جامعة المنصورة – كلية الهندسة
قسم الرياضيات والفيزياء الهندسية
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الزمن ثلاث ساعات
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الامتحان ورقة واحدة وجهان

- أجب عن أسئلة الحرارة والديناميكا الحرارية في نصف منفصل من كراسة الإجابة، وخواص المادة والموجات في النصف الآخر
- **ممنوع الكتابة أو الرسم في ورق الرسم البياني**

The heat and Thermodynamics

افهم السؤال أولاً وأجب عن المطلوب فقط ولا تزيد

Question 1 [14 Marks]

a) Draw only the heating curve of water. ارسم فقط مع كامل البيانات علي الرسم [3 points]

b) Write down the basic idea only for making the following thermometers; اكتب فقط فكرة العمل لكل حالة
(i) constant-volume gas thermometer, (ii) resistance thermometer and (iii) thermocouple thermometer. [3 points]

c) Write down one advantage only for the following thermometers; اكتب ميزة واحدة فقط لكل حالة مطلوبة مما يلي
(i) constant-volume gas thermometer and (ii) liquid thermometer. [2 points]

d) Draw the following processes on PV diagram and then express the work done, w, on each. (ارسم واكتب المعادلة فقط لكل إجراء)
(i) Constant-pressure process, (ii) Constant-volume process and (iii) Isothermal process. [6 points]

Question 2 [18 Marks]

a) A 250 g of ice at -10°C is added to 2 kg of water at 30°C. What is the final equilibrium temperature of the system? Take the specific heat, for ice is 2100 J/Kg°C and for water 4186 J/Kg°C and the latent heat of fusion for ice is 3.337×10^5 J/Kg. [6 points]

b) A glass window has total surface area 5 m^2 and thickness 6 mm. Find the quantity of heat lost through the window per day if the temperature difference between its faces is 20°C. Take the thermal conductivity for glass is 0.8 W/mC. [6 points]

c) A long-thin wire of steel was stretched by a tensile stress to fix it at 20°C between two rigid points separated by a distance shorter than its free length by 0.012%. (i) Find the temperature at which the wire should be released from the stress. (ii) What is the type and magnitude of the stress developed in the wire if the temperature changes to the 15°C. Take for steel, the expansion coefficient $\alpha = 12\times10^{-6}\ C^{-1}$ and $E=2\times10^{11}$ Pa. [6 points]

Question 3 [18 Marks]

a) Find the equilibrium temperature of the pavement at noon if it absorbs sun radiation by rate of 300 W per square meter. Consider the pavement behaves like black body and the average atmospheric temperature is 30°C. Take Stefan's constant $5.67\times10^{-8}\ W/m^2K^4$. [6 points]

b) An ideal gas with an initial volume of 2 liters and an initial pressure of 1.5 MPa expands to final volume of 1 m^3. The relationship between pressure and volume during the expansion is PV = cnst. Determine, (i) the value of the constant in SI units, (ii) the work done, w and (iii) the heat, Q. [6 points]

c) A Carnot engine takes 5000 J of heat and produces 1500 J of work during each cycle. If the temperature of its cold reservoir is 50 °C, find (i) the efficiency, (ii) the heat expelled to the cold reservoir in each cycle and (iii) the temperature of its hot reservoir. [6 points]

Mechanical properties of matter , Oscillations & Waves

Question (4) (20 Marks)

a) An expression of buoyant force is $F_B = \rho g V$, where ρ (density) and g (gravity). Is V volume or velocity? Prove. **6 points**

b) An Aluminum bar have a length of 3.0m and a diameter 25 mm. **(i)**What force is required to compress the bar 1.2mm? **(ii)** Calculate the lateral strain. **(iii)** Calculate the safety factor if the working stress is 200 MPa. **(iv)** Calculate the strain when the stress equal 500 $x10^6$ Pa. **[σ_y = 440 MPa, E = 6.9 $x10^{10}$ Pa, G = 2.6 $x10^{10}$ Pa]** **8 points**

c) Sketch: **(i)** The variation of the kinetic energy, potential energy, and total energy as a function of position for simple harmonic motion. **(ii)** The variation of under damped, over damped, and critical damped displacement with time. **6 points**

Question (5) (16 Marks)

a) A 3-Kg mass attached to a spring with k=140 N/m is oscillating in an oil, which damps the oscillations. **(i)** If the damping constant of the oil is b=10kg/s, how long will it take the amplitude of the oscillation to decrease to 1% of its original value? **(ii)** What is the frequency of this damped oscillation? **6 points**

b) A mass m=1 kg in a spring-mass system with k= 1 N/m is observed to be moving. Suppose the initial conditions are such that at time t=0, the mass is at x=0.5m and moving to the right with a speed of 1m/s. **(i)** Determine the equation of the motion **(ii)** Find the position of the mass at t =4 sec. **6 points**

c) In a factory, three machines produce noise with intensity levels of 85.0 dB, 90.0 dB, and 93.0 dB. When all three are running, what is the intensity level? **4 points**

Question (6) (14 Marks)

a) Two overlapping waves travel in opposite directions, each with a speed of 40 cm/s. They have the same amplitude of 2 cm and a frequency of 8 Hz. **(i)** Write the wave function for the resulting standing wave. **(ii)** What is the distance between adjacent nodes? **(iii)** What is the maximum displacement of a particle at x = 0.5cm? **6 points**

b) A source and an observer are each traveling at 0.5 times the speed of sound. The source emits sound waves at 1.0 kHz. Find the observed frequency if the source and observer are moving away from each other. **4 points**

c) The density of a sample of air is 1.205 kg/m^3, and the bulk modulus is $1.42x10^5$N/m. **(i)** Find the speed of sound in the air sample. **(ii)** Find the temperature of the air sample. **4 points**

With my best wishes
Dr. Mervat Abo-Elkhier