply                // OD;
SENDTODIV,      LDA     Num2
                SZA                             //IF(rightOperand == 0)
                BUN     ELSE1           //DIV_FUNC();
                BUN PRINTDIVZERO                //THEN
ELSE1,          BSA     DIV_FUNC
PrintResDiv,    LDA     counterDIV              //THEN
                STA     Res
                LDA     resMinusFlag
                ADD Minus1
                SZA                             //if(resMinusFlag == 1)
                BUN     OutPutResDiv
                LDA     Res                                     //THEN
                CMA
                INC
                STA     Res
OutPutResDiv,   LDA     Res
                BSA     putSignedIntt
                LDA     openParenthesis
                OUT
                CLA
                STA     flagZero
                LDA     remainder
                STA     Res
                BSA     putSignedIntt
                LDA     closedParenthesis
                OUT
                BUN     Reset
PRINTDIVZERO,   LDA     STRPTRDIVZERO I         //THEN
                SZA                             //IF StrPtrDivZero == 0
                BUN     CONTINUESTRDIV0
                BUN     Reset                           //
```

```
CONTINUESTRDIV0,    OUT                             //THEN
                    ISZ     STRPTRDIVZERO
                    BUN     PRINTDIVZERO
DIV_FUNC,           HEX     0                       //DIV_FUNC() {
                    LDA     Num
chckMinusFlagR,     BSA     PosOrNeg
                    STA      minus_flagLeft
checkMinusFlagL,    LDA     Num2
                    BSA     PosOrNeg
                    STA     minus_flagRight
                    ADD     minus_flagLeft
                    STA     resMinusFlag

equalOne,           LDA     Num
                    CMA
                    INC
                    ADD     Num2
                    SZA                 //if(Num == Num2 or -num == -num2)
                    BUN     checkOpose
                    LDA     One                     //THEN
                    STA     counterDiv
                    LDA     zero
                    STA     remainder
                    BUN     DIV_FUNC I
checkOpose,         LDA     Num
                    ADD     Num2
                    SZA                 //if(num == -num2 or -num == num2)
                    BUN     LeftToPositive
                    LDA     One                     //THEN
                    STA     counterDiv
                    LDA     zero
                    STA     remainder
                    BUN     DIV_FUNC I
LeftToPositive,     LDA     minus_flagLeft
                    SPA                             //if(minus_flagLeft == 1)
                    BUN     RightToPositive
                    LDA     Num
                    CMA                             //THEN
                    INC
                    STA     Num
RightToPositive,    LDA     minus_flagRight
                    SPA                             //if(minus_flagRight == 1)
                    BUN     positiveResultDiv
                    LDA     Num2                    //THEN
                    CMA
                    INC
                    STA Num2
positiveResultDiv,  LDA     Num2                    //two operands are positive
                    CMA
                    INC
                    ADD     Num
                    SPA                             //if(Num > Num2)
                    BUN     remainderLeft
FOR_LOOPDIV1,       LDA     Num2                    //THEN
                    CMA
                    INC
                    ADD     Num
                    STA     Num
```

```
                        SNA                             //if(acc < 0)
                        BUN     counterPlusDiv
FIDIV,                  ADD     Num2                    //THEN
                        STA     remainder
                        BUN DIV_FUNC I
counterPlusDiv,         ISZ     counterDIV
                        BUN     FOR_LOOPDIV1
remainderLeft,          LDA     minus_flagLeft
                        SZA                             //if(minus_flagLeft == 0)
                        BUN     convertRemainder
                        LDA     Num                             // THEN
                        STA     remainder
                        BUN     DIV_FUNC I
convertRemainder,       LDA     Num
                        CMA
                        INC
                        STA     remainder
                        BUN     DIV_FUNC I
errIsNotDigit,          LDA     cReturn
                        OUT
                        LDA     Cc
                        ADD     ascii_Offset
                        OUT
                        LDA     StrNotDigit
                        STA     strTemp
                        BSA     PrintString
                        BUN     Reset
//This function returns true (negative number) or false (positive number)
PosOrNeg,               HEX     0
                        CLE
                        CIL
                        CLA
                        CIL
                        BUN     PosOrNeg I

// main() data
strTemp,                HEX     0
minus_nine,             DEC     -9
openParenthesis,        HEX     28
closedParenthesis,      HEX     29
remainder,              DEC 0
One,                    DEC     1
tmpNum,                 DEC     0
counterDIV,             DEC     0
StrPTRTEMP,             HEX     0
four,                   DEC     4
DigitCount,             DEC 0
Digits,                 DEC     -16
resMinusFlag,           DEC     0
STRPTRDIVZERO,          HEX     600
StrPTROP,               HEX     400                     //
StrNotOp,               HEX     430
StrOpInput,             HEX     325
StrNotDigit,            HEX     450
StrPTRNum1,             HEX     470
StrPTRNum2,             HEX     480
copyStrOpInput,         HEX     325
copySTRPTRDIVZERO,      HEX     600
```

