Problem of the Week
Problem A and Solution
Dated Messages

Problem

A *Caesar Cipher* is a way to create secret messages by shifting letters in text. For example, a Caesar Cipher of 3 shifts each letter in the text by 3. If you want to shift the letter **D** by 3, then you count three letters forward to arrive at the letter **G**. Similarly, if you want to shift the letter **E** by 3, then you count three letters forward to arrive at the letter **H**. So in a Caesar Cipher of 3, the letter **D** is encoded with the letter **G**, the letter **E** is encoded with the letter **H**, and so on. When shifting letters, if you reach the end of the alphabet, you continue counting at the letter **A**. For example, if you want to shift the letter **Y** by 3, then you count forward to **Z**, then to **A**, and end up at the letter **B**.

(a) Using a Caesar Cipher of 3, encode the message **FRACTIONS**.

(b) To decode a secret message you shift the letters in the opposite direction. For example, in a Caesar Cipher of 4 the letter **G** would be decoded as **C**.
Decode the message **AEXIVPSS** using a Caesar Cipher of 4.

(c) A *Date Cipher* shifts the letters in a message by the corresponding digit of a date in the form *YYYYMMDD*. If the message is longer than the date, then we repeat the date as many times as necessary. In the table below, the message **FRACTIONS** has been encoded using the digits from the International Women's Day, 20240308.

Original Letter	F	R	A	C	T	I	O	N	S
Digit of Date	2	0	2	4	0	3	0	8	2
Encoded Letter	H	R	C	G	T	L	O	V	U

The secret message for **FRACTIONS** would be **HRCGTLOVU**.

A famous mathematician has the birthdate December 9, 1906 (19061209). Use the Date Cipher and this date to **decode** the message **HAAIFJOYQNR** to find the name of the famous mathematician.

Solution

(a) We encode the message by shifting each letter by 3. The results are summarized in the table below.

Original Letter	F	R	A	C	T	I	O	N	S
Encoded Letter	I	U	D	F	W	L	R	Q	V

So the encoded message is **IUDFWLRQV**.

(b) We decode the message by shifting each letter by 4 in the opposite direction. The results are summarized in the table below.

Coded Letter	A	E	X	I	V	P	S	S
Decoded Letter	W	A	T	E	R	L	O	O

So the decoded message is **WATERLOO**.

(c) We decode the message by shifting each letter in the opposite direction by the corresponding digit of the date. The results are summarized in the table below.

Original Letter	H	A	A	I	F	J	O	Y	Q	N	R
Digit of Date	1	9	0	6	1	2	0	9	1	9	0
Decoded Letter	G	R	A	C	E	H	O	P	P	E	R

So the decoded message is **GRACE HOPPER**.

Note that we can check that we have decoded properly by encoding the message to make sure we get the original secret message that was sent to us.

Teacher's Notes

The answer when decoding the secret message in part (c) is Grace Hopper.

Grace Murray Hopper was a pioneer in the early days of Computer Science. She joined the U.S. Navy during World War II, and eventually achieved the rank of Admiral. World War II was a catalyst for the rapid progression towards the modern digital computer. In 1944, Grace Hopper was part of the team who worked on the Harvard Mark I which was one of the earliest general purpose electromechanical computers.

One of Hopper's most notable contributions in the history of Computer Science is her work with compilers. A compiler converts a program that is written in a programming language that is more English-like, and is reasonably easy for humans to read into machine language. Machine language is a sequence of zeros and ones. Before compilers were created, people had to write programs in assembly language, which had instructions like: `addi`, `beq`, or `lw`. Assembly code programs took many more instructions to accomplish the same task as modern programming languages. A compiler made coding more accessible and programs easier to write and modify. Grace Hopper created one of the earliest compilers for a language called `A-0`.