UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION 2008/09

TITLE O F PAPER: INTRODUCTORY PHYSICS I

COURSE NUMBER: P101

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR OUT OF FIVE QUESTIONS

EACH QUESTION CARRIES 25 MARKS

MARKS FOR EACH SECTION ARE IN THE RIGHT HAND MARGIN

GIVE CLEAR EXPLANATIONS AND USE CLEAR DIAGRAMS IN YOUR SOLUTIONS. MARKS WILL BE LOST WHERE IT IS NOT CLEAR HOW THE EQUATIONS USED WERE OBTAINED

THIS PAPER HAS SEVEN (7) PAGES INCLUDING THE COVER PAGE

THE LAST PAGE CONTAINS DATA THAT MAY BE USEFUL IN SOME QUESTIONS

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GIVEN BY THE CHIEF INVIGILATOR

QUESTION 1

(a) A body reaches the origin with a velocity of 2 m/s at $t = 0$ and accelerates to 12 m/s in 5 s, and then moves at constant velocity for 5 s after which it accelerates to - 2 m/s in 7 s. Sketch

(i) the velocity-time, **(4 marks)**

(ii) the acceleration-time, and **(5 marks)**

(iii) the distance-time graphs for this motion. **(6 marks)**

(b) A soccer ball is kicked with a velocity $\upsilon_0 = 15$ m/s at an angle $\theta = 45°$ with the horizontal and hits a widow of a building at a height h above ground with zero vertical velocity.

(i) What is the height h of the point where the ball hits the window? **(4 marks)**

(ii) How much time does the ball spend in flight from the ground to the window? **(3 marks)**

(iii) What is the range R of the ball? **(3 marks)**

QUESTION 2

(a) The system shown in Figure 1 is in equilibrium. Determine the tension in each string and the mass m_2. The pulley is frictionless. **(10 marks)**

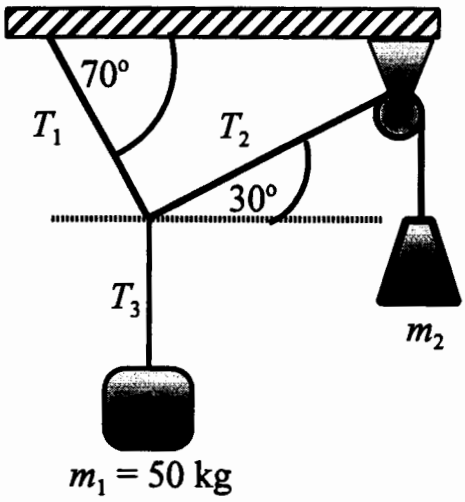

Figure 1.

(b) The system shown in Figure 2 moves such that m_2 moves down the inclined plane and m_1 moves upward. Neglect the mass of the string, and assume the pulley has negligible mass and frictionless. The coefficient of kinetic friction between the mass m_2 and the inclined surface is 0.6.

(i) Make a resolved force diagram for each body from which useful equations of motion can be obtained. **(4 marks)**

(ii) Write down the equations of motion for each body. **(6 marks)**

(iii) Determine the acceleration of the system. **(5 marks)**

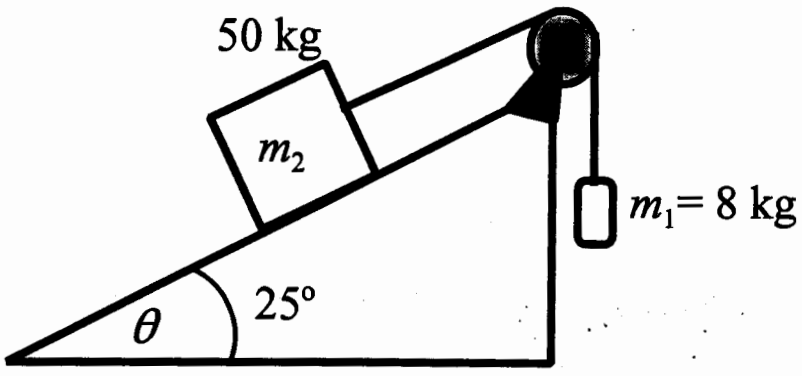

Figure 2.

QUESTION 3

(a) The system in Figure 3 is released from rest with the 50 kg block 8 m above the floor. Use the principle of conservation of energy to find the velocity with which the 50 kg block hits the floor. Neglect friction and assume that the mass of the pulley is negligible. **(12 marks)**

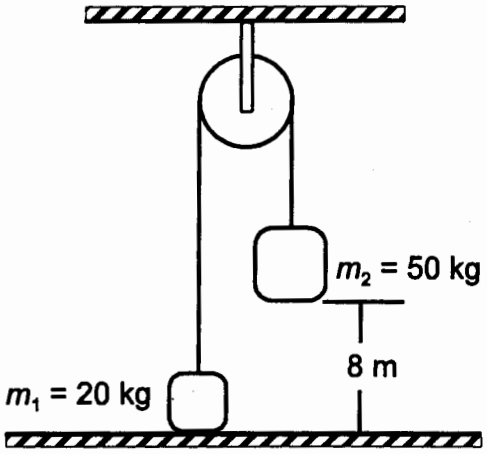

Figure 3.

