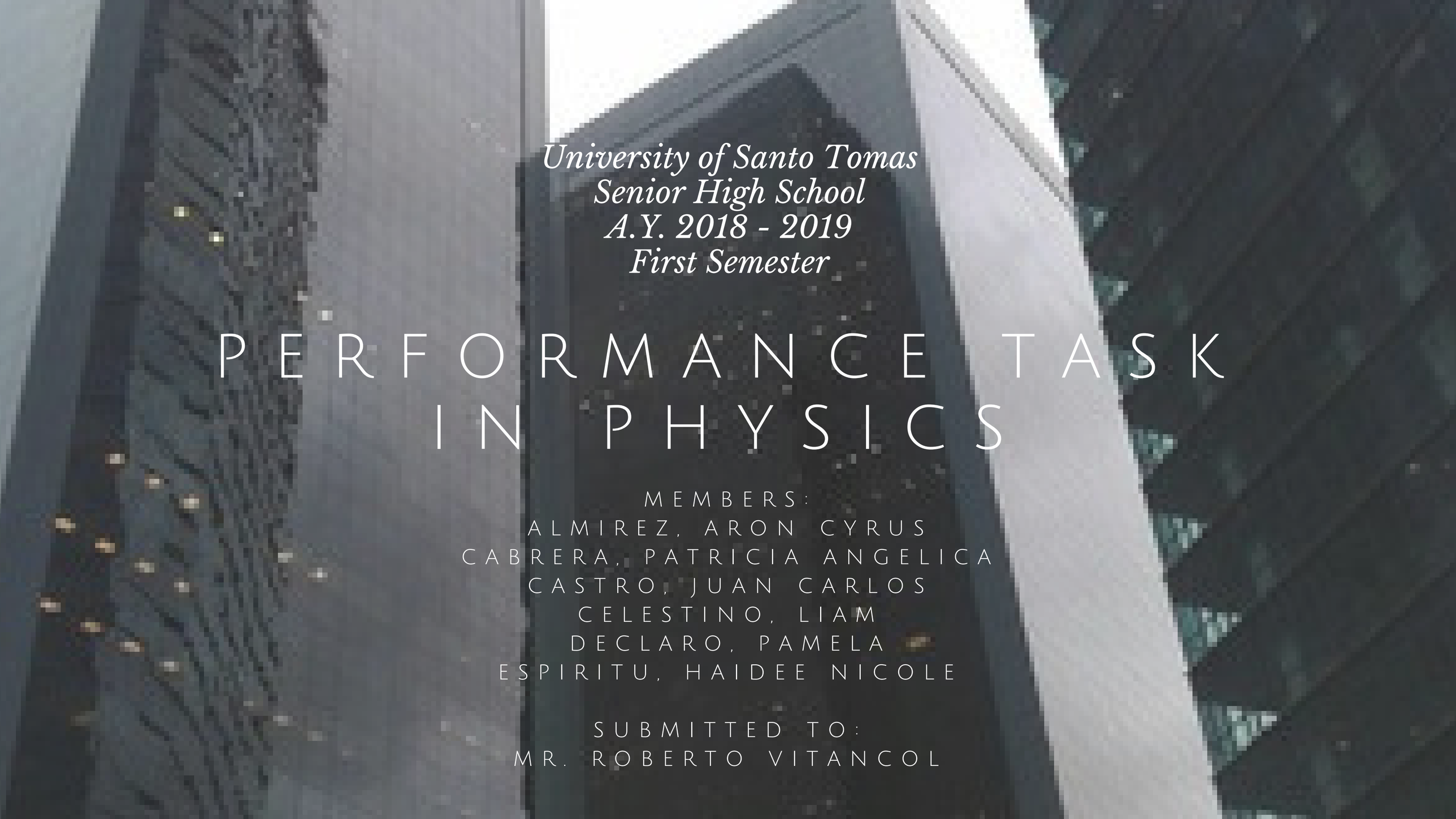


University of Santo Tomas
Senior High School
A.Y. 2018 - 2019
First Semester

PERFORMANCE TASK IN PHYSICS

MEMBERS:
ALMIREZ, ARON CYRUS
CABRERA, PATRICIA ANGELICA
CASTRO, JUAN CARLOS
CELESTINO, LIAM
DECLARO, PAMELA
ESPIRITU, HAIDEE NICOLE

