Benha University
Faculty of science
Physics Department

1st year student, First Term
Final Exam.2015-2016
Time: 2 hours. Date: 31-1-15

General Physics (1), [100ph.]
الاجابات [Heat & Properties of Matter]

تاريخ الامتحان / الخميس 2015/12/31 10-12 ص

استاذ المادة / د/ محمود حسنى موسى مقلد

Answer the following questions:

Q$_1$) Choose the right answer: [60 Marks]

21. The principle of the Thermoelectric Thermometer depends on:
A. Stefan's law **B.** Joule's heating. **C.** Seebeck effect **D.** Newton's law of cooling.

22- The rate of emission of radiation for a perfect black body at temperature of 4×10^3 K is…
(where $\sigma = 5.67 \times 10^{-8}$ watt/m^2.K^4).
A. 2.45×10^3 W/m^2 **B.** 1.45×10^7 W/m^2 **C.** 5.67×10^3 W/m^2 **D**. 5.67×10^7 W/m^2

23. At 4 °C , water has…
A. maximum volume **B.** minimum volume **C.** minimum density **D**. nothing

24. The amount of heat required to raise the temperature of one gram of water through 1 ^{o}C is
A. Calorie **B.** specific heat of water **C.** latent heat **D.** A and B

25. The linear thermal expansion coefficient α can be given as
A. $(\Delta T L_0)/L$ **B.** $(\Delta T \Delta L) / L_0$ **C.** $\Delta L/ (\Delta T L_0)$ **D**. $(\Delta L\ L_0) / \Delta T$

26. The rate of emission of radiation from a black body is proportional to …
A. The square power of its temperature. **B**. The fourth power of its absolute temperature.
C. Its absolute temperature per unit area. **D**. The fourth power of its density.

27. The electrical resistance of a platinum wire as a function of temperature that may be expressed by the relation:
A. $R_T = R_0 (1 - \alpha T)^2$ **B.** $R_T = R_0 (1 + \alpha T)$ **C.** $R_T = R_0 (1 + \alpha T^2)$ D. $R_T = R_0 (1 - \alpha T)$

28. The units of thermal conductivity is given by…
A. W/m.^{0}C **B.** W/m **C.** W/m^2 **D.** W/m^2.^{0}C

29. The coefficient of linear expansion of certain steel is 0.000012 ^{0}C^{-1}. The coefficient of volume expansion, in ^{0}C^{-1} , is:
A. 2 x 0.000012 **B**. 0.000012 / 3 **D**. $(0.000012)^3$ **C**. 3 x 0.000012.

30. Shiny surfaces have emissivity (ε) close to:

A. zero **B**. one **C.** infinity **D** . none of them.

31. The boiling point temperature of a liquid increases as…

A. the volume of the liquid increases. **B.** the external pressure increases.

C. the mass of the liquid decrease **D**.the density decrease.

32. The rate of heat flow by conduction (dQ/dt) through a slab does NOT depend on the:

A. coefficient of expansion **B.** thermal conductivity of the slab

C. temperature gradient **D.** cross-sectional area of the slab.

33. The variation of generated emf (E) with temperature in thermoelectric thermometer is given by:

A. $E=\alpha T-\beta T$ **B.** $E=\alpha T+\beta T$ **C.** $E=\alpha T+\beta T^2$ **D.** $E=\alpha T^3+\beta$

34. The resistance of a platinum resistance thermometer is 2 Ω at 0 ^{0}C and 2.5 Ω at 100 ^{0}C . At temperature 60 ^{0}C wills the resistance become …

A. 1.3 Ω **B**. 3.3 Ω **C**. 2.5 Ω **D**. 2.3 Ω.

35- The "triple point" of a substance is that point for which the temperature and pressure are such that:

A. Solid and liquid are in equilibrium **B**. temperature is constant

C. Solid, liquid, and vapor can coexist in equilibrium. **D**. All the previous.

36. The principle of any method to determine the specific heat of materials depends on..

A. Temperature of materials **B.** conservation law of energy

C. Seebeck effect **D.** Stefan's law .

37. The water equivalent is numerically equal to…

A. mass x thickness **B.** the volume of water

C. mass x specific heat **D**. none of them.

38. The rate of heat loss by the body (dQ/dt) to the surrounding is manly proportional to…

A. thickness of the body **B.** area of exposed surface

C. temperature of the body **D.** specific heat of the body

39. Calorie/ gm.^{0}C are the unit of:

A. Heat capacity. B. Specific heat. C. Latent heat. D. Thermal conductivity.

40. The heat can be transferred by radiation in ………………………

A. conductors **B.** liquids **C.** vacuum **D.** all the previous.

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3. Drive the formula of the rate of heat flow through a compound wall made of two materials of the same area at the steady state? **[5 Marks**]

