# 09 Waves phenomena review questions

Part A: SHM

1. For an oscillation of 8Hz calculate the value of T and ω

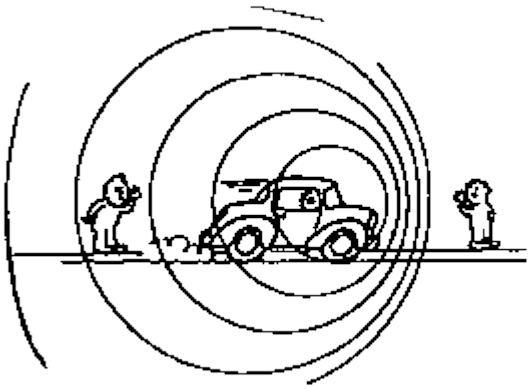
2. The period of oscillations of a mass of m kg on a spring of stiffness constant k is given by:

   $T = 2\pi\sqrt{(m/k)}$

   a) Calculate the period of oscillation of mass of 4 kg on a spring of stiffness constant 200 $Nm^{-1}$?
   b) If the amplitude of the oscillation is 0.05m calculate the kinetic, potential and total energies of the system when the mass is 0.03m from equilibrium.
   c) Sketch a graph showing the changing values of kinetic, potential and total over time.
   d) Explain the effect of air resistance and friction in the mass-spring system.

Part B: Doppler effect:

1. Two listeners hear the frequency of a moving car engine at differently. The speed of sound is 340$ms^{-1}$ and the speed of the car is 50$ms^{-1}$. The main frequency of the motor sound is 200Hz.

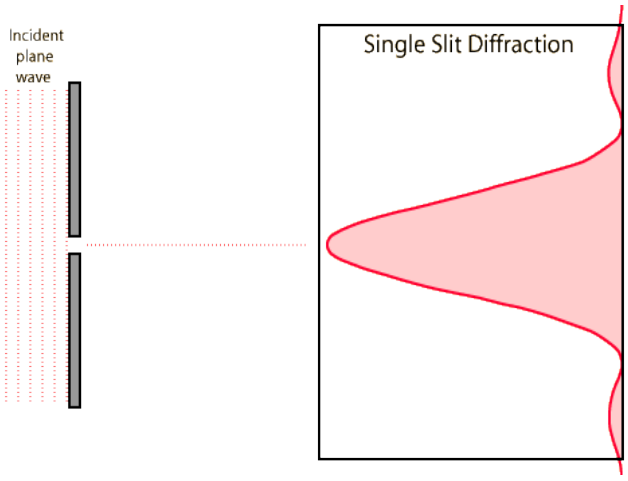


   a. Explain whether the listener who is in front of the car hear a higher frequency or a lower frequency than the listener behind the car.
   b. Calculate the frequency heard by the listener who is behind the car.
   c. If the listener in front of the car is playing a note of frequency 440Hz sketch a graph of frequency heard by the driver as the driver passes the listener playing the note. Add values of frequency to the y axis.

2. A source of 440Hz waves whose speed is 330$ms^{-1}$ waves is travelling at 500$ms^{-1}$. Calculate the frequencies observed by a stationary listener for this approaching source. What does the negative result mean?
3. M31 (the Andromeda galaxy) is approaching us at about 120.0 kms-1. Some light it emits has a wavelength, relative to M31, of 480.0 nm. What is its wavelength as observed by us?

**Part C: Diffraction**

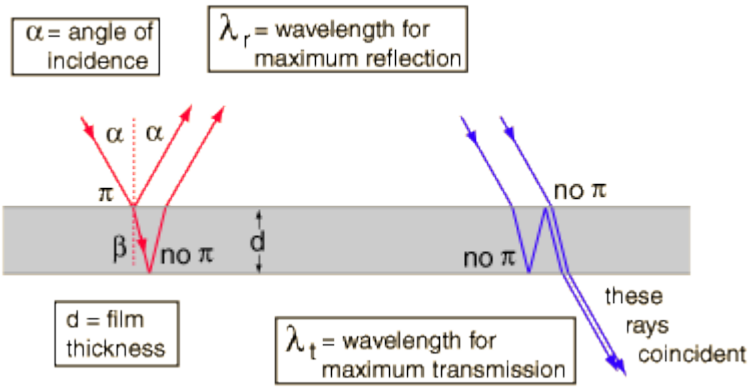
1. When sketching intensity of the single slit diffraction pattern state three key elements of the sketch.
2. For the diagram on the left the wavelength of the radiation used is 3x10-2m and the slit width is 7x10-2m. Calculate the angle at which the first minimum is found.



3. Electromagnetic waves from a source pass through a slit of width $5 \times 10^{-4}$m. A detector is used to detect the level of intensity arriving at a distance 1m away from the slit. The detector detects a strong continuous level intensity of radiation along a horizontal line of 5cm length. The detector is kept at the 1m distance. Estimate the wavelength of the radiation being used.

**Part D: Interference**

1. Some sources of waves are coherent for example a LASER, water waves created by a wave machine, many sound waves. A sufficiently thin slit will make waves coherent. Explain what is meant by a coherent source and why interference patterns are only stable for coherent sources.
2. Coherent light passes through a diffraction grating which has 16000 slits across a length of 4cm. Calculate the angle for the first order maximum
    a. For red light (λ = 660nm)
    b. For Blue light (λ = 470nm)
    c. How many maxima will be visible in total?
3. A thin film will cause a diffraction pattern due to light travelling through or reflecting off the surfaces. State the path difference that will cause destructive interference due to thin film interference.




    a. For light transmitting though a thin film
    b. For light reflecting off a thin film with a phase change.
    c. A thin oil film floating on water produced thin film interference patterns with a phase change on the first reflection. When light is shining on the film the second maxima for red light is observed. If the refractive index of the oil is 1.46 and red light has a wavelength of 660nm calculate the thickness of the oil film.

**Part E: Resolution**

1. When waves pass through a gap or reflect off a narrow surface they diffract.
    a. Explain why smaller wavelengths are needed to accurately detect small objects.
    b. Explain why an electron of energy 1 MeV can provide more resolution than light.
2. The sand ripples on a beach are approximately 8cm apart. A camera is used to take a picture of a beach from a helicopter flying at a height of 500m. The camera lens has an aperture of 4mm. Explain whether the sand ripples on the beach will be resolved on the image of the camera.

3. For the diffraction grating in PartD 2. calculate the minimum number of slits that must be illuminated for the red and orange light to be resolvable in the first order spectrum. Take the wavelength of orange light to be 600nm.