UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

MODULE: PHE2LB1/PHYL02E

PHYSICS FOR THE LIFE SCIENCES L02E

CAMPUS: APK

SUPPLEMENTARY EXAM

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MODERATOR: **MR D UNWUCHOLA**

DURATION: 150 MINUTES **MARKS: 100**

NUMBER OF PAGES: 17 PAGES (including this information page)

INSTRUCTIONS:

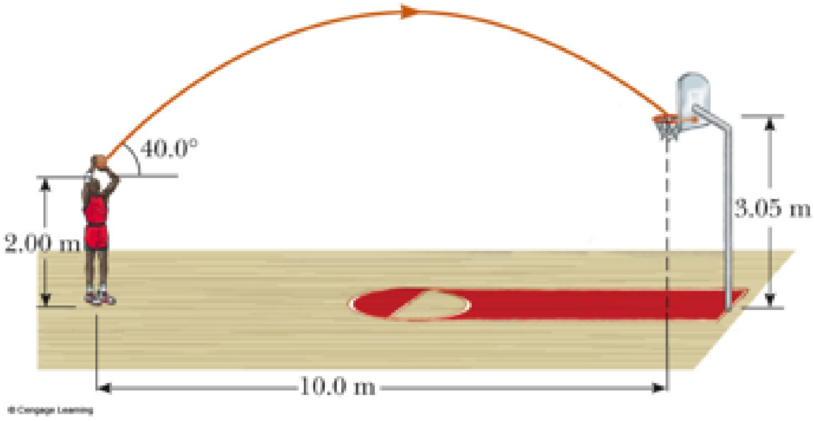
1. Answer ALL the questions in the space provided. Use back of page if more space is needed.
2. Programmable calculators are not permitted.
3. Pencil may be used for diagrams only.

QUESTION 1 [30]

1.1 A car traveling at a constant speed of $24\ m/s$ passes a trooper hidden behind a billboard. One second after the speeding car passes the billboard, the trooper sets off in chase with a constant acceleration of $3\ m/s$. Calculate how long it takes the trooper to overtake the speeding car. **[5 marks]**

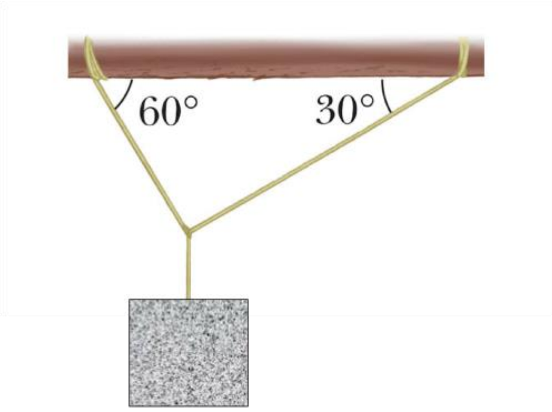
1.2 Two students are on a balcony $19.6\,m$ above the street. One student throws a ball vertically downward at $14.7\,m/s$. At the same instant, the other student throws a ball vertically upward at the same speed. Calculate the difference in the two balls' time in the air. **[6 marks]**

1.3 A $2\ m$ tall basketball player is standing on the floor $10\ m$ from the basket, as shown in the figure below. If he shoots the ball at an angle of 40^0 with the horizontal, calculate the initial velocity with which he must throw the basketball so that it goes through the hoop without striking the backboard. The height of the basket is $3.05\ m$. **[6 marks]**



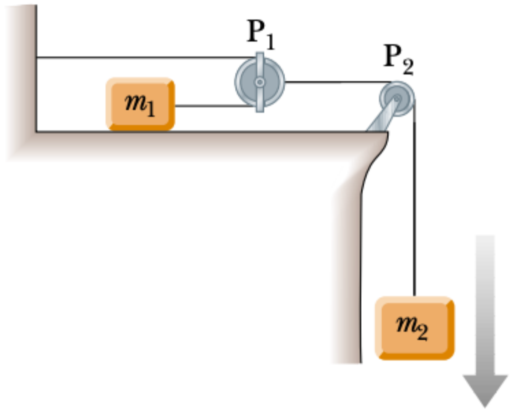
1.4 An airplane starts from an airport and first flies to city A, located $175\ km$ away in a direction 30^0 north of east. Next it flies for $150\ km$ 20^0 west of north to city B. Finally, the plane flies $190\ km$ due west to city C. Calculate the location of city C relative to the location of the starting point. **[6 marks]**

1.5 Three cables as shown in the figure below support an object weighing 150 N. Draw the free body diagram for the object and calculate the tension in each cable. **[7 marks]**



QUESTION 2 [30]

