Questions & Answers for *The Secret Code Menace*
Pamela Cosman

Chapter 0001:

1. What code is used to get rid of an annoying little sister?
2. What code would you use to indicate that somebody was sneaking up on your friend?
3. What does 10001001 mean?
4. How did the students pass codes if they did not have anything to write on?
5. What is the purpose of the code 0110?
6. This book was published in England, so it uses British English spelling. Can you find an example in this chapter of a word that is spelled differently in British English from American English? And how is that word spelled in American English?
7. The secret code has 16 code words. Each is 4 digits long, and each digit is either zero or one. Suppose the code words were only 2 digits long, instead of 4. How many different code words could you make in that case? Write them all out.
8. What if the code words were 3 digits long? How many different code words are there, and what are they?
9. Think about this code:
   00 = CATS   01 = FISH   10 = EAT   11 = FOOD
   What does the following sentence say?   01100111
10. Use the code from the previous question to make at least three different sentences.

Chapter 0010:

1. How are Daniel, Sara, and Jared related?
2. What did Sara do to get into trouble?
3. Why did Sara do what she did?
4. With Jared's hand signals, a closed fist means zero, and a finger held up means one. Think of a way that a code word can be sent using your face or head, instead of your hands.
5. What are some advantages or disadvantages of your signaling method from the previous question compared to hand signals?
6. On page 26, Miss Robinson uses the word *headteacher*, which is a British word. In American schools, what does one call a *headteacher*?
7. In this chapter, find two additional examples of words (not counting the word *headteacher*) that are spelled differently in British English, and write how those words would be spelled in American English.

Chapter 0011:

1. Why was the code that Sara received wrong?
2. Which lunch club does Sara want to join? Which one does Daniel want to do?
3. How many bits are in 1111?
4. In triplicate encoding, one writes each number 3 times. Duplicate encoding, where one writes each number twice, would be shorter and faster to write. So, is duplicate encoding better?
5. If triplicate encoding is good, why wouldn't we just use 9-times encoding, where you repeat each bit nine times? Wouldn't that be more reliable than triplicate? How many errors could get corrected?
6. Let's take some examples of long code words, that have 10 bits each. For example:
   0011100001 and
   0000010101
   What is the *distance* between these two code words?
7. What are all the code words of length 4 which have a distance of 1 from the word 1010?
8. 0100 and 0101 have a distance of only 1 from each other. After triplicate encoding, what do these two words become? What is the distance between them *after* triplicate encoding?
9. In this chapter, find two additional examples of words that are spelled differently in British English, and write how those words would be spelled in American English.

Chapter 0100:

1. Why doesn't Sara want to question kids about the note?
2. What does *diversify* mean?
3. What is the official name for the three-circle method?
4. In what way is the three-circle method better than triplicate encoding?
5. Use the three-circle encoding method to encode the following code word: 0010
6. Without writing down the three circles, can you figure out in your head what the parity bits must be for encoding the all-zeroes code word (0000) using the Hamming code?
7. Use the 3 circles approach to decode this word: 1111101

Chapter 0101:

1. The Apollo Moon Lander is an example of something designed to have a section that can get crushed or bashed without the important part getting damaged. Can you think of other examples of things designed with this same goal?
2. Here is a sentence that uses the symbol * in place of each space between words.

   I*love*to*ride*my*bike.

Show how this message can be interleaved across 3 pages similar to the interleaving on page 82. Notice that the interleaving on page 82 uses 4 pages, but here you are asked to use only 3. Here are 3 pages for you to use.
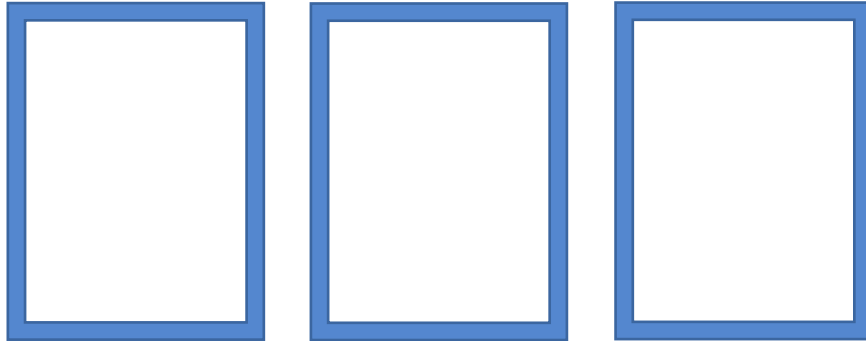
3. Here are 4 pages which have an interleaved sentence. The symbol * is used in place of each space between words. What is the sentence?

