

Final Exam  
**MPHYS -II: PHYSICS - II**  
Fall 2025

**Points of attention:**

- For each question, the maximum earned points are specified in the question.
- Write clearly! Answers that are not readable are not marked and don't earn marks!
- All answers should be written in English using **blue or black pens** only.
- Use the pencil only for diagrams and graphs.
- Show all the calculation steps in the given space.
- When finished, submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

**Exam Duration:** 2.5 hours  
**Instructor's Name:** RANJIT V  
**Exam Date:** 30/12/2025  
**Program:** ME

	<b>40</b>
	<b>10</b>

Student Information	
Name:	<input type="text"/>
ID:	<input type="text"/>
Signature:	<input type="text"/>

Invigilator	
Initials:	<input type="text"/>
Time received:	<input type="text"/>
<input type="checkbox"/> Student ID checked	

**Question 1****[11 marks]**

- a) A marine engineering cadet observes that a steel handrail on an open deck, a wooden toolbox, and a bucket of seawater left under direct sunlight reach different temperatures after one hour.

Explain why these three objects do not heat evenly. Justify with suitable reasons.

(2 marks)

- b) Choose the correct material which will require the most heat to raise its temperature by  $1^{\circ}\text{C}$  per kg?

(1 mark)

i. Steel

ii. Copper

iii. Brass

iv. Gold

- c) A marine diesel engine runs for long hours and generates a large amount of heat in its cylinders, exhaust valves, and cooling jackets. To prevent overheating and damage, the chief engineer must choose a coolant that can absorb a large amount of heat and maintain safe engine operating temperatures. Decide which is the best suited coolant which can be used in engine cooling system. Support your answer with clear scientific reasons.

(2 marks)

- d) During an engine room maintenance drill, a 1.5 kg copper component is mistakenly heated to  $165^{\circ}\text{C}$  and must be safely cooled using a calorimeter. The calorimeter contains 0.6 kg of water at  $25^{\circ}\text{C}$  and a 450 g copper calorimeter cup. Assuming no heat loss to surroundings,

Determine

- i) The final equilibrium temperature of the system.

(4 marks)

- ii) Explain why heat flow stops after some time in the calorimeter to reach a thermal equilibrium. Justify with suitable reason.

(2 marks)

**Question 2****[12 marks]**

- a) State any two applications of thermal expansion and briefly name the device used in each case.

(2 marks)

- b) Explain how a bimetallic strip works when it is heated.

(2 marks)

- c) A steel flange plate with a circular bolt hole is fitted to an exhaust pipeline in the engine room. During operation, the exhaust temperature rises significantly, causing the entire steel plate to heat up and expand uniformly.

When the steel flange plate is heated and expands uniformly, what happens to the diameter of the bolt hole? Circle the correct answer.

(1 mark)

(i) The hole becomes smaller

(ii) The hole remains the same size

(iii) The hole becomes larger

d) Onboard the container vessel MV SOHAR STAR, the lubricating oil service tank has a capacity of  $2.00 \text{ m}^3$  at  $25^\circ\text{C}$ . Before departure from Sohar Port, the tank is filled with  $1.90 \text{ m}^3$  of lubricating oil at  $25^\circ\text{C}$ . During the voyage, the engine room temperature rises and both the tank and oil reach  $65^\circ\text{C}$ .

i) Analyse whether overflow will occur in the lubricating oil service tank on MV SOHAR STAR when the temperature increases to  $65^\circ\text{C}$ .

(5 marks)

ii) Suggest two operational preventive measures to prevent hazards due to thermal expansion based on engineering practice.

(2 marks)

**Question 3****[11 marks]**

Onboard the cargo vessel MV OCEAN VOYAGER, freshwater is produced using an evaporator–condenser system in the engine room. During cold-weather operations, ice may form in parts of the freshwater storage line. Before restarting the system, engineers must first melt the ice, then heat the water, and finally convert part of it into steam for desalination.

- a) Differentiate between latent heat of fusion and latent heat of vaporization by giving their definitions , and their typical values related to water.

(2 marks)

- b) Why does temperature remain constant during melting and boiling even though heat is supplied?

(2 marks)

- c) On MV OCEAN VOYAGER, 2 kg of ice at  $-20^{\circ}\text{C}$  is present in a freshwater pipe. The ice must be completely converted into high temperature steam at  $200^{\circ}\text{C}$  for use in the ship's evaporator.

Calculate the total heat energy required to convert the ice completely into steam.

(7 marks)

**Question 4****[6 marks]**

In a bulk carrier ship, the starting-air system includes a rigid air reservoir used to supply compressed air for engine starting. During engine room operations, the reservoir is exposed to heat from nearby machinery and its air temperature rises. The reservoir contains 2 kg of air at a pressure of 1200 kN/m<sup>2</sup> and a temperature of 26°C. The air is heated to 85°C while the reservoir volume remains constant (no expansion).