(b) A bullet of mass m = 50 g moving with an initial speed υ_0 = 480 m/s strikes a stationary block of mass M = 1.5 kg and passes through the block with a velocity υ_f as shown in Figure 4. The block acquires a velocity of 2 m/s after the impact in the original direction of motion of the bulet. What is the final velocity of the bullet υ_f? **(7 marks)**

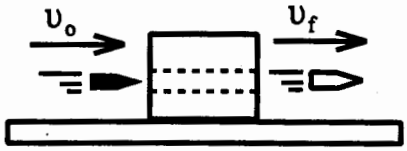

Figure 4.

(c) A flywheel of moment of inertia I = 65 kg m^2 is under a torque of 10 Nm.

(i) What is the angular acceleration of the wheel? **(2 marks)**

(ii) What is the angular velocity of the wheel at t = 5 s? **(2 marks)**

(iii) What angle in radians does the wheel turn through in the first 5 s? **(2 marks)**

QUESTION 4

(a) Sketch a fully labelled stress versus strain graph for a ductile metal (a metal that can be easily made into a wire) and discuss all its parts. **(8 marks)**

(b) The liquid in the open tube manometer shown in Figure 5 is mercury, $y_1 = 5$ cm and $y_2 = 30$ cm.

(i) What is the absolute pressure of the gas in the gas in the tank? **(7 marks)**

(ii) What is the gauge pressure of the gas in the tank? **(2 marks)**

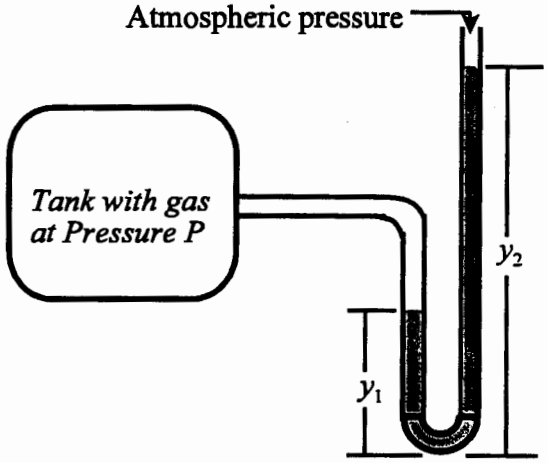

Figure 5.

(c) State Archimedes principle. **(3 marks)**

(d) Write down Bernoulli's equation. **(3 marks)**

(e) Write down the equation of continuity for fluid flow. **(2 marks)**

QUESTION 5

(a) Make a sketch of the graph of temperature versus heat supplied for a certain mass of water when heated from ice at minus 10 °C to steam at 150 °C. State the phases of the water at each stage and give the equations for the heat transferred to the water. **(8 marks)**

(b) A block of mass 300 g at 150 °C is placed into a 100 g copper cylinder containing 250 g of water at 20 °C. The final temperature of the system is $T_f = 35$ °C. The specific heat capacity of copper is 385 J/(kgK). What is the specific heat capacity of the block c_b? **(10 marks)**

(c) Four moles of krypton at 3 atmospheres are at a temperature of 20 °C.

(i) What is the volume of the gas? **(3 marks)**

(ii) If the gas is expanded at constant temperature until the pressure drops to 1 atmosphere, what is the new volume? **(4 marks)**

GENERAL DATA SHEET

Avogadro's number $N_A = 6.022 \times 10^{23}$ mol^{-1}
Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s
Speed of sound in air = 334 m/s
Gravitational acceleration = 9.80 m/s^2
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2/kg^2
Density of mercury = 1.36×10^4 kg/m^3
Density of water = 1000 kg/m^3
Standard atmospheric pressure = 1.013×10^5 Pa
Gas constant $R = 8.314$ J/(K mol)
Threshold of hearing $I_0 = 10^{-12}$ W/m^2
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J
Specific heat capacity for water $c_w = 4186$ J/(kg K)
Specific heat capacity for ice $c_i = 2090$ J/(kg K)
Specific heat capacity for steam $c_s = 2079$ J/(kg K)
Latent heat of fusion for ice $L_f = 3.33 \times 10^5$ J/kg
Latent heat of vapourisation for water $L_v = 2.260 \times 10^6$ J/kg
Coulomb's constant $k_e = \dfrac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9$ Nm^2/C^2
Charge of an electron = -1.6×10^{-19} C
Charge of a proton = $+1.6 \times 10^{-19}$ C
1 atomic mass unit = 1 amu = 1 u = 1.66×10^{-27} kg
Electron mass, $m_e = 9.109 \times 10^{-31}$ kg
Proton mass, $m_p = 1.673 \times 10^{-27}$ kg
Neutron mass $m_n = 1.675 \times 10^{-27}$ kg