Kafr Elshiekh University
Faculty of Engineering
Department of
Physical and Mathematical Engineering
First Year

Engineering physics (2)

28- 02- 2021
3 hours
90 Marks
Final exam: 8 pages

Answer the following questions:

Useful data: $q=1.6*10^{-19}C$, $c=3*10^{8}m/s$, $h=6.626*10^{-34}J.s$, $m_e=9.11*10^{-31}kg$, Cu:$E_f=7.05$ ev, $k_B=8.617*10^{-5}$ ev.k^{-1}

(ILOs: a1,a2,b1,c2)

An ideal system that absorbs the radiations incident on it, is :

1. (A) Compton effect (B) Work function (C) Wave function (D) A black body

$\lambda_{max}*T=2.898*10^{-3}m.k$

2. (A) Stefan's law (B) Wien's displacement law (C) Compton effect (D) Photoelectric effect

$\lambda_{max}$is:

3. (A) The time at the peak of the curve (B) The temperature at the peak of the curve (C) The wavelength at the peak of the curve (D) The frequency at the peak of the curve

Find λ_{max} of the black body radiation emitted by the human body when the skin temperature measured by the ear thermometer is 35°C

- The absolute temperature T=

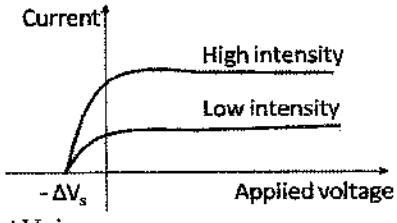
4. (A) 308 K (B) 35 k (C) 308°C (D) 35°C

- λ_{max}=

5. (A) 6.8μm (B) 7.8μm (C) 8.8μm (D) 9.8μm

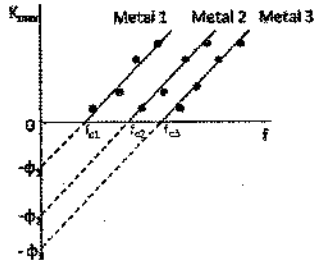
Light incident on certain metallic surface causes electrons to be emitted from those surfaces. This phenomenon is known as :

6. (A) Compton effect (B) Photoelectric effect (C) Superconductor (D) Meissner effect



ΔV_s is:

7. (A) stopping frequency (B) Stopping energy (C) Stopping potential (D) stopping current



- F_c is:

8. (A) Total energy (B) Kinetic energy (C) Cutoff frequency (D) Work function

- Φ is:

9. (A) Total energy (B) Kinetic energy (C) Cut off frequency (D) Work function

A sodium metal is illuminated with light having a wavelength of 300 nm. The Φ of the metal is 2.46 ev. Find:

- h*f =

10. (A) 589ev (B) 504ev (C) 1.67ev (D) 4.13ev

- The maximum kinetic energy:

11. (A) 589ev (B) 504ev (C) 1.67ev (D) 4.13ev

- The cut off wavelength of the sodium :

12. (A) 504nm (B) 595nm (C) 1.67nm (D) 4.13nm

- The cut off frequency of the sodium :

13. (A) $595*10^{12}$Hz (B) 504Hz (C) 1.67Hz (D) 4.13Hz

X-ray of wavelength λ=0.2 nm are scattered from a block of material. The scattered x-ray are observed at an angle of 45° to the incident beam. Calculate:

- λ'-λ=

14. (A) $0.7117*10^{-3}$ Hz (B) $0.7117*10^{-3}$ nm (C) 0.20071 Hz (D) 0.2007 nm

- λ'=

15. (A) $0.7117*10^{-3}$ nm (B) $0.7117*10^{-3}$ Hz (C) 0.20071 Hz (D) 0.20071nm

Calculate the de-Broglie wavelength for an electron moving at 10^7m/s

16. (A) $6.28*10^{-11}$m. (B) $7.28*10^{-11}$m (C) $8.28*10^{-11}$m (D) $9.28*10^{-11}$m

$\Psi = e^{i(kx-\omega t)}$

- Ψ is:

