الـــجـامـعــة الوطـنـيـة
National University
Science & Technology
كلـيـة عمــان البحــرية 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:			

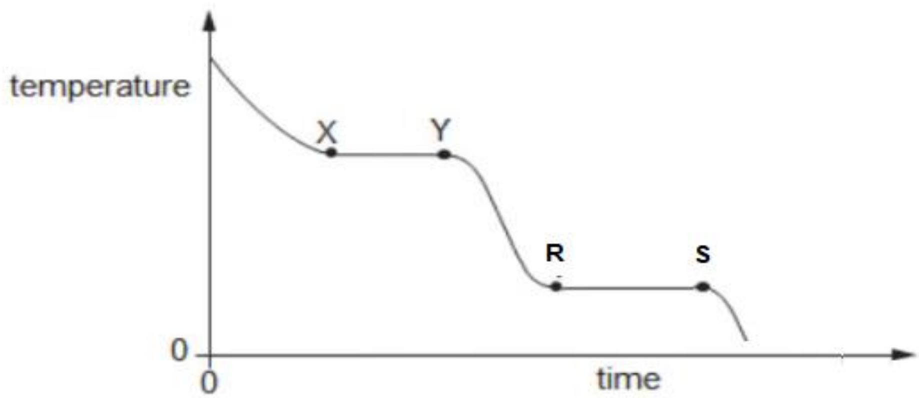
Invigilator

Initials:		☐ Student ID checked
Time received:		

Question 1 **[6 marks]**

MCQ questions – Each question carries one mark.

a) A substance is cooled using a cooling system. The change in temperature of the substance with the time is shown in the figure below:



(Monahan, n.d.)

Choose the correct statements regarding the region X-Y and R-S from the table below.

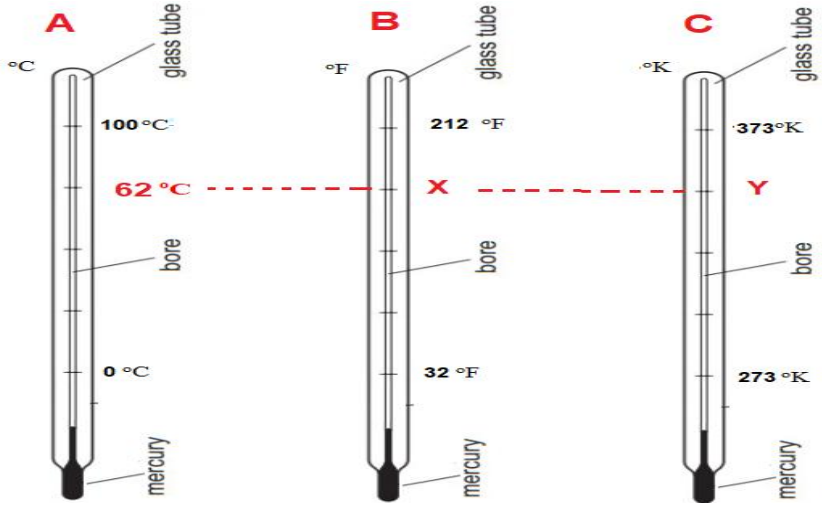
	Region X to Y	Region R to S
i	The gas is cooling	The liquid is freezing
ii	The gas is condensing	The liquid is freezing
iii	The gas is vaporizing	The liquid is cooling
iv	The gas is evaporating	The liquid is melting

b) Two metallic cylinders, P and Q, are heated using an electric heater. Both receive the same amount of thermal energy. Ther temperature of cylinder P increases by a small amount when compared to cylinder Q .

What is your conclusion from this scenario.

i	P has lower specific heat capacity	ii	Q has higher specific heat capacity
iii	Q has lower specific heat capacity	iv	P has higher specific heat capacity

a) Three thermometer A, B and C are shown in the figure given below:



(physicswala.com, 2024)

Choose the temperature X and Y on thermometer B and C corresponding to 62 °C on thermometer A.

i	143.6 °F , 335 K	ii	134.6 °F , 211 K
iii	143.6 °F , 221 K	iv	112.6 °F , 211 K

b) A hole is drilled in a metal plate. What happens to the length of the plate and the diameter of the hole when the metal plate is heated?