SUBMITTED TO:
MR. ROBERTO VITANCOL

I. INTRODUCTION

THROUGHOUT THE COURSE OF HUMANKIND'S HISTORY, PEOPLE HAVE BUILT MANY MARVELS FROM THE MOAI OF THE EASTER ISLANDS TO THE PARTHENON OF GREECE MOST OF THESE STRUCTURES WERE CREATED THROUGH SHEER MANPOWER, BLOOD, SWEAT, TOIL AND EXCELLENT PLANNING, BUT AN INVENTION CAME ABOUT THAT REVOLUTIONIZED ARCHITECTURE AND ENGINEERING, THE MECHANISM WE KNOW AS THE "CRANE".

CRANES ARE A COMMON FIXTURE AT ANY CONSTRUCTION SITE [1]. WITH THIS NEW TECHNOLOGY AT THEIR FINGERTIPS MAN HAS BEEN ABLE TO GO ABOVE AND BEYOND WHAT WAS PREVIOUSLY POSSIBLE LOADING, UNLOADING, LIFTING, AND TRANSPORTING MATERIALS AND BUILDING MASTERPIECES OF ARCHITECTURE AND ENGINEERING.

I.INTRODUCTION

NOW WHAT EXACTLY IS A CRANE? THE MECHANISM IS SIMPLE ENOUGH, LEVERS MANIPULATE THE TORQUE INVOLVED AND ENABLE CONSTRUCTION ENGINEERS TO LIFT HEAVY LOADS. A PULLEY SERVES ITS BASIC PURPOSE, WHICH IS TO DISTRIBUTE THE AMOUNT OF WEIGHT NEEDED TO LIFT AN OBJECT. INCLUSION OF ELECTRONIC COMPONENTS HAS MADE CRANES EVEN EASIER TO OPERATE BECAUSE THE CONTROL REMAINS NO MORE MANUAL. A HI-TECH CRANE WILL ESSENTIALLY BE A COMBINATION OF SIMPLER SYSTEMS INTEGRATED TOGETHER.