17. (A) Angular wave number (B) Total energy (C) Angular frequency (D) Wave function

- k is:

18. (A) Angular wave number (B) Angular frequency (C) Total energy (D) Wave function

- ω is:

19. (A) Angular wave number (B) Total energy (C) Wave function (D) Angular frequency

A free electron has $\Psi = Ae^{i(5*10^{10}x)}$ where x is in meter. Find:

- Its de-Broglie wave length :

20. (A) 136 Pm (B) 126 Pm (C) 136 nm (D) 126 nm

- Its momentum :

21. (A) $5.52*10^{-24}$kg.m/s (B) $6.52*10^{-24}$kg.m/s (C) $7.52*10^{-24}$kg.m/s (D) $8*10^{-24}$kg.m/s

The probability of finding the particle in the arbitrary interval a≤x≤b is:

22. (A) $P_{ab} = \int_a^b |\psi| \, dx$ (B) $P_{ab} = \int_a^b |\psi^2| \, dx$ (C) $P_{ab} = \int_a^b |2\psi| \, dx$ (D) $P_{ab} = \int_a^b \sqrt{\psi} \, dx$

An electron is described by

$$\psi(x) = \begin{cases} 0 & for\ x < 0 \\ Ce^{-x}(1-e^{-x}) & for\ x > 0 \end{cases}$$

- Normalization of ψ(x) is:

23. (A) $\int_0^{+\infty} [Ce^{-x}(1-e^{-x})]dx =$ (B) $\int_a^b [Ce^{-x}(1-e^{-x})]^2 dx = 1$ (C) $\int_0^{+\infty} [Ce^{-x}(1-e^{-x})]^2 dx = 1$ (D) $\int_0^{+\infty} \psi[Ce^{-x}(1-e^{-x})]^2 dx = 1$

- The average position <x> for the electron is:

24. (A) $\langle x \rangle \equiv \int_0^{+\infty} [Ce^{-x}(1-e^{-x})]^2 dx$ (B) $\langle x \rangle \equiv \int_0^{+\infty} x[Ce^{-x}(1-e^{-x})]^2 dx$ (C) $\langle x \rangle \equiv \int_0^{+\infty} \psi[Ce^{-x}(1-e^{-x})]^2 dx$ (D) $\langle x \rangle \equiv \int_a^b x[Ce^{-x}(1-e^{-x})]^2 dx$

A quantum particle of mass m moves in a potential well of length 2L. Its potential energy is infinite for x<-L and for

x>+L. Inside the region –L<x<L , its potential energy is given by $U(x) = -\frac{\hbar^2 x^2}{mL^2(L^2-x^2)}$

In addition, the particle is in a stationary state that is described by the wave function

$\Psi(x) = A\left(1 - \frac{x^2}{L^2}\right)$ for -L<x<LAnd $\Psi(0) = 0$ elsewhere.

Determine:

- $\frac{d\psi}{dx} = ?$

25. (A) $\frac{-\hbar^2}{2m}\frac{d^2\Psi}{dx^2} + U\Psi = E$ (B) $-2A\frac{x}{L^2}$ (C) $E = \frac{\hbar^2}{mL^2}$ (D) $-\frac{2A}{L^2}$

- $\frac{d^2\psi}{dx^2} = ?$

26. (A) $-2A\frac{x}{L^2}$ (B) $\frac{-\hbar^2}{2m}\frac{d^2\Psi}{dx^2} + \Psi = E\Psi$ (C) $E = \frac{\hbar^2}{mL^2}$ (D) $-\frac{2A}{L^2}$

- Time independent schrodinger equation is :

27. (A) $-2A\frac{x}{L^2}$ (B) $E = \frac{\hbar^2}{mL^2}$ (C) $\frac{-\hbar^2}{2m}\frac{d^2\Psi}{dx^2} + U\Psi = E\Psi$ (D) $-\frac{2A}{L^2}$

- The energy of the particle in terms of $\hbar$,m and L

28. (A) $-2A\frac{x}{L^2}$ (B) $\frac{-\hbar^2}{2m}$ (C) $E = \frac{\hbar^2}{mL^2}$ (D) $-\frac{2A}{L^2}$

A 30ev electron is incident on a square barrier of height 40ev.

