



University of Fort Hare
Together in Excellence

QUESTION PAPER

DEGREE AND DIPLOMA EXAMINATIONS: ☒ MAIN ☐ SUPP ☐ SPECIAL

EXAM MONTH AND YEAR : OCTOBER 2025

FACULTY	:	Science and Agriculture
DEPARTMENT	:	Physics
QUALIFICATION	:	Bsc
SUBJECT NAME	:	Properties of Matter and Thermodynamics
SUBJECT CODE	:	PHY122F
EXAMINER(S)	:	MTHIMUNYE TV
MODERATOR	:	MAPANTSELA Y
INSTRUCTIONS	:	Instructions • Answer all five (5) questions
ANNEXURES/ADDENDA	:	3 pages
DURATION	:	3 hours
MARKS	:	100
NUMBER OF PAGES	:	8 (INCLUDING COVER PAGE).
ASSESSMENT WEIGHTING	:	50

EXAMINATION RULES ARE NOW IN FULL FORCE AND EFFECT
DO NOT TURN THE PAGE BEFORE BEING TOLD TO DO SO.

UNIVERSITY OF FORT HARE

PHY122F

EXAMINATIONS OCT / NOV

Time: 3 HOURS

Subject: FLUIDS, HEAT, AND THERMODYNAMICS

Marks: 100

This paper consists of 8 pages, including a cover page

Internal Examiner
Mr. T.V Mthimunya

Moderator
Ms. Y Mapantsela

Instructions

- Answer all five (5) questions
- Read the question more than once and clearly write down your data.
- On problem solving, specify useful definitions and draw clearly labeled diagrams.



University of Fort Hare
Together in Excellence

Question 1**(Fluid Mechanics)****[20]**

1.1. Scientists have found evidence that Mars may once have had an ocean 0.500 km deep. The acceleration due to gravity on Mars is 3.71 m/s^2 .

1.1.1. What would be the gauge pressure at the bottom of such an ocean, assuming it was fresh water? (2)

1.1.2. To what depth would you need to go in the Earth's ocean to experience the same gauge pressure? (3)

1.2. A table-tennis ball has a diameter of 3.80 cm and an average density of 0.0840 g/cm^3 . What force is required to hold it completely submerged under water? (5)

1.3. State Pascal's law in words. (2)

1.4. A hydraulic jack is used to lift a 1200 kg car on a piston of diameter 30 cm.

1.4.1. How much force is needed to push down the smaller piston if its diameter is 2 cm? (4)

1.4.2. How much is the car lifted with a single push, assuming the small piston moves 0.50 m? (4)

Question 2**(Temperature and Thermal Expansion)****[20]**

2.1. State the Zeroth law of thermodynamics and use it to explain whether the two objects can be in thermal equilibrium if they are not in physical contact. (3)

2.2. Put a soft drink bottle in a refrigerator and leave it until its temperature drops by 10.0 K. What is its temperature change in Fahrenheit and Celsius degrees? (4)

2.3. A liquid has a density ρ_l .

Specific Heat c		
Substance	$\text{J kg}^{-1} \cdot ^\circ\text{C}$	$\text{cal g}^{-1} \cdot ^\circ\text{C}$
<i>Elemental solids</i>		
Aluminium	900	0.215
Beryllium	1830	0.436
Cadmium	230	0.055
Copper	387	0.092 4
Germanium	322	0.077
Gold	129	0.030 8
Iron	448	0.107
Lead	128	0.030 5
Silicon	703	0.168

Specific Heat c		
Substance	$\text{J kg}^{-1} \cdot ^\circ\text{C}$	$\text{cal g}^{-1} \cdot ^\circ\text{C}$
<i>Other solids</i>		
Brass	380	0.092
Glass	837	0.200
Ice (-5°C)	2090	0.50
Marble	860	0.21
Wood	1700	0.41
<i>Liquids</i>		
Alcohol (ethyl)	2400	0.58
Mercury	140	0.033
Water (15°C)	4186	1.00

