## PHYSICS AND MATHEMATICS

## **COMPETENCE - BASED ITEMS**

## HOLIDAY PACKAGE FOR S.3 2024

## MATHEMATICS

Item	Element of Construct	Topics
Item one	Numbers	<ol> <li>Number bases</li> <li>Working with Integers</li> <li>Rectangular Cartesian Coordinates in 2- Dimensions</li> <li>Fractions, percentages and decimals</li> <li>Numerical concepts 1 and 2         <ul> <li>(a) Indices</li> <li>(b) Surds</li> <li>Ratios and Proportions</li> </ul> </li> </ol>
Item two	Patterns and Algebra	<ol> <li>Sequence and patterns</li> <li>Equation of lines and curves</li> <li>Algebra 1 and 2</li> <li>Mappings and relations</li> <li>Vectors and translation</li> <li>Inequalities and regions</li> <li>Equation of a straight line</li> <li>Simultaneous equations</li> <li>Quadratic equations</li> <li>Composite functions</li> <li>Equations and inequalities</li> <li>Linear programming</li> <li>Loci</li> </ol>
Item three and four	Data and Probability	<ol> <li>Data collection/display and presentation</li> <li>Graphs</li> <li>Set theory</li> <li>Matrices</li> <li>Probability</li> </ol>

		Geometry and Measures	1.	Geometric Constructions Skills
Item	five and six		2.	Bearings
			3.	General and angle properties of geometric
				figures
			4.	Reflection
			5.	Business mathematics
			6.	Time and time tables
			7.	Similarities and enlargement
			8.	Circles
			9.	Rotation
			10.	Length and area properties of two dimensional geometrical figures.
			11.	Nets, areas and volumes of solids
			12.	Trigonometry
			13.	Vectors
			14.	Matrix transformations
			15.	Circle properties
			16.	Lines and planes in three dimensions

1. A. What is the probability that the fire problem in schools is attributed to learners? Poor performance in Mathematics was observed among learners. The school administration through academic board came up with strategies to improve on the learner's performance. Some of the strategies are that a prize is given to learners scoring above 70% and a remedial exam be given to learners scoring at most 45%. A Mathematics examination was given to

12	56	45	67	90	95	76	34	24	78
45	25	15	56	78	90	56	45	57	56
57	45	59	56	76	45	67	59	52	67
23	19	53	45	66	55	76	54	90	98

S.4 learners and marks were obtained as below;

Starting with the lowest mark obtained from the above performance, construct a frequency distribution table of equal class width of 10, Help the administration to find;

- I. The mean performance
- II. The most likely performance
- III. What is the average performance of the class?

**B.** He also visited the library and found out that the previous candidates used three books for their revision. Longhorn, Baroque or Maths Clinic. From the librarian's records, it is clear that all the candidates that did not use any book failed the subject greatly. Out of the **35** candidates this year **13** used Longhorn, **20** used Baroque and **17** used Maths Clinic. **9** used Longhorn and Maths Clinic, **3** used Longhorn and Baroque while **8** used Baroque

and Maths Clinic only. The records show that **2** used all the three books. He observed that he should replace one book type of the three with Fountain publisher since no student read it only alone. **TASKS:** 

(a) (i) Help the head teacher group the marks to make an informed decision one the fate of the department and defend it.

(ii) Display the students' marks in groups on a simple statistics diagram.

(b) (i) Help the head teacher identify the book he should replace and explain why?

(ii) Find the probability that a student selected from the class failed.

2. In survey to determine the average weight of a new born baby, the medical class of St. Julian collected weights of 40 babies from Kagongo hospital. The weights in kg are given in the table below.

2.0	2.1	2.0	2.2	6.4	2.6	3.0	3.5
3.1	3.2	2.3	2.7	2.8	3.4	4.0	3.2
3.7	4.5	5.0	5.4	4.9	6.0	6.4	6.3
5.4	4.7	4.6	4.9	6.2	6.2	6.7	2.5
2.6	2.9	4.4	5.3	3.6	4.8	6.3	5.0

#### TASKS:

(a) Form frequency distribution table with intervals of 0.5Kg starting with the lowest weight of 2.0 Kg

(b) What is the mean weight?

(c) Represent the information on a statistical graph to obtain the modal weight.

(d) Help the class obtain the median weight.

3. St. JULIAN is to transport its S. 4 students for fieldwork in Kasenyi. All the 400 students are to be

transported using either coasters or buses. Each coaster can carry 40 people while each bus can carry 80 people.

The transport department of the school has only 8 drivers on duty and up to four coasters. If the cost of hiring a

coaster is shs. 150,000 and that of hiring a bus is shs. 300,000. While in Kasenyi their geography teacher Mr Kefa

visited Mr Sembatya's shop from which he found that three shirts and two trousers cost shs. 105,000 at Mr.

Sembatya's shop. Two shirts and five trousers cost shs. 180,000 at the same shop;

Task:

- (a) (i) Write down the five inequalities representing the above information.
  - (ii) Represent the inequalities on a graph paper.
  - (iii) Find the possible number of coasters and buses that can be used and hence determine the minimum cost.
- (b) Find the cost of;
  - (i) Each shirt and each trouser.
  - (ii) Three items of each type at the shop.

4. A friend to your guardian wants to bring his child to the same school you attend. He calls your guardian and requests her to direct him to your school. There are two routes you can use from home to school; Route A: A straight direct marram road from home to school

Route B: From home, drive in the direction of 135 degrees for 55km and then makes a bearing 180 degrees turn and drive more 40km you will find Kalagi trading Centre .From Kalagi you will further drive in the western direction until you reach the school. The home is vertically located above the school premises. The friend requests your guardian to send him a drawing instead summarizing his direction but she assigns you to draw.

