UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION 2012/2013

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 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 GRANTED BY THE CHIEF INVIGILATOR

QUESTION 1

(a) Given two vectors $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$ and $\vec{B} = 3\hat{\imath} + 2\hat{\jmath} - 2\hat{k}$, find

(a) the angle between the two vectors, and **(6 marks)**

(b) the cross product of the two vectors $\vec{C} = \vec{A} \times \vec{B}$. **(4 marks)**

(b) A body with an initial velocity of 3 m/s is accelerated at 2 m/s^2 for 4 s. It then moves at constant velocity for 3 s, after which it is accelerated at -3 m/s^2 for 4 s. Sketch the

(a) acceleration-time **(4 marks)**

(b) velocity-time, and **(5 marks)**

(c) displacement-time graphs for this motion. **(6 marks)**

QUESTION 2

(a) Consider Figure 1 below. Let the coefficient of static friction between the block and the incline be μ = 0.4. Find the maximum and minimum values of the mass m_1 to keep the system in static equilibrium? In each case derive an expression for m_1 and substitute for numerical values at the end. **(13 marks)**

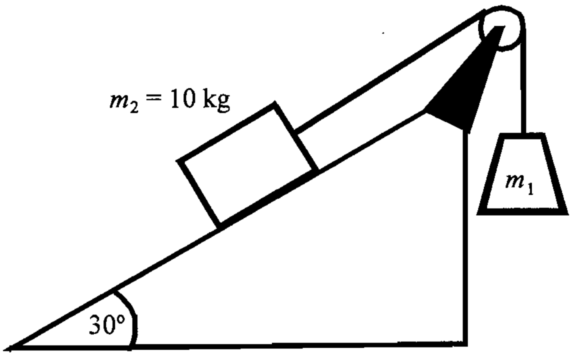

Figure 1.

(b) The system shown in Figure 2 is in equilibrium. The platform is uniform, 10 m long, and has a weight $W = 2400$ N. The cord holding up the platform is connected at the other end from the wall, and makes an angle of 30° with the horizontal. Some supplies of mass $m = 320$ kg are positioned 6 m from the wall.

(i) Determine the tension in the cord. **(6 marks)**

(ii) Find the x- and y- components of the reaction force on the platform by the wall, using the usual coordinates. **(3 marks)**

(iii) Determine the angle the reaction force makes with the wall. Also illustrate the angle. **(3 marks)**

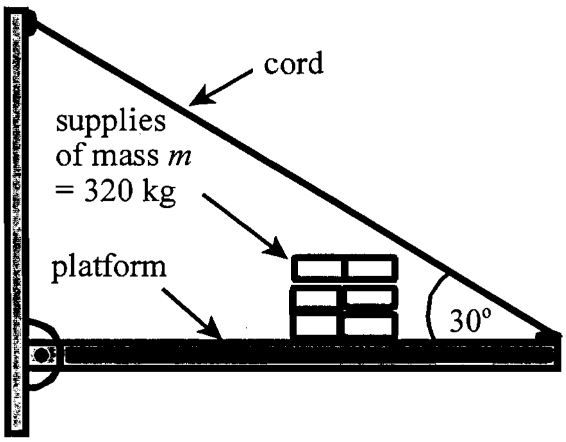

Figure 2.

QUESTION 3

(a) The system in Figure 3 is released from rest with the 40 kg block at a height h = 8 m above the floor. Use the principle of conservation of energy to find the velocity with which the 40 kg block hits the floor. (Neglect friction and assume that the mass of the pulley is negligible.) **(8 marks)**