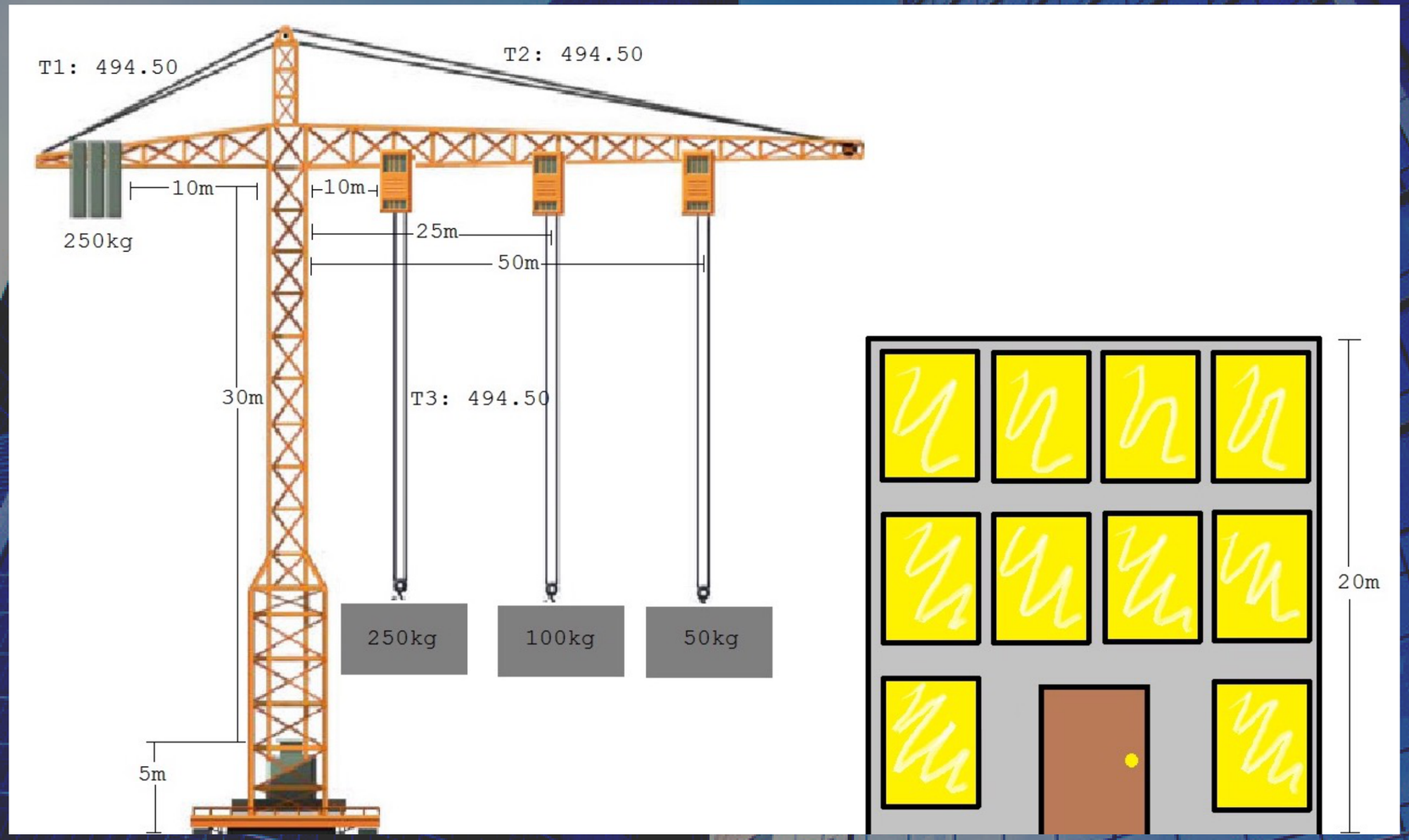
[2]THE TYPES OF CRANES IN USE TODAY VARY IMMENSELY FROM CRANES THAT ARE MOUNTED ON VEHICLES FOR EASE OF TRANSPORT, STATIONARY TOWER CRANES, ALL TERRAIN CRANES FOR ROUGH SURFACES, AND EVEN CRANES BUILT ON HARBORS AND PORT AREAS FOR LOADING AND UNLOADING OF SHIPS.

