Question 1

3. A student used a cylindrical column of air closed at one end and a tuning fork of frequency 512 Hz in an experiment to measure the speed of sound in air.

The following data was recorded:

Length of column of air for first position of resonance	= 16.2 cm
Diameter of air column	= 1.15 cm

Draw a labelled diagram of the apparatus used in the experiment. (9)

Describe how the first position of resonance was found. (9)

Using the recorded data, calculate the speed of sound in air. (9)

Why was it necessary to measure the diameter of the air column? (6)

Another student carried out the experiment. She measured the length of the column of air for each of the first two positions of resonance but she did not measure the diameter of the air column. Explain how this second student would find the speed of sound in air. (7)

Question 2

10. Blood pressure can be measured in many ways. One technique uses the Doppler effect; another uses strain gauges contained in Wheatstone bridges.

What is the Doppler effect?

Explain, with the aid of labelled diagrams, how the Doppler effect occurs. (18)

An ambulance siren emits a sound of frequency 750 Hz. When the ambulance is travelling towards an observer, the frequency detected by the observer is 820 Hz.

What is the speed of the ambulance? (12)

State two other practical applications of the Doppler effect. (4)

Question 3

7. What is meant by the term resonance? How would resonance be demonstrated in the laboratory? (15)

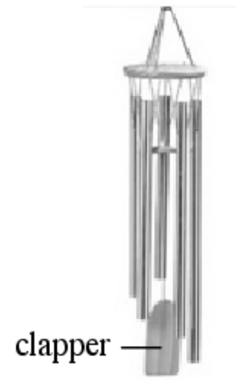
A set of wind chimes, as shown in the diagram, is made from different lengths of hollow metal tubing that are open at both ends. When the wind blows, the wind chimes are struck by a clapper and emit sounds.

The sound from one of the tubes was analysed. The following frequencies were identified in the sound: 550 Hz, 1100 Hz and 1651 Hz.

What name is given to this set of frequencies? (5)

Draw labelled diagrams to show how the tube produces each of these frequencies.

The length of the metal tube is 30 cm. Use any of the above frequencies to calculate a value for the speed of sound in air. (24)



A sample of wire, of length 12 m and mass 48 g, was being tested for use as a guitar string. A 64 cm length of the wire was fixed at both ends and plucked. The fundamental frequency of the sound produced was found to be 173 Hz. Calculate the tension in the wire. (12)

Question 4

3. In an experiment to investigate the variation of the fundamental frequency f of a stretched string with its length l, the following data were recorded.

f/Hz	95	102	114	126	141	165	194	232
l/m	0.603	0.553	0.503	0.453	0.403	0.353	0.303	0.253

How were the data obtained? (15)

Using the data, draw a suitable graph on graph paper to show the relationship between the fundamental frequency of the stretched string and its length. (12)

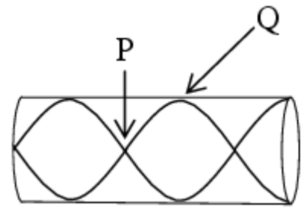
The fundamental frequency of a stretched string depends on factors other than its length. Name one of these factors and give its relationship with the fundamental frequency.

If you were doing an experiment to establish the relationship between the fundamental frequency of a stretched string and this other factor, how would you obtain the relevant data? (13)

Question 5

8. (*a*) Destructive interference can occur when waves from <u>coherent sources</u> meet.
Explain the underlined term.
Give two other conditions necessary for total destructive interference to occur. (14)

The diagram shows a standing wave in a pipe closed at one end.
The length of the pipe is 90 cm.



(i) Name the points on the wave labelled P and Q.

(ii) Calculate the frequency of the standing wave.

(iii) What is the fundamental frequency of the pipe?

The clarinet is a wind instrument based on a pipe that is closed at one end.
What type of harmonics is produced by a clarinet? (24)

(*b*) An audio speaker at a concert emits sound uniformly in all directions at a rate of 100 W. Calculate the sound intensity experienced by a listener at a distance of 8 m from the speaker.