| T*ps itr | hpy* noo | au*g g*w | tpio *g. |
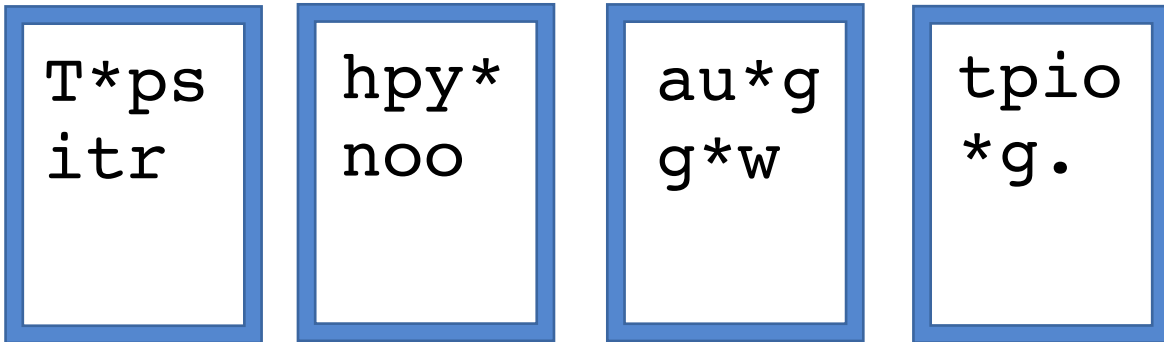
4. A sentence that uses the * symbol in place of each space between words has been interleaved across 5 pages. But the middle page is missing. Oh no! Can you figure out what the sentence is?

| Town bsmy *d*s | huag eee* m*ce | ? | *e*y asoa vhe | m*a* uodd eee |
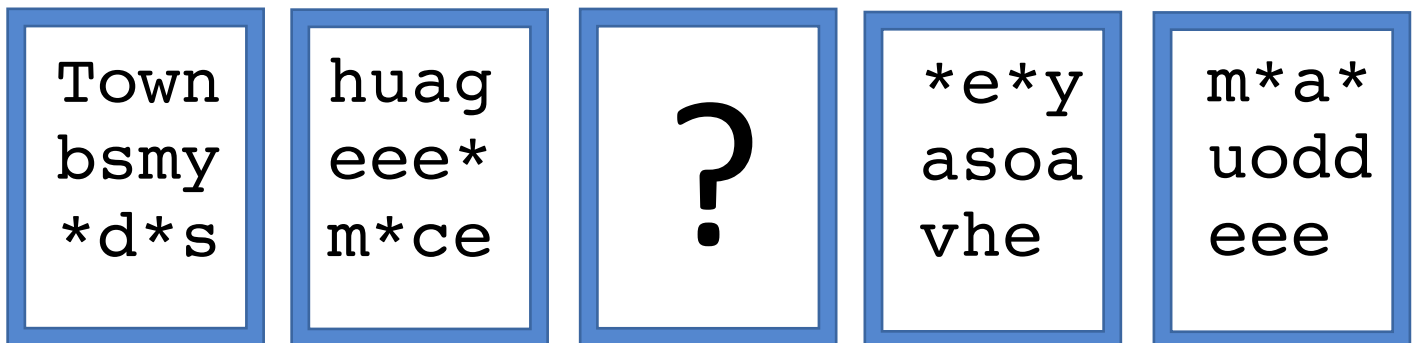
Hint: Start by writing out all the letters in order and put a ? symbol every time you come to the missing page.