- The probability that the electron tunnels through the barrier calculated by:

29. (A) $T = e^{-cL}$ (B) $T = e^{+2cL}$ (C) $T = e^{-4cL}$ (D) $T = e^{-2cL}$

- The constant C equal to :

30 (A) $15.18*10^9$ (B) $16.18*10^9$ (C) $17.18*10^9$ (D) $18.18*10^9$

- The probability that the electron tunnels through the barrier with width 0.1mm is:

31. (A) 39 (B) 3.9 (C) 0.39 (D) 0.039

- The probability that the electron reflected from the barrier is :

32. (A) 7.61 (B) 8.61 (C) 9.61 (D) 0.961

The lowest energy state for the particle in a box is:

33. (A) Total energy (B) The ground state (C) High frequency (D) Low temperature

An electron is confined between two impenetrable walls 0.2 nm apart. Determine:

- The energy level for state n=1

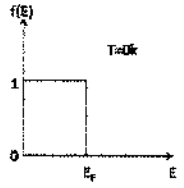
34. (A) 9.42 J (B) 84.8ev (C) 9.42ev (D) 37.7ev

- The energy level for state n=2

35. (A) 37.7ev (B) 9.42ev (C) 84.8ev (D) 37.7 J

- The energy level for state n=3

36. (A) 84.8ev (B) 37.7ev (C) 84.8J (D) 9.42ev



E_f is:

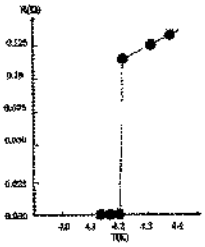
37. (A) Total energy (B) Ground state (C) Fermi energy (D) Cut off energy

For copper at 300k calculate the probability that a state with an energy equal to 99% of E_F is occupied :

38. (A) 300 (B) 99 (C) 9.37 (D) 0.937

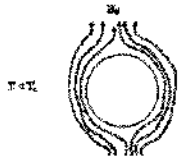
The energy for the electron in a three dimensional box is:

39. (A) $E=\frac{\hbar^2\pi^2}{2m_eL^2}(2n_xn_yn_z)$ (B) $E=\frac{\hbar^2\pi^2}{2m_eL^2}(n_xn_yn_z)^2$ (C) $E=\frac{\hbar^2\pi^2}{2m_eL^2}(n_x+n_y+$ (D) $E=\frac{\hbar^2\pi^2}{2m_eL^2}(n_x^2+n_y^2+n_z^2)$



A material loses its electrical resistivity below a certain temperature. Is:

40. (A) Superconductor (B) Photoelectric effect (C) Compton effect (D) Tunneling

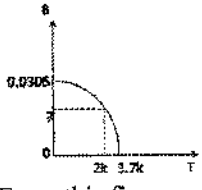


Field excluded from the conductor below a certain temperature is:

41. (A) Photoelectric effect (B) Compton effect (C) Meissner Effect (D) Tunneling

Maglev transport is an application of:

42. (A) Photoelectric effect (B) Meissner Effect (C) Tunneling (D) Compton effect



From this fig. - Critical temperature at zero magnetic field is:

43. (A) T_c=3.7 k (B) 2K (C) 3.7°C (D) 2°C

- Critical field at 0k is:

44. (A) 3.7 (B) $B_c(0)$=0.0306 (C) 2 (D) 30.6

- Critical field at 2k is:

45. (A) 0.0216 Tesla (B) 0.0306 Tesla (C) 3.7 Tesla (D) 2 Tesla

46-An oscillator is subjected to a damping force that is proportional to its velocity. A sinusoidal force is applied to it. After a long time:

A. its amplitude is an increasing function of time
B. its amplitude is a decreasing function of time
C. its amplitude is constant
D. its amplitude is a decreasing function of time only if the damping constant is large