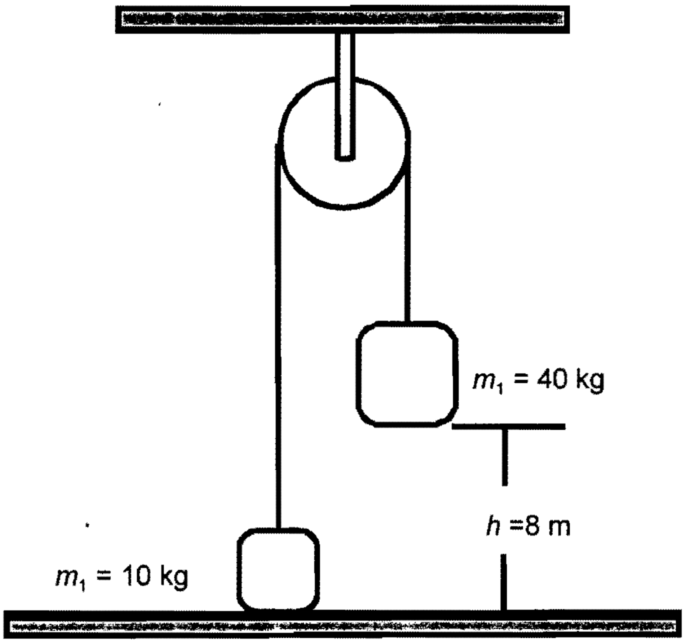

Figure 3.

(b) A bullet of mass $m = 200$ g moving with an initial speed $v_0 = 450$ m/s strikes a stationary block of mass $M = 6$ kg. The block acquires a velocity $V' = 10.0$ m/s after the impact.

(i) What is the final velocity of the bullet v_f? **(7 marks)**

(ii) Comment on the motion of the bullet after the impact. **(2 marks)**

(c) A engine flywheel is accelerated from 800 rpm to 4000 rpm in 5 s.

(i) What is the angular acceleration of the flywheel? **(5 marks)**

(ii) What is the torque acting on the flywheel? **(3 marks)**

QUESTION 4

(a) The Achilles tendon of a 75 kg athlete has a cross-sectional area of 56.3 mm^2 and a length of 26.5 cm. During a high jump, the athlete exerts a force equal to 10 times his weight on the tendon and the tendon stretches by 0.634 cm. Determine

(i) the stress on the tendon, **(4 marks)**

(ii) the strain on the tendon, and **(2 marks)**

(iii) the Young's Modulus of the tendon. **(2 marks)**

(b) Explain (using physics) why it is easier to make a cut on an object with a sharp instrument than a blunt one. **(4 marks)**

(c) State Pascal's law and give one example with explanation on how it is used in every day life. **(6 marks)**

(d) A slab of wood has a thickness t = 50 cm, and a density $\rho_s = 650$ kg/m^3. The slab is to be used to support a load of mass m = 540 kg on water. What should be the minimum area of the slab of wood to just support the load? **(7 marks)**

QUESTION 5

(a) What is the temperature in °C on a day when the temperature is 98°F? **(3 marks)**

(b) In an experiment to determine the thermal coefficient of linear expansion of a material, the material is made into a uniform rod and measured to have a length of exactly $l_0 = 50.00$ cm at 0°C. The rod is then heated to 150°C, and its length measured to be $l = 50.45$ cm. Determine the thermal coefficient of expansion α for this material. **(4 marks)**

(c) Explain why beverage containers break if kept in a freezer for two long? **(4 marks)**

(d) Explain how a thermoflask works. **(6 marks)**

(e) A metal ball of mass m_b = 450 g has specific heat capacity c_b = 650 J/(kg·K). It is heated to a temperature T_b = 130°C and is then immersed in water of mass m_w = 800 g at a temperature T_w = 18°C in an insulating container. Find the final temperature reached by the system. **(8 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 = 343 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 (Hg) = $1.36 \times 10^4\ kg/m^3$
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

c_{water} = 4186 J/(kg K) c_{ice} = 2090 J/(kg K) c_{steam} = 2079 J/(kg K)
$L_{f\text{-}ice} = 3.33 \times 10^5$ J/kg $L_{v\text{-}water} = 2.260 \times 10^6$ J/kg

Refractive index of water $n_{water = 1.333}$
$k_e = 8.9875 \times 109\ N{\cdot}m^2/C^2$
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