

KABARAK



UNIVERSITY

**UNIVERSITY EXAMINATIONS
2010/2011 ACADEMIC YEAR
FOR THE DEGREE OF BACHELOR OF EDUCATION
SCIENCE**

COURSE CODE: PHYS 121

COURSE TITLE: HEAT & THERMODYNAMICS

STREAM: Y1S2

DAY: FRIDAY

TIME: 9.00 – 11.00 A.M.

DATE: 25/03/2011

INSTRUCTIONS:

- Answer Question ONE and any other TWO

PLEASE TURN OVER

Question 1 (30 marks)

- (a) Distinguish between heat and temperature (2 marks)
- (b) i. What is a bimetallic strip? (1 mark)
- ii. Explain how a bimetallic strip can be used as a temperature regular (2 marks)
- (c) i. State the zeroth law of thermodynamics. (1 mark)
- ii. Explain the fact that the practical use of a thermometer is based on the *Zeroth Law of Thermodynamics*. (2 mark)
- (d) Name the two reference points used in the Kelvin scale (2 marks)
- (e) Explain why ice is less dense than water (2 marks)
- (f) i. State Gay-Lussac's law of gases (1 mark)
- ii. Explain why it is dangerous to throw aerosol cans into a fire. (2 marks)
- (g) i. Define specific heat capacity of a substance (2 marks)
- (h) Explain an isochoric process; hence show that for an isochoric process, the first law of thermodynamics reduces to:
$$Q = \Delta U$$

(5 marks)
- (j) Consider a gas in a cylinder at room temperature ($T = 293 \text{ K}$), with a volume of 0.065 m^3 . The gas is confined by a piston with a weight of 100 N and an area of 0.65 m^2 . The pressure above the piston is atmospheric pressure.
- i.. Calculate the pressure of the gas. (3 marks)
- ii.. The gas is heated, expanding it and moving the piston up. If the volume occupied by the gas doubles, how much work has the gas done?

(3 marks)

Question 2 (20 marks)

State four postulates of Kinetic theory, hence show that the relationship between pressure of an ideal gas is related to the kinetic energy of the gas particles.

(2, 18 marks)

Question 3 (20 marks)

- (a) (i) Define latent heat. (2 marks)
- (ii) Represent graphically the changes in temperature with time when ice is heated until it enters gaseous phase. (4 marks)
- (iii) A boiler with a steel base 3 cm thick rests on a hot stove. The area of the base of the boiler is 1000 cm^2 . The water inside the boiler is at 100°C and it is found that 500 g is evaporated every 5 minutes. What is the temperature of the base of the boiler? (take thermal conductivity of steel = $50.2 \text{ W/m}^\circ\text{C}$; $L_v(\text{water}) = 2.25 \times 10^6 \text{ J/Kg}$) (7 marks)

Question 4 (20 marks)

- (a) Sketch a well-labeled schematic flow diagram of a heat engine (5 marks)
- (b) (i) State the second law of thermodynamics (1 mark)
- (ii) State the condition for an engine to have 100% efficiency. (1 mark)
- (iii) Explain why a heat engine with 100% efficiency would violate the 2nd law of thermodynamics (2 marks)
- (c) Draw a PV diagram representing a Carnot cycle, hence show that the ideal Carnot efficiency (e_C) can be expressed as:

$$e_C = 1 - \frac{Q_{cold}}{Q_{hot}} = 1 - \frac{T_{cold}}{T_{hot}}$$

where Q_{in} and Q_{out} are heat transfers at constant temperatures T_{hot} and T_{cold} respectively. (11 marks)