#### Task

a). Assist her to make the drawing showing the road map to school.

b). If after the drawing a friend rather decides to take the southern direction from home. Through what distance will he drive to reach the school?

c). If he starts driving at 12: 30pm and arrives at 2: 30pm through route B non-stop. What shall be his average speed?

d). which option of the two routes should he take and why?

5. In a school, the S.3 classroom block, the S.4 classroom block and the computer room are joined by a straight concrete path that runs from west to the East. The S.3 block is west of the S.4 block while the computer room is east of the S.4 block. The computer room is 19.2m from the S.3 block. The ratio of the distance between the S.3 block and the S.4 block to the distance between the S.4 block to the computer room is 1:3. The school library is 21.6m north of the S.4 block. A contractor has been given the task of constructing a concrete path connecting the library to the computer room using the shortest distance.

#### Task

Help the contractor determine how long the distance will be so that he can calculate the total cost of this project.

6. A produce wholesale dealer in Kalerwe Farmers Market has a broker who has been helping him order for his produce on his half. However he has been informed that his broker left for Saudi Arabia in quest for greener pastures, he is much troubled yet he wants to order for **1200 bags** of produce. He visited his business books and noticed that in January, when he bought **300 bags**, the cost of transporting each bag was **UGX4500** and in February when he bought **700 bags**, the cost of transporting each bag was **UGX8500**. He has resorted to do the ordering and buying by himself. In preparation for Easter he went to Luuka Village to buy some produce with his lorry. Unfortunately his Lorry broke down and opted for two vehicles a Pickup and an Isuzu Diana. The pickup can transport **18 bags** while the Isuzu Diana can transport **30 bags**. The number of bags to be transported must exceed **120**. Each trip the Pickup and Isuzu Diana makes cost **UGX240**, **000** and **UGX300**, respectively yet he has allocated **UGX2**, **400**, **000** to cater for transport. The number of trips made by the pickups should not exceed those made by the Isuzu Diana by more than 2

### TASKS:

- (a) Determine the cost the whole sale dealer will pay for the **1200 bags**.
- (b) Help the dear obtain how many trips each vehicle will make in order to minimize the cost of transport.

7. There is a quarantine of all cattle and goats in some parts of Western Uganda especially Mbarara District. The area honorable Member of Parliament (M.P) wants to throw for his constituents a celebration party for the success of the Parish Development Model (PDM) and he has invited a lot of guests. However due to the quarantine he can not buy any animals from Mbarara and he has been advised to go to Kayunga where cheap cattle and good Yoghurt can be found. He moves from Mbarara to Masaka which is **160km** North of Mbarara. From Masaka he moves west wards **150km** to Kampala. From Kampala he heads to Mukono which is in the direction *S*75°*W* which is **90km** from Kampala. From Kampala he heads to Kayunga which is **148km** and south of Mukono. When he reached Kayunga he bought **400** cows and each costs **UGX850**, per cow. The farmer and owner of the cow first gives a **5**% discount on each cow plus an additional **10**% discount for any number of cows bought in excess of **250**. In order to package the yoghurt, he bought two identical types of buckets. A smaller bucket with a base radius of **30cm** and a larger bucket with a base radius of **50cm**. He intends to use the buckets to keep the Yoghurt for his guests. The capacity of the smaller bucket is **45 litres** and he is to buy **4** smaller buckets and **2** larger buckets.

#### TASKS.

- (a) Direct the honorable MP on the shortest route he should take and the shortest distance between Mbarara and Kayunga.
- (b) Find the total cost he incurred in purchasing the cows.
- (c) What is the maximum amount of Yoghurt be bought for his guests.

8. Holy Prayers Ministries International for a long time has been soliciting money to construct a church which can congregate all the church members. The Senior Pastor has a vision of a Hexagonal church which can fit exactly in the plot of land available. He wants to know the actual cost of constructing the church. He also has to buy a Sino Truck to transport all building materials and requirements. The contractor informs him that the area of each triangle that can be formed from the hexagonal church will cost him **UGX 128,000,000**.

He then proceeded to Nina Motors to buy the Sino truck. A brand new Sino Truck costs four hundred eighty millions on cash. It can also be bought by paying a deposit of a quarter of the cash price value and either pay **UGX7**. **5 millions** weekly for **50 weeks** or pay **24**. **5 millions** monthly for **15 months**. The pastor does not have the required money to obtain the Sino Truck on cash. **TASKS**:

- (a) Help the pastor determine the cost of the church.
- (b) How much extra will he pay for the Sino Truck and explain why

9. Mr. Lwanga Badru Sheila's father a S.4 South student went to Kampala on Independence Day and visited three shops. A clothing Store shop that was offering a general 25% discount on all there stock. However for that Independence Day only, the store advertised an additional 10% discount to celebrate with the Ugandans Independence Day. The price tag on Sheila's sweater was marked UGX 60,000. He then proceeded to SG furniture dealers and found this information on the show room entrance.

**"BEST TERMS ON SOFA SETS" CASH PRICE:** UGX **4,200,000** with a **10%** DISCOUNT **HIRE PURCHASE:** DEPOSIT **UGX 1,200,000** AND PAY **8** EAQUAL MONTHLY INSTALLMENTS OF **UGX 431,250** 

Mr. Lwanga could not pay cash and opted for hire purchase. He then proceeded to his saving scheme which gave him a top up loan of UGX3, 000, 000 at a compound interest rate of 4. 8% per annum. If he was to pay back the loan in a period of 24 months.

Tasks:

(a) What was the sale price of sweater?

(b) Find the extra amount of money he paid to the furniture dealer because he did not pay cash.