```
copyStrPTROP,           HEX    400                  //
copyStrNotDigit,        HEX    450
copyStrPTRNum1,         HEX    470
copyStrPTRNum2,         HEX    480
Num,                    DEC    0
Num2,                   DEC    1
Res,                    DEC    0
NumMinus,               DEC    -32768                    //
StrDivBy0,              HEX    600
digit,                  DEC 0
ascii_Offset,           HEX 30          // digit to ascii representation offset
Stripped,               DEC 0           // +ve value of TNum
Minus1,                 DEC -1
count,                  DEC 0
It_count ,              DEC 4           // loop count (for 16 bit integer)
Power10Ptr,             HEX    500      // @Power10Array
ptr,                    HEX    0                    // //
// GetSignedInt Data
minusMinusASCII,        HEX -2D
OperatorFlag,           DEC  0
minus_flagLeft,         DEC  0
minus_flagRight,        DEC  0
flagZero,               DEC 0
FlagOn,                 DEC  1
FlagOff,                DEC  0
FlagLeftOperand,        DEC  0          //If left operand was assigned
// GetOperatorData
TOperator,              DEC  0
//ALL OPERATORS
minusX,                 HEX  -58
Mul,                    HEX 2A
Minus,                  HEX  2D
Plus,                   HEX  2B
Div,                    HEX  2F
Equal,                  HEX  3D
ProtoMul,               HEX 2A      // Prototype will reassign */+- to the original.
ProtoMinus,             HEX  2D
ProtoPlus,              HEX  2B
ProtoDiv,               HEX  2F
zero,                   DEC    0
//GetUnsignedInt Data
TNum,                   DEC  0
Cc,                     DEC  0
mASCII_zero,            HEX  -30
minusCReturn,           HEX    -D
cReturn,                HEX    D

PRINTRES,               LDA    Mul
                        SZA                              //IF ITS MUL
                        BUN    STEP2
                        BSA    convertResultOfMul        //THEN
STEP2,                  CLE
                        LDA    Equal
                        OUT
                        LDA    Res
                        BSA    putSignedIntt             // PutUnsignedIntt(Num);
                        BUN    Reset                             //
//putSignedIntt function will print all the digits of the result to the screen one by one
```

```
putSignedIntt,          HEX   0// putSignedIntt(short signed int Tnum) {   will print digits
                        STA   Tnum                          //
                        LDA   Power10Ptr                    //
                        STA   Ptr                           // Ptr = @Power10Array
                        LDA   It_count
                        STA   Count   // Count = It_count; i.e. 4 in the case of 16 bits
                        LDA   TNum                          // IF (TNum 0; Count--)
                        SNA                                 //
                        BUN   Positive
Negative,               LDA   TNum
                        CMA
                        INC
                        STA   Stripped
                        LDA   ProtoMinus
                        BSA   Putc
                        BUN   ForLoop
Positive,               LDA   TNum
                        STA   Stripped
ForLoop,                LDA   Count
                        SPA
                        BUN   EndFor                        //
                        CLA                                 // DO digit =0;
                        STA   Digit                         //
Loop,                   LDA   ptr I                 // WHILE (Stripped - *Ptr > 0)
                        ADD   Stripped                      // DO
                        SNA
                        BUN   Continue                       //
                        BUN   Outx //
Continue,               STA   Stripped                      // Stripped=Stripped - *Ptr;
                        ISZ   digit                         // digit++;
                        BUN   Loop                          // OD;
Outx,                   LDA   digit
                        SZA                                 //if(digit==0)
                        BUN   printDigit                    //else
checkFlagZero,          LDA   flagZero                      //THEN
                        SZA                                 //if(flagZero==0)
prePrintDigit,          BUN   COUNTERIT                     //else flagZero++
                        BUN   gotoNextDigit                 //then gotoNextDigit
COUNTERIT,              ISZ   flagZero
printDigit,             ISZ   flagZero
                        LDA   digit
                        ADD   ascii_Offset                  //
                        BSA   Putc                          //
gotoNextDigit,          ISZ   ptr                           // ptr++;
                        LDA   count                         // Count--;
                        ADD   Minus1                        //
                        STA   Count                          //
                        BUN   ForLoop                        // OD;
EndFor,                 LDA   Stripped                      //
                        ADD   ascii_Offset                  //
                        BSA   Putc                          // Output(last digit);
// print units – the left over in ACC
End,                    BUN   putSignedIntt I               // return; }
ConvertResultOfMul,     HEX   0
                        LDA   resMinusFlag
                        ADD   Minus1
                        SZA                                 //If(resMinusFlag == 1)
                        BUN   ConvertResultOfMul I
```

