Syllabus for Test 9: L21 and L22 and L 23 (partial)

L21: General definition of wave motion, periodic and solitary waves; Properties of progressive waves: time period, frequency, wavelength, crest, cycle, amplitude of a wave; Transverse and longitudinal waves; Phase of a wave, wave-front, rays; Superposition principle, standing waves, nodes/anti-nodes, resonant frequencies, Energy transport by a wave, intensity of a wave; General description of wave phenomena: reflection and refraction of waves, refractive index, diffraction and interference of waves.

L22: Review of general properties of wave motion and general wave phenomena; Polarization of waves, unpolarized, plane-polarized, elliptically or circularly polarized lights; Propagation of waves, propagation of a general pulse, general equation of a wave; Transverse waves on a string, one-dimensional differential equation for transverse waves on a stretched string, general solution to the one-dimensional differential equation for wave motion; Reflection and transmission of waves on a stretched string, cases on boundary conditions.

L23: Review of one-dimensional differential equation of wave motion and its general solution; Review of reflection and transmission of waves; Criteria of phase change upon reflection at a boundary.

1.
Give an example of a non-mechanical wave.

radio wave
sound wave
surface wave
seismic wave
oceanic waves

Ans: radio waves

2.
What is the relation between the amplitude and the frequency of a wave?

Independent of each other.
Equal to each other.
Inverse of each other.
The amplitude decreases with an increase in the frequency.
The amplitude increases with an increase in the frequency.

Ans: Independent of each other.

3.
A swimmer floating in the water moves up and down as the waves pass by her. The distance the swimmer moves up and down would be

twice the amplitude
the wavelength
the amplitude
twice the wavelength
half the amplitude

Ans: twice the amplitude

4.
The equation of a progressive wave traveling on a stretched string is y = 10 sin (t/0.02 -x/100) where x and y are in cm and t is in sec. what is the speed of the wave?

500 cm/s
50 m/s
40 m/s
400 cm/s
20 m/s

Answer: 50 m/s. Explanation: We can rewrite the equation of the wave as: y =A sin[t/T –x/lambda], where T is the time period and lambda is the wavelength. Then, the speed is lambda/T=100 cm/0.02 s which gives v= 100*(100/2) cm/s = 50 m/s

5.
The amplitude of a wave is:

independent of its speed.
directly proportional to its speed.
directly proportional to the square of the inverse of its speed.
directly proportional to the inverse of its speed.
directly proportional to the square of its speed.

Ans: amplitude of a wave is independent of its speed.

6.
In the equation of a wave given by y = a sin [q(x – pt) pi], where, q = 2/λ, then the speed of the wave is

p
qp
q/p
p/q
q

Ans: p. Explanation: Wave equation y = a sin [q(x – pt) pi], where (pi)q=k, and (pi)qp=omega = 2(pi) nu => nu = qp/2 = 2p/2λ = p/λ => nu λ = v= p

7.
Two sound waves having a phase difference of 60° have path difference of:

2 lambda
lambda/2
lambda/6
lambda/3
lambda/4

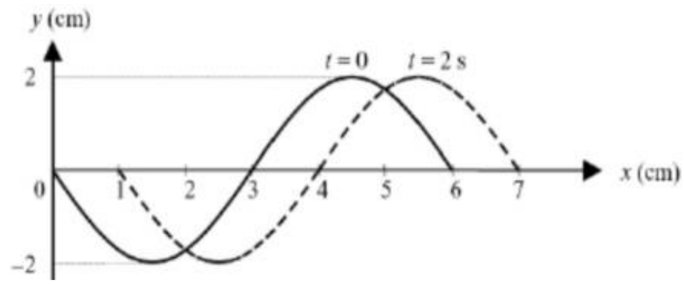
Ans: lambda/6. Explanation: $\Delta x/\lambda = \Delta\phi/2\pi \Rightarrow \Delta x = (\lambda/3)\pi/(2\pi) \Rightarrow \Delta x = \lambda/6$

8.
The velocity of a transverse wave in a string does NOT depend on

Tension
Mass/length of the string
Radius of the string
Length of the string
Depends on all of the mentioned.

Ans: Length of the string.

9.
The figure below shows the positions of a travelling wave at time intervals t = 0 and t = 2 s. The speed of the wave is:



0.5 cm/s
2.0 cm/s
0.5 m/s
2.0 m/s
1.0 cm/s

Ans: 0.5 cm/s. In 2 s, the wave travels 1 cm -> speed = 1 cm / 2 s = 0.5 cm/s

10.
The equation y= A sin^2 (k x-omega t) represents a wave motion with:

amplitude A and frequency omega/(2 pi)
amplitude A/2 and frequency omega/pi
amplitude 2A and frequency omega/(4 pi)
amplitude 2A and frequency omega/(2 pi)
none of the mentioned

Ans: amplitude A/2 and frequency omega/pi. Explanation: $y = A\sin^2(kx-\omega t) = (A/2)2\sin^2(kx-\omega t) = (A/2)[1-\cos(2kx-2\omega t)] = (A/2)\,[1-\cos(k'x-\omega' t)]$. Hence, the frequency is $\nu = \omega'/2\pi$ $\Rightarrow \nu = 2\omega/2\pi = \omega/\pi$

11.
For a transverse wave on a string the displacement of the particles of the string is described as:

$$y(x,t) = \frac{1}{1+(x-at)^2}$$

where a is a negative constant. Which of the following is true:

The shape of the string at $t = 0$ is $y = 1/(1+x^2)$
The shape of the waveform does not change as its move along the string
Waveform moves in the $-x$ direction
The speed of the waveform is |a|
All of the mentioned.