	Length of plate	**Diameter of the hole**
i	decreases	decreases
ii	decrease	increases
iii	increases	increases
iv	increases	decreases

c) The SI unit of heat capacity of a substance is

i	J/kg °K	ii	kJ/g °C
iii	cal/kg	iv	J/kg

d) Water is used as a universal coolant in engines and machines because

i	it is easily available	ii	it has the highest specific heat capacity.
iii	it is nontoxic for environment	iv	It has the highest lubricating nature and in turns cools engine

Question 2 **[9 marks]**

Thermal energy conversion is a very important technique in marine engineering and its application is vast in many processes. The specific heat capacity of metals can be calculated using the principle of energy conversion.

a) In your own words, differentiate between heat and thermal energy in not more than 50 words. (2 marks)

b) An group of students wishes to determine the specific heat capacity of an unknown liquid. They conduct an experiment where

- a sample of a liquid of mass 250 g is taken.
- It is heated using a heater of rating 240 V, 1 A.
- The initial temperature of the liquid was 27 ^{0}C and after 2 minutes of heating the final temperature of the liquid becomes 78 ^{0}C.

i. State the principle used in determining the specific heat capacity of liquid. (1 mark)

ii. Determine the specific heat capacity of the liquid. (4 marks)

iii. Suggest any possible error which could be possible in the calculation of specific heat capacity. Recommend a correction in the experiment to overcome this error. (2 marks)

Question 3 **[9 marks]**

Calorimetry is the study of heat transfer between a hot object and a cold object.

a) Define the term “specific heat capacity” of a material. Is it an important parameter in heat transfer. Justify your answer with suitable reason. (2 marks)

b) Describe a calorimeter in your own words. Write the principle involved in a calorimeter. (2 marks)

c) 344.6 g of an unidentified solid at 817.4 K is dropped in a container with 717 g of water at 297.5 K. The system comes to thermal equilibrium at 311.6 K. The specific heat capacity of water is 1.00 cal/g·K.

Calculate the specific heat capacity of the unknown solid. (4 marks)

d) Can you identify the unknown solid. If yes, Justify your answer by giving suitable reasons. (1 mark)

Question 4 **[9 marks]**

a) Onboard a marine cargo ship, the chief engineer needs to test the efficiency of a multi-stage boiler system during a routine maintenance check. As part of the calibration test, exactly 2500 grams of ice at -20°C is placed into the boiler. The ice is heated, melted, vaporized, and finally superheated to 200°C steam, simulating how seawater might be desalinized and used to drive auxiliary steam turbines.

Calculate the total thermal energy (in joules) required to convert the 2500 g of ice at -20 °C into steam at 200°C. (6 marks)

b) In a marine diesel engine room, a storage tank contains **1.8 kg of nitrogen gas** at an initial temperature of **320 K**. The gas is heated at **constant volume** until the temperature reaches **580 K**. Given Cp = 1013 J/kg K and Cv = 743 J/kg K

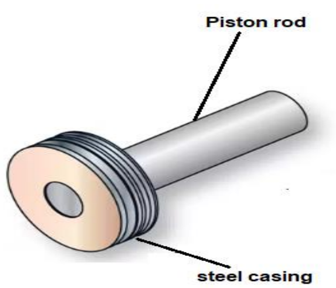
i) Calculate the work done by the nitrogen gas. (1 mark)

ii) Determine the internal energy stored in the cylinder. (1 mark)

iii) If the same heating occurred in a cylinder with a movable piston at constant pressure, what would be the new **work done**? (1 mark)

Question 5 **[7 marks]**

A brass piston rod used in the auxiliary steam system is 2.0 meters long with a cross-sectional area of 4 cm^2 and is tightly fitted into a steel casing. Both materials are subjected to temperature changes from 20°C to 120 ^0C as the engine room warms up during operation.



(www.powermotiontech.com, n.d.)

a) Calculate the increase in length and area of the brass rod due to heating. (3 marks)

b) Will the rod remain tightly fitted in the steel hole as temperature increases? Justify your answer using thermal expansion concepts. (1 mark)

c) The lubrication oil in the ship is stored in containers made of steel having volume of 20 L. The engineer needs to check how much lubricating oil would overflow if the container is completely filled at 20^{0}C and gets heated to 120°C during engine operation. (3 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}
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	**1,2,3**	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.