47-In simple harmonic motion, the magnitude of the acceleration is:

A. constant
B. proportional to the displacement
C. inversely proportional to the displacement
D. greatest when the velocity is greatest

48-The x and y coordinates of a point each execute simple harmonic motion. The frequencies are the same but the amplitudes are different. The resulting orbit might be:

A. an ellipse B. a circle C. a parabola D. a hyperbola

49-For an oscillator subjected to a damping force proportional to its velocity:

A. the displacement is a sinusoidal function of time.

B. the velocity is a sinusoidal function of time.

C. the frequency is a decreasing function of time.

D. none of the above is true.

50-Five particles undergo damped harmonic motion. Values for the spring constant k, the damping constant b, and the mass m are given below. Which leads to the smallest rate of loss of mechanical energy?

A. k = 100N/m, m = 50g, b = 8g/s

B. k = 150N/m, m = 50g, b = 5g/s

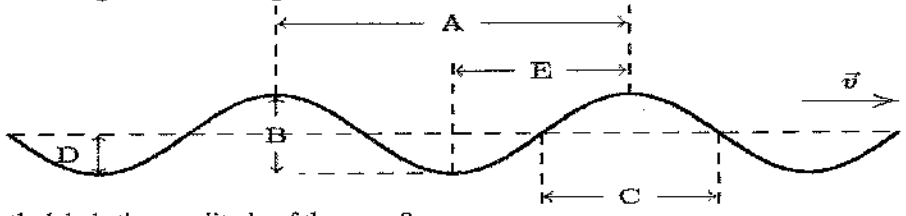
C. k = 150N/m, m = 10g, b = 8g/s

D. k = 200N/m, m = 8g, b = 6g/s

51-A sinusoidal force with a given amplitude is applied to an oscillator. At resonance the amplitude of the oscillation is limited by:

A. the damping force B. the initial amplitude C. the initial velocity D. none of the above

A sinusoidal wave is traveling toward the right as shown.



52-Which letter correctly labels the amplitude of the wave?

A B C D

53-Which letter correctly labels the wavelength of the wave?

A B C D

54- Sinusoidal water waves are generated in a large ripple tank. The waves travel at 20 cm/s and their adjacent crests are 5cm apart. The time required for each new whole cycle to be generated is:

A. 100 s B. 4 s C. 2 s D. 0.25 s

55-The tension in a string with a linear mass density of 0.0010 kg/m is 0.4 N. A sinusoidal wave with a wavelength of 20 cm on this string has a frequency of:

A. 0.0125 Hz B. 0.25 Hz C. 100Hz D. 630Hz

A transverse traveling sinusoidal wave on a string has a frequency of 100Hz, a wavelength of 0.04m, and amplitude of 2mm.

56-The maximum velocity in m/s of any point on the string is:

A. 0.2 B. 1.3 C. 4 D. 15

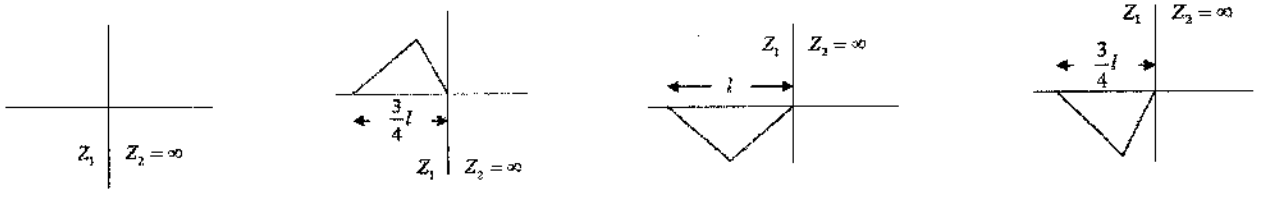
57-The maximum acceleration in m/s^2 of any point on the string is:

A. 0 B. 130 C. 395 D. 790

58-A wave on a stretched string is reflected from a fixed end P of the string. The phase difference, at P, between the incident and reflected waves is:

A. zero B. π rad C. $\pi/2$ rad D. depends on the velocity of the wave

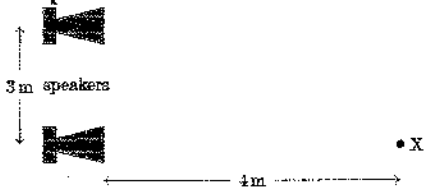
A triangular shaped pulse of length l is reflected at the fixed end of the string on which it travels ($Z_2 = \infty$).