4. A 50 gm of ice at 0 ^{0}C is add to 200 gm of water at 30 ^{0}C. What the final temperature. Since the specific heat of water 4186 J/kg.^{0}C and the latent heat of fusion is 3.33x10^5 J/kg. **[5 Marks]**

Kind regards

Answer sheet:

21----------C
22----------B
23----------B
24----------D
25----------C
26----------B
27----------B
28----------A
29----------C
30----------A
31----------B
32----------A
33----------C
34----------D
35----------C
36----------B
37----------C
38----------B
39----------B
40----------D.

(3)

Consider a compound wall (or a slap) made of two materials I and II of thicknesses, L_1 and L_2 and of the same area A, see Fig. Let K1 and K_2 are the coefficient of thermal conductivity of the two materials, respectively. T_1 and T_2 are the temperatures of the faces ($T_1 > T_2$) and T_x is the temperature of the surface in contact. After the steady state is reached, the rate of heat flow H across any cross section is the same.

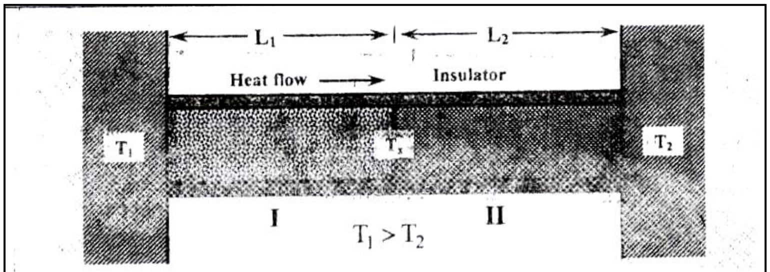


Fig. (2): Conduction of heat through a compound wall

From the material I and II

$$H_1 = \frac{dQ_1}{dt} = -K_1 A \frac{T_x - T_1}{L_1} \text{ , and } \quad H_2 = \frac{dQ_2}{dt} = -K_2 A \frac{T_2 - T_x}{L_2}$$

At steady state $H_1 = H_2 = H$ therefore,

$$T_1 - T_x = \frac{HL_1}{AK_1} \text{ ----- (1)} \qquad \text{and} \qquad T_x - T_2 = \frac{HL_2}{AK_2} \text{ --------- (2)}$$

Add the two equations, then

$$T_1 - T_2 = \frac{H}{A}\left[\frac{L_1}{K_1} + \frac{L_2}{K_2}\right]$$

Consequently, the rate of heat flow through the compound the compound wall is given as

$$H = \frac{dQ}{dt} = -\frac{A(T_2 - T_1)}{\left({L_1}/{K_1}\right) + \left({L_2}/{K_2}\right)} \quad \text{-----------------} \qquad (3)$$

In general for any number of walls

$$H = \frac{dQ}{dt} = -\frac{A(T_2 - T_1)}{\sum_i \left({L_i}/{K_i}\right)} \quad \text{-------------------------} \qquad (4)$$

(4)

Suppose that the final temperature of the mixture is T_f

Heat gained by ice = Heat lost by water

$$m_{ice} L_f + m_{ice} c_w \Delta T_{ice} = m_w c_w \Delta T_w$$

$$0.05 \text{ x } 3.3\text{x}105 + 0.05 \text{ x } 4186 \text{ x } (T_f - 0) = 0.2 \text{ x}4186 \text{ x } (30 - T_f)$$

$T_f = 8.23\ ^0$C

1- A large spring requires a force of 150 N to compress it only 0.010 m. What is the spring constant of the spring?

a. 125 000 N/m

b. 15 000 N/m

c. 15 N/m

d. 1.5 N/m

2- Which of the following is an example of a longitudinal wave?

