Musical code (20 marks)

This problem involves a musical code which would enable someone to send a secret message encoded as a melody – probably not a very catchy one, admittedly – which could be transmitted for example over the radio.

The code uses musical notation, but you don't have to know anything about music (other than the facts listed below) to crack the code. In fact, if you do know musical notation, beware of making assumptions based on your knowledge that are not given below – they could be misleading.

Musical notation is based on a 'stave' consisting of five parallel lines. Notes are identified by their position relative to the stave, where they may be written either on or between the lines. The value of each note position can be raised, lowered or returned to its 'natural' value by adding one of the following 'accidental' symbols before the note:

#	♭	♮
sharp (raised)	flat (lowered)	natural

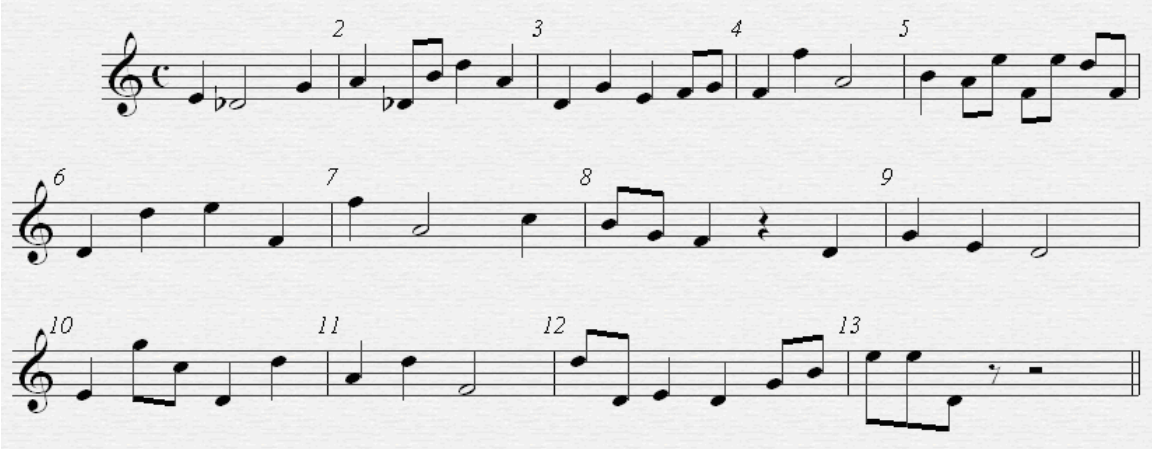
Any such changes remain in force for the remainder of the bar (indicated by a vertical bar line across the stave), after which the value of the note reverts to its natural value. A sharp or flat note can be returned to its original value within a bar using the 'natural' symbol. In our problem, only notes in the spaces can be sharp or flat. (Musicians note that C♭ and B and other such pairs are considered different notes.) Moreover, for musical reasons, the accidentals can be omitted in this code, as they have been after the first two bars in our message.

Note length is indicated as follows:

♩	𝅗𝅥	♪ (♫ when linked)	𝄽
one beat (crotchet)	two beats (minim)	half beat (quaver)	one beat rest

There is no significance in the direction of the stems. The symbols at the end of the message also represent rests, but can be ignored.

Q8.1. Your first task is to decode the message below. The first word is "ATTENTION". Write the decoded message in the answer sheet.



Q8.2. Insert the missing accidentals from bars 3-13 in the stave in the answer sheet.

Q8.3. Why are some sequences coded as quavers?