A B C D

59- The shape of the pulse after a length l/4 of the pulse has been reflected.
60- The shape of the pulse after a length l/2 of the pulse has been reflected.
61- The shape of the pulse after a length 3l/4 of the pulse has been reflected.
62- The shape of the pulse after a length l of the pulse has been reflected.
63-A sound wave has a wavelength of 3m. The distance from a compression center to the adjacent rarefaction center is:
A. 0.75m B. 1.5m C. 3m D. needs to know wave speed

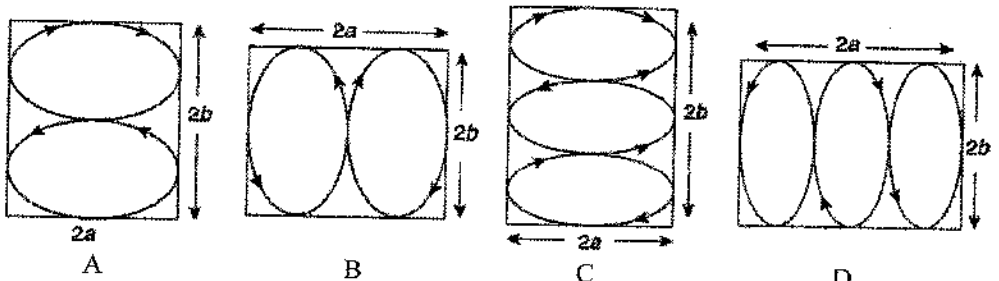
Two small identical speakers are connected (in phase) to the same source. The speakers are 3m apart and at ear level. An observer stands at X, 4m in front of one speaker as shown.



64-If the amplitudes are not changed; the sound he hears will be least intense if the wavelength is:
A. 1m B. 2m C. 3m D. 4m
65- If the amplitudes are not changed; the sound he hears will be most intense if the wavelength is:
A. 1m B. 2m C. 3m D. 4m
66- "Beats" in sound refer to:
A. interference of two waves of the same frequency
B. combination of two waves of slightly different frequency
C. reversal of phase of reflected wave relative to incident wave
D. two media having slightly different sound velocities
67- The largest number of beats per second will be heard from which pair of tuning forks?
A. 200 and 201 Hz
B. 256 and 260 Hz
C. 534 and 540 Hz
D. 763 and 774 Hz
68- A stationary source generates 5Hz water waves whose speed is 2m/s. A boat is approaching the source at 10m/s. The frequency of these waves, as observed by a person in the boat, is:
A. 5Hz B. 15 Hz C. 20Hz D. 30 Hz
69- If the speed of sound is 340m/s a plane flying at 400m/s creates a conical shock wave with an apex half angle of:
A. 0 (no shock wave) B. 32° C. 40° D. 58°
70-A "wave front" is a surface of constant:
A. phase B. frequency C. wavelength D. amplitude
71-Huygens' construction can be used only:
A. for light
B. for an electromagnetic wave
C. if one of the media is vacuum (or air)
D. for all of the above and other situations
72-In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:
A. a fourth of a wavelength
B. a half a wavelength
C. a wavelength
D. none of the above
73-In a Young's double-slit experiment, light of wavelength 500 nm illuminates two slits that are separated by 1mm. The separation between adjacent bright fringes on a screen 5m from the slits is:
A. 0.1 cm B. 0.25 cm C. 0.5 cm D. none of the above

