Examples of Solving $Cm$ Cons*

Solving C-2 from Sample $Cm$
Cryptarithmetic

* “$Cm$ Cons” means “cipher constructions in The Cryptogram” -- the bi-monthly publication for members of the American Cryptogram Association (ACA) -- www.cryptogram.org
Examples of Solving

This series shows specific examples of solving ACA ciphers. It tries to give successive hints of what to look at, then follows through by using each hint, building to the solution.

Try to solve the cipher on your own, using as many hints as you need, or just read along.

Please report errors or send suggestions to nudge@cryptogram.org
References

• The ACA and You, Ch. 4, How to Solve a Problem in *The Cryptogram*.

• An Approach to Cryptarithmetic, by FIDDLE, 1963.
What is a Cryptarithm?

A cryptarithm is an arithmetic operation in which letters have been used to represent the digits. Use the rules of arithmetic to infer what digit each letter represents. Each cryptarithm has a unique solution.

Cryptarithms in $Cm$ are written in a single line to conserve space.
Getting started on a Cryptarithm

Start by rewriting the arithmetic in normal form. Then learn facts about the digits. E.g.,

• What represents zero, one, or nine?
• What cannot represent zero?
• What digit is greater than another?
• What set of digits can each letter represent?
Solving C-2 from Sample Cm

C-2. Multiplication. (Two words, 9-0) VERMONSTER
SUNNY * DAY = ADOONY; + NAMTSY; + SRMRNU = SAOMRASY

What does the first line tell us?
Cipher ID: C-2
Type: Multiplication
Key: the letters will spell out two words when listed in order from 9 to 0 (9876543210)
Created by ACA member VERMONSTER
Solving C-2 from Sample $C_m$

Rewrite the cryptarithm in traditional format, aligning digits correctly. Always a good first step.

$SUNNY \times DAY = ADOONY; + NAMTSY; + SRMRNU = SAOMRASY$

\[
\begin{array}{c}
  \text{SUNNY} \\
  \times \text{DAY} \\
  \hline
  \text{ADOONY} \\
  \text{NAMTSY} \\
  \text{SRMRNY} \\
  \hline
  \text{SAOMRASY}
\end{array}
\]

9876543210
(2 wds)
Solving C-2 from Sample *Cm*

Rewrite the cryptarithm in traditional format, aligning digits correctly. Always a good first step.

SUNNY * DAY = ADOONY; + NAMTSY; + SRMRNU = SAOMRASY

We are multiplying by a three-digit number and we have three partial products. Therefore, all digits of the multiplier (DAY) are nonzero, and everything lines up nicely.
Solving C-2 from Sample $C_m$

$Y$ times SUNNY gives a partial product that ends with $Y$. What can we say about $Y$?

```
SUNNY
   x  DAY
   ADOONY
   NAMTSY
   SRMRNY
   SAOMRASY

9876543210
(2 wds)
```
Solving C-2 from Sample $C_m$

Y times SUNNY gives a partial product that ends with Y. Digits that behave like Y are: (0,1,5,6)

\[
\begin{array}{ccc}
SUNNY \\
\times \text{DAY} \\
\hline
\text{ADOONY} \\
\text{NAMTSY} \\
\text{SRMRNY} \\
\hline
\text{SAOMRASY} \\
\end{array}
\]

9876543210

(2 wds)
Solving C-2 from Sample $Cm$

Y times SUNNY gives a partial product that ends with Y. Possible digits for Y: (0,1,5,6)
Y has a six digit partial product. Y cannot be zero.

\[
\begin{array}{c}
\text{SUNNY} \\
\times \text{DAY} \\
\hline
\text{ADOONY} \\
\text{NAMTSY} \\
\text{SRMRNY} \\
\text{SAOMRASY} \\
\end{array}
\]