5. What is the main purpose of cryptography, and how is it different from the main purpose of error correction coding?
6. In this chapter, find an additional example of a word that is spelled differently in British English, and write how this word would be spelled in American English.

Chapter 0110:

1. What reason does Sara give for staying in the Newspaper Club?
2. What reason does Daniel give for staying in Math Club?
3. What other reasons might Sara have for staying, besides the reason she gives?
4. What does *path diversity* mean?
5. Daniel notices that exactly four of the words in the original code are reversible, that is, they read the same forwards and backwards. They are:
    0000   1111   0110   1001
    Suppose you were using the code words of length 3 from Question 7 of Chapter 0001. How many of those are reversible? Which ones are they?
6. Find all the code words of length five which are reversible. Hint #1: there are 8 of them. Hint #2: In order to be reversible, the last 2 bits have to be the same as the first two bits (just backwards), but the *middle* bit can be anything.
7. Some real English words are reversible. Words which read the same backwards and forwards are called palindromes. For example, racecar, radar, and kayak are all palindromes. Can you think of other words which are palindromes? Hint: the time of day when many people eat lunch is a palindrome.
8. In this chapter, find an additional example of a word that is spelled differently in British English, and write how this word would be spelled in American English.
9. On page 91, Mr. Jones is taking out the *rubbish*. Which words might people use in American English in place of rubbish?

Chapter 0111:

1. For the birthday party, what does Mrs Felton provide as construction materials?
2. What is a *rebar*?
3. Sara has lots of pen pals in order to collect what?
4. Daniel is learning the 24-Game, in which you have to combine numbers with addition, subtraction, multiplication, and division to get the number 24. One could do this with numbers other than 24. For example:
    a. Combine 13, 6, 9, and 3 in any order to make 23.
    b. Combine 8, 8, 2, and 14 in any order to make 28.
    c. Combine 1, 12, 12, and 4 in any order to make 36.

Chapter 1000:

1. Why does Daniel send 1110100?
2. What happened when Sara sent postcards to the Postmaster in various cities around the world (Lausanne, Bangkok, Reykjavik)?
3. Decode the following Hamming code word: 110?00? where ? means that a digit is unknown (erased).
4. The Hamming code can correct *any two* erasures. That means, if two digits get erased, it doesn't matter *which two* get erased… a person can still figure out the code word. But what if there are *three* erasures? Is it possible to figure out the correct word if there are three erasures (where you know the erasure positions, but not what the digits are)?
    a. Find an example with three erasures where it is possible to figure out the correct code word.
    b. Find an example with three erasures where it is not possible to figure out the correct code word.

Chapter 1001:

1. How did Sara know that the foreign money which says "Du Litai" is from Lithuania?
2. Who is Ms. Sanchez?
3. How many keys are needed to open a safe deposit box? How many does the customer keep?
4. How many gunmen are there?
5. What kinds of things do you think the bank robbers want from the safe deposit boxes?
6. In this chapter, find an additional example of a word that is spelled differently in British English, and write how this word would be spelled in American English.

Chapter 1010:

1. Why do you think Sara made 3 identical lines to send her code word?
2. In this chapter, find two additional examples of words that are spelled differently in British English, and write how those words would be spelled in American English.
3. What does *incredulous* mean (page 144)?
4. For the code word that Sara was writing on the floor, it made a difference whether Jared interpreted it from the point of view of the camera, or from Sara's point of view. Give an example of a 7-bit Hamming encoded code word from their code set for which these two different points of view would not have mattered (that is, would have seen the same code word).

Chapter 1011:

1. How does Jared make use of the fact that the tray says "Jumpin' Burgers" on it?
2. In American English, what is a common way to say *trousers*?
3. Why does Sara hand some food to the woman in the blue suit?
4. Jared made "0010111" using drink bottles for zeroes and straws for ones. Richard removed a drink and a straw before the tray entered the vault. Suppose that instead of removing a drink and a straw, he had simply moved the last straw to another position in the line of items. What words could he have formed, and how would Sara have decoded each one?