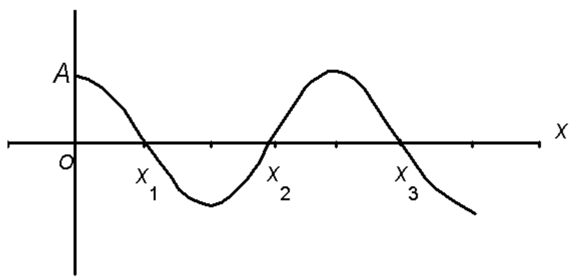
a. sound wave in air

b. wave traveling in a string

c. both a and b
d. neither a nor b

3- The wavelength of a traveling wave can be calculated if one knows the:
a. frequency.
b. speed and amplitude.
c. amplitude and frequency.
d. frequency and speed.

4- Consider the curve $f(x) = A \cos(2\pi x/\lambda)$. The wavelength of the wave will be:



a. the distance *0* to *A*.
b. twice the distance *0* to *A*.
c. the distance x_2 to x_3.
d. twice the distance x_2 to x_3.

5- The superposition principle has to do with which of the following?
a. effects of waves at great distances
b. the ability of some waves to move very far
c. how displacements of interacting waves add together
d. describe wave behavior

6- In an elastic solid there is a direct proportionality between strain and:
a. elastic modulus.
b. temperature.
c. cross-sectional area.
d. stress.

7- The bulk modulus of a material, as a meaningful physical property, is applicable to which of the following?
a. only solids
b. only liquids

c. only gases

d. solids, liquids and gases

8- The flow rate of a liquid through a 2.0-cm-radius pipe is 0.008 0 m^3/s. The average fluid speed in the pipe is:

a. 0.64 m/s.

b. 2.0 m/s.

c. 0.040 m/s.

d. 6.4 m/s.

9- Think of Bernoulli's equation as it pertains to an ideal fluid flowing through a horizontal pipe. Imagine that you take measurements along the pipe in the direction of fluid flow. What happens to the sum of the pressure and energy per unit volume?

a. It increases as the pipe diameter increases.

b. It decreases as the pipe diameter increases.

c. It remains constant as the pipe diameter increases.

d. No choices above are valid.

10- The moment of inertia of a uniform circular disk of mass m and radius R about an axis passing through its center perpendicular to its plane is.

a- (1/2) mR^2 b- mR2 c- (3/2) mR2 d- (1/3) mR2

11- The equation of motion of simple harmonic motion for LC circuit is

a- $L(d^2I/dt^2) = (1/C)\, I$ b- $L(d^2I/dt^2) = -(1/C)\, I$

c- $L(d^2I/dt^2) = (L/C)\, I$ d- $L(d^2I/dt^2) = (L/C)\, I^2$

12- A fluid has a density of 1040 kg/m^3. If it rises to a height of 1.8 cm in a 1.0-mm diameter capillary tube, what is the surface tension of the liquid? Assume a contact angle of zero.

a- 0.046 N/m b- 0.056 N/m c- 0.092 N/m d- 0.11 N/m

13- The equation of continuity in fluid flowing through a pipe of non uniform size of cross sectional area A and velocity of fluid v is:

a- Av^2 = constant b- A^2v = constant

c- A^2v^2 = constant d- Av = constant

14- Bernoulli's equation can be derived from the conservation law of:

a- energy b- mass c- angular momentum d- volume

15- An oscillatory motion must be simple harmonic if:

a- the amplitude is small B. the frequency is zero

c- the motion is along the arc of a circle

d- the acceleration varies sinusoidally

16- A tire stops a car by use of friction. What modulus should we use to calculate the stress and strain on the tire?

a- Young's modulus b- compression modulus

c- shear modulus d- bulk modulus

17- In mechanics, physicists use three basic quantities to derive additional quantities. Mass is one of the three quantities. What are the other two?

a- length and force b- power and force

c- length and time d- force and time

18- The surface tension coefficient γ is ………. proportional to the surface length.

(a) Directly (b) inversely (c) no (d) constant

19- The superposition of two waves having the same amplitude, frequency and differ in the direction gives………

(a) Beats (b) S.H.M (c) standing waves (d) destructive interference

20- The fluid is nonviscous, this means that the internal……… is neglected.

(a) Motion (b) force (c) power (d) friction

Q) Prove that the following equation represents the wave equation $y = A\sin(kx - \omega t)$.

