

### ITEM 23 DENIS .W

Two passenger ferries leave Entebbe dock at the same time to ferry goods across lake victoria, ferry A heads North at 12km/hr, while ferry B departs eastward at 9km/hr. Onboard, a student studying physics becomes curious about whether the two vessels are moving away from or toward each other, and how their paths relate from one ferry's point of view.

She sketches a diagram and uses vector diagram to calculate the relative motion between the vessels. She also discusses with the captain how such analysis helps in avoiding collisions. The conversation of her eyes to how abstract classmates topics like velocity vector have life-saving applications in the t/p industry

#### Task

- Determine the relative velocity of ferry B relative to ferry A
- Calculate the distance between the ferries after 30mins
- Describe the role of relative velocity in ensuring marine safety and how it is applied to real-time navigations

### ITEM 28 EASTLOOK

During a car racing competition, two cars A and B were at different stations P and Q respectively. Car A of mass  $m_1$  travelling with a velocity  $u_1$  makes a head on collision with a stationary car B of mass  $m_2$ . If the collision is elastic and the speed of A and B after collision after impact are  $V_1$  and  $v_2$  respectively and taking  $B = \frac{M_1}{M_2}$

#### Task

- Show that;
  - $\frac{u_1}{v_1} = \frac{B+1}{B-1}$
  - $\frac{V_2}{v_1} = \frac{2B}{B-1}$
- State the difference between a perfectly inelastic collision and a perfectly elastic collision.

### ITEM 29 N.EMMA

In 1914, Archduke Franz Ferdinand was arrested which resulted in to the great war between Australia and hung any Military bases were formed in different places and had to be equipped with military equipment's like guns. As a result of shortage guns from one of the bases, a lorry of mass 3tonnes is used to pull 2 trailers each of mass 2 tones, along the horizontal road which was connecting the two military bases. If the lorry is accelerating at  $0.8\text{ms}^{-2}$  from base one to two and then, the driver applies brakes for the lorry to stop

#### Task

Help the driver to;

- Calculate the;
  - Net force acting on the whole combination.
  - Tension to the coupling between the lorry and the 1<sup>st</sup> trailer.
  - Tension in the coupling between the 1<sup>st</sup> and the 2<sup>nd</sup> trailer.

- b) Explain what happened to the driver when he applies brakes
- c) State Newton's law of motion

ITEM 33 LYDIA K

At a smart warehouse, three small autonomous delivery robots A, B and C are positioned along a frictionless horizontal conveyor belt. Their masses are  $m_1, m_2$  and  $m_3$  respectively. The robots are initially powered off and at rest. However due to programming error, robot A is activated accidentally and began to roll forward robot B with a velocity  $v_1$ .

Upon collision, robot A and robot B undergo a perfectly elastic collision. Robot B continues moving and then collides with robot C into a perfectly inelastic collision.

The warehouse manager is analyzing the bug that caused this situation and needs to calculate final velocity of the combined robot (B+C) system in order to evaluate the risk of damage to fragile parcel near the end of the conveyor line

Task

As a physics student, help the warehouse manager to show him how the equation of the final velocity  $v_3$  can be derived so that he can fill in the values he has in order to get the final velocity,  $v_3$  which is given by;

$$v_3 = \frac{2m_1 m_2 u_1}{(m_1 + m_2)(m_2 + m_3)}$$

ITEM 34 VANISHA

The doctor advised companies that manufacture vaccines which must be stored at temperatures below  $-180^\circ\text{C}$  to always use the constant volume gas thermometer to monitor storage temperatures instead of a liquid in glass thermometer, claiming that the thermometric property of the gas thermometer is more reliable compared to the liquid that of the liquid in glass thermometer. This left one of the manager in state of confusion.

In an investigation, the length of  $h$  of the liquid column in the liquid in glass thermometer was found to vary with temperature  $\theta$  according to the equation;

$$h\theta = h_0(1 + \alpha\theta + \beta\theta^2)$$

where  $h_0$  is the length of the liquid column at  $0^\circ\text{C}$ ,  $\alpha$  and  $\beta$  are constants such that  $\alpha = 100\beta$ .

Task.

Use your knowledge of physics to,

- a) Obtain the temperature on the liquid in glass thermometer corresponding to  $50^\circ\text{C}$  on a constant volume gas thermometer and explain the discrepancies in the two values.
- b) State the qualities of a good thermometric property.
- c) Describe how a thermometer can be used to measure temperature on a Celsius scale.