TABLE 21.2

Molar Specific Heats of Various Gases

Molar Specific Heat (J/mol · K) ^a				
Gas	C_p	C_v	$C_p - C_v$	$\gamma = C_p/C_v$
<i>Monatomic gases</i>				
He	20.8	12.5	8.33	1.67
Ar	20.8	12.5	8.33	1.67
Ne	20.8	12.5	8.33	1.67
Kr	20.8	12.5	8.33	1.67
<i>Diatomic gases</i>				
H ₂	28.8	20.4	8.33	1.41
N ₂	29.1	20.8	8.33	1.40
O ₂	29.1	20.8	8.33	1.40
CO	29.3	21.0	8.33	1.40
Cl ₂	31.7	23.7	8.06	1.35
<i>Polyatomic gases</i>				
CO ₂	37.0	28.5	8.50	1.30
SO ₂	40.4	31.4	9.00	1.29
H ₂ O	35.4	27.0	8.47	1.30
CH ₄	35.5	27.1	8.41	1.31

^a All values except that for water were obtained at 300 K.

2.3.1. Show that the change in density of a substance, when the temperature changes by ΔT , is given by $\Delta\rho = -\rho\beta\Delta T$. (4)

2.3.2. What does the negative sign signify? (1)

2.3.3. What is the fractional change in density of a lead sphere whose temperature decreases from 25.0°C to -40.0°C ? (4)

2.4. A copper cylinder is initially at 20.0°C . At what temperature will its volume be 0.150% larger than it is at 20.0°C ? (5)

Question 3 (Calorimetry and Phase Change) [20]

3.1. A physics student wants to cool 0.25 kg of Diet Omni-Cola (mostly water), initially at 25.0°C , by adding ice initially at -20.0°C . How much ice should she add so that the final temperature will be 0°C with all the ice melted if the heat capacity of the container may be ignored? (10)

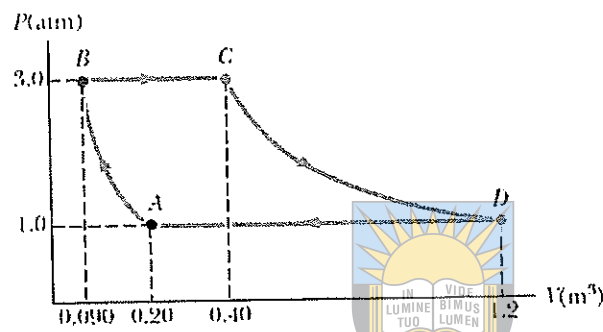
3.2. An insulated beaker with negligible mass contains 0.250 kg of water at a temperature of 75.0°C . How many kilograms of ice at a temperature of -20.0°C must be dropped into the water to make the final temperature of the system 30.0°C ? (5)

3.3. A copper calorimeter with mass 0.100 kg contains 0.160 kg of water and 0.0180 kg of ice in thermal equilibrium at atmospheric pressure. What is the final temperature if 0.750 kg of lead at 255°C is dropped into the calorimeter can? Assume that no heat is lost to the surroundings. (5)

Question 4**(First Law of Thermodynamics and Application)**

[20]

4.1 A sample of an ideal gas goes through the process shown in the figure. From A-B, the process is adiabatic; from B-C, the process is isobaric with 100kJ of energy entering the system by heat. From C-D, the process is isothermal; From D-A, it is isobaric with 150 kJ of energy leaving the system by heat. Determine the difference in internal energy $E_{\text{int, B}} - E_{\text{int, A}}$. (11)



4.2 A 2.00 mol sample of helium gas initially at 300 K and 0.400 atm is compressed isothermally to 1.20 atm. Noting that the helium behaves as an ideal gas, find

4.2.1. The final volume of the gas, (3)

4.2.2. the work done on the gas, and (3)

4.2.3. The energy transferred by heat. (3)

Question 5 (Heat Engines, Entropy, and the 2nd Law of Thermodynamics)

[20]

5.1 Does the second law of thermodynamics contradict or correct the first law? (5)

5.2 State Carnot's theorem. (3)

5.3 A heat engine takes 360 J of energy from a hot reservoir and performs 25.0 J of work in each cycle. Find

5.3.1 The efficiency of the engine (2)

- 5.3.2 The energy expelled to the cold reservoir in each cycle.
(2)
- 5.4 Discuss the change in entropy of a gas that expands (4)
- 5.4.1 At constant temperature (4)
- 5.4.2 Adiabatically. (4)



University of Fort Hare
Together in Excellence



University of Fort Hare
Together in Excellence