الـجامـعـة الوطـنـيـة
National University
Science & Technology للعلوم والتكنولوجيا
كليـة عمـان البحـرية الـدولية
International Maritime College Oman

Final Exam

MPHYS-II: PHYSICS II

Spring 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 hours
Instructor's Name:	RANJIT V
Exam Date:	17/6/2025
Program:	ME

	40
	10

Student Information			
Name:		ID:	
Signature:			

Invigilator		
Initials:		☐ Student ID checked
Time received:		

Question 1 **[6 marks]**

MCQ questions – Each question carries one mark.

a) A liquid of mass 0.75 kg requires 60,000 J to boil. The latent heat of vaporisation of the liquid is

i 8 kJ/kg ii 0.80 kJ/kg

iii 80 kJ/kg iv 8000 J/kg

b) A gas enclosed in a closed vessel increases its internal energy by 43 kJ. This process involves 25 kJ of thermal energy supplied to the gas.

Decide which of the following statements is correct.

i 18 kJ of work will be done on the gas.

ii 18 kJ of work will be done by the gas.

iii 68 kJ of work is done on the gas.

iv 68 kJ of work is done by the gas.

c) In a marine engine cooling system, seawater is most effective than many other metals in absorbing large quantity of heat despite having lower density because

i Seawater has a higher thermal conductivity than metals.

ii Seawater has a high specific heat capacity, allowing it to absorb more heat without a large temperature rise.

Iii Metals corrode easily in seawater, reducing their cooling efficiency.

iv Seawater expands rapidly when heated, which helps in cooling faster.

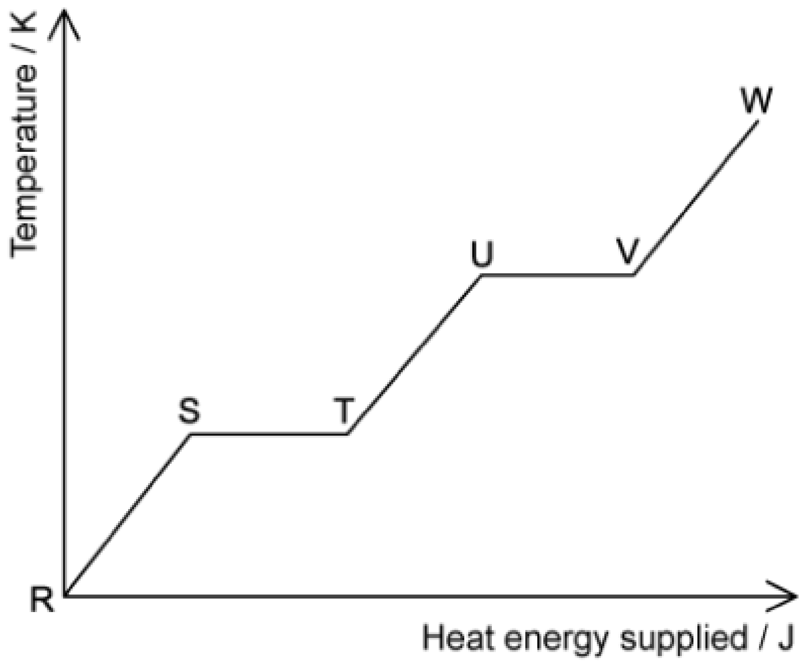
d) When temperature of a substance increase, the quantity which decreases is

i Specific heat capacity ii volume

iii density iv mass

e) A substance, which is initially in its solid form, is heated at a constant rate.

The graph shows how its temperature changes with the heat energy supplied.



Which part of the graph represents the latent heat of fusion.

i	UV	ii	ST
iii	TU	iv	VW

f) Which factor does **not** affect the amount of thermal expansion in solids?

i	Initial length (l_o)	ii	Temperature change(ΔT)
iii	Materials coefficient of expansion(α)	iv	Mass (m)

Question 2 **[11 marks]**

Heat transfer in matter involves a lot of changes happening with respect to the increase in intermolecular distance which resulting in phase change.

a) In your own words, differentiate between specific heat capacity and latent heat related to state of matter in not more than 50 words. (2 marks)

b) In an experiment to determine the specific heat capacity of the lead, 800 g of lead shot at a temperature of 95°C is poured into an insulated copper calorimeter of mass 0.5 kg containing 300 g of water at 23.5°C . The resultant temperature of the lead shots and the water is 26.5°C after 8 min.

i. Calculate the energy lost by the lead shots during the 8 mins. (2 mark)

ii. Calculate the specific heat capacity of the lead shot in SI units using the principle of calorimetry. (4 marks)

iii. Compare the value of specific heat capacity you have calculated above with the standard value of specific heat capacity the appendix table.

Justify with suitable reasons why the calculated value and the standard value of specific heat capacities are different. Also discuss what modifcation in the experimental setup can be done to improve the results.

(3 marks)

Question 3 **[9 marks]**

Compressed air stored in a rigid steel tank is used to start a large marine diesel engine. Before use, the air is heated using an electric heater in the steel tank.

a) Decide which type of heating of the air (at constant volume or at constant pressure) is more likely to happen. Justify your answer with suitable reasons (2 marks)

b) The steel tank holds 2.5 kg of air at an initial temperature of 300 K. The air is heated to 600 K. (Assume ideal gas behavior of gas, R = 287 J/kg K ; $c_{p\ air}$ = 1005 J/kg K)

i. Calculate heat added to the air by the heater. (3 marks)

ii. Write the work done by the gas during this heating process. (1 mark)

iii. State the change in internal energy of the air. (1 mark)

c) Which one of the heating is better – heating at constant volume or heating at constant pressure? Justify your answer with suitable reason. (2 marks)

Question 4 **[6 marks]**

Onboard a ship, a brass propeller shaft and the lubricating oil inside its bearing housing chamber both experience a temperature rise during continuous operation. The shaft is 1.5 m long, and the bearing housing chamber volume is of 1.2 liters at 25 °C. During the operation of the engine, the temperature reaches upto 95°C.

a) Calculate the increase in length of the brass shaft due to thermal expansion. (2 marks)

b) Calculate the increase in volume of the lubricating oil.

(2 marks)

c) Explain why it is important to consider thermal expansion of different materials in marine shaft and bearing systems

(2 marks)

Question 5 **[8 marks]**

A marine refrigeration system is designed to condense steam vapour and cool the resulting water to produce ice for food storage on a cargo vessel.

During operation, 350 g of steam at 120°C is passed into the condenser unit, where it condenses to water and is then cooled and frozen to form ice at –10°C.

a) Calculate the total heat released when 350 g of steam at 120°C is condensed, cooled to water at 0°C, frozen, and finally cooled to ice at –10°C. (6 marks)

b) State any two marine engineering applications where similar heat removal is essential. (2 marks)

Formuale Sheet

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

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}
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 vaporisation in (J/kg °C)***	***Latent Heat of vaporisation 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	**1,2,3**	Knowledge, Apply, Analysis	**6**	
2	**1,4**	Knowledge, Analyse,	**9**	
3	**1,2,4**	Knowledge, Apply and Analyse	**9**	
4	**2**	Apply	**8**	
5	**2,3**	Apply , Analysis	**8**	

Reference

Monahan, C. (n.d.). *Phase Change Diagrams — Overview & Examples*. [online] expii. Available at: https://www.expii.com/t/phase-change-diagrams-overview-examples-8057.

www.powermotiontech.com. (n.d.). StackPath. [online] Available at: https://www.powermotiontech.com/technologies/cylinders-actuators/article/21882647/engineering-essentials-cylinders.