Question 1

7. The Doppler effect applies to all types of waves and is named after Christian Johann Doppler, an Austrian scientist who explained this phenomenon in 1842.

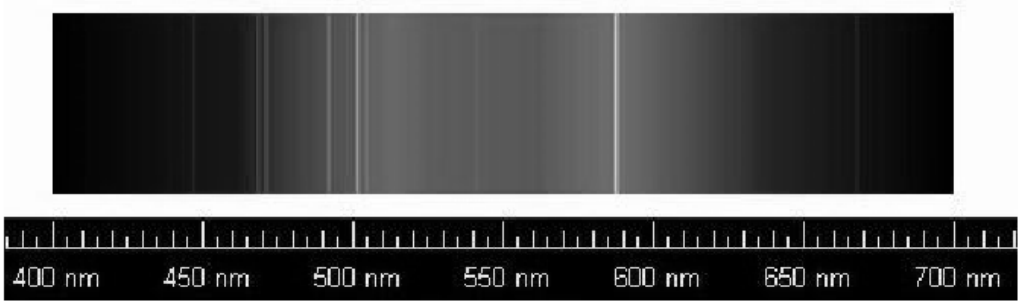
What is the Doppler effect?

Explain, with the aid of labelled diagrams, how this phenomenon occurs. (18)

Describe a laboratory experiment to demonstrate the Doppler effect. (9)

In the early part of the twentieth century, Hubble and other astronomers made the first measurements on the spectra from distant stars. They observed that these spectra were shifted and they used the Doppler effect to explain these shifts.

What causes the red shift in the spectrum of a distant star? (6)



The yellow line emitted by a helium discharge tube in the laboratory has a wavelength of 587 nm as shown in the diagram. The same yellow line in the helium spectrum of a star has a measured wavelength of 590 nm.

What can you deduce about the motion of the star?

Calculate the speed of the moving star. (18)

Give another application of the Doppler effect. (5)

(speed of light = 3.00×10^8 m s^{-1})

Question 2

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

A person's exposure to radiation when using a mobile phone is measured in terms of the Specific Absorption Rate (SAR). This is a measure of the rate at which radio frequency energy is absorbed by a person's body during a phone call and is expressed in watts per kilogram.

A radio frequency wave penetrates the body to a depth that depends on its frequency. At mobile phone frequencies the wave energy is absorbed by about one centimetre of body tissue. The energy absorbed is converted into heat and is carried away by the body. Any adverse health effects from radio frequency waves are due to heating. Current scientific evidence indicates that exposure to radiation from mobile phones is unlikely to induce cancer.

(*Adapted from a Dept. of Communications, Energy and Natural Resources Press Release of 22 March 2007.*)

(*a*) Give two properties of radio waves. (7)

(*b*) In a three-minute phone call, 10 g of head tissue absorbs 0.36 J of radio frequency energy. Calculate the SAR value. (7)

(*c*) What happens to the radio frequency energy absorbed by the body? (7)

(*d*) Why are radio frequency waves not very penetrating? (7)

(*e*) A mobile phone converts the received radio frequency waves to sound waves. What are the audible frequency limits for sound waves? (7)

(*f*) Give two safety precautions you should take when using a mobile phone. (7)

(*g*) A mobile phone transmits at 1200 MHz from its antenna. Calculate the length of its antenna, which is one quarter of the wavelength that it transmits. (7)

(*h*) Name an electromagnetic wave which may induce cancer. Justify your answer. (7)

(speed of light = 3.0×10^8 m s^{-1})

Question 3

(*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)

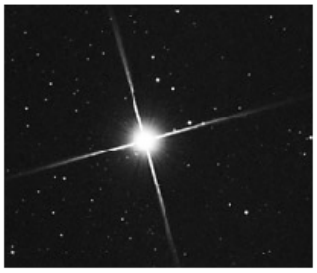
A rally car travelling at 55 m s^{-1} approaches a stationary observer.
As the car passes, its engine is emitting a note with a pitch of 1520 Hz.
What is the change in pitch observed as the car moves away? (12)

Give an application of the Doppler effect. (4)

Question 4

7. What is the Doppler effect?
Explain, with the aid of labelled diagrams, how this phenomenon occurs. (18)

The emission line spectrum of a star was analysed using the Doppler effect.
Describe how an emission line spectrum is produced. (12)



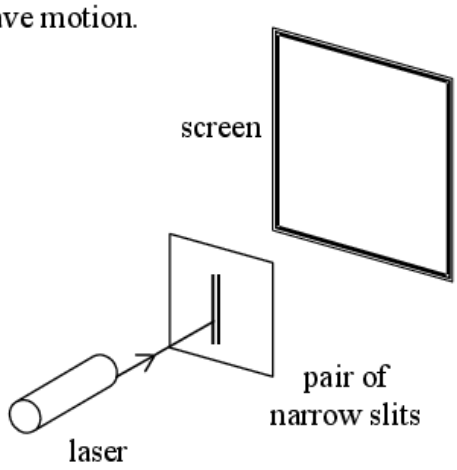
The red line emitted by a hydrogen discharge tube in the laboratory has a wavelength of 656 nm. The same red line in the hydrogen spectrum of a moving star has a wavelength of 720 nm.
Is the star approaching the earth? Justify your answer. (8)

Calculate:
(i) the frequency of the red line in the star's spectrum
(ii) the speed of the moving star. (18)

(speed of light = 3.00×10^8 m s^{-1})

Question 5

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)

Question 6

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

Question 7

(d) How is infra-red radiation detected? (7)