I. INTRODUCTION

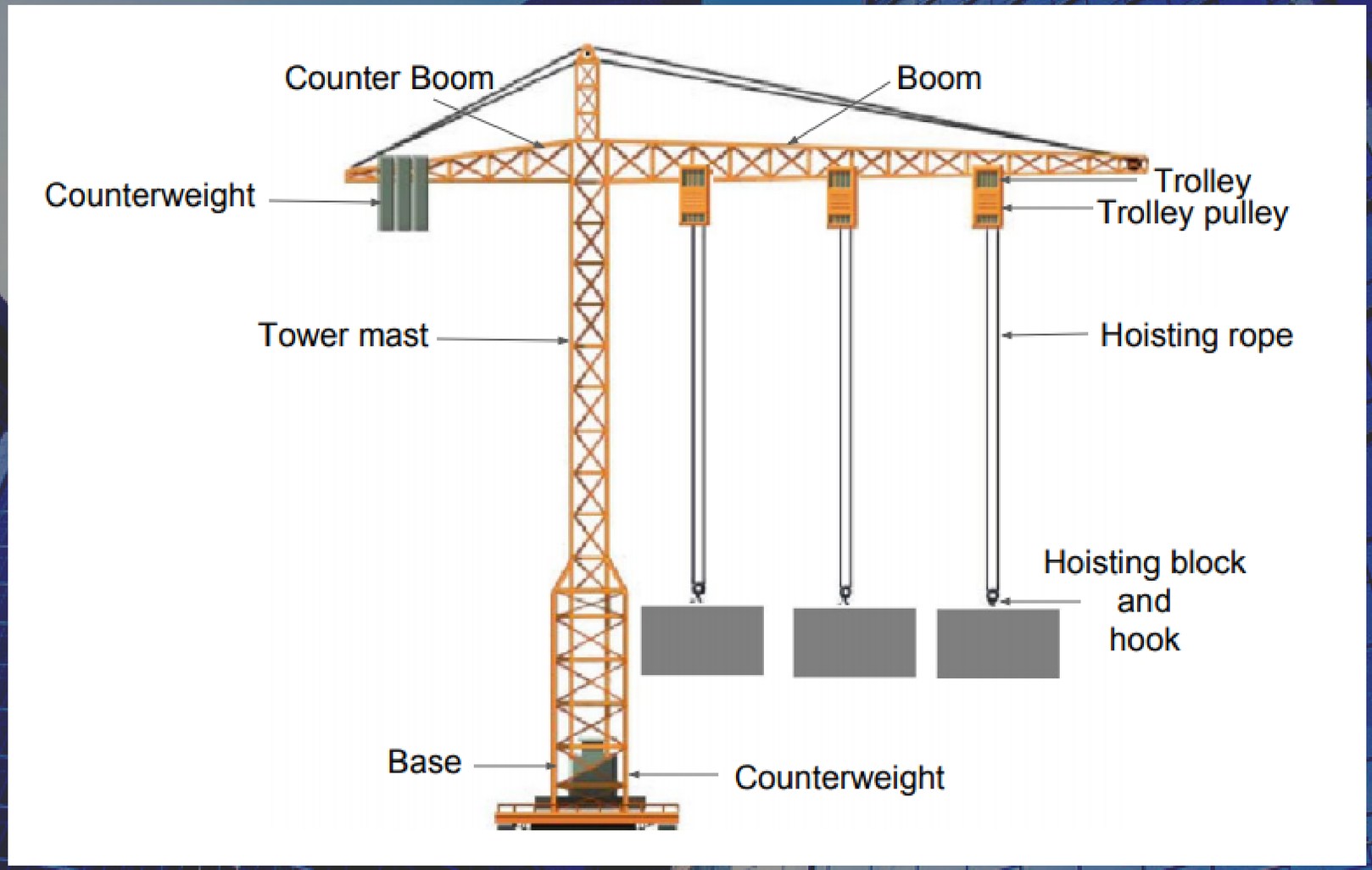
[3]PHYSICS PRINCIPLES THAT WE CAN APPLY TO CRANES ARE AS FOLLOWS: FIRSTLY, THE MACHINE MUST BE ABLE TO LIFE THE WEIGHT OF THE LOAD. SECONDLY, THE WEIGHT OF THE LOAD MUST NOT MAKE THE MACHINE TOPPLE OVER. FOR THESE TO BE OBSERVED, ESPECIALLY WHEN A SIMPLE-LOOKING CRANE NEEDS TO MOVE A HEAVY LOAD OVER A PARTICULARLY LONG DISTANCE, PRINCIPLES OF LEVERAGE, PULLEYS AND HYDRAULICS MAY HAVE TO BE COMBINED TO ENSURE THE STRUCTURE WORKS AS DESIGNED.

