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P510/1

PHYSICS

$2\frac{1}{2}$**HRS**

UGANDA MARTRYS SECONDARY SCHOOL-KAKIRI

END OF TERM 2 EXAMINATIONS

SENIOR FIVE PHYSICS

TIME: $2\frac{1}{2}$ HRS

INSTRUCTIONS TO CANDIDATES

- *Attempt any **five** items only*
- *Each item **must** begin on a fresh page*
- *Assume where necessary acceleration due to gravity,* $g = 9.81\,ms^{-2}$

Section A

Item 1

A group of friends, Alex and Ben, are driving on a straight highway. Alex is driving car A at a constant velocity of 25 m/s and overtakes Ben's car B, which is stationary at the side of the road. Two seconds later, Ben starts driving and accelerates at a uniform rate of $6ms^{-2}$ in pursuit of Alex.

Meanwhile, their friend Chris is standing on the edge of a cliff and throws a stone vertically upwards at 15 m/s. The cliff is 20 meters high, and Chris wants to know after what time the stone will hit the ground below. As they wait for the stone to land, they start discussing the basics of physics and try to recall the definitions of scalar and vector quantities, along with some examples.

Tasks:

a) Calculate the distance car B travels before catching up with car A.
b) Determine the time it takes for the stone to hit the ground 20 meters below the point of projection.
c) Explain the terms scalar and vector quantities and give three examples of each.

Item 2:

A team of researchers is conducting experiments to study the physics of collisions and motion. In one experiment, they fire a bullet of mass 50g horizontally into a block of wood of mass 8kg, which is suspended by a string of length 2.5m. After the collision, the block swings upwards through an angle of 30 degrees. The researchers want to calculate the velocity of the bullet, assuming it gets embedded in the block just after the collision.

Meanwhile, a train is traveling on a level road at a speed of 72 km/h. The resistance to the motion of the train due to friction is equal to $\frac{1}{160}$ of the weight of the train. As the train reaches the foot of an incline of 1 in 150, the steam is turned off, and the train starts to roll up the incline. The researchers want to know how far the train will go up the incline before it comes to rest.

Tasks:

a) i) Calculate the velocity of the bullet before it collides with the block of wood.

   ii) State the factors that the angle of swing depends on.

b) i) Use Newton's laws to prove that momentum is conserved for a system under collision

   ii) Determine the distance the train will travel up the incline before coming to rest.

Item 3

Two boys Ben and Austin, are playing using a ball, Ben threw the ball downwards along an inclined plane at an angle φ and Austin said, mechanical energy is conserved through out its motion, but Ben was left puzzled.

Meanwhile the two boys have to fetch water for home use, they use a pump to draw water from underground. The pump draws $3.6\,cm^3$ of water of density $1000\,kg\,m^{-3}$ from a well 5m below the ground in every minute, and issues it at ground level to a pipe of cross-sectional area $40\,cm^2$. Ben was left wondering the speed with which water leaves the pipe and the rate at which the pump is working. At their home, there is a uniform ladder which

is 5m long and has a mass of 20kg leans with its upper end against a smooth vertical wall and its lower end on a rough ground. The bottom of the ladder is 3m from the wall. Ben is curious about the coefficient of friction and the frictional force between the ladder and the ground.

Task

a) i) Help Ben to understand what Austin meant?
   ii) Explain conservative and non-conservative forces stating two examples in each.
b) i)Help Ben to understand the speed at which the water leaves the pipe and the rate at which the pump is working
c) (ii) If the pump is only 80% efficient, find the rate at which it must work
d) (iii) Find the power wasted

Item 4

A team of researchers at a university laboratory are conducting experiments to determine the properties of various fluids. They are studying the viscosity of motor oil and other liquids using a sphere-drop method. In one experiment, they measure the terminal velocity of a glass sphere falling through a container of motor oil. The sphere has a mass of $1.2\,x\,10^{-4}$kg and it has a circumference of $1.26\,x\,10^{-3}m$, it reaches a terminal velocity of $5.4\,x\,10^{-2}\,ms^{-1}$. The density of the oil is 860 kg/m^3. The researchers want to compare the viscosity of this oil with another liquid, which has a density of 900 kg/m^3. In a separate experiment, they measure the distance and time it takes for the same sphere to fall through this new liquid, and they find that it moves 6 mm in 0.005 s. Meanwhile, it was drizzling outside the laboratory, Ann, one of the researchers is studying the behavior of rain droplets in the atmosphere. She observes that 27 spherical rain droplets, each with the same mass and radius, are falling with a terminal velocity of 15 cm/s. She wonders what the terminal velocity would be if these droplets were to coalesce into a single larger droplet.

Tasks

a) Calculate the coefficient of viscosity of the motor oil.
b) Determine the ratio of the coefficient of viscosity of the second liquid to that of the motor oil.
c) Calculate the terminal velocity of the larger rain droplet formed by the coalescence of the 27 smaller droplets.
d) Examine the differences and similarities between viscosity and solid friction.

Item 5

Mandela wanted to compare the coefficient of viscosity of different fluids but was not sure on which method to use. He inquired from a friend who told him that he can use poiseuille's formula in his experiment. After a while, he was curious about what happens to a spherical rain drop when it falls through air. The friend told him that it attains a maximum velocity and that its behavior can be represented on a graph. Meanwhile it was drizzling outside, he observed a spherical raindrop of radius $2.0\text{x}10^{-4}$m, falling vertically in air at constant temperature, when the densities of air and water are $1.3 kg\,m^{-3}$ and $1\text{x}\,10^{3} kg\,m^{-3}$ respectively and the viscosity of air at constant temperature is $1.8\text{x}10^{-5}$pa.

Task

a) Help Mandela to describe the experiment to determine the coefficient of viscosity of a liquid using poiseuille's formula
b) Sketch the graph to represent the behavior of the rain drop as it falls through air
c) Find the terminal velocity of the drop
d) Derive stoke's law and define all the terms used, given that the constant, $k = 6\pi$

END