الجامعة الوطنية
National University
Science & Technology للعلوم والتكنولوجيا
كلية عمان البحرية الدولية
International Maritime College Oman

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

	40
	10

Student Information			
Name:		ID:	
Signature:			

Invigilator			
Initials:		☐ Student ID checked	
Time received:			

Question 1 **[4 marks]**

a) Explain why small gaps are provided between metal railway tracks or concrete blocks in long structures. (2 mark)

b) Hot water or steam pipes should not be laid in long straight lengths because (1mark)

i. Heat loss increases
ii. Pressure decreases
iii. Bending or leakage due to thermal expansion
iv. Flow rate becomes zero

c) Two metal rods, A and B, have the same length and cross-section but are made of different materials. Both rods are heated through the same temperature increase and are free to expand. Which statement is most correct? (1mark)

i. Both rods expand by the same amount because the temperature change is the same
ii. The rod with the higher coefficient of thermal expansion expands more
iii. The heavier rod expands more because it has greater mass
iv. Expansion depends only on the final temperature, not the material

Question 2 **[8 marks]**

Onboard the bulk carrier MV OCEAN GUARDIAN, compressed air is used in a piston–cylinder device as part of an auxiliary pneumatic system. The piston is free to move, making sure that the pressure remains constant during heating. The cylinder contains 0.33 kg of air initially at a pressure of 300 kPa (gauge) and temperature of 20°C. Heat is supplied to the air from nearby machinery, raising its temperature to 242°C, while the piston moves to maintain constant pressure.

[Use: Atmospheric pressure = 101 kPa ; $C_p = 1.005 \frac{kJ}{kgK}$ and $C_v = 0.718 \frac{kJ}{kgK}$]

a) Calculate the heat supplied to the air during this constant-pressure process. (2 marks)

b) Determine the final volume of air in the cylinder. (2 marks)

c) Calculate the work done by the air on the piston. (2 marks)

d) Determine the change in internal energy of the air. (2 marks)

Question 3 **[10 marks]**

A ship stores ballast water at 6°C in a 500 m^3 double-bottom steel tank filled to 490 m^3 during winter operations in the North Atlantic. When traveling to the Indian Ocean, tank and water may reach 40°C. Using your engineering judgement

a) Calculate the temperature at which overflow begins. (6 marks)

b) Decide whether this filling plan is safe, given max temperature of 40°C. (2 marks)

c) Recommend two design/operational controls to prevent thermal overflow in real ships. (2 marks)

Question 4 **[10 marks]**

a) Why does a metal deck surface feel hotter than wooden flooring on a ship, even though both are at the same temperature? (2 marks)

b) A substance with low specific heat capacity will (1 mark)

I. Heat up slowly

II. Require more heat to raise its temperature

III. Heat up quickly for a given heat input

V. Not change temperature

c) During a thermal fluid lab onboard, a 0.50 kg brass component heated to 160°C dropped into a copper calorimeter (0.45 kg) containing 0.80 kg water at 25°C. Assume no heat loss,

I. Calculate the final equilibrium temperature. (4 marks)

II. State the principle used in a calorimeter experiment and explain why heat transfer stops after some time. (3 marks)

Question 5 **[8 marks]**

Onboard the tanker MT SEA HORIZON, potable water is produced using a freshwater generator. During winter sailing in cold regions, ice forms in the freshwater collection tray. Before restarting the system, the ice must be melted and part of the water converted into steam to continue freshwater production.

1.5 kg of ice at – 8°C is trapped inside the freshwater generator drain line. The ice must be completely converted into steam at 100°C.

a) Calculate the total heat energy required to convert the ice completely into steam. (6 marks)

b) The second engineer observes that most of the fuel energy is consumed during the evaporation stage rather than during heating.
Analyse why the evaporation stage requires significantly more energy than heating ice or water. (2 marks)

Formuale Sheet

	$Celisus = \frac{5}{9} \times (F - 32)$
	$Fahrenheit = \frac{9}{5} \times C + 32$
	Kelvin = θ [°C] +273
$\Delta L = \alpha_L \times L_1 \times \Delta T$ $L_2 - L_1 = \alpha \times L_1 \times \Delta T$	$\Delta A = \alpha_A \times A_1 \times \Delta T$ $A_2 - A_1 = \alpha_A \times A_1 \times \Delta T$
$\Delta V = \beta \times V_1 \times \Delta T$ $V_2 - V_1 = \beta \times V_1 \times \Delta T$	$R = C_P - C_v$
$Q = W + \Delta U$ $Q = P \times \Delta V + \Delta U$	$Q = m \times c \times \Delta T$
$Q_v = m \times C_v \times \Delta T$	$Q_p = m \times C_p \times \Delta T$
$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
$P_1V_1 = P_2V_2$	

Appendix Table 1: THERMAL EXPANSION COEFFIECNT OF DIFFERENT MATERIALS:

	Material	Coefficient of linear expansion α_L (1/°C)		Coefficent of volumetric expansion β (1/°C)
SOLIDS	Aluminum	25×10^{-6}		
	Brass	19×10^{-6}		
	Copper	17×10^{-6}		
	Gold	14×10^{-6}		
	Iron or Steel	12×10^{-6}		
	Lead	29×10^{-6}		
	Silver	18×10^{-6}		
	Glass (ordinary)	9×10^{-6}		
	Glass (Pyrex®)	3×10^{-6}		
LIQUIDS	Ethyl alcohol			1100×10^{-6}
	Lubricating oil			950×10^{-6}
	Glycerin			500×10^{-6}
	Mercury			180×10^{-6}
	Water			210×10^{-6}
	Sea Water			$\mathbf{510}\times10^{-6}$
GASES	Air and most other gases at atmospheric pressure			3400×10^{-6}

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

Substance	Specific Heat in (J/kg °C)	Specific Heat in (kJ/kg °C)
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
Substance	**Latent Heat of fusion in (J/kg)**	**Latent Heat of fusion in (kJ/kg)**
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
Substance	**Latent Heat of steam in (J/kg °C)**	**Latent Heat of steam in in (kJ/kg °C)**
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

Q #	MLO Addressed	Complexity Level	Mark	Remark
1	**1,3**	Understand, knowledge, Analysis	**4**	All question need to be done
2	**2**	Apply	**8**	
3	**2,3**	Apply and Analysis	**10**	
4	**1,2,3**	Knowledge, Apply, Analyse	**10**	
5	**2,3**	Apply, Analyse	**8**	