ALAS, WITH THIS PERFORMANCE TASK, WE WILL DESIGN A CRANE AND EXPLAIN HOW THE MACHINE WORKS.

II. DESIGN AND CONCEPT



II. DESIGN AND CONCEPT



II. DESIGN AND CONCEPT

IN ORDER TO BALANCE THE TOWER CRANE, THE CENTER OF GRAVITY SHOULD BE AT THE BASE OF THE TOWER CRANE THUS, THE MASS OF THE BASE SHOULD BE THE GREATEST THAN TO THE MAXIMUM LOAD THE HOOK CAN ACCOMMODATE AND THE MASS OF THE COUNTER JIB BALLAST. THE BASE OF THE TOWER CRANE HAS A COUNTERWEIGHT WEIGHING 500 KG AND HAS A HEIGHT OF 5 METERS. THE TOWER MAST IS 30 METERS TALL MADE OF ALUMINUM BAR.

THE TOTAL HEIGHT OF THE TOWER CRANE IS 35 METERS AND WAS SPECIFICALLY MADE IN CONSTRUCTING A 4 STOREY BUILDING WITH A MAXIMUM HEIGHT OF 20 METERS. BETWEEN THE TOWER MAST AND THE BASE ARE TWO GROUP OF PARTS, ONE ROTATING AND THE OTHER ONE IS STEADY, SO THAT THE TOWER MAST CAN BE ROTATED FROM THE BASE IN ORDER TO SERVE MORE FUNCTION. THE TWO PARTS ARE CONNECTED BY SCREWS ASSEMBLED BY PRESSURE ON THE INTERNAL SUPPORT OF THE BASE AS WELL AS AT THE EXTERNAL. THE BOOM,

II. DESIGN AND CONCEPT

AS WELL AS THE COUNTER BOOM IS ALSO MADE FROM ALUMINUM BAR, IS 70 METERS LONG. A TROLLEY PULLEY IS ATTACHED TO THE BOOM WHERE THE HOISTING ROPE THAT EXTENDS TO THE HOOK IS ATTACHED. ATTACHED TO IT IS THE HOISTING BLOCK WHERE THE HOOK IS ALSO FOUND. THE RAILS OF THE BOOM IS LONGER THAN THE COUNTER BOOM. THE COUNTER BOOM IS 10 METERS LONG FROM THE INNER OF THE COUNTER WEIGHT TO THE INTERSECTION OF APEX AND TOWER MAST. ATTACHED TO IT IS THE COUNTER WEIGHT. THE COUNTER WEIGHT TROLLEY IS SLIDING DEPENDING ON THE LOAD OF THE HOOK. THIS IS EQUAL THE BOOM MOMENT THUS, MAINTAIN BALANCE.

THE OPERATION OF THE PROPOSE TOWER CRANE WILL BE BASED ON THE BALANCE OF MOMENTS AND IT WILL BE GIVEN BY THE RELATIONSHIP (AVILA, RAMIREZ, PONCE, & ALCALA, 2007). THE TROLLEY CONSISTS OF A METAL BASE TO ENSURE STRENGTH AND FOUR WHEELS FOR AN EASIER HORIZONTAL DISPLACEMENT. THE REAR PENDANT IS CONNECTED TO THE MOTORS GOING TO THE APEX AND THEN TO THE SIDE OF THE HOOK

III. COMPUTATIONS

SUMMATION OF TORQUE SHOULD BE EQUAL TO 0 TO ENSURE THAT THE CRANE DOESN'T TIP OVER. TO GET THIS, YOU MULTIPLY THE WEIGHT (MASS X GRAVITY) OF ONE SIDE WITH ITS LENGTH AND ADD IT WITH THE WEIGHT X LENGTH OF THE OTHER SIDE. SINCE 250KG IS HEAVIER, IT HAS THE TENDENCY TO ROTATE IN COUNTERCLOCKWISE HENCE IT IS POSITIVE. THE OTHER SIDE WITH 50KG IS LIGHTER AND HAS THE TENDENCY TO ROTATE IN CLOCKWISE MAKING THE SUM NEGATIVE.