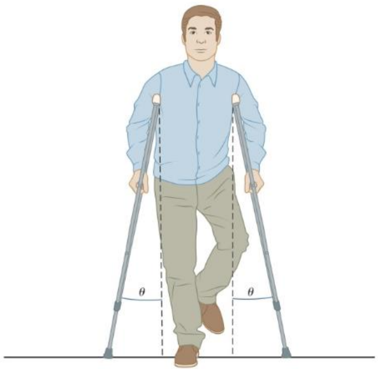
2.1 An object of mass m_1 on a frictionless horizontal table is connected to an object of mass m_2 through a very light pulley P_1 and a light fixed pulley P_2 as shown in the figure below



(a) If a_1 and a_2 are the accelerations of m_1 and m_2, respectively, what is the relation between these accelerations? **[3 marks]**

(b) Express the tensions in the strings and the accelerations a_1 and a_2 in terms of the masses m_1 and m_2, and g. **[7 marks]**

2.2 In the figure below a standard man uses crutches. The crutches each make an angle $\theta = 35°$ with the vertical. A quarter of the standard man's weight is supported by the crutches; the remaining is supported by the normal forces acting on the soles of the feet. Assuming the standard man is motionless, find the magnitude of the force supported by each crutch. **[7 marks]**

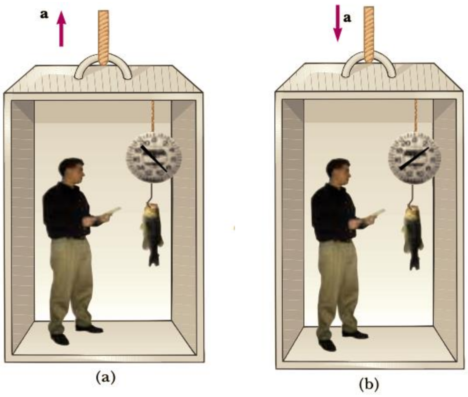


2.3 A standard man (m = 70 kg) intends to do concentration curls in a gym. At the beginning of this exercise, he holds with his left arm vertical, a dumbbell of mass M = 4 kg. Calculate the ratio of the magnitude of the tension in the shoulder to the magnitude of the force that pulls the fist down. **[7 marks]**

<u>Given</u>: Mass of arm = 4.6 kg.

2.4 Define apparent weight. **[2 marks]**

2.5 A person weighs a fish of mass m on a spring scale attached to the ceiling of an elevator, as illustrated in the Figure below. Show that if the elevator accelerates either upward or downward, the spring scale gives a reading that is different from the weight of the fish. **[4 marks]**



QUESTION 3 [25]

3.1 An 65 kg man and his 15 kg daughter stand on opposite ends of a 4.2 m-long wooden plank with a mass of 12 kg.

(c) If the system is taken to be the man and the daughter, how far along the plank from the daughter is the center of mass of that system? **[2 marks]**

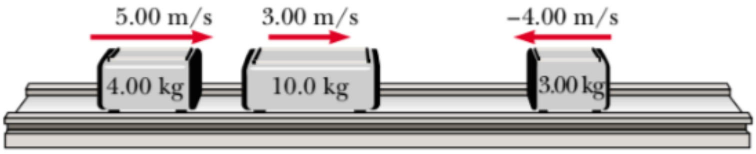
(d) If the system is taken to be the man, the daughter, and the wooden plank, how far along the plank from the daughter is the center of mass of that system? **[3 marks]**

(e) If you want to balance the wooden plank with the man and daughter on it, would you place the pivot directly under the center of mass you found in part (a) or in part (b)? Explain. **[2 marks]**

3.2 Show that the total linear momentum of an isolated system does not change in time.

[7marks]

3.3 Three carts of masses 4.00 kg, 10.0 kg, and 3.00 kg move on a frictionless horizontal track with speeds of 5.00 m/s, 3.00 m/s, and 4.00 m/s, as shown in the figure below. Velcro couplers make the carts stick together after colliding. Find the final velocity of the train of three carts. **[4 marks]**



3.4 A car with a mass of 1200 kg and a speed of $12\ m/$s heading north approaches an intersection. At the same time, a mini-van with a mass of 1300 kg and speed of $24\ m/s$ heading east is also approaching the intersection. The car and the mini-van collide and stick together. What is the velocity of the wrecked vehicles just after the collision? Ignore friction between the tires and the surface of the road. **[7 marks]**

QUESTION 4 [15]

4.1 A ladder rests against a frictionless wall. It has a mass of 50 kg, a length of 5.0 m, and makes an angle of 60° with the ground. Find the horizontal and vertical force components exerted by the ground on the bottom of the ladder if a standard man stands on the ladder 4 m from the ground. **[7 marks]**

4.2 Show that the angular momentum of a system is conserved if no net torque acts on the system. Show all steps. **[8 marks]**

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