(c) How much interest did the SACCO earn from Mr. Lwanga?

10. You are an athlete and soon competing with someone. You wanted to test your chances of winning the race by testing your speed and time in relation to that of your competitor you started to run at **4**: **50pm**. From your home where you started from, you ran a distance of **5km** North West to place P, then from P, you turned south and ran **4km** until you were at place Q that is west of your home and then ran back and arrived at **5**: **12pm**. Your competitor ran the same distance during training at a speed of **10m/s**.

Tasks:

- (a) What is the total distance that you ran?
- (b) What is the total time you took to run that distance?
- (C) How fast were you?
- (d) (i) Do you think you will win the race or not? (ii) Why do you think that way?

11. You are an athlete and soon competing with someone. You wanted to test your chances of winning the race by testing your speed and time in relation to that of your competitor you started to run at **4**: **50pm**. From your home where you started from, you ran a distance of **5km** North West to place P, then from P, you turned south and ran **4km** until you were at place Q that is west of your home and then ran back and arrived at **5**: **12pm**. Your competitor ran the same distance during training at a speed of **10m/s**. **Tasks:** 

- (e) What is the total distance that you ran?
- (f) What is the total time you took to run that distance?
- (g) How fast were you?
- (h) (i) Do you think you will win the race or not?

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(iii) Why do you think that way?
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12.	In Maxwell Stationery S	hop, the manager gets the monthly allowances as follows
	Medical	Shs 480,000 per annum
	Transport	Shs 50, 000
	Housing	Shs 10% of the gross monthly income
		1
	Marriage	Shs $\overline{B0}$ of the gross annual income.
	Lunch	Shs 7,500 per week.
• 1		

Family allowance for four children using following system;

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12 years and below Shs 3000
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Above 12 years but below 18 years Shs 2000

Okurut earns a gross annual income of shs 9,180,000 and his children are aged 5, 9, 15, 17 and 22.

His tax structure is given below.

Taxable Income (shs)	Rate %
0 – 130, 000	5.0
130, 001 – 260, 000	10.0
260,001 – 360, 000	15.0
360,001 – 400, 000	20.5
400, 000 and above	30.0

(a) Calculate Okurut's

(i) Monthly taxable income

(ii) Monthly income tax

(b) Express the net income paid as a percentage of his gross monthly income. (Correct your answer to 1 d.p)

13. Kampala (K) and Arua (A) are about 450km apart. At 7:30 a.m, a bus starts from Arua and moves towards Kampala (K) at a steady speed of 100km/hr while a lorry starts from Kampala (K) an hour later moving at an average speed of 60km/hr to Arua (A). At 10.00 a.m, the bus is stopped at town C by police and ordered to reduce speed. After 30 minutes at C, it resumes its journey at a reduced average speed of 50km/hr until it reaches Kampala (K).

Task:

- (a) State the difference in time when the two vehicles arrive at their destinations.
- (b) Determine when and at what distance from Arua the two vehicles meet.
- (C) Find the average speed of the bus.
  - 14. During their baking lesson, the students were given a recipe for 10 scones using the following ingredients:
    - 80g butter
    - 350g self-rising flour
    - 30g sugar

• 2 eggs

However the student has the following ingredient and is preparing for the exhibition due to take place at school and wishes to bake 25 scones for the exhibition because he expects parents and visitors to support his entrepreneurial venture.

- 100g butter
- 1kg self-rising flour
- 50g sugar
- 4 eggs Task:
- a. Determine if the student has enough of each ingredient to bake 25 scones based on the recipe.
- b. Determine how much more of each ingredient the student needs to buy.
- c. If the prices of the ingredients are as follows:
  - i. Butter: 5,000 shillings per 100g
- ii. Self-raising our: 6,000 shillings per kg
- iii. Sugar: 1,000 shillings per 50g
- iv. Eggs: 500 shillings per egg

Calculate the total cost for the additional ingredients needed.

- d. Determine how much the student should sell each scone .Electricity and other expenses are provided free by the school.
- 15. Your aunt is planning to enroll you in a boarding school for your O-level education. She has a budget of Shs 5,000,000 for your school expenses. To visit the school, she decides to take a boda-boda. The boda-boda travels 3 km west from your home to the main road, then 4 km south to reach the school. However, you later realize there's a shortcut path that leads directly from your home to the school. Upon reaching the school, your aunt learns that the school fees are Shs 3,000,000, boarding fees are Shs 1,500,000, and the cost of school supplies is Shs 500,000. Fortunately, the school o ers a scholarship program. Students with excellent primary school leaving exam results receive a 50% discount on school fees, a Shs 200,000 reduction in boarding fees, and a Shs 150,000 voucher for school supplies. You are eligible for this scholarship based on your outstanding performance. The school also o ers two payment options for school fees:
  - Option 1: Two Installments Pay two- fifths of the school fees at the beginning of the term and the remaining balance before the midterm exams.
  - Option 2: Four Installments Pay equal amounts at the beginning of the term, before midterm exams, after midterm, and before final exams.

Task:

- a. What is the distance from your home to the school using the direct path?
- b. i. Considering the scholarship, calculate the total amount your aunt will pay for your school expenses.
  - ii. Can your aunt afford the school expenses based on her budget?
- c. i. For those paying the full school fees amount, calculate the amount paid per installment for each payment option.
  - ii. Which payment option would you recommend and why?
- 16. Your uncle owns a small bakery and plans to bake two types of loaves of bread: whole wheat bread and white bread. Due to the bakery's oven capacity, your uncle can bake at most 15 loaves of bread in a day. He wants

to bake at least 3 loaves of whole wheat bread. Additionally, he wants to bake more whole wheat bread than white bread because it is more popular among his customers. The selling prices are as follows:

Whole wheat bread is sold at Shs 6500 per loaf.

