TUTORIAL ANSWERS_SUPERPOSITION

Question 1

$x = \frac{\lambda D}{a}$, **increase D, distance from slits to the screen. (Ans: C)**

Question 2

If amplitude reduces by ½, intensity will reduce by ¼. (Ans: D)

Question 3

a.) $[(1 \times 10^{-3}) / 300] \sin\theta_1 = (1)(530 \times 10^{-9})$, $\theta_1 = 9.1°$

$[(1 \times 10^{-3}) / 300] \sin\theta_2 = (2)(530 \times 10^{-9})$, $\theta_2 = 18.5°$

$\theta_2 - \theta_1 = 9.4°$

b.) $[(1 \times 10^{-3}) / 300] \sin 90° = (n)(530 \times 10^{-9})$, n =6.28 = **6th order.**

c.) 6 + 6 + 1 at center = **13 bright fringes**

Question 4

$x = \frac{\lambda D}{a}$

$x = 4.52 \times 10^{-3}$ m

Question 5

$x = \frac{\lambda D}{a}$

$x = 3.19 \times 10^{-3}$ m

$\lambda = \frac{ax}{D}$

$\lambda = 5.2 \times 10^{-7}$ m

Question 6

$d \sin 45° = (3)\lambda$

$d \sin 90° = (n)\lambda$, since d & λ is the same, thus

$n = 3 / \sin 45° = 4.24$

n = 4

Question 7

(Ans: D)

Question 8

$$a = \frac{\lambda D}{x}$$

$a = 1.77 \times 10^{-2}$ m

Question 9

x = 4.8 mm / 4

x = 1.2 mm

$$a = \frac{\lambda D}{x}$$

$a = 3.93 \times 10^{-4}$ m

Question 10

They will have constant phase difference. (Ans: B)

Remember, constant phase difference does not mean the waves have to be in-phase!

Question 11

a.) If we assumed the waveform is a sine wave, then for S_1 upon reaching 3 m, it would be a negative max. displacement (amplitude). On the other hand, for S_2 upon reaching 5 m, it would be a positive max. displacement (amplitude).

So the resultant amplitude will be ZERO.

b.) If the wavelength is 2 m, then S_1 and S_2 will reach point P in-phase.

So the resultant amplitude will be 2A.

Question 12

For dark fringe / destructive interference, this condition must be true

λ/2, 3λ/2, 5λ/2, 7λ/2, … (n + ½)λ OR

π, 3π, 5π, 7π, 9π, … (2n + 1)π rad

(Ans: D)

Question 13

(Ans: B)

Question 14

(Ans: D)

Question 15

100 mm – 80 mm = 20 mm
Path difference = 20 mm
Wavelength = 40 mm
Phase difference = $\frac{20}{40}$ x (2π) = **π rad / 90°**

Question 16

v = fλ
1st harmonic would give λ = 4L
300 = f(4 x 0.6)
f_{1st} = 125 Hz

v = fλ
3rd harmonic would give λ = 4L / 3
300 = f(4 x 0.6 / 3)
f_{3rd} = 375 Hz

Question 17

v = fλ , λ = 4L
f = v/4L

Now, λ = 2L
f_{new} = v/2L = 2(v/4L)
f_{new} = 2f (Ans: D)

Question 18

v = fλ , λ = 1.5 x 2 = 3.0 cm
f = v/ λ = 3 x 10^8 / 3.0 x 10^{-2}
f = 1 x 10^{10} Hz

Question 19

(Ans: E)

Question 20

Longest wavelength, λ_1 = 2L = **2.0 m**
2nd longest wavelength, λ_2 = L = **1.0 m**
3rd longest wavelength, λ_3 = 2L/3 = **0.67 m**
(Ans: E)

Question 21

There will be a total of 21 nodes, which means there are 20 loops.
2 loops will be equal to a wavelength, λ. So there are 10 λ.
So, λ = 1.9 / 10 = 0.19 m
v = f λ = (2500)(0.19), **v = 475 ms^{-1}**

Question 22

$f_1 = v/\lambda$, $\lambda = 2L$ $\quad\quad$ $f_2 = v/\lambda$, $\lambda = L$

$f_1 = v/2L$ $\quad\quad$ $f_2 = v/L$

So $f_2 / f_1 = (v/L) / (v/2L) =$ **2**

$v = f\lambda =$ **f_2L**

(Ans: C)

Question 23

(Ans: C)

Question 24

(Ans: D)

Question 25

a.) Use Pythagoras theorem,

$AP^2 = (810\ m)^2 + (514\ m - 70\ m)^2$

AP = 0.9237 m = 923.7 mm

b.) Number of wavelengths = 923.7 m / 30 m

= 30. 8

c.) Use Pythagoras theorem to find BP,

$BP^2 = (810\ m)^2 + (514\ m + 70\ m)^2$

AP = 0.9986 m = 998.6 mm

Path Difference = 0.9986 – 0.9237 = 0.0749 = 0.075 m

n = P.D / λ = 0.075 / 0.030

n = 2.5 (this is destructive interference). So ZERO intensity will be received by the detector.

d.) Constructive interference / maxima occur at nλ, where n is any whole integer.

This case the largest value for n is 2.

So there will be 2 maxima detected as detector moves from P to Q.