Answers to Tutorial No 1, Semester 2, 2025/26

1. Two flagpoles next to each other are swaying repeatedly from left to right during a strong wind, and the shorter flagpole completes 9 cycles in the same period of time during which the taller flagpole completes 8 cycles. If the taller pole completes 4 full cycles in 5 seconds, what are the frequencies of vibration for each of these two flagpoles? When the wind gets even stronger, the frequency of the taller flagpole increases to 1.08 Hz, and the frequency of the shorter flagpole increases by the same proportion. Calculate the frequency of the shorter flagpole when the storm gets stronger.

   Answer: The taller pole completes 4 cycles in 5 seconds so it will complete $\frac{4}{5}$ or 0.8 cycles in one second, and hence its frequency is 0.8 Hz. Therefore the taller pole will complete 8 cycles in a time given by 8 cycles divided by 0.8 Hz i.e. 10 seconds. The shorter flagpole will therefore complete 9 cycles during this time, and hence its frequency is given by 9 cycles divided by 10 seconds i.e. 0.9 Hz. Since the frequency of the taller pole increases from 0.8 Hz to 1.08 Hz when the wind gets stronger, the frequency of the shorter pole will increase by the same proportion and will thus be equal to $\frac{1.08}{0.8}$ times 0.9 Hz i.e. 1.215 Hz.

2. A woman who is taking a walk in a park sings a note

with a frequency of 880 Hz, and a bassoon player sitting nearby in the park then plays a note which is 4 octaves below the woman's note. Calculate the frequency of the bassoon's note. If a tenor singer standing a short distance away then sings a note which has a frequency of 220 Hz, what is the number of octaves between the tenor singer's note and the bassoon's note? A flute player standing nearby then plays a note which is 5 octaves above the bassoon's note. Calculate the frequency of the flute's note and the number of octaves this note is above the tenor singer's note. If the frequency of the woman's note is 1,000 Hz instead of 880 Hz, calculate the frequencies of the bassoon's note, the tenor singer's note and the flute's note, if these notes maintained the same frequency relationships to each other as before.

Answer: Since the frequency of the woman's note is halved if we move down by an octave and the bassoon's note is 4 octaves below 880 Hz, its frequency is equal to 880 Hz divided by 2 four times, giving a frequency of 55 Hz. The tenor singer's note has a frequency of 220 Hz, and multiplying 55 Hz by 2 twice gives 220 Hz, so the tenor singer's note must be two octaves above the bassoon's note. Since the flute's note is 5 octaves above the bassoon's note, its frequency is equal to 55 Hz multiplied by 2 five times i.e. 1,760 Hz which is three octaves above the tenor singer's note. If the woman's note had been 1,000 Hz instead of 880 Hz, the bassoon's note would be equal to 1,000 Hz divided by 2 four times i.e. 62.5 Hz. The tenor singer's note is two octaves above the bassoon's note so its frequency would be equal to 62.5 Hz times 2 twice i.e. 250 Hz. The flute's note is 5 octaves above the bassoon's note, and hence its frequency would be equal to 62.5 Hz multiplied by 2 five times i.e. 2,000 Hz.

3. The first item at a concert which you are attending is a choir which registers 88 dB on a sound level meter which you are holding. The next item is a clarinet solo which is much softer and produces a reading of 58 dB on your sound level meter. How much less is the sound power of the clarinet compared with that of the choir? After the clarinet item, a jazz band performs with a sound power reaching your sound level meter 10,000 times greater than that of the clarinet. What would you expect the reading on your sound level meter due to the jazz band to be?
   Answer: Since a decrease of 10 dB of the sound level meter reading indicates a 10 times decrease in sound power, a decrease in the reading from 88 dB to 58 dB, i.e. 30 dB, must be equivalent to 10 times 10 times 10 times i.e. 1,000 times less sound power. The jazz band has a sound power that is 10,000 times or 10 times 10 times 10 times 10 times more powerful than that of the clarinet. This will mean the sound level meter reading would be 10 dB plus 10 dB plus 10 dB plus 10 dB more i.e. the reading will be 58 dB plus 40 dB i.e. 98 dB.

4. A solo oboe is to perform a piece of music which begins with a time signature of 20/8. One particular bar in this piece begins with three dotted quavers

and ends with two quavers and a dotted crotchet. How many semiquaver notes could fit into the middle of this bar in order to correspond exactly with the time signature? If the bar begins with three quavers instead of three dotted quavers, how many semiquavers would then fit exactly into the middle of the bar? (If we add a dot to a note or a rest, the duration of the note or rest is increased by 50%.)

