

### Affine cipher alphabets

**Overview.** You will choose an affine cipher key and construct an affine cipher alphabet.

**Example.** We'll construct an alphabet for the affine key  $(9, 2)$ . That is, the cipher mapping is

$$x \mapsto 9x + 2 \bmod 26.$$

Using our convention that the plaintext is written in lower case and below the ciphertext (which is in upper case), we work from bottom to top. We begin with the numeric equivalents of the plaintext letters:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

We multiply each of these numbers by 9 (modulo 26). This is easy; we get almost all the numbers from the 9<sup>th</sup> row of our multiplication table.

0	9	18	1	10	19	2	11	20	3	12	21	4	13	22	5	14	23	6	15	24	7	16	25	8	17
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

To finish, we add 2 to each of the numbers in the top row above, and convert them back to (ciphertext) letters.

C	L	U	D	M	V	E	N	W	F	O	X	G	P	Y	H	Q	Z	I	R	A	J	S	B	K	T
2	11	20	3	12	21	4	13	22	5	14	23	6	15	24	7	16	25	8	17	0	9	18	1	10	19
0	9	18	1	10	19	2	11	20	3	12	21	4	13	22	5	14	23	6	15	24	7	16	25	8	17
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

The completed alphabet looks like this:

C	L	U	D	M	V	E	N	W	F	O	X	G	P	Y	H	Q	Z	I	R	A	J	S	B	K	T
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

**Things to do.**

1. Pick an affine key. Remember that the “multiplying” number has to be an odd number other than 13. Prepare an alphabet using your key.
2. Compose a short message and encrypt it using your alphabet. Write the ciphertext and the key on an index card.
3. Collect an index card from another group. Prepare an alphabet using the key on the card, and try to decrypt the other group’s message.