The listener moves back from the speaker to protect her hearing. At what distance from the speaker is the sound intensity level reduced by 3 dB? (18)

(speed of sound in air = 340 m s^{-1})

Question 6

(*c*) Explain the term resonance and describe a laboratory experiment to demonstrate it. (15)

Give two characteristics of a musical note and name the physical property on which each characteristic depends. (9)

Explain why a musical tune does not sound the same when played on different instruments. (4)

Question 7

(*d*) The sound intensity level at a concert increases from 85 dB to 94 dB when the concert begins. By what factor has the sound intensity increased? (7)

Question 8

(*c*) What is the relationship between the frequency of a vibrating stretched string and its length? (7)

Question 9

(*b*) The pitch of a musical note depends on its frequency.
On what does (i) the quality, (ii) the loudness, of a musical note depend? (6)

What is the Doppler effect? (6)

A rally car travelling at 55 m s^{-1} approaches a stationary observer.
As the car passes, its engine is emitting a note with a pitch of 1520 Hz.
What is the change in pitch observed as the car moves away? (12)

Give an application of the Doppler effect. (4)

Question 10

(*b*) Define sound intensity. (6)

A loudspeaker has a power rating of 25 mW. What is the sound intensity at a distance of 3 m from the loudspeaker? (9)

The loudspeaker is replaced by a speaker with a power rating of 50 mW.
What is the change:

(i) in the sound intensity?

(ii) in the sound intensity level? (9)

The human ear is more sensitive to certain frequencies of sound.
How is this taken into account when measuring sound intensity levels? (4)

Question 11

3. A cylindrical column of air closed at one end and three different tuning forks were used in an experiment to measure the speed of sound in air. A tuning fork of frequency *f* was set vibrating and held over the column of air.
The length of the column of air was adjusted until it was vibrating at its first harmonic and its length *l* was then measured. This procedure was repeated for each tuning fork.
Finally, the diameter of the column of air was measured.

The following data was recorded.

f/Hz	512	480	426
l/cm	16.0	17.2	19.4
Diameter of column of air = 2.05 cm			

Describe
- (i) how the length of the column of air was adjusted;
- (ii) how the frequency of the column of air was measured;
- (iii) how the diameter of the column of air was measured. (16)

How was it known that the air column was vibrating at its **first** harmonic? (9)

Using all of the data, calculate the speed of sound in air. (15)

Question 12

(d) A sound wave is diffracted as it passes through a doorway but a light wave is not. Explain why. (7)

Question 13

(e) What is the Doppler effect? (7)

Question 14

9. What is an electric current? Define the ampere, the SI unit of current. (12)

Describe an experiment to demonstrate the principle on which the definition of the ampere is based. (15)

Sketch a graph to show the relationship between current and time for
- (i) alternating current;
- (ii) direct current. (9)

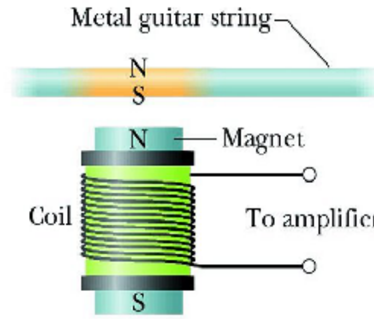
The peak voltage of the mains electricity is 325 V. Calculate the rms voltage of the mains? (6)

What is the resistance of the filament of a light bulb, rated 40 W, when it is connected to the mains? (9)

Explain why the resistance of the bulb is different when it is **not** connected to the mains. (5)

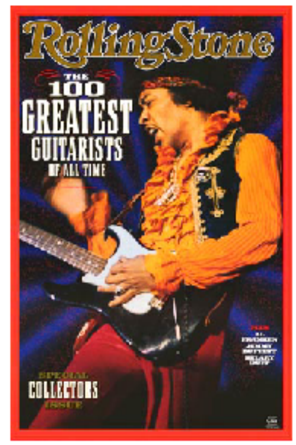
11. Read the following passage and answer the accompanying questions.

The growth of rock music in the 1960s was accompanied by a switch from acoustic guitars to electric guitars. The operation of each of these guitars is radically different.