### ITEM 35 HAM

Students of s5 were tasked to boil water in a beaker and others were tasked to observe ice placed on a plate resting on a table. They watched bubbles favoring at the bottom bottom and ice changing to water.

#### Task

- Explain using molecular theory how melting occur.
- If steam from boiling water is bubbled into a plate of of mass 1kg and S.H.C  $400\text{Jkg}^{-1}$ , containing 50g of ice at  $0^\circ$  and all the ice melts. Calculate the mass of steam condemned if the final temp of the mixture is  $20^\circ\text{C}$ , S.L. $h_v = 2.30 \times 10^6\text{JKg}^{-1}$  and  $L_f = 3.367 \times 10^5\text{JKg}^{-1}$
- With aid of labeled diagram, determine how specific latent heat of vaporization can be determined using electrical method can be determined using electrical method.
- State the advantage of electrical method over the method of mixtures in determining specific heat capacity of a liquid

### ITEM 8 ILHUM

Two small boats, Boat A and boat B, are navigating river Nile in opposite directions. Boat A travel downstream at  $18\text{km/hr}$  and boat B moves upstream of  $12\text{km/hr}$ . when a drone captures their position, they are  $600\text{m}$  apart. With no onboard communication systems, there is concern that the boats might collide unless one adjusts upwards or change course

A nearby marine safety officer insists a group of students to use their physics knowledge to predict the outcome. They must apply relative motion and time-distance analysis to decide how much time remains before the boats would meet and suggest safety innervations

#### Task

- Find the velocity of boat B relative to boat A
- Calculate the time It will take before the boats meet
- Explain how thus kind of analysis is applied in marine and air navigation and discuss method modern vessels use to avoid such collisions.

### ITEM 10 ALBERT

A team of agricultural engineers in lira are designing an irrigation system for a banana plantation. They need to connect narrow pipe to water tank and must measure the internal diameter of the pipe to determine the appropriate connections

Using three instruments, meter rule, vernier calipers, and a micro meter screw gauge – they each take a measurement, but the result differ slightly. This raises concerns about the pressure and accuracy of their readings to ensure proper fitting, the engineer must decide which reading is most reliable. They also discuss how small measurement errors can affect water pressure and flow in the pipe leading couplers

To minimize risks they consider applying dimensional analysis when testing formula to confirm whether calculated results are physically valued.

Task

- a) If the three instruments give readings of 2.5cm, 2.4cm, and 2.42cm. Calculate the average internal diameter and state the absolute error for each reading.
- b) Find the percentage error from each reading based on the average diameter.
- c) Explain how dimension analysis can help engineers verify formulae and prevent costly installments mistakes?

#### ITEM 31 VINA

At a police training facility, a fire arm accident occurred during a target practice session. A bullet was accidentally fired into a wooden ballistic pendulum block used to test communication. Fortunately, no one was harmed. Investigators are trying to determine whether the gun was functioning with the safe recoil limit of not going above the guns recoil velocity of  $1.5\text{ms}^{-1}$  and the velocity the bullet's speed at the time of firing using the evidence left on the pendulum.

This is what was found during the investigation .

- ) The mass of the wooden block was 1.5kg
- ) The mass of the gun was 3.0kg
- ) The mass of the bullet was 20g
- ) Length of the pendulum string was 1.2m
- ) The bullet's initial velocity was  $350\text{ms}^{-1}$

To determine whether the gun's recoil exceeded safe standards, the leads investigator needs to know;

- a) The velocity of the bullet just before impact with the wooden block.
- b) The height to which the bullet block system rose
- c) The angle of swing.
- d) The recoil velocity of the gun.

#### ITEM 32 prof. GODFREY

In a biscuit manufacturing factory, steel balls are used to test the timing and motion sensors on a smooth horizontal conveyor table. These balls simulate packages in motion. Once the ball reaches the end of the table, it rolls off and lands on a target mat that signals a "PASS" when hit precisely.

However, a problem has arisen, the test ball is missing the test mat and triggering a "FAIL" alert. The engineer suspects that either the initial push or the table's motorized acceleration has changed slightly.

In order to recalibrate the system, a test was conducted where;

- A) It was recorded that the ball covered 5.4m in its 4<sup>th</sup> second and 6.6m in its 5<sup>th</sup> second.
- B) The height of the table is known to be 7.66m and the length of the table is 21m.

Apart from the values obtained above, the engineer also wishes to know the initial velocity, acceleration of the ball, the velocity of the ball just before it rolls off the table, the time of flight of the ball and the horizontal range. These are all needed to calibrate the system for better precision.

Task

Help the engineer to obtain these values.