White bread is sold at Shs 5000 per loaf.

To cover his costs and make a profit, your uncle needs to earn more than Shs 30,000 from the sales each day. **Task:** 

- (a) Write mathematical statements that show the relation between the whole wheat bread and white bread.
- (b) Show the feasible region of the relation on the Cartesian plane.
- (C) How many loaves of each type should your uncle bake in order to make the maximum pro t?
- (d) What is the minimum number of loaves he can bake and still make a profit?
- 17. The company manager is organizing a party for her colleagues. The cost of renting a local hall is UGX 2,000,000 for the evening. She then has to budget for food, which will cost approximately UGX 20,000 per person. The manager needs to ensure that the total cost of the evening stays within her budget. The manager has a maximum budget of UGX 5,000,000

Task:

- a. Write down a formula connecting the total cost of the evening with the number of people attending.
- b. Find the total cost for the evening if 25 people attend.
- c. Find the greatest number of people she is able to invite.
- d. In the end, only 16 people will attend. Calculate how much each person should be charged so that the manager covers her costs.

Your friend is shopping at a supermarket in Kampala during a clearance sale. He wants to buy a calculator that originally costs 120,000 UGX. The store has reduced the price of all calculators by 35% for the sale. Additionally, today there is an extra markdown of 40% applied to the sale price of all calculators.

Task:

- e. Develop a function that calculates the sale price of the calculator today, where x is the original price of the calculator.
- f. Using the function from (a), determine the final price your friend will pay for the calculator.
- 18. A manufacturer considers that men and women workers are equally efficient and so he pays them at the same rate. He has 30 units of male workers and 17 units of female workers and capital respectively, which he uses to produce two types of goods, A and B. To produce one unit of A, 2 workers and 3 units of capital are required, while 3 workers and 1 unit of capital are required to produce one unit of B. Goods A and B are priced at UGX 100,000 and UGX 120,000 per unit respectively.

Task:

- a. Write mathematical statements that show the relation between the units of goods A and B produced
- b. Show the feasible region of the relation on the Cartesian plane
- c. How should he use his resources to maximize the total revenue?
- d. Do you agree with this view of the manufacturer that men and women workers are equally efficient and so should be paid at the same rate?
- 19. In a school survey, 200 students were asked about their internet usage habits. They were asked to choose from three activities: Social Media (like Facebook and TikTok), Academic Work (such as research and homework), and Playing Games. The results showed that 165 students use the internet for Social Media, 130 use it for Academic Work, and 100 use it for Playing Games. Among them, 70 students use it for both Social Media and Academic Work only, 60 use it for both Social Media and Playing Games, and 50 use it for both Playing Games and Academic Work. Additionally, no students exclusively use the internet for playing games. Now, the school needs to decide whether to set rules if more than 60% of students spend their internet time on Social Media.

Task:

a. Calculate how many students use the internet for at least one of these activities.

- b. Determine how many students don't use the internet at all.
- c. Estimate the percentage of students who use the internet solely for Academic Work.
- d. Based on the findings, advice the school on whether to implement rules or not.
- 20. A certain company in Kampala is analyzing the optimal departure time for its 40 employees to ensure they reach home by 6:00 PM, minimizing their commute time and avoiding peak traffic congestion. The company conducts a survey to track the times employees typically arrive home after work, measured in minutes past 5:00 PM.

15	20	25	30	35	40	45	50	55	60
65	70	75	20	25	30	35	40	45	50
55	60	65	70	75	80	25	30	35	40
45	50	55	60	65	70	75	80	30	35

Task:

- a. Based on calculations using the collected data, suggest an optimal departure time for employees to begin their commute home.
- b. Following advice to allow employees to leave work when at least 50% of them have already arrived home, determine the optimal departure time.
- c. As the company management, which of the two suggested departure times from (a) and (b) would you choose to ensure employees reach home by 7:00 PM, and why?
- 21. A layer chicken farmer decided to weigh a sample of 800 eggs on his farm and classify them according to their mass (m grams) to optimize the packing process. The frequency distribution of the egg masses is as follows:

Mass in grams	Number of eggs
40-44	36
45-49	142
50-54	286
55-59	238
60-64	76
65-69	22

The farmer's plan is to pack eggs in given weights.

Task:

- a. Determine the median mass of an egg from the given frequency distribution to understand the central tendency of the egg weights.
- b. What would be the percentage of eggs which would be classified as large (over 62 grams)
- c. The farmer plans to pack eggs that weigh over 62 grams, with each pack containing 12 eggs. If each pack costs UGX 12,000, calculate the total revenue the farmer will earn from selling all the large eggs and compare the revenue earned from selling the same eggs to a middle man who he is buying at UGX 9000. What advice will you offer to the farmer.
- 22. In preparation for the upcoming national voter registration drive in Uganda, the Electoral Commission needs to determine the optimal opening time for registration centers across various districts. This decision aims to facilitate maximum voter registration and ensure efficient processing of the data of the citizens eager to participate in the upcoming elections. Here are the arrival times of citizens at a sample voter registration center in minutes past the scheduled opening time (8:00 AM):

11	66	21	88	33	67	41	45	47	41
27	62	32	43	31	34	66	20	21	36
26	75	80	45	12	44	58	48	42	38

Task:

56

63

- 68
   24
   21
   65
   68
   63
   72
   38
- a. Based on calculations using the collected data, suggest an opening time for voter registration centers.
- b. Following advice to open registration centers when at least 50% of expected citizens have arrived, determine the opening time.
- c. As the Electoral Commission of Uganda, which of the two suggested opening times from (a) and (b) would you choose, and why?
- 23. A group of tourists has just arrived at Entebbe International Airport in Uganda for a safari adventure. They are interested in reaching the source of the Nile in Jinja. The touring company has approximated the distance from Entebbe to Jinja to be about 94 km, which should take around 3 hours without traffic, assuming an average speed of 30 km/h for the whole journey. Here are the directions they are following:
  - From Entebbe Airport, travel north for 35 kilometers to reach Kampala, the capital city.
  - From Kampala, head east on the Jinja highway. As they approached Mukono, approximately 25 km from Kampala, the guide was alerted by a friend coming from Jinja to change the route and use the Kayunga road due to an accident in Mabira. The driver changed the route at Mukono and went in the northeast direction to Kayunga, approximately 45 km away.
  - From Kayunga, they headed to Jinja on a bearing of 130<sup>0</sup>, which took them 1 hour and 44 minutes as they enjoyed the scenery along the roadside.

Task

- **a.** Describe the direction from Jinja to Entebbe.
- b. How far is it from Mukono to Jinja using the direct route instead of the Kayunga route? (c) How

long does the journey from Entebbe to Kampala take?

- (d) If each liter of fuel costs UGX 4900 and the car van consumes 1 liter per 10 km, how much fuel and money would they have saved if there was no accident in Mabira?
- (e) How much extra time did they spend on the road due to the detour, and what recommendations would you make to avoid such delays in the future?
- 24. The Parks Department in a Ugandan village has acquired a new sprinkler system to water their lower equilateral triangular lawn, which is essential for maintaining the village greenery. The equilateral triangular lawn, with each side measuring 10 meters, is surrounded by pathways, and the sprinkler needs to be strategically placed to ensure effective coverage without wasting water on the pathways.



Diagram not on scale **Task:** 

- a. Explain whether or not you think all of the lawn in the triangle can be watered with a circular sprinkler
- b. Determine the best location inside the equilateral triangular lawn where the sprinkler should be positioned to maximize the watering coverage while avoiding the pathways.

- c. Estimate the area of the lawn that will not receive water effectively once the sprinkler is optimally placed.
- 25. The geography department of Jinja Progressive Secondary School is planning to transport its senior four students for a fieldwork in Kasenyi in Entebbe municipality on Mon 8<sup>th</sup>. July.2024. Each trip of the bus costs shs 40,000 and that of a coaster costs shs 25,000. The bus has a capacity of 42 students and that of a coaster is 14 students. All the 126 registered students contributed a total of shs 200,000 and will go for the tour. The coaster is expected to make more trips than the bus.

While in Kasenyi, their geography teacher Mr. Sempa visited the nearby shopping mall which happen to be the largest called Victoria shopping mall. While inside it, he found out that three shirts and two trousers costed shs.105, 000. Also two shirts and five trousers costed shs.180, 000.

#### Task

a) (i) As a mathematics student, help the geography department to formulate five inequalities from the information given above.

(ii) Determine the number of trips each vehicle should make so as to spend the least amount of money.

- b) Find the cost;
  - (i) Each shirt and each trouser.
  - (ii) Three items of each type at the shopping mall?
- 26. James, a petroleum engineering master's graduate from Makerere University, has landed a job at a Ugandan NGO. The organization offers a comprehensive benefits package, including.
  - o Housing allowance: Shs. 14,000 per month
  - o Marriage allowance: y
  - o Medical allowance: Shs. 50,700 per annum
  - o Transport allowance: Shs. 10,000 per month

However, James must pay an annual insurance premium of Shs. 68,900. He has five children, with three under 8, one 16-year-old, and a 20-year-old. The NGO provides a family allowance for four children, as follows: Shs. 3,400 for each child above 18 years; Shs. 4,200 for each child between 1018 years; Shs. 5,400 for each child below 9 years.

The tax rates for working-class citizens in Uganda are shown in the table below:

Income (Shs) per annum	Tax rate (%)
1st Shs. 80,000	7.5
Next Shs. 80,000 (80,001 - 160,000)	12.5
Next Shs. 80,000 (160,001 – 240,000)	20.0
240,001 - 320,000	30.0
320,001 - 400,000	36.5
400,001 - 480,000	45.0
Above 480, 000	52

The accountant revealed to James that his **annual income taxes** would be Shs 100,320. James was confused because he didn't understand how his income was calculated, and he didn't know how to figure out his **gross annual income**. He also learned that his annual **total tax free – income** would **exceed his taxable income by 24%**. James aims to **constantly** set aside half of his annual net income to purchase **a 40 m x 22** m plot in Kayunga village within the next ten years, taking advantage of the stable land prices. The land is expected to be priced at UGX 4,000 per square meter within this time frame.

#### TASK

- a) (i) Help James arrive at his accurate taxable income figure through careful calculation and logical thinking.
  - (ii) Assist James in understanding his annual marriage allowance compensation.
  - (iii) Support James in figuring out his annual take-home pay.

Assist James in determining if he can reach his goal of purchasing the land within the desired timeframe.

27. Fortunate high school taught their learners entrepreneurs kills and recently their entrepreneurship club made 1000 boxes of chalk after a long time challenge in the school due to the increase in prices. The school had to find a way of keeping these small boxes of chalk inside other bigger boxes before they are kept in a special designated office shelf for future use Hint:

The small boxes of chalk measure 5cmx3cmx4cm)

The bigger boxes that on the shop measure (32cmx5cmx6cm)

The office shelf measures (0.5mx0.4mx0.4m)

Eachbiggerboxissoldugx1500



The club patron is stranded yet he must make a proper plan for keeping this chalk from the club. **Task** 

As a mathematics student, you are tasked to help this patron on the following:

a) The number of bigger boxes he should buy to keep the small boxes.

b) The amount of money that the school is to spend on these bigger boxes.

c) Analyze basing on calculations whether the space in the office shelf will been enough to keep all the bigger boxes and comment on your findings.