Chapter 1100:

1. In this chapter, find an additional example of a word that is spelled differently in British English, and write how this word would be spelled in American English.
2. What was the reason Jason gave for changing the number on the secret message?
3. On page 171, Jared uses hand signals to send Finger, Fist, Fist, Fist. What does that mean, and why does he send it?
4. At the end of the story, why is Sara thinking about choosing all new meanings for the code words?

Chapter 0001:

1. 0101
2. You would use 1101, which means "Hidden trouble"
3. It means "I'm very sad"
4. They used hand signals. A closed fist means a zero, and a finger held up means a one. To send a message, the students would alternate the two hands.
5. This code means "Aren't you jealous of my awesome code?" If you sent this message to a person who actually knows the code, then that person wouldn't be jealous of it, because they are in on the secret. So the purpose of the code 0110 is to annoy someone... to send it to someone who does *not* know what it means, because they will feel annoyed and possibly jealous that they don't know what the code is saying.
6. The word *centre* on page 15 would be spelled *center* in American English.
7. There would be only 4 different code words in that case. The 4 words are:
   00   01   10   11
8. There would be 8 different code words in that case. The 8 words are:
   000   001   010   011   100   101   110   111
9. FISH EAT FISH FOOD
10. There are many possible sentences, for example:
    001011 = CATS EAT FOOD
    001001 = CATS EAT FISH
    0001 = CATS FISH (using FISH as a verb)
   011001 = FISH EAT FISH

Chapter 0010:

1. Sara and Jared are sister and brother. Daniel is their first cousin.
2. Sara started singing a song during class.
3. Sara was creating a diversion, so she must have thought that Daniel, in his message to her, was asking her to create a diversion.
4. There are many ways that this could work. For example, a wink with the right eye means a zero, and a wink with the left eye means a one. Or a single blink with both eyes means a zero, and blinking quickly twice with both eyes means a one. Or you can do things with sticking out your tongue, or smiling and frowning to mean zero and one.
5. Depending on where you are, and where the other person is, it might be easier to see the hand signals than to see a wink, since your hands are bigger than your eyes. But a wink or blink might be less obvious and therefore more secretive.
6. In an American school, the *headteacher* is called the *Principal*.
7. The word *swop* on page 21 would be spelled *swap* in American English, and *Maths* on page 22 would be *Math*.

Chapter 0011:

1. Someone must have changed one of the bits.
2. Sara wants to do Math Club. Daniel wants to do Newspaper Club.
3. 4
4. In triplicate encoding, if you receive a 011 or 101 or 110, for example, you can use majority voting to guess that a 1 was originally intended. But with duplicate encoding, if you receive a 01 or a 10, you don't have a good guess for whether a zero or one was originally sent.
5. If you repeat something 9 times, then if 4 of them are wrong, and 5 of the are right, you can still use majority voting to determine the correct bit. So, this encoder could correct up to 4 errors. It is more reliable. But it requires writing each bit nine times, which might take a lot of time to write.
6. The distance between two code words is the number of positions in which the bits differ. If we line them up like this:
   0011100001
   0000010101
   and we compare each bit to the one below, we can see that they are different in the 3rd, 4th, 5th 6th, and 8th positions. That means they have a distance of 5.
7. The following words all have a distance of 1 from 1010:
   0010, 1110, 1000, 1011
8. After encoding, the words become 000111000000 and 000111000111
   The distance between these is 3.
9. The word *Mum* on page 37 would be spelled *Mom* in American English, and *practise* on page 47 would be *practice*.
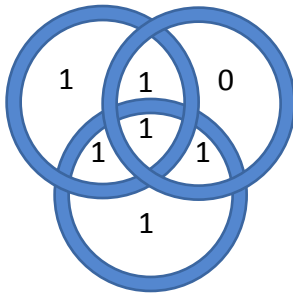
Chapter 0100:

1. Sara doesn't want to question them because she doesn't want to give anyone the idea of changing the numbers on their secret messages in the future.
2. The word *diversify* means to make something more diverse or more varied. For example, if you have a bag with red balls in it, and you add some balls that are green and blue and yellow, then you are *diversifying* the colors of the balls.
3. The official name is Hamming encoding.
4. The Hamming method has an advantage over triplicate coding of being shorter. The Hamming code adds only 3 extra bits to an initial group of 4 bits, whereas a triplicate encoder adds an extra 8 bits to an initial group of 4 bits.
5. Using the circles, we can see this encodes to 0010111
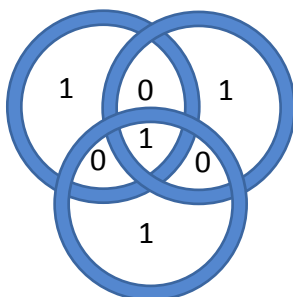
6. Because the code word only has zeroes, each circle starts out with three zeroes, so the parity bits have to be all zeroes too. This is the easiest word to encode.
7. If we put this word into the circles, we can see that the circle on the top left has correct parity, and so does the circle on the bottom. But the circle on the top right has incorrect parity. Since that is the only circle with incorrect parity, we can correct the one bit which is only in that circle. So, the information bits are 1111.

Chapter 0101:

1. Cars are usually designed with the engine in front and some trunk space in the back, and people sit in the middle. This way, if there's a crash from the front or the back, that section can crush but the people in the middle will be less hurt than if they directly got this hit. Another example is a bicycle helmet, which is designed to absorb the force of a blow and protect the rider's head.
2. The 3 pages would look like this:

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Io**
dmbe
```
```
*vtr
eyi.
```
```
leoi
**k
```
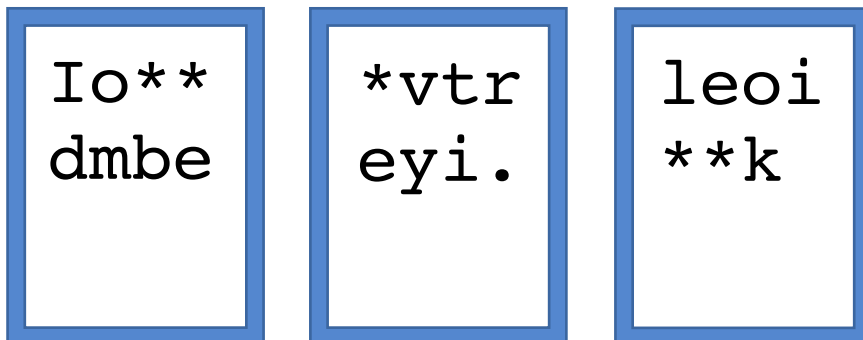
3. The sentence is: That*puppy*is*going*to*grow
4. The*mouse*was*angry*because*somebody*had*moved*the*cheese.
5. The main purpose of cryptography is to prevent other people from knowing what your message says, whereas the main purpose of error correction coding is to correct errors that occur during transmission of your message.
6. The word *coloured* on page 78 would be spelled *colored* in American English.

Chapter 0110:

1. Sara says that she has to stay because there are not many kids in the Club, so Mr. Whitaker needs all of them.
2. Daniel says he has to stay in Math Club because there are 12 kids in it, and 12 is a useful number for dividing the kids into same-size groups for playing games.
3. Sara might also want to stay because she likes Mr. Whitaker, or because she thinks that writing newspaper stories might be fun.
4. Path diversity means sending the same message over multiple different paths, so even if one of the paths is blocked and the message doesn't get through properly on one path, the message overall will still get through because some of the paths will be OK.
5. There are 4 code words which are reversible. They are

       000   111   010   101
6. The 8 reversible code words of length 5 are:
   00000 00100 01010 01110 10001 10101 11011 11111
7. Some palindromes are noon, pop, tot, bib, sis, yay, dad, mom, level, refer.
8. The word *favourite* on page 91 would be spelled *favorite* in American English.
9. In American English, people would tend to use the word *garbage* or *trash* in place of rubbish.

Chapter 0111:
1. The construction materials are marshmallows and uncooked spaghetti noodles.
2. A steel bar that goes inside concrete to strengthen it.
3. Stamps
4. Answers:
   a. 13 + 9 + (6 / 3) = 23
   b. 8 + 8 + 14 − 2 = 28
   c. 12 * 4 − 12 * 1 = 36

Chapter 1000:

1. Daniel sends 1110100 because Sara's shoes are untied.
2. In Lausanne, the Postmaster sent the postcard to a school principal to share with the students. In Bangkok, the Postmaster stuck the postcard up on a bulletin board. In Reykjavik, the postcard got published in the newspaper.
3. We put the digits into the circles like this:
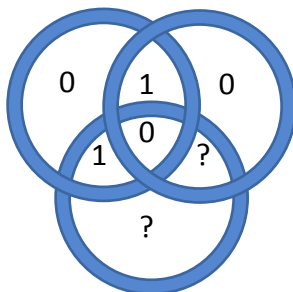
The top left circle is fine. The bottom circle cannot be decoded right away because it has two questions marks. The top right circle has only 1 question mark, so we are able to figure out that the question mark must be a 1. Then we can figure out that the question mark in the bottom circle has to be a zero. So, the code word is 1101000, and the decoded word (information bits) are 1101.

4. Yes, sometimes it is possible to figure out the correct code word even if there are three erasures. It depends where they occur.
    a. If you receive the code word ?0101?? it is possible to figure out the word even though there are three erasures. Try it!
    b. But if you receive ???1010 then you cannot figure it out.

The general idea is that you start by putting the information you know into the 3 circles. If there is some circle that has only one erasure, then you can figure out what that value must be. And figuring that out might help you then figure out some other circle. But when you put the information you know into the 3 circles, if there is *no* circle that has only 1 erasure, if they all have 2 or 3, then you can't start the fixing anywhere.

Chapter 1001:

1. Sara knows the money is from Lithuania because she has a pen pal from there.
2. Ms. Sanchez is a bank clerk, and she is giving the students a tour of the bank.
3. Two keys are required, and one is kept by the customer.
4. There are two.
5. The robbers probably want jewelry, cash, and gold.
6. The word *chequebook* on page 134 would be spelled *checkbook* in American English,

Chapter 1010:

1. Sara probably made 3 identical lines to make clear she was doing something deliberate, not just playing around, so that the police would try to figure out what it meant.
2. The word *jewellery* on page 141 would be spelled *jewelry* in American English, and *behaviour* on page 142 would be *behavior*.
3. *Incredulous* means unwilling or unable to believe something.
4. Any reversible code word in the code set would have looked the same from the camera view and from Sara's view point. The only reversible code words in their code set are 0000000, 1111111, and 1100011.

Chapter 1011:

1. Jared uses the writing on the tray to help show which way is up (that is, which way the code words are supposed to be read).
2. In American English, people are more likely to use the word *pants* instead of *trousers.*

3. Sara gives her some food as a way of answering the question on the tray "Who is it?"
4. If the last straw is put down at the start (before the first straw), then the word looks like this: 1001011 which decodes to 0001 which means "I told you so." If the straw is put down after the first drink, then the word is this: 0101011 which also decodes to 0001, meaning "I told you so." If that last straw is put down after the second drink (or after the first straw), the word would be 0011011 which, believe it or not, also decodes to 0001. So, we should be glad that Richard did not just pick up a straw and put it down in a different spot on the tray! And finally, if the last straw were put down next to the end straws, the word would still look like 0010111 which is what Jared put in the first place.

Chapter 1100:

1. The word *tyres* on page 166 would be spelled *tires* in American English.
2. Jason thought it would be funny.
3. It means "I'm sad" and he sends it because Sara's birthday is going to come sooner than his, so he won't get to have error correction coding at his birthday party.
4. Sara wants to make a new code because Isabelle is learning the old code.