```
                        LDA     Res                         //THEN
                        CMA
                        INC
                        STA     Res
                        BUN     ConvertResultOfMul  I
///PrintString will print any string in address of strTemp
PrintString,            HEX     0                   //PrintString(strTemp);
                        STA     strTemp
forLoopString,          LDA     strTemp I
                        SZA                                 //if(*strTemp == 0)
                        BUN     PrePUTC
                        BUN     PrintString I               //THEN
prePUTC,                BSA     Putc
                        ISZ     strTemp
                        BUN     forLoopString
MultBy10,               HEX     0
                        CLE
                        CIL
                        STA     tmp
                        CIL
                        CIL
                        ADD     tmp
                        BUN     MultBy10 I
// MultBy10 data
tmp,                    DEC     0
// subroutine getC()
Getc,                   HEX     0
Inp_char,               SKI
                        BUN     Inp_char
                        INP
Echo,                   SKO
                        BUN     Echo
                        OUT
                        BUN     Getc I
//After the calculation we must reinitialize all our variables
Reset,                  LDA     ProtoMinus
                        STA     Minus
                        LDA     ProtoPlus
                        STA     Plus
                        LDA     ProtoMul
                        STA     Mul
                        LDA     ProtoDiv
                        STA     Div
                        LDA     zero
                        STA     Num
                        STA     resMinusFlag
                        STA     Num2
                        STA     counterDIV
                        STA     count
                        STA     digit
                        STA     strTemp
                        STA     tmp
                        STA     tmpNum
                        STA     DigitCount
                        STA     operatorFlag
                        STA     FlagLeftOperand
                        STA     flagZero
                        STA     Stripped
```

```
                    STA     minus_flagRight
                    STA     minus_flagLeft
                    STA     OperatorFlag
                    STA     flagZero
                    STA     ptr
                    STA     Res
                    STA     TNum
                    STA     Cc
                    LDA     four
                    STA     It_count
                    LDA     copyStrOpInput
                    STA     StrOpInput
                    LDA     copySTRPTRDIVZERO
                    STA     STRPTRDIVZERO
                    STA     StrDivBy0
                    LDA     copyStrNotDigit
                    STA     StrNotDigit
                    LDA     copyStrPTRNum1
                    STA     StrPTRNum1
                    LDA     copyStrPTRNum2
                    STA     StrPTRNum2
                    LDA     copyStrPTROP
                    STA     StrPTROP
                    CLA
                    CLE
                    BUN     NotFirstTime

//==================DATA OF OPENING SENTENCE
ORG     400
Str,                HEX     0D
                    HEX     4F
                    HEX     70
                    HEX     20
                    HEX     61
                    HEX     76
                    HEX     61
                    HEX     69
                    HEX     6C
                    HEX     61
                    HEX     62
                    HEX     6C
                    HEX     65
                    HEX     3A
                    HEX     20
                    HEX     2B
                    HEX     20
                    HEX     2D
                    HEX     20
                    HEX     2A
                    HEX     20
                    HEX     2F
                    HEX     2E
                    HEX     20
                    HEX     50
                    HEX     72
                    HEX     65
                    HEX     73
                    HEX     73
```

```
                    HEX   20
                    HEX   58
                    HEX   20
                    HEX   74
                    HEX   6F
                    HEX   20
                    HEX   65
                    HEX   78
                    HEX   69
                    HEX   74
                    HEX   D
                    HEX   4F
                    HEX   70
                    HEX   3A
                    DEC   0          // null - end of string = '\0
ORG 325
OpInput,            HEX   D
                    HEX   4F
                    HEX   70
                    HEX   3A
                    DEC   0
ORG 430
CcNotOp,            HEX   20
                    HEX   69
                    HEX   73
                    HEX   20
                    HEX   6E
                    HEX   6F
                    HEX   74
                    HEX   20
                    HEX   61
                    HEX   6E
                    HEX   20
                    HEX   6F
                    HEX   70
                    HEX   65
                    HEX   72
                    HEX   61
                    HEX   74
                    HEX   6F
                    HEX   72
                    DEC   0
ORG    450
CcNotDigitStr,      HEX   20
                    HEX   69
                    HEX   73
                    HEX   20
                    HEX   6E
                    HEX   6F
                    HEX   74
                    HEX   20
                    HEX   61
                    HEX   20
                    HEX   64
                    HEX   69
                    HEX   67
                    HEX   69
                    HEX   74
```

```
                        DEC     0
ORG 470
EnterNum1STR,           HEX     0D
                        HEX     4E
                        HEX     75
                        HEX     6D
                        HEX     31
                        HEX     3A
                        DEC     0

ORG     480
EnterNum2STR,           HEX     0D
                        HEX     4E
                        HEX     75
                        HEX     6D
                        HEX     32
                        HEX     3A
                        DEC     0

ORG 500
Power10Array,           DEC     -10000          // -10 to power of 4
DEC     -1000                                   // -10 to power of 3
DEC     -100                                    // -10 to power of 2
DEC     -10                                     // -10 to power of 1
//Subroutine to print a char to screen
Putc,                   HEX     0                       // void Putc(char) {
Out,                    SKO
                        BUN     Out
                        OUT                             // print(char);
                        BUN     Putc I
//DATA OF ERROR MSG DIVISION BY ZERO!
ORG 600
errorDivZero,           HEX     45
                        HEX     52
                        HEX     52
                        HEX     4F
                        HEX     52
                        HEX     3A
                        HEX     20
                        HEX     44
                        HEX     49
                        HEX     56
                        HEX     49
                        HEX     53
                        HEX     49
                        HEX     4F
                        HEX     4E
                        HEX     20
                        HEX     42
                        HEX     59
                        HEX     20
                        HEX     30
                        DEC     0               // null - end of string = '\0'
END
```