Use  $C_v = 0.718 \text{ kJ/kg}\cdot\text{K}$  ; Atmospheric pressure = 101 kN/m<sup>2</sup>

- a) Calculate the heat energy transferred to the air during heating. (2 marks)
- b) The final absolute pressure of the air in the reservoir after heating. (2 marks)
- c) Change in internal energy of the system. (2 marks)

## Formuale Sheet

	$Celsius = \frac{5}{9} \times (F - 32)$
	$Fahrenheit = \frac{9}{5} \times C + 32$
	$Kelvin = \theta [^{\circ}C] + 273$
$\Delta L = \alpha_L \times L_1 \times \Delta T$ $L_2 - L_1 = \alpha \times L_1 \times \Delta T$	$\Delta A = \alpha_A \times A_1 \times \Delta T$ $A_2 - A_1 = \alpha_A \times A_1 \times \Delta T$
$\Delta V = \beta \times V_1 \times \Delta T$ $V_2 - V_1 = \beta \times V_1 \times \Delta T$	$R = C_p - C_v$
$Q = W + \Delta U$ $Q = P \times \Delta V + \Delta U$	$Q = m \times c \times \Delta T$
$Q_v = m \times C_v \times \Delta T$	$Q_p = m \times C_p \times \Delta T$
$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
$P_1 V_1 = P_2 V_2$	

**Appendix Table 1: THERMAL EXPANSION COEFFICIENT OF DIFFERENT MATERIALS:**

Material		Coefficient of linear expansion $\alpha_L$ ( $1/^\circ\text{C}$ )	Coefficient of volumetric expansion $\beta$ ( $1/^\circ\text{C}$ )
SOLIDS	Aluminum	$25 \times 10^{-6}$	
	Brass	$19 \times 10^{-6}$	
	Copper	$17 \times 10^{-6}$	
	Gold	$14 \times 10^{-6}$	
	Iron or Steel	$12 \times 10^{-6}$	
	Lead	$29 \times 10^{-6}$	
	Silver	$18 \times 10^{-6}$	
	Glass (ordinary)	$9 \times 10^{-6}$	
	Glass (Pyrex®)	$3 \times 10^{-6}$	
LIQUIDS	Ethyl alcohol		$1100 \times 10^{-6}$
	Lubricating oil		$950 \times 10^{-6}$
	Glycerin		$500 \times 10^{-6}$
	Mercury		$180 \times 10^{-6}$
	Water		$210 \times 10^{-6}$
GASES	Air and most other gases at atmospheric pressure		$3400 \times 10^{-6}$

**Table 2: SPECIFIC HEAT, LATENT HEAT OF FUSION AND VAPORIZATION FOR DIFFERENT SUBSTANCES:**

<b>Substance</b>	<b>Specific Heat in (J/kg °C)</b>	<b>Specific Heat in (kJ/kg °C)</b>
Copper	390	0.390
Aluminum	900	0.900
Brass	394	0.394
Concrete, granite, Glass	840	0.840
Gold	129	0.129
Iron, steel	452	0.452
Lead	128	0.128
Silver	235	0.235
Ice (-50°C to 0°C)	2040	2.040
water	4200	4.200
Steam	1996	1.996
Benzene	1740	0.174
Glycerin	2410	0.241
Mercury	139	0.139
<b>Substance</b>	<b>Latent Heat of fusion in (J/kg)</b>	<b>Latent Heat of fusion in (kJ/kg)</b>
Ice/Water	335000	335
Mercury	11800	11.8
Lead	24500	24.5
Aluminum	380000	380
Silver	88300	88.3
Gold	64500	64.5
Copper	134000	134
Tungsten	184000	184
Uranium	84000	84
Wood	1700	1.7
<b>Substance</b>	<b>Latent Heat of steam in (J/kg °C)</b>	<b>Latent Heat of steam in (kJ/kg °C)</b>
Water/Steam	2256700	2256.7
Mercury	270000	272
Lead	871000	871
Aluminum	11400000	11400
Silver	2336000	2336
Gold	1578000	1578
Copper	5069000	5069

**MLO and Bloom's Level of Complexity**

<b>Q #</b>	<b>MLO Addressed</b>	<b>Complexity Level</b>	<b>Mark</b>	<b>Remark</b>
1	<b>2,3,4</b>	Apply, Analyse and Evaluate	<b>11</b>	All question need to be done
2	<b>2,3,4</b>	Apply, Analyse and Evaluate	<b>12</b>	
3	<b>2,3</b>	Apply and Analysis	<b>11</b>	
4	<b>2</b>	Apply,	<b>6</b>	