$$\Sigma\tau = 0 = (250kg \times 9.8m/s^2 \times 10m) - (50kg \times 9.8m/s^2 \times 50m)$$
$$2500 = 2500$$

III. COMPUTATIONS

WITH THIS CONCEPT, WE CAN INCREASE THE CAPACITY OF THE CRANE BY PLACING THE LOAD CLOSER TO THE MAST OF THE CRANE.

$$(M \times 9.8m/s^2 \times 25m) = (250kg \times 9.8m/s^2 \times 10m)$$
$$M = (250kg \times 9.8m/s^2 \times 10m) \div (9.8m/s^2 \times 25m)$$
$$M = 100kg$$

$$\Sigma\tau = 0 = (250kg \times 9.8m/s^2 \times 10m) - (M \times 9.8m/s^2 \times 10m)$$
$$(M \times 9.8m/s^2 \times 10m) = (250kg \times 9.8m/s^2 \times 10m)$$
$$M = (250kg \times 9.8m/s^2 \times 10m) \div (9.8m/s^2 \times 10m)$$
$$M = 250kg$$

III. COMPUTATIONS

*free body diagram
T - mg = ma
T = ma + mg

d = 35m
t = 20s

T - mg = ma
T = ma + mg

d = 35m
t = 20s

$= 35m \div 20s$

$v = d \div t$

$= 1.75m/s$

$a = (vf - vi) \div t$

$= (1.75 - 0) \div 20$

$= 0.09m/s^2$

$T = 50(0.09m/s^2 + 9.8m/s^2)$

$= 494.50N$

WITH THIS WE CAN COMPUTE THE WORK AND THE POWER.

III. COMPUTATIONS

WORK

TO COMPUTE THE WORK THAT IS NEEDED TO LIFT A 50KG OBJECT 35 METERS INTO THE AIR WE USE THE FORMULA: FORCE X DISPLACEMENT X COS THUS,

$$W = F \times d \times \cos\theta$$
$$= (50kg \times 9.8m/s^2) \times 35m \times \cos\theta$$
$$= 490 \times 35m \times 1$$
$$= 17,307J$$

POWER

TO CALCULATE THE POWER NEEDED BY THE CRANE TO LIFT THE LOAD 35 METERS INTO THE AIR WE USE THE FORMULA: WORK/TIME THUS,

$$P = W \div t$$
$$= 17,307J \div 20s$$
$$= 865.35watts$$

IV. CONCLUSION

CRANES ARE MADE TO LIFT OR LOWER ONLY A SPECIFIC NUMBER OF OBJECTS BASED ON ITS MAXIMUM WEIGHT CAPACITY. THE PULLEYS AND CABLES THAT MAKE UP THE MACHINE ARE THE ONES THAT MAKE THE TRANSPORTATION OF MATERIALS EFFICIENT. THE PULLEY MINIMIZES THE WORK DONE WHILE THE CABLES ALLOW PROPER DISTRIBUTION OF TENSION. A COUNTERWEIGHT IS ALSO IMPORTANT TO MAINTAIN THE BALANCE OF THE CRANE. IT DETERMINES THE MAXIMUM LOAD THE MACHINE CAN CARRY DEPENDING ON THE OBJECT'S DISTANCE FROM THE CENTER OF THE POLE. THE WHOLE SYSTEM IS ABLE TO FUNCTION WITH THESE PARTS WORKING HAND ON HAND. ALL THE FORCES ACTING ON THE MACHINE ARE DISTRIBUTED THROUGHOUT THE MACHINE AS IT LIFTS AN OBJECT THUS CREATING AN EQUILIBRIUM DURING AND AFTER THE TRANSPORTATION OF HEAVY OBJECTS.

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