Answers to Tutorial No 1, Semester 1, 2026/27

1. Two trees next to each other are swaying repeatedly from side to side during a storm. The shorter tree completes 10 cycles in the same time during which the taller tree completes 6 cycles. If the taller tree completes 3 cycles in 4 seconds, calculate the frequencies of vibration of each of these two trees. When the storm gets weaker, the frequency of the taller tree decreases to 0.6 Hz. If the frequency of the shorter tree decreases by the same proportion, what would be the frequency of the shorter tree when the storm gets weaker?

   Answer: Since the taller tree completes 3 cycles in 4 seconds, it will complete $\frac{3}{4}$ or 0.75 cycles in one second, so its frequency is 0.75 Hz. The taller tree completes 6 cycles in a time given by 6 cycles divided by 0.75 Hz i.e. 8 seconds. The shorter tree completes 10 cycles during this time, and its frequency is thus equal to 10 cycles divided by 8 seconds i.e. 1.25 Hz. The frequency of the taller tree decreases from 0.75 Hz to 0.6 Hz when the storm gets weaker, so the frequency of the shorter tree which decreases by the same proportion will thus be equal to $\frac{0.6}{0.75}$ times 1.25 Hz i.e. 1 Hz.

2. A girl in a shopping mall sings a note with a frequency of 660 Hz, and a trombone player standing nearby then plays a note which is 3 octaves below

the girl's note. What is the frequency of the trombone's note? A soprano singer nearby then sings a note which has a frequency of 1,320 Hz. Calculate the number of octaves between the soprano singer's note and the trombone's note. A clarinet player sitting a short distance away then plays a note which is 2 octaves above the trombone's note. Calculate the frequency of the clarinet's note. What is the interval between the clarinet's note and the soprano's note? If the frequency of the girl's note is 440 Hz instead of 660 Hz, calculate the frequencies of the trombone's note, the soprano singer's note and the clarinet's note assuming that these notes maintained the same frequency relationships to each other as before.

Answer: The frequency of any note is halved if we move down by an octave. Since the trombone's note is 3 octaves below 660 Hz, its frequency is equal to 660 Hz divided by 2 three times, giving a frequency of 82.5 Hz. The soprano singer's note has a frequency of 1,320 Hz which is an octave above 660 Hz, since 660 Hz multiplied by the ratio of an octave gives 1,320 Hz. Therefore the soprano's note is four octaves above the trombone's note. The clarinet's note is 2 octaves above the trombone's note so its frequency is given by 82.5 Hz times 2 two times i.e. 330 Hz. If we divide 1,320 Hz by 2 twice we obtain 330 Hz, so the clarinet's note is two octaves below the soprano singer's note. If the girl's note is 440 Hz instead of 660 Hz, the frequencies of the trombone's note, the soprano's note and the clarinet's note would be 55

Hz, 880 Hz and 220 Hz respectively.

3. A fire engine passing in front of you registers a siren sound level of 98 dB on a sound level meter you are carrying. The fire engine then stops at a house on fire some distance away, and the sound from its siren is 10,000 times weaker than when it was in front of you. What would the reading on your sound level meter due to the fire engine's siren be? The fire engine then turns off its siren and a police car passing in front of you registers a siren sound level of 78 dB on your sound level meter. How many times more powerful is this sound compared to the fire engine's siren when the fire engine is at the house on fire? (Assume that the readings on the sound level meter are due only to the police car's siren or the fire engine's siren.)
Answer: Since a decrease of 10 dB of the sound level meter reading indicates a decrease in sound power of 10 times, a decrease of 10,000 times i.e. 10 times 10 times 10 times 10 times sound power will result in a decrease of 10 dB plus 10 dB plus 10 dB plus 10 dB i.e. 40 dB in the sound level meter reading. Therefore the reading on the sound level meter due to the fire engine's siren when it is at the house on fire will thus be given by 98 dB minus 40 dB i.e. 58 dB. The difference in sound level between the police car's siren and the fire engine's siren when the fire engine is at the house on fire is 78 dB minus 58 dB i.e. 20 dB which is 10 dB plus 10 dB. Therefore the sound from the police car's siren is 10 times 10 or 100 times more powerful.

4. A piece of music performed by a solo flute begins with a time signature of 26/8. A certain bar in this piece begins with a dotted crotchet and ends with three quavers and four semiquavers. Calculate the number of semiquaver notes which could fit into the middle of this bar in accordance with the time signature. If the bar begins with two crotchets instead of a dotted crotchet, 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: Since the time signature is 26/8, this means that each bar of the piece should have the duration equivalent of 26 quavers or 52 semiquavers. The beginning of the bar already has a dotted crotchet (which is equivalent to 6 semiquavers), and the end of the bar has three quavers (equivalent to 6 semiquavers) and 4 semiquavers, so the bar already has a total of 16 semiquavers. Therefore the middle of the bar should be filled with another 36 semiquavers. If the bar begins with two crotchets (equivalent to 8 semiquavers) instead of a dotted crotchet, the middle of the bar would need another 34 semiquavers.

5. If you start from any key on a piano keyboard and go up or down to a key which is its immediate neighbour, the interval moved is always that of a semitone. If we start 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. Starting from the piano key with the letter

name of F just above Middle C, how many semitones are there from this F to the D sharp which is just below Middle C? What is this interval in terms of octaves? Give the letter name of the piano key which is the same number of semitones above the starting F. What is the number of octaves from this higher note to the D sharp just below Middle C?

Answer: If you start from the F just above Middle C and move down to the D sharp just below Middle C, this movement is by an interval of 14 semitones. This is equivalent to one and one-sixth of an octave. Going up from the starting F by 14 semitones, you will reach the note G which is seven semitones above the C one octave above Middle C. There is a total of 28 semitones, or two and one-third octaves, from this G to the D sharp just below Middle C.

6. The ratio of a musical interval from one musical note to another musical note at a higher pitch is defined as the ratio of the frequency of the higher note to the frequency of the lower note. Starting from a note with a frequency of 440 Hz and moving up by an interval with a ratio of $\frac{25}{8}$, calculate the frequency of the higher note on which we will arrive. Starting from this second note and going down by an interval with a ratio of $\frac{15}{9}$, what is the frequency of the third note on which we will arrive? Calculate the ratio of the interval between the first note and the third note.

   Answer: The first note has a frequency of 440 Hz, and going up by an interval with a ratio of $\frac{25}{8}$ means

multiplying 440 Hz by $\frac{25}{8}$, which gives 1,375 Hz as the frequency of the second note. Going down by an interval with a ratio of $\frac{15}{9}$, we obtain the frequency of the third note by dividing 1,375 Hz by $\frac{15}{9}$, which is the same as multiplying by $\frac{9}{15}$. This gives a frequency of 825 Hz for the third note. The ratio of the interval from the first note to the third note can be obtained by multiplying $\frac{25}{8}$ by $\frac{9}{15}$, giving a ratio of 1.875. This ratio can also be obtained by dividing the frequency of the third note by the frequency of the first note, giving a ratio of $\frac{825}{440}$ which is also equal to 1.875.

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.