74-If two light waves are coherent:
A. their amplitudes are the same
B. their frequencies are the same
C. their wavelengths are the same
D. their phase difference is constant
75-Sound differs from light in that sound:
A. is not subject to diffraction
B. is a torsional wave rather than a longitudinal wave
C. does not require energy for its origin
D. is a longitudinal wave rather than a transverse wave

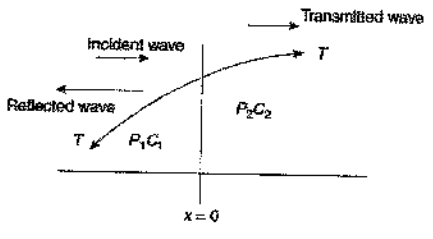
Simple Lissajous figures produced by perpendicular simple harmonic motions of different angular frequencies ω_x and ω_y and phase difference ϕ



A B C D

76-Which figure corresponding to $\omega_x/\omega_y = 2$ and $\phi = 0$.
77- Which figure corresponding to $\omega_x/\omega_y = 3$ and $\phi = \pi/2$.
78- Methods of Describing the Damping of an Oscillator
A. The logarithmic decrement
B. Relaxation Time
C. The Quality Factor
D. All of the above
79- The magnitude of the displacement, x, and its phase, ϕ, with respect to the driving force, $F_0 \cos \omega t$, after the transient term dies away.
A. There is no phase difference ϕ exists between x and the force because of the reactive part ($\omega m - s/\omega$) of the mechanical impedance.
B. That an extra difference is introduced by the factor -*i* and even if ϕ were zero the displacement x would lag the force $F_0 \cos \omega t$ by 90°.
C. That the maximum amplitude of the displacement x is $F_0/\omega Z_m$. We see that this is dimensionally incorrect because the velocity x/t has dimensions F_0/Z_m.
E. None of the above
80- One of the different types of velocities in wave motion:
A. The particle velocity
B. The phase velocity
C. The group velocity
D. All of the above
81-The following function might be a solution to the wave equation with phase velocity c.
A. $f(x,t) = (ct - x)^2$ B. $f(x,t) = \sin(ct - x)$ C. Both of the above D. None of the above

For the incident and reflected wave shown



82- The dynamical boundary condition is:
A. The displacement is the same immediately to the left and right of x = 0.
B. There is a continuity of the transverse force at x = 0.
C. Both of the above
D. None of the above
83- The geometrical boundary condition is:
A. The displacement is the same immediately to the left and right of x = 0.
B. There is a continuity of the transverse force at x = 0.
C. Both of the above
D. None of the above
84-To match the transmission between media of impedance Z_1 and Z_2 a third medium is added with
A. $Z_3 = Z_1Z_2$ and its length = λ
B. $Z_3 = Z_1Z_2$ and its length = $\lambda/2$
C. $Z_3 = Z_1Z_2$ and its length = $\lambda/4$
D. None of the above
85- The Categories of Sound Waves are:
A. Audible waves
B. Infrasonic waves
C. Ultrasonic waves
D. All of the above
86- The Anti-Collision Detection is one application of:
A. Audible waves
B. Infrasonic waves
C. Ultrasonic waves
D. All of the above
87-What speed should a galaxy move with respect to us so that the sodium line at 589 nm is observed at 589.6 nm?
A. 306 m/s B. 306 Km/s C. 306 mile/s D. None of the above
88-To make interference of waves from two sources:
A. The sources must be coherent
B. The sources should be monochromatic
C. Both of the above
D. None of the above
89- Two slits are made one millimeter apart and the screen is placed one meter away. What is the fringe separation when blue-green light of wavelength 500 nm is used?
A. 0.5 nm B. 0.5 mm C. 0.5 μm D. None of the above
90- An oscillatory motion must be simple harmonic if:
A. the amplitude is small
B. the potential energy is equal to the kinetic energy
C. the motion is along the arc of a circle
D. the acceleration varies sinusoidally with time
E. the derivative, dU/dx, of the potential energy is negative

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Best Wishes

Dr. Ahmed Saeed **Dr. Demyana Adel**