Answer: The time signature is 20/8 which means that each bar of the piece should have the duration equivalent of 20 quavers or 40 semiquavers. Since the beginning of the bar already has three dotted quavers (which are equivalent to 9 semiquavers), and the end of the bar two quavers (equivalent to 4 semiquavers) and a dotted crotchet equivalent to 6 semiquavers, the bar already has a total of 19 semiquavers. The middle of the bar thus should be filled with another 21 semiquavers. If the beginning of the bar had three quavers (equivalent to 6 semiquavers) instead of three dotted quavers, the middle of the bar would need another 24 semiquavers.

5. Starting from any key on a piano keyboard and going up or down to a key which is its immediate neighbour, the interval moved is always that of a semitone. Therefore starting from any key to the next key above or below which has the same letter name (i.e. A, B, C, etc), the interval moved is always 12 semitones or one octave. If we start from the piano key with the letter name of E just below Middle C, how many semitones are there from this E to the D

which is just above Middle C? Express this interval in terms of octaves. What is the letter name of the piano key which is the same number of semitones below the starting E? Calculate the number of octaves from this lower note to the D just above Middle C.
Answer: Starting from the E just below Middle C and moving up to the D just above Middle C, you would have moved up by an interval of 10 semitones, which is equivalent to five-sixths of an octave. If you go down from the starting E by 10 semitones, you will reach the note F sharp which is six semitones below the C one octave below Middle C. There is thus a total of 20 semitones, or one and two-thirds octaves from this F sharp to the D just above Middle C.

6. We define the ratio of a musical interval from one musical note to another musical note at a higher pitch as the ratio of the frequency of the higher note to the frequency of the lower note. If we start from a note with a frequency of 240 Hz and move up by an interval with a ratio of $\frac{17}{10}$, what is the frequency of the higher note on which we will arrive? If we start from this second note and go down by an interval with a ratio of $\frac{16}{11}$, calculate the frequency of the third note on which we will arrive. What is the ratio of the interval between the first note and the third note?
Answer: Since the first note has a frequency of 240 Hz, going up by an interval with a ratio of $\frac{17}{10}$ means multiplying 240 Hz by an interval of $\frac{17}{10}$, giving 408 Hz as the frequency of the second note. If we go

down by an interval with a ratio of $\frac{16}{11}$, the frequency of the third note is obtained by dividing 408 Hz by $\frac{16}{11}$, which is the same as multiplying by $\frac{11}{16}$, giving a frequency of 280.5 Hz for the third note. We can obtain the ratio of the interval from the first note to the third note by multiplying $\frac{17}{10}$ by $\frac{11}{16}$, which gives a ratio of 1.16875. The same ratio can also be obtained by dividing the frequency of the third note by the frequency of the first note, giving a ratio of $\frac{280.5}{240}$ which is also equal to 1.16875.

Scientific Inquiry discussion points

1. Science seeks to discover and understand the universe through the methodology of scientific inquiry. Scientists observe the universe and formulate hypotheses to explain what they observe. They test their hypotheses through experiments and further observation. A hypothesis becomes an accepted theory if supported strongly by experimental or observational evidence. Can you think of examples of scientific inquiry which changed our perception and understanding of the universe?

   There are many examples of scientific inquiry which changed our perception and understanding of the universe. One of the most important was the hypothesis that the earth revolves around the sun and not vice versa. Johannes Kepler was the first scientist to work out the physics of how the earth went around the sun. A more modern example is Albert Einstein's prediction in his general theory of relativity that light could be bent by gravitational force. The British astronomer

Arthur Eddington actually observed such a bending of light when he led an expedition to observe the 1919 solar eclipse in Brazil. They actually observed light from distant stars being deflected by the sun during the solar eclipse.

2. Technology seeks to shape and modify the universe in order to improve the quality of life in human society. Technology can include simple objects like chairs and lamps, and complex objects like computers and integrated circuits. Like science, technology dates back to the earliest days of mankind, and technological tools and artefacts can be found in the earliest archeological sites. What are good examples of technological achievements in early societies and in modern civilisation?

   Perhaps the most important example of a technological advance in ancient times was the invention of the wheel. How and when this happened is lost in the mists of time, but the wheel very likely came about independently in different civilisations. In more recent times, a significant technological innovation was the telegraph, which made almost instantaneous communications possible. An equally important innovation was the steam engine, which gave society immensely greater motive power beyond human and animal muscle strength and was unaffected by the vagaries of wind and water power.