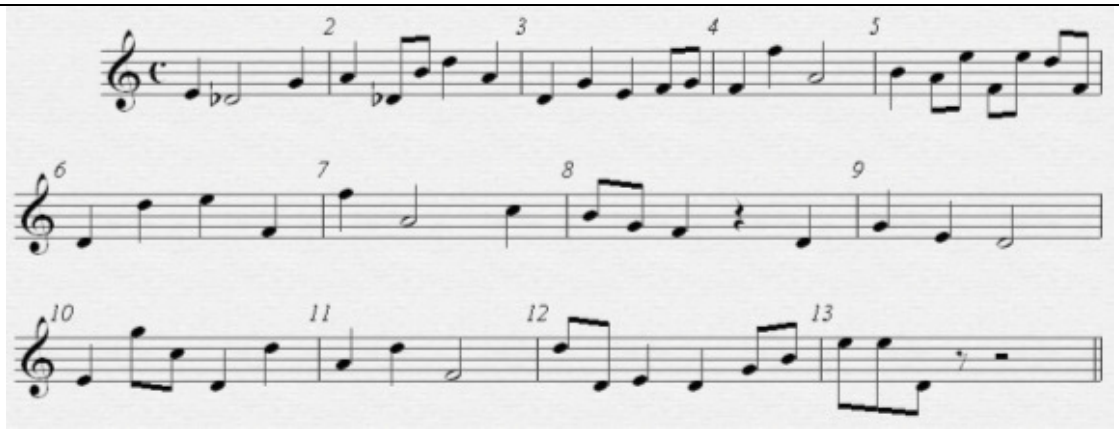
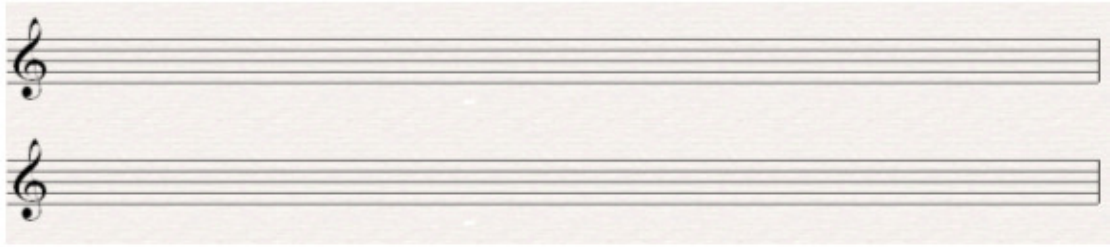
Q8.4a. On the stave on the answer sheet, show the tune that represents the following message:

WE NEED FIVE BOXES OF AMMUNITION.

Assume the same “time signature” (i.e. number of beats per bar) as in the first code. You may omit accidentals.

Q8.4b. This problem raises three difficulties with the code. Say what they are, and either how you solved them or why you couldn't solve them.

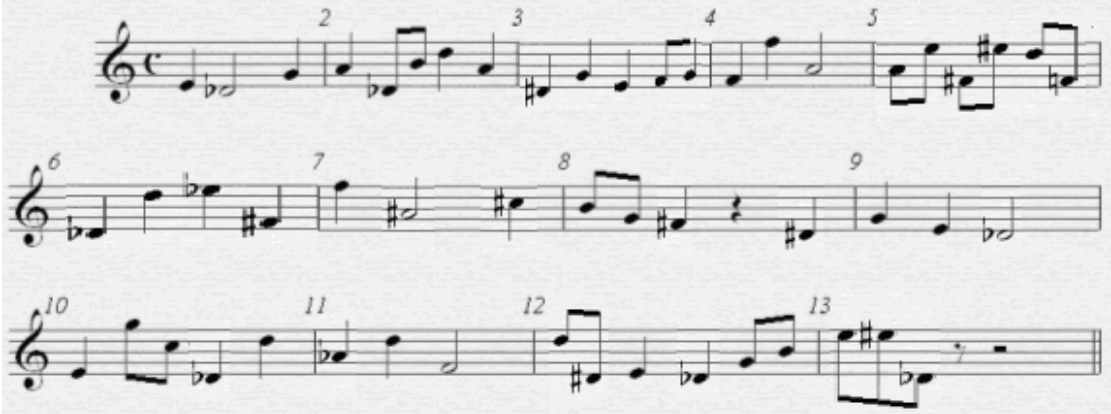
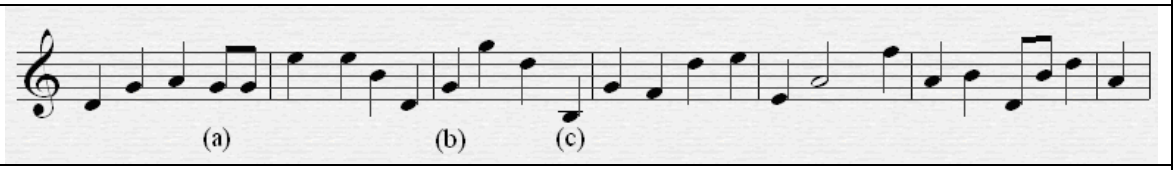
Q8.5. Why is it OK to omit accidentals, and under what circumstances (in general) might they be necessary?