Ans: All of the mentioned.

12.
Two waves are represented by x1 = A sin (omega t + pi/6) and x2 = A cos(omega t), then the phase difference between them is:

pi/6
pi/2
pi/3
pi
pi/4

Answer: pi/3. Explanation: x2= A cos(omega t) = A sin(pi/2 + omega t), phi_2 – phi_1 = Delta phi = pi/2 –pi/6 = (3 pi – pi)/6 = pi/3

13.
Standing waves:

are a result of the superposition of two travelling waves.
can only occur in vibrating strings.
occur only when the wavelength of the wave is smaller than the length of the string.
can occur with number of antinodes greater than the number of nodes.
move with a speed equal to the speed of sound.

Ans: Standing waves are a result of the superposition of two travelling waves. Explanation: Standing waves may occur in different systems. For wavelength of the wave need not necessarily be longer of smaller of the length of the string. For fundamental mode of vibration, $L = \lambda/2$.
The number of nodes is always one more than the number of antinodes as nodes always occur at the boundary points. The speed of a standing wave is zero.

14.
Which of the following is not a standing wave

y = A sin(2πx/λ) cos(2πvt/λ)
y = A cos(qx) sin (rt)
y = A sin(qx+rt)+psin(qx−rt)
y = A sin(qx+rt)
None of the mentioned.

Ans: y = A sin(qx+rt). Explanation: y = A sin(qx+rt) is an equation of a transverse wave.

15.
A guitar string resonates at a frequency of 500 Hz forming a standing wave pattern with 5 loops. What is the fundamental frequency?

100 Hz
200 Hz
300 Hz
400 Hz
500 Hz

Ans: 100 Hz.

16.
The change in the phase if a wave is reflected from a denser medium is given by:

3π
0
π
2π
π/2

Ans: π

17.
Which parameter of a wave gets affected after superposition?

wavelength
direction
amplitude
frequency
speed

Ans: amplitude. Explanation: Superposition refers to addition of two waves at a point. Hence the net amplitude changes.

18.
The amplitude of resulting wave dues to superposition of y1 = A sin (ωt − kx) & y2 = A sin (ωt − kx + δ) is:

2A cos (δ)
2A tan (δ/2)
A cos (δ) sin (δ)
2A cos (δ/2)
2A sin (δ)

Ans: A cos (δ/2) .Explantion: The net displacement is: $y_{net} = y_1 + y_2 = A\sin(kx - \omega t) + A\sin(kx - \omega t + \delta)$ where δ is the (initial) phase difference between the waves. Hence we have:

$$y_{net} = y_1 + y_2 = A\sin(kx - \omega t) \ + A\sin(kx - \omega t + \delta) = A[\sin(\alpha) + \sin(\alpha + \delta)]$$

$$\Rightarrow y_{net} = A\ 2\sin\left[\frac{(2\alpha + \delta)}{2}\right]\cos\left[\frac{(\alpha + \delta - \alpha)}{2}\right] = 2A\sin\left(\alpha + \frac{\delta}{2}\right)\cos\left(\frac{\delta}{2}\right)$$

$$\Rightarrow y_{net} = 2A\sin\left(kx - \omega t + \frac{\delta}{2}\right)\cos\left(\frac{\delta}{2}\right)$$

19.
What kind(s) of interference can occur between two identical waves moving in opposite directions?

Constructive interference only
Destructive interference only
Both constructive and destructive interference
Neither constructive nor destructive interference
Only partial interference.

Ans: Both constructive and destructive interference

20.
A helicopter pilot notices water waves that strike a small island are bending around the back of the island. This property of a wave is called

diffraction
refraction
interference
scattering
reflection

Ans: Diffraction.

21.
Which of the following does NOT exhibit polarization

Longitudinal wave in a gas
Transverse wave in a gas
None of the options mentioned
All types of waves in a gas
Transverse wave in a string

Answer: Longitudinal wave in a gas. Polarization is a property of transverse waves and longitudinal waves in a gas, e.g. sound waves does not exhibit polarization.

22.
Consider a wave pulse moving on a stretched two-piece string. The wave gets partially reflected and partially transmitted at the junction. The reflected wave is inverted in shape as compared to the incident one. If the incident wave has wavelength λ and that of the transmitted wave is λ', then

$\lambda' > \lambda$
$\lambda' = \lambda$
$\lambda' < \lambda$
$\lambda' = 2\lambda$
nothing can be said about the relation of λ and λ'

Ans: $\lambda' < \lambda$ Explanation: Since the reflected wave gets inverted, the second medium, i.e. the second part of the string is heavier than the first part. Hence, its speed is less than the speed in the lighter first part. Note that, the frequency of a wave does NOT change upon reflection or refraction.
Hence, the wavelength decreases into the second part of the string i.e. $\lambda' < \lambda$.