T.C.

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MASTER’S DEGREE THESIS

THE EFFECT OF TEACHING PHYSICS WITHOUT FORMULAS ABOUT KINEMATIC SUBJECT ON ACADEMIC ACHIEVEMENT

Untung Nugroho HARWANTO

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KİNEMATİK KONULARINDA FORMÜLSÜZ FİZİK ÖĞRETİMİNİN AKADEMİK BAŞARIYA ETKİSİ

Untung Nugroho HARWANTO

AĞUSTOS 2016

I confirm that this Master's Thesis entitled THE EFFECT OF TEACHING PHYSICS WITHOUT FORMULAS ABOUT KINEMATIC SUBJECT ON ACADEMIC ACHIEVEMENT submitted by Untung Nugroho HARWANTO in accordance with the standards of the Department of Physics.

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ABSTRACT

THE EFFECT OF TEACHING PHYSICS WITHOUT FORMULAS ABOUT KINEMATIC SUBJECT ON ACADEMIC ACHIEVEMENT

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Physics is considered as a difficult subject. Physics is difficult because students have to understand with across different representation such as theory, experiment, formula, symbol, calculation and graph. Mathematics can be used to solve physics problems but students often fail how to use mathematics. There was some research exploring on what makes physics difficult and these kind of research are still going on. The complexity and abstraction of the formula is an important problem in physics. The complexity of physical concept, symbol and formula can be explained by a simple expression. Therefore, the use of physics without formula based on meaningful learning can provide a better achievement on introductory physics. One of the most difficult one faced by students in learning physics is on how to use mathematical correlation and equation. This problem is not only for the difficult questions but also they cannot solve the simple physics questions too. Physics without formula can be used to teach the introductory physics. Physics without formula is used not only to explain the principles in physics but also to solve the problems.

This study was administered to collage's preparatory class students in Indonesia. The preparatory class students were taught by physics without formula. Two separate classes were taught by different learning method on introductory physics. Students in the experimental group were taught by physics without formula and the students in the control group were separately taught by traditional method of learning physics. In the study, motion and force achievement test was developed by the researchers and explored it into two groups as their pre-test and post-test. According to the statistical t-test result, it was significant difference between these two groups in their academic achievement test. This result indicates that physics without formula applications is more effective than conventional learning method.

Keywords: Learning Physics, Physics without Formula, Meaningful Learning, Academic Achievement.

ÖZET

KİNEMATİK KONULARINDA FORMÜLSÜZ FİZİK ÖĞRETİMİNİN AKADEMİK BAŞARIYA ETKİSİ

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Fizik genellikle zor bir konu olarak görülmektedir. Fizik, öğrencilerin teoriler, deneyler, formüller, semboller, hesaplamalar ve grafikler gibi farklı durumları anlamasını gerektirir. Fizik problemlerini çözmek için matematik kullanılır, ancak öğrenciler sık sık matematiği nasıl kullanacağını bilemez. Öğrenciler için fiziğin neden zor olduğunu araştırmak üzere birçok çalışma yapılmış ve halen de bu tür çalışmalar yapılmaktadır. Fizikte formülerin karmaşıklığı ve soyutluğu önemli bir sorundur. Öğrencilere karmaşık gelen birçok fizik kavramı, sembolleri veya formülleri basit ifadelerle anlatılabilir. Dolayısıyla formül kullanmaksızın temel fizik konuları için anlamlı öğrenme süreci öğrencilere değerli kazanımlar sağlayabilir. Fizik öğrenmede öğrencilerin karşılaştığı en önemli problemlerden biri de formüllerin matematiksel bağıntısı ve formülleri nasıl kullanılacağı sorusudur. Bu durum sadece zor sorular için değil basit bir fizik sorusu için de geçerli olabilir. Fizik derslerinde formül kullanmaksızın temel fizik konuları öğretilebilir. Sadece fizik prensiplerini açıklamak için değil fizik problemlerini çözmek için de formülsüz fizik kullanılabilir.