[؟؟؟ marks]

------------------------------------ Solution ------------------------------------

The equation of any wave is the solution of a different equation called the wave equation. The exact form of this equation is

$$\frac{d^2y}{dt^2} = \upsilon^2 \frac{dy^2}{dx^2} \qquad (1)$$

Any function satisfying an equation of the form of Eq. (1) describes a wave. The form given in the question is

$$y = A\sin(kx - \omega t)$$

Differentiating this equation twice with respect to coordinate, x, we get

$$\frac{dy}{dx} = kA\cos(kx - \omega t)$$

$$\frac{d^2y}{dx^2} = -k^2 A\sin(kx - \omega t)$$

$$\frac{d^2y}{dx^2} = -k^2 y \qquad (2)$$

Differentiating Eq. (1) twice with respect to time, t, we get

$$\frac{dy}{dt} = -\omega A\cos(kx - \omega t)$$

$$\frac{d^2y}{dt^2} = -\omega^2 A\sin(kx - \omega t)$$

$$\frac{d^2y}{dt^2} = -\omega^2 y$$

Substituting about $\omega = k\upsilon$

$$\frac{d^2y}{dt^2} = -k^2\upsilon^2 y \qquad (3)$$

By substituting from Eqs (2) and (3) in Eq. (1), we get

$$-k^2\upsilon^2 y = -k^2\upsilon^2 y$$

so the given equation represents a wave equation

Q) Derive an expression for the moment of inertia of a uniform bar about an axis perpendicular to its length and passing through

(a) One end of the bar

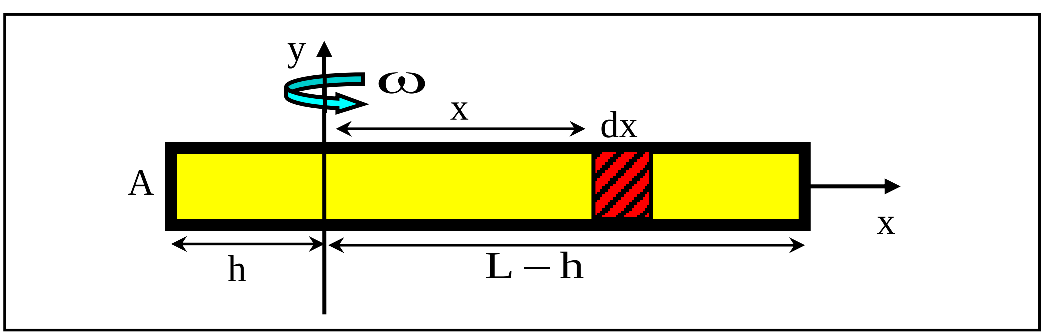
(b) In the center of the bar.

[؟؟؟ marks]

------------------------------------- Solution -------------------------------------

Moment of inertia of a uniform bar (rod)

Consider a uniform bar of mass m, density ρ, length L and cross sectional area A rotating about an axis passing through any point and perpendicular to its length, as in Figure. Consider an element of length dx at a distance x from the axis, then



1. Volume of the bar $V = AL$
2. Total mass of the bar $m = \rho AL$
3. Volume element $V = Ax \quad \Rightarrow \quad dV = A\,dx$
4. Moment of inertia of the bar $I = \int \rho r^2 \, dV$

$$I = \rho A \int_{-h}^{L-h} x^2 \, dx = \tfrac{1}{3}\rho A \, x^3 \Big|_{-h}^{L-h}$$

$$= \tfrac{1}{3}\rho A \left[(L-h)^3 - (-h)^3 \right]$$

$$= \tfrac{1}{3}\rho A \left[L^3 - 3L^2 h + 3Lh^2 - h^3 + h^3 \right] \quad , \qquad m = \rho AL$$

$$I = \tfrac{1}{3} m \left[L^2 - 3Lh + 3h^2 \right] \qquad (1)$$

(a) One end of the bar

At the end of the bar $h = 0$ so Eq. (1) gives

$$I = \tfrac{1}{3} mL^2$$

(b) In the center of the bar.

At the center of the bar $h = \tfrac{1}{2}L$ so Eq, (1) gives

$$I = \tfrac{1}{3} m \left[L^2 - 3L\left(\tfrac{1}{2}L\right) + 3\left(\tfrac{1}{2}L\right)^2 \right]$$

$$I = \tfrac{1}{3} mL^2 \left[1 - \tfrac{3}{2} + \tfrac{3}{4} \right]$$

$$I = \tfrac{1}{12} mL^2$$