9876543210

(2 wds)
Solving C-2 from Sample $C_m$

Y times SUNNY gives a partial product that ends with Y. Possible digits for Y: (1, 5, 6)  
Y has a partial product that is not SUNNY. Y cannot be one.
Solving C-2 from Sample $Cm$

Y times SUNNY gives a partial product that ends with Y. Possible digits for Y: (5,6)
SUNNY times D, A, and Y all end in Y. Only 6*1 and 6*6 end in 6, so can’t satisfy three different values ending in 6. Y cannot be 6.

```
SUNNY
  x  DAY
  ADOONY
  NAMTSY
  SRMRNY
  SAOMRASY

9876543210
(2 wds)
```
Solving C-2 from Sample Cm

Y times SUNNY gives a partial product that ends with Y. Possible digits for Y: (5)
Y must be 5. SUNNY times D, A, and Y all end in Y. Any odd number times 5 ends in 5, so that’ll work, too. Record Y=5. Remember also that D and A must be odd.

D is one of (3, 7, 9). A is one of (3, 7, 9).
Solving C-2 from Sample Cm

All of the partial products have six digits. The one starting with S must be larger than the rest – it is closer to 10 * SUNNY. So D > A, D > Y. D is one of (7, 9). Also, S > N, S > A.

D is one of (7, 9). D > A. A is one of (3, 7).

SUNNY
_____ x DAY
ADOONY
NAMTSY
SRMRNY
SAOMRASY

9876543210
Y (2 wds)
Solving C-2 from Sample \( C_m \)

Y times SUNNY ends with NY; D times SUNNY ends with NY.
We can tabulate the products of a range of NNY times 5, 7, and 9. See which *7 or *9 products have the same right two digits as the corresponding *5 entry. Can omit N=0, 5.

D is one of (7, 9). D > A. A is one of (3, 7).
Solving C-2 from Sample $Cm$

Y times SUNNY ends with NY; D times SUNNY ends with NY.
We can tabulate the products of a range of NNY times 5, 7, and 9. See which *7 or *9 products have the same right two digits as the corresponding *5 entry. Can omit N=0, 5.

D is one of (7, 9). D > A. A is one of (3, 7).

<table>
<thead>
<tr>
<th>N</th>
<th>NNY</th>
<th>* 5(Y)</th>
<th>* 7</th>
<th>* 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>115</td>
<td>575</td>
<td>805</td>
<td>1035</td>
</tr>
<tr>
<td>2</td>
<td>225</td>
<td>1125</td>
<td>1575</td>
<td>2025</td>
</tr>
<tr>
<td>3</td>
<td>335</td>
<td>1675</td>
<td>2345</td>
<td>3015</td>
</tr>
<tr>
<td>4</td>
<td>445</td>
<td>2225</td>
<td>3115</td>
<td>4005</td>
</tr>
<tr>
<td>6</td>
<td>665</td>
<td>3325</td>
<td>4655</td>
<td>5985</td>
</tr>
<tr>
<td>7</td>
<td>775</td>
<td>3875</td>
<td>5425</td>
<td>6975</td>
</tr>
<tr>
<td>8</td>
<td>885</td>
<td>4425</td>
<td>6195</td>
<td>7965</td>
</tr>
<tr>
<td>9</td>
<td>995</td>
<td>4975</td>
<td>6965</td>
<td>8955</td>
</tr>
</tbody>
</table>

Y (2 wds)
Solving C-2 from Sample \( Cm \)

Y times SUNNY ends with NY; D times SUNNY ends with NY.
In rows 225 & 775 (N=2, N=7) the last two digits of the 5 & 9 are the same. This identifies that D=9 (record it), N is one of (2, 7).