Bu çalışma Endonezya’daki üniversite hazırlık sınıfı öğrencilerine uygulanmıştır. Hazırlık sınıfında okuyan öğrencilere formülsüz fizik öğretilmeye çalışılmıştır. Temel fizik konularında iki ayrı sınıfa faklı yöntemlerle ders işlenmiştir. Kontrol grubu olarak rastgele seçilen sınıfta geleneksel yöntemle fizik dersi işlenirken diğer deney grubunda ise formül kullanmaksızın fizik konuları öğretilmiştir. Çalışmada, araştırmacı tarafından geliştirilen kuvvet ve hareket konusuyla ilgili fizik başarı testi her iki grubu da öntest sontest olarak uygulanmıştır. T-testi sonuçlarına göre her iki grubun akademik başarıları arasında deney grubu lehine anlamlı farklılık tespit edilmiştir. Bu sonuç formülsüz fizik uygulamalarının geleneksel yöntemden daha etkili olduğunu göstermektedir.

Anahtar kelimeler: Fizik Öğretimi, Formülsüz fizik, Anlamlı Öğrenme, Akademik Başarı.

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SYMBOLS AND ABBREVIATIONS

SYMBOLS

N	Sample Number
p	Significance Level
t	t-value

ABBREVIATIONS

ADS	Asian Development Bank
BPS	*Badan Pusat Statistik* (Indonesia) /Central Bureau of Statistics of Indonesia
CHIP	Computational Homework in Physics
GASING	*Gampang Asyik Menyenangkan*/Easy Fun and Enjoyable
GILS	*Gasing* Integrated Learning System
KAT	Kinematics Achievement Test
LPMP	*Lembaga Penjaga Mutu Pendidikan*/ Educational Quality Assurance Council
MLT	Meaningful Learning Theory
SAL	Special Autonomy Law
SD	Standard Deviation

1. INTRODUCTION

1.1. General Overview of the Research Problem

According to the students, physics is a difficult subject especially for the “average” students (Sobel, 2009). Introductory physics is difficult for many students (Ornek, Robinson and Haugan, 2008). Physics is unlike any other subject you will encounter (Aikenhead, 2003). It requires a unique approach; concepts and practice. Physics introduction is a rapidly paced class. Missing even one lecture will set you back. Playing catch-up in physics usually results in the student not fully understanding concepts. Get ahead and stay ahead. Learning physics is comparable to learning a new language. If you don’t put in the time, it’s difficult to succeed.

Math is the language used to communicate physics. Lasry, Finkelstein and Mazur (2009) fully agreed that physics without any enough mathematical background is an incomplete subject. However, it was equally incomplete when math without any physics concepts.

Students’ understanding of the course is depending on their view about a course. Why some students failed on their physics course is because their view of “physics is a difficult subject”. Angell, Guttersrud, Henriksen & Isnes (2004) explored the students’ view about physics. On their research, they found that physics seem so difficult because the students have to deal with very colorful representations such as graphs, equation, diagrams, experiments and conceptual understanding at the same time. And also the students have to able to make conversion among them at the same time. As an example, students sometimes need to be able to convert mathematical formulas into physical explanation and sometimes they have to be able to transform from mathematical representation to physical explanation.

According to Redish (1994), they explore what make students judge physics as a difficult course. Physics is a discipline requires learners to be able to apply a variety of methods of learning and to convert from numbers to graphs, equation to diagrams and others.

Angell at al. (2004) also found that some students viewed physics to be boring and irrelevant course. They, however, showed that it was students that did not study physics that felt this way; those that were taking physics classes actually claimed it was relevant and interesting. The major obstacle to enrolment in physics may be getting students through the door of a physics classroom; once there, perhaps the students' negative perceptions can change. Alternatively, it may demonstrate that only those students who have positive preconceptions of physics are enrolling in physics.