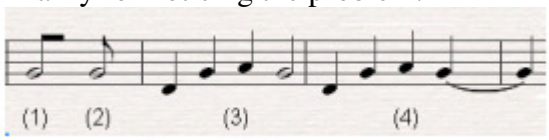
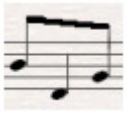
8.1.	attention
8.2.	 Note: you lose marks for unnecessary natural signs.
8.3.	
8.4a.	
8.4b.	
8.5.	

Musical code (20 marks, 70 points)

Assigning points:

- 8.1: 5 points for a perfect answer, deduct 1 per error up to 5. [Replace after the end of the official marking by: Add ½ point for each correct word and deduct ½ for each wrong word.]
- 8.2: Add 1 point for each correct accidental, deduct one for every wrong one. (max 18, min 0)
- 8.3: 2 points for the idea, 1 extra for an example. (max 3)
- 8.4a: Add 1 for each correct note, deduct 1 for each error. Ignore accidentals and bar-lines. (25 max, 0 min)
- 8.4b. 4 for describing each problem, 1 for each solution or explanation of insolubility. (15 max)
- 8.5. 2 for mentioning or describing ambiguity not resolved by context plus 2 for a plausible example. (4 max)

8.1.	attention WE ARE RUNNING SHORT OF SUPPLIES. WE ATTACK TOMORROW AT EIGHT.
8.2.	
8.3.	Sequences are coded as quavers when they represent di- or trigraphs, i.e. sequences of letters representing a single sound: TI, RE, NG, SH, OR, IE, CK, OW, GHT. [Accept without OR since some speakers pronounce the /r/. Accept alternative terminology for 'di/tri-graph' if its intention is clear, e.g. 'compound sound' or 'two letters that make one sound' or 'they produce a single sound' or 'the letters are supposed to be pronounced together'.]
8.4a.	
	[Accept minim at (a) instead of double quaver. See the summary of the code below.]

8.4b.	Difficulties are: At (a) EE in NEED is a double letter, but is also a digraph. One solution is to ignore the fact that it is a double letter as above. Other solutions, especially from non-musical people, might involve trying to draw a white note with a bar (1) or a tail (2). Non-musical students might also choose to represent it as a double letter, ignoring the fact that it is a digraph. This might lead to (3), or (4) for students who know musical notation but choose this option. All solutions are OK, as the marks are primarily for noticing the problem.  (b) The word FIVE contains a discontinuous digraph I-E.  There was something similar in the first message with the word ARE, which showed RE as a digraph, but in this case there is a stronger connection between the I and E of FIVE. There is no obvious solution to this within musical notation. Non-musical students may suggest something like this (left). Again, the marks are for noting the problem rather than its solution. (c) The message requires us to represent X, which was not in the original message, and which is beyond the "system" of consonants in spaces starting with the space above the top line for BCD and ending with the space below the bottom line for TVW. Musical students will know about ledger lines, and probably offer the solution shown above. Some might suggest a double sharp, the symbol for which coincidentally looks like a small x. Marks can be awarded for any solution, including "There is no way to show an X". [Don't accept general answers such as 'I couldn't understand the code'. The question asks for three specific problems and requires a deep understanding of the code.]
8.5.	It is OK to omit accidentals because the context usually allows you to tell which of the three possible letters is intended. They might be necessary where the context is insufficient, for example a short message, or one containing an ambiguous word (e.g. CABBIE vs CADDIE, HUFFER vs HUGGER, DIMMER vs DINNER vs DIPPER) particularly if it's a name (e.g. LIBBY vs LIDDY, LEMMON vs LENNON). [Accept any answer so long as it mentions limited options, ambiguity/uncertainty and context in some way.]

Comments

As background to the details given above, here's a brief summary of how the code works:

Vowels are on the lines, going up: a on the bottom line, u on the top line.

Consonants are assigned, three at a time, to the spaces, going down: bcd on the very top space, above the top line, fgh on the space between the top two lines, and so on.

When necessary, accidentals distinguish the consonants, with flat for the (alphabetically) first and sharp for the third.

Minims show a double letter, e.g. tt

Quavers (which are always linked) show a di- or tri-graph.