



- 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

Question 1 [15 marks]

افهم السؤال أولاً وأجب عن المطلوب فقط ولا تزيد

- a) Draw only the heating curve of water. ارسم فقط مع كامل البيانات علي الرسم منحني التسخين للماء. [3 marks]
- b) Write down the basic idea only for making the following thermometers; (i) Constant-volume gas thermometer, (ii) Bimetallic thermometer, (iii) Resistance thermometer and (iv) Thermocouple thermometer. [4 marks]
- c) A long-thin wire (سلك طويل ورفيع) of steel was stretched at 10°C between two rigid points 30 m apart so that the wire had an initial tensile stress of $3.6 \times 10^7 \text{ Pa}$. (i) What is the type and magnitude of stress at each of the temperatures 20°C and 38°C ? (ii) What is the length of the wire at each of the temperatures 20°C and 38°C ? Take the linear expansion coefficient of steel is $12 \times 10^{-6} \text{ C}^{-1}$ and the Young's modulus is $2 \times 10^{11} \text{ Pa}$. [8 marks]

Question 2 [19 marks]

- a) A 300 g of ice at -10°C is added to 600 g of water at 15.0°C . (i) What is the final equilibrium temperature of the system? (ii) Calculate the mass of each of the ice and water of the mixed system after it reaches the equilibrium state. (احسب كتلة كل من الثلج والماء) Take the specific heats, for ice is $2100 \text{ J/Kg}^{\circ}\text{C}$ and for water $4186 \text{ J/Kg}^{\circ}\text{C}$ and the latent heat of fusion for ice is $3.337 \times 10^5 \text{ J/Kg}$. [6 marks]
- b) A box with a total surface are of 0.25 m^2 and a wall thickness of 8 mm is made of insulating material. A 30-W electric heater inside the box maintains the average temperature of the inside surface of the box is 15°C above that of the outside surface. (i) Find the thermal conductivity of the insulating material. (ii) If the electric heater is replaced by another one of 25-W, what is temperature difference between inside and outside surfaces? [7 marks]
- c) A solid thin disc of radius 10 cm is maintained at a temperature of 100°C . Assuming it to be a black body. Calculate the net power radiated by the disc to the surrounding atmosphere of -10°C . The Stefan-Boltzmann constant is $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$. [6 marks]

Question 3 [16 marks]

- a) (i) Draw the isothermal process on the PV diagram. [2 marks]
- b) Express the work done, w, by an ideal gas during the following processes. (اكتب المعادلة فقط) (بدون إثبات) (i) constant volume process (ii) constant pressure process and (iii) isothermal process [3 marks]
- c) An ideal gas with an initial volume of 0.01 m^3 and an initial pressure of 2.0 MPa expands isothermally to a final volume of 1 m^3 . Determine, (i) the work done, w, (ii) the heat, Q, and (iii) the change in the internal energy, ΔU . [6 marks]
- d) A Carnot engine takes 1000 J of heat and produces 400 J of work during each cycle. If the temperature of its cold reservoir is 40°C , find (i) the efficiency of this engine, (ii) the heat expelled to the cold reservoir in each cycle and (iii) the temperature of its hot reservoir. [5 marks]

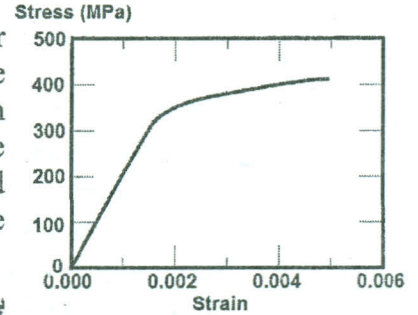
Mechanical properties of matter and waves

ملحوظة هامة: يجب المحافظة على ترتيب الأسئلة عند الإجابة عليها.

Question 4 [18 marks]

(a) The amplitude of underdamped oscillation is given by $A=A_0e^{-bt/2m}$ where m is the mass, t is the time, and b is the damping constant. Using **dimensional analysis**, find the dimension of the damping constant b . (4 marks)

(b) A bar of steel alloy that exhibits the stress-strain behavior shown in the following figure is subjected to a tensile load; the specimen is 300 mm long, and of square cross section 4.5 mm on a side. (i) Determine the modulus of elasticity (ii) What is the type of this material? Why? (iii) Compute the magnitude of the load necessary to produce an elongation of 0.45 mm. (iv) What will be the deformation after this load has been released? (8 marks)



برجاء نقل الرسم الموضح بالشكل في ورقة الإجابة وليس في ورقة الرسم البياني وتوضيح خطوات الحل علي الرسم عند الحاجة إلي ذلك

(c) Sketch only (وضح بالرسم فقط مع كتابة كامل البيانات) (6 marks)

(i) The displacement of the **critically** and **over damped** oscillation as a function of **time**

(ii) The variation of the potential energy, kinetic energy and total energy for simple harmonic motion as a function of **displacement**

(iii) The stress-strain diagram for a material at different temperatures

Question 5 [18 marks]

(a) A block of mass 0.03 kg oscillates in a simple harmonic motion with an amplitude 0.12 m at the end of horizontal spring whose constant is 1.4 N/m. (i) What are the velocity, acceleration, potential energy and the total energy when the displacement from equilibrium x is 0.08 m? (ii) If a frictional force is put in the previous system, find the damping constant b to have critically damping system. (10 marks)

(b) The equation of a transverse traveling wave is given by $Y=0.01 \sin 2\pi (0.05 X - 1000 \cdot t)$ m. (i) Calculate the speed of the wave (ii) If a similar wave is travelling in the opposite direction, derive **استنتج** the equation of the resultant wave. (iii) What is the distance between two adjacent antinodes? (8 marks)

Question 6 [14 marks]

(a) Define only (i) Poisson's ratio (ii) Inverse square law (4 marks) أكتب التعريف فقط

(b) Train S is moving with speed 20 m/s and blowing a whistle with a frequency of 240 Hz. (i) What is the frequency observed by the driver of another train L moving with speed 10 m/s when the two trains are approaching each other **يقتربوا من بعض**? (ii) What is the change of the frequency observed by train L driver when the two trains pass each other? (The speed of the sound in the air=340 m/s) (6 marks)

(c) A speaker emits 0.8 W of acoustic power. Assume that it behaves as a point source which emits uniformly in all directions. (i) At what distance will the intensity level be 85 dB? (ii) What are **the dimensions** of the intensity and intensity level? (4 marks)