# **PHYSICS ITEMS**

- 1. A young man is planning to build his first house in life. He has no experience in construction work. He approaches an engineer who recommends him to buy the following materials for the foundation of the house
- Steel bars (hollow type)
- Damp proof course
- Clay bricks
- ➢ Cement
- ➢ Gravel

After construction of the foundation, he has to hire a casual worker who uses a force of 80N to push 50Kg of soil along a piece of timber which is 15m long to fill the foundation with soil.

The height of the foundation is 2m from ground. The young man complains that these materials are many and some of them should be removed.

Using the knowledge of Physics,

- (a) Explain to the young man why;
  - (1) Damp proof course is important in this work
  - (ii) Hollow steel bars are necessary

- (b) Advise the man on how the foundation should be made stronger and stable
- (C) Determine the efficiency of the system used to fill the foundation with soil.
- 2. **Pole Pole** is organizing a graduation party after finishing honors degree in civil engineering. He intends to invite most of his old students and teachers. He has hired a catering group that will cook for his function. The washing facility this catering group has is cylindrical in nature with its base diameter having 20m and 30m tall. They fill this facility with boiled clean water up to the top but they do not know where to create a space to put a tap from.

They also use a device with two cylindrical arms with pistons of 50cm and 80cm in diameter to lift some luggage of 200Kg.



#### TASK

- (a) Help the catering group to locate the appropriate position where to put a hole for inserting the tap. Give a reason for this position (Draw the facility only)
- (b) Find the pressure this washing facility will exert on the stand if the density of water is 1000kgm<sup>-3</sup>.
- (C) Explain the operation of their device used to lift the load of 200kg.
- (d) Find the force that will be required to raise this load if the lord is placed on a cylinder with a large piston.
- 3. A certain maize milling company produces maize flour. People suspected that its maize flour contains some metallic pieces of grinding machines because they assume that the machines are too old to process the maize. Investigations were carried out by the authorities to check whether these allegations are true by obtaining a sample of about 1kg.

#### TASK

Assuming that you were on the authority team, using the following materials; 6 inch iron nails, insulated copper wire, dry cells and switch, make a simple circuit and use it to prove whether the allegations are right or wrong?

4. On one weekend, it rained heavily and as a result, lightning struck and destroyed one of the transformers supplying power in your community. Due to the blackout created in your community in absence of electricity in the surrounding area, you were left with no light at home however, inside your home you found an empty tin, paraffin, cotton cloth and a razor blade for cutting the cloth and a box of match sticks.



- (a) Develop the guidelines you should follow to use the available materials to
- (b) Solve the problem of darkness in your home. Include the illustration.
- 5. At a construction site, Mbwali Milly was tasked to carry bricks from where they were to the masons. The task was tiresome. She applied a lot of energy and would carry a few bricks a day. She asked the foreman for a wheelbarrow. Soon, she had to take the bricks up the building. This time, she asked for a plank of wood which she used to make an inclined plane. But she would be tired by noon! So, the foreman suggested that she makes a single machine that would move the bricks up vertically. When the foreman looked in the vicinity, he realized that there was a motorcycle wheel, long ropes, straight poles, tall enough to reach the position where the bricks were to be put, and a large hemispherical pan.

### Tasks

- (a) Make a brief explanation why and how each machine was able to simplify work.
- (b) Show how Milly could assemble the items to come up with a simple machine and how she would use it

to lift the building materials up to the floor in the shortest time possible.

6. A certain family stays near the marram road and a school. Every day, the family receives dust raised by moving vehicles from the road and the bad smell from the school pit latrines. In the morning hours, the dust is not so much and the smell from the pit latrine is not so much either. These conditions worsen around midday on hot sunny days. The family is disgusted by these conditions. They do not know the cause of these conditions. As a Physics student, write a message to this family explaining what **causes** the above conditions and **possible ways** of solving the above problem. You all have experienced a force in some way. Forces play a role in everything that we do. It may be kicking a ball, playing games and others. **BLUE** team and **RED** team are playing a tag of war. If each person in the blue team pulls the flag with a force of **200N** and each person in the red team pulls the flag with force of **100N**.



By showing your working, which team do you think will win the game? In addition, how many people should be added to the losing team to match the strength of the winning team?

7. At 1:30pm in the dining hall, students were surprised that a live coverage was happening somewhere. Learners watched heavy fog-rains and floods being experienced in a certain outside country on an international T.V live channel. To worsen matters, the floods were happening at night and this risked many natives as many of them were ambushed while asleep. Learners wondered how it would be night and heavily raining in an area yet it was day and the Sun was highly shinning at that time in their school.

#### Task:

As a physics learner help the learners clear their queries about;

- a) Occurrence of the floods in one area yet it was shining in their school at the same time.
- b) Why it was night in that outside country yet it was day-time in their area?
- c) How T.V signals broadcast from where the floods were happening reached them.

8. A certain high way restaurant in one of the towns in Uganda is known to provide warm water to its customers for washing hands during lunch time. On a hot afternoon, an attendant who works in this hotel was given two plastics cylindrical tanks A and B. Tank A has cross-sectional area of **18380***cm*<sup>2</sup> and height of **5.5***m*. While tank B has cross-sectional area of **22200***cm*<sup>2</sup> and height of **4.5***m* Tank A is painted black while tank B is painted white.