The frequency of oscillation of the strings in both guitars can be adjusted by changing their tension. In the acoustic guitar the sound depends on the resonance produced in the hollow body of the instrument by the vibrations of the string. The electric guitar is a solid instrument and resonance does not occur.

Small bar magnets are placed under the steel strings of an electric guitar, as shown. Each magnet is placed inside a coil and it magnetises the steel guitar string immediately above it. When the string vibrates the magnetic flux cutting the coil changes, an emf is induced causing a varying current to flow in the coil. The signal is amplified and sent to a set of speakers.



Jimi Hendrix refined the electric guitar as an electronic instrument. He showed that further control over the music could be achieved by having coils of different turns.

(Adapted from Europhysics News (2001) Vol. 32 No. 4)

(a) How does resonance occur in an acoustic guitar? (7)

(b) What is the relationship between frequency and tension for a stretched string? (7)

(c) A stretched string of length 80 cm has a fundamental frequency of vibration of 400 Hz. What is the speed of the sound wave in the stretched string? (7)

(d) Why must the strings in the electric guitar be made of steel? (7)

(e) Define magnetic flux. (7)

(f) Why does the current produced in a coil of the electric guitar vary? (7)

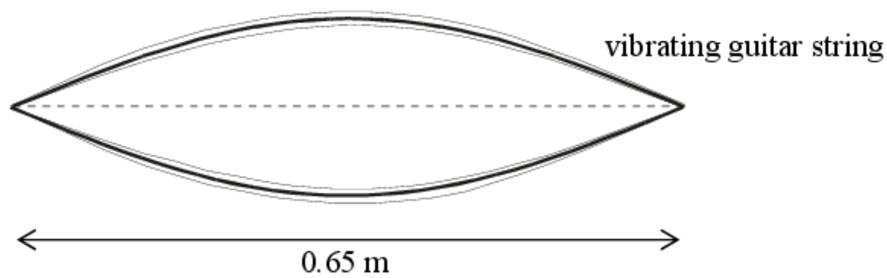
(g) What is the effect on the sound produced when the number of turns in a coil is increased? (7)

(h) A coil has 5000 turns. What is the emf induced in the coil when the magnetic flux cutting the coil changes by 8×10^{-4} Wb in 0.1 s? (7)

Question 15

(c) The frequency of a stretched string depends on its length.

Give two other factors that affect the frequency of a stretched string. (6)



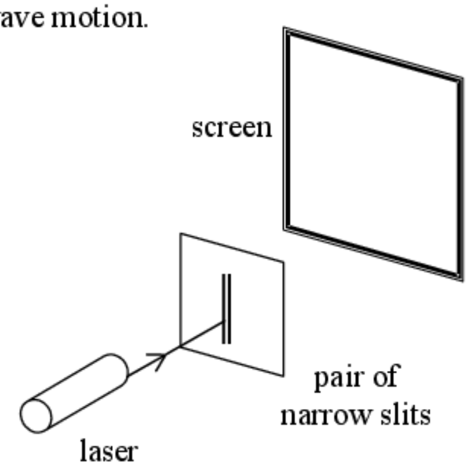
The diagram shows a guitar string stretched between supports 0.65 m apart. The string is vibrating at its first harmonic. The speed of sound in the string is 500 m s^{-1}. What is the frequency of vibration of the string? (9)

Draw a diagram of the string when it vibrates at its second harmonic. (7)

What is the frequency of the second harmonic? (6)

Question 16

7. A student used a laser, as shown, to demonstrate that light is a wave motion.



(i) Name the two phenomena that occur when the light passes through the pair of narrow slits. (6)

(ii) A pattern is formed on the screen. Explain how the pattern is formed. (12)

(iii) What is the effect on the pattern when
  (a) the wavelength of the light is increased.
  (b) the distance between the slits is increased. (8)

Describe an experiment to demonstrate that sound is also a wave motion. (12)

Sound travels as longitudinal waves while light travels as transverse waves. Explain the difference between longitudinal and transverse waves. (9)

Describe an experiment to demonstrate that light waves are transverse waves. (9)