<table>
<thead>
<tr>
<th>N</th>
<th>NNY</th>
<th>( \times 5(Y) )</th>
<th>( \times 7 )</th>
<th>( \times 9 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>115</td>
<td>575</td>
<td>805</td>
<td>1035</td>
</tr>
<tr>
<td>2</td>
<td>225</td>
<td>1125</td>
<td>1575</td>
<td>2025</td>
</tr>
<tr>
<td>3</td>
<td>335</td>
<td>1675</td>
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<td>3015</td>
</tr>
<tr>
<td>4</td>
<td>445</td>
<td>2225</td>
<td>3115</td>
<td>4005</td>
</tr>
<tr>
<td>6</td>
<td>665</td>
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<tr>
<td>7</td>
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<td>5425</td>
<td>6975</td>
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<td>8</td>
<td>885</td>
<td>4425</td>
<td>6195</td>
<td>7965</td>
</tr>
<tr>
<td>9</td>
<td>995</td>
<td>4975</td>
<td>6965</td>
<td>8955</td>
</tr>
</tbody>
</table>

N is one of (2, 7). A is one of (3, 7).
Solving C-2 from Sample $Cm$

N + Y ends with S. If N=2, then S=7. If N=7, then S=2.
So...

N is one of (2, 7). A is one of (3, 7).
Solving C-2 from Sample \textit{Cm}

N + Y ends with S. If N=2, then S=7. If N=7, then S=2. Either way, 7 is in use, so A can only be 3. Record that.

\begin{center}
\begin{tabular}{c}
SUNNY \\
\_ x DAY \\
ADONNY \\
NAMTSY \\
SRMRNY \\
SAOMRASY \\
\end{tabular}
\end{center}

N is one of (2, 7). S is one of (2, 7).

9876543210
D Y A (2 wds)
Solving C-2 from Sample Cm

N + Y ends with S. If N=2, then S=7. If N=7, then S=2. Either way, 7 is in use, so A can only be 3. Record that. We also know S > N, so S=7, N=2. Record those.

SUNNY
x DAY
ADOONY
NAMTSY
SRMRNY
SAOMRASY

9876543210
D S Y AN (2 wds)
SUNNY ends in 225. We can calculate some digits.

Y * 225 = 1125.
A * 225 = 675.
D * 225 = 2025.
SUNNY ends in 225. We can calculate some digits.

\[ Y \times 225 = 1125. \quad ONY=125. \quad O=1. \]
\[ A \times 225 = 675. \quad TSY = 675. \quad T=6. \]
\[ D \times 225 = 2025. \quad RNY=025. \quad R=0. \quad \text{Record } O, T, R. \]
We are still missing U and M. U is only in SUNNY. M is in two of the partial products and the final sum.
Solving C-2 from Sample *Cm*

We are still missing U and M. U is only in SUNNY. M is in two of the partial products and the final sum. We can find U by using the first partial product (all other letters known).

```
   SUNNY
   x  DAY
  __________
   ADOONY
   NAMTSY
   SRMRNY
  _________
   SAOMRASY

  9876543210
  D STY ANOR (2 wds)
```
Solving C-2 from Sample \( C_m \)

We are still missing U and M. U is only in SUNNY. M is in two of the partial products and the final sum. We can find U by using the first partial product (all other letters known).

\[ 5 \times \text{SUNNY} = 391125. \text{ So } \text{SUNNY} = 78225. \text{ Record } U=8. \]

```
SUNNY
 x DAY
 ADOONY
 NAMTSY
 SRMRNY_
 SAOMRASY
```

9876543210
DUSTY ANOR (2 wds)
Solving C-2 from Sample $Cm$

We can calculate $M$, but 4 is the only one digit left, so $M=4$. 

```
SUNNY
   x  DAY
   ADOONY
  NAMTSY
 SRMRNY
SAOMRASY
```

9876543210
DUSTYMANOR (2 wds)
Solving C-2 from Sample $C_m$

All done! And the letters ordered 9-0 form two words.

Record the solution so you could later submit it for credit.

C-2 DUSTYMANOR

SUNNY
___
 x  DAY
 ADOONY
 NAMTSY
 SRMRNY
 SAOMRASY

9876543210
DUSTYMANOR (2 wds)
Thank you. Try another. Try the ACA!

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