The attendant is supposed to store **10000***kg* of water in any of the tanks. She is worried about which tank she can use that can accommodate all the available water and which one can keep water warm.

To ensure smartness in the restaurant, each tank is supposed to be supported on plastic stands as shown in the figure. As a learner of physics;

- a) Help to explain to the attendant on;
  - i. The tank she would use to store the required amount of water.
  - ii. The type of tank that would keep water warm for customers.
- b) If one of the tanks was to be used for hand washing and the owner of the restaurant wants to put a tap on it.
  - iii. Show him by letter K, the position where the tap can be put.
  - iv. Explain to the restaurant owner on the choice of position K.
- c) What advice would you give to the restaurant owner on the measures he would ensure for the tank stand to withstand the weight of the tank for a long time.
- 9. A businessman who sells boiled eggs has decided to buy a solar system since he has been spending a lot of money on the purchase of charcoal. He has decided to go to the local shop which deals in solar systems. He has found two types of solar panels and he has completely failed to choose the best to use for boiling the water for his business.



The panel is to be placed on the top tray of the metallic frame. The frame will then be placed on the top of the iron sheeted roof. All its iron sheets can withstand a pressure of 150,000 Pa without getting damaged by the pressure exerted by the weight of the frame and the solar panel.



Hint

- > The total weight of the frame and the solar panel is 10 kg.
- > Acceleration due to gravity is  $10 \text{ ms}^{-2}$ .
- > Total area of contact of the four legs of the metallic frame is  $5 \ cm^2$ .

As a physics student,

- (C) Advise the businessman on the best type of the solar panel to buy by comparing the two types of solar panels.
- (b) Help him find out whether his iron sheets will remain safe if the frame and the solar panel are placed on it.
- (C) Suggest the ways of maintaining the frame on top of the roof without getting blown away by wind.
- (d) Sensitize the businessman on the advantages of using solar energy over other sources of energy.
- 10. After selling part of his harvest, the farmer decided to buy a big radio set with specification on it of 100 V, 5A and 50 Hz which he does not interpret. At his home, electricity from the national grid is supplied at 240 V and 5A. The radio failed to work which disturbed him but on checking in the box that contained the new radio set, there were two resistors of 20  $\Omega$  and 8 $\Omega$  which he could not use either.

**Hint:** Resistors can be connected either in series or in parallel to lower the input Voltage of the radio from 240 *V* to 100 *V* 

#### Task

- $(\alpha)$  Help the farmer to connect the resistors to have his radio set work.
- (b) Explain to the farmer why you have decided to make the above connection.
- 11. The mother developed a dental challenge but could not identify the exact tooth that should be extracted even after checking using her phone mirror. She decides to go the dental clinic. In the dental clinic, a small mirror was used and the tooth was easily identified. This made the mother to be more interested in the mirror and on checking, it had the following writings. Radius of curvature =  $20 \ cm$

When she placed her face about 6.0 cm in front of the mirror, her face appeared different with

bigger eyes and nose which left her wondering. As a physics student,

- (C) Make use of a ray diagram to explain how the mirror in the clinic is different from the one at home and how it works.
- (b) Use a graph to support your explanation to the mother about the nature of the image of her face when she tried to look through it.
- 12. Students of a certain school organized a tour to a water packing factory constructed on a mountain. On their way at the railway crossing, they stopped to allow the fast moving long train to cross. Many students moved out of the school bus to have a view of the train and to take selfies but they experienced a force pushing them towards the train which left them wondering whether the train has a magnetic effect that attracts human beings. At the water factory, they were told and even saw that the heated water moves through a vertical height against gravity to another storage tank without pumping it but the tour guide never explained to them the cause of this. On top of the hill where the factory is located, the barometer they had moved with read 740 mmHg.

Hint: At sea level, the mercury barometer reads 760 mmHg. **Density of mercury is 13600**  $kgm^{-3}$ 

**Density of air is 1.25** kgm<sup>-3</sup>. As a student of physics,

(C) Help the students understand what happened at railway crossing.

- (b) Write a brief report explaining what makes it possible for the hot water to move against gravity.
- (C) Show the students how you would determine the height of the point on the hill where the factory is constructed above sea level.
- 13. During a hospital tour, a liquid in a bottle spilled on one of the visitors. The visitor was told that the liquid that had spilled was a radioactive material of activity 450 counts per second with a half-life of two days. He was told to self-isolate in the hospital until the count rate drops to 6.25 counts per second. The relatives of the isolated person tasked the hospital administration to come up with better ways to keep such materials.

Support: Background radiation is 50 counts per second.

Use your knowledge of physics to;

- (C) Determine how much time the patient would take in the hospital
- (b) Explain to the relatives the dangers associated with radioactive materials. (c) Explain to the hospital staff how such materials should be handled.
- 14. Students in a certain school are going for a trip in a mountainous area where the maximum height one is allowed to climb is 1 km per day. They were allowed to have stop overs at specific points for various reasons. They had also been warned of the possibility of nose bleeding while climbing the mountain. Another group of students who had visited the same place earlier told them that their first stop over was at point B where the barometer read 68.2 cmHg while it read 75.7 cmHg at point A which was going to be the starting point. The students were told that cooking would be done at point A but they could not understand why this was so.

Use your knowledge of physics to help the students

- (C) Determine if they will be allowed to climb beyond point B.
- (b) Explain why the students were warned of the possibility of nose bleeding.
- (C) To explain why cooking had to be done at point A.
- 15. A certain family uses a special type of wax candle for multiple purposes including mosquito repellant, sources of light and heat and timer. This type of candle has uniform cross sectional area of 3.0 cm<sup>2</sup>, length of 15.0 cm and a mass of 39.0 g. As it burns, wax melts at a rate of 2.0 cm per 30 minutes. It generates an odour which repels mosquitoes in all the rooms in the house. A student in this house is planning to use a similar candle of length 10.0 cm to revise at night from 8:00 pm to 11:00 pm. He is not sure whether this will be possible. The family also intends to place this type of candle on the water in a small water pool in order to chase the mosquitoes. (Use density of water as 1.0 gcm<sup>-3</sup>)

As a student of physics,

- (C) Help this family to understand how mosquitoes are chased away from all the rooms including the ceilings.
- (b) Advise the family on whether the candles will be able to float on water.
- (C) Help the student to find out whether the candle will burn for his planned time.

- (d) Suggest other traditional ways of measuring time.
- 16. A patient who was suffering from liver cancer visited a hospital for treatment. He first checked in the radiographer's room. He was injected with Yttrium (Y-90) radioisotope dose of mass 6 mg into his bloodstream. The radiographer wrote a brief report.

He forgot to indicate the date of the next visit. The patient then went for X-ray photography. Unfortunately, he was told that the low voltage supply of the X-ray machine had mechanical issues and he was not worked on. The patient failed to understand the effect of that part of the machine on production of X-rays. Using half-life of Y-90 as 5 days,

As a student of physics,

- $(\alpha)$  Help the patient to determine the date for his next visit.
- (b) Explain to the patient the effect of the faulty part of the X-ray machine on production of X-rays.
- (C) Sensitize the patient on the dangers of such dosages in treatment of the disease.
- 17. A boy was listening to a science program on BBC radio. The radio presenters opening remarks were;
- (i) Human beings are born and later die, so is the sun
- (ii) The death of the sun will automatically translate into death of the earth

Immediately the radio went off due to power black out

Using the knowledge of physics, help the boy to understand the two remarks.

18. During an evening down pour, a sharp flash coupled with loud sound were witnessed. As a result, the whole village experienced a total blackout. Later it was discovered that a transformer had been damaged by the sharp flash. The village organized a meeting to solicit funds to purchase a new transformer. In attendance was the area Member of Parliament (MP) who promised the members that he was to purchase a device which can safeguard the transformer against other damages from such a flash. People wondered how the device can protect the transformer. After two weeks, the funds were realised and a committee was selected to go to town and buy the new transformer. The transformer dealer presented to the committee a transformer which supplies 12 V when connected to 240 V mains supply and it takes a current of 1.1 A from the mains when used to light ten 12V, 24W lamps in parallel. The dealer convinced the buyers that the transformer had an efficiency of at Least 96%. They were not

Name: X	
Date of visit: 2 <sup>nd</sup> June, 2024	
Next visit:	
To report for next visit when dosage has reduced to 0.75 mg	
Dr.A	

sure of how the dealer arrived at that value.

Using the knowledge of physics,

- (C) Find out whether the trader was trustworthy when he stated the above value.
- (b) Sensitise the community on how the device would guard the transformer against such destruction.

- 19. An article in the newspaper gave information that on 2<sup>nd</sup> December 2022, Ugandan engineers with the help of Japanese engineers launched a satellite. The literature teacher who picked interest who picked interest in the article found new words like artificial and natural satellites. He developed a number of un answered questions which could be answered by a physics learner like you.
- $(\mathbf{C})$  Explain the difference between the two types of satellites in the article.
- (b) With reasons, justify why Uganda should spend all that much money to launch its own satellite.
- (C) In case Uganda is to develop to a super rocket capable of reaching different planets. List with reasons the planets it can land on and planets it cannot land on.

#### PRACTICAL ITEMS

1. In your school, the physics club produces wooden metre rules as their project and sells them to Ministry of education and sports to be supplied to schools. The Ministry offers free transportation to her client only if the mass of the items exceed 20 tones. However, the club has a total of 35000 metre rules of the size and made from the same wood but have no idea of the mass of each metre rule, neither their total mass, and do not have any access to a weighing scale. One of the club executive members has approached you with a sample of these metre rules for help

Task: Carry out a scientific investigation to determine whether the club qualifies to get the offer of free

transportation for their metre rules.



 $\rightarrow M_R = \frac{20x}{y}$ 

Hint:

- 2. In one of secondary schools in the central region, the laboratory technician in charge of the biology laboratory went to the village for burial, unfortunately this happened when senior one biology class were to use microscopes to study in depth features of a leaf. An effort to get the copy of keys from head of department hit a dead end since he was equally out station. This prompted the biology teacher to consult other departments where he was advised to improvise by using convex lens of magnifying power of 10 D. Physics laboratory has plenty of such lenses but are mixed with other lenses of different specification and are all not labeled.
- Task: As a physics student, carry out a scientific investigation to sort the lenses such that lesson does not fail. Hint.



Other experimental setups may be used
<u>xy</u>

 $rac{}{}$  f =  $\overline{x+y}$  where x- is the object distance while y-is the image distance.

- 3. A battery manufacturing company has received complaints of its products overheating, and having low life span. This made the company director to have a consultation with its team of experts' in-charge of quality assurance; they predicted that this could be as result of internal resistance of the batteries exceeding 1.8  $\Omega$  and proved it right. In a bid to improve on the quality and life span of the batteries, the company's executive director decided that all the newly manufactured batteries should be tested before putting them into the market. Unfortunately after the commencing the process of testing, the machine broke down. This forced them to seek for alternative approach which they are not familiar with, they seek for your expertise.
- Task: Carryout scientific investigation to determine whether their newly manufactured batteries meet the minimum standards.

**Hint:** E = V + Ir where E is e.m.f of the cells, V is p.d drop and I is current