The research found that students generally viewed physics as abstract, difficult and unattractive. And sometimes physics looks like a luxurious subject only fit for multitalented or extra gifted students. Whereas while their view and liking for biology remains reasonably stable or no significantly different, but their liking for physics declines or decreases by the time. In the final stage they noted that biology as interesting subject but physics as a boring course.

There were various factors on explaining why students think that physics is a difficult subject. In a study in United State of America, the factors were separated into three categories, such as factors related to the students, factors related to the course and factors related the nature of physics.

1.2. Objectives of the Study

This is a thesis research on what makes physics difficult according to the Indonesian students specially the students who live in remote area, how to develop a new method of learning physics based on physics without formula in order to give an alternative way for Papuan students who most of them are having no enough mathematical background and also how the effect of meaningful teaching through physics without formula on the students' achievement on motion and force unit.

1.3. Significance of the Study

Actually there are several points to clarify the significance of this research. First of all, the exploration of one question on what makes physics difficult? Physics is often considered as a difficult lesson, an observation of exploring on what makes physics difficult is the first important question that should be answered before. A questionnaire was developed to find out the students' opinion on why physics is difficult for them? From the collected data of this questionnaire, the researcher can easily understand the fundamental reason of the students' problem on physics learning. The goal of this research will be useful if the product can solve the fundamental problem of students when they are learning physics.

The second is the selection of the topic. It is very important to select an appropriate topic. As all physics teachers know that force and motion is a fundamental topic of introductory physics. It was believed that if the students had a good conceptual understanding in this fundamental area, they will be no problem to go to the next steps in physics course.

The third important point in how an alternative learning method can solve the students' view on "physics is difficult". Two classes were prepared separately into two groups. The first class was treated with traditional learning method and the second class was treated with *gasing* learning method based on meaningful learning.

1.4. The Main Problems and Sub-Problems

1.4.1. The Main Problems

The main problems of these study are what makes physics difficult according to the Indonesia students who are taking special math and science course in Surya Collage of Education and also the development and evaluation of meaningful learning through physics without formula on kinematics learning, which is less equation oriented and more simple mathematics used, which provides a medium for preparation class students to study the concept of motion and force with the use of their scientific thinking and creative skills. The main problem has 3 major dimensions as (1) what makes physics difficult, (2) the development physics without formula-learning model, and (3) evaluation of physics without formula-learning model on the students' achievement test on motion and force.

1.4.2. The Sub-problems

1. What is the most influenced factor on making physics difficult according to the rural students in Indonesia?
2. What can be done to solve the problem of making physics difficult according to the students?
3. Is there a significant mean difference between the effects of meaningful learning model through physics without formula and traditionally designed physics instruction on students" academic achievements towards mechanical concept?

1.5. Limitations

1. This study was specially designed to the Indonesian rural students who are studying in Surya Collage of Education.

2. The initial survey was limited to the data collected from 115 rural students of Surya Collage of Education in the academic year of 2014/2015.
3. The experimental research was limited to the 52 Papuan and West Papua students in preparation class in Surya Collage of Education.
4. The study was limited to the topic of classical mechanics “linear motion, accelerated motion, 2 dimensional motion, and force” as the basic introductory physics.

1.6. Definition of Important Terms

Traditional instruction is a teaching model where the teacher presents the planned learning content in front of the class talk more one direction, rarely discussion and more reading the slide. And the students passively receive lecture, listening too much what their teacher talking about, write down all the teachers explained, rarely ask questions, lack of express the ideas, and no more experiments.

Physics achievement on kinematics unit is a tool that can be used to measure the level of students’ understanding toward kinematics unit.

Equation of motion: either an explicit or implicit equation that describes the motion of a physical setting. In physical simulations, equations of motion are mostly written in the form of a second order differential equation, which represents acceleration of a mass.

Practice Teaching*:* the course given to student teachers in the last semester of teacher education program; based on presentations and training in real classroom and school settings in coordinating schools and providing them supervisory in faculty for acquiring required skills to become a teacher.

Student teacher: the individual who is registered to practice teaching course in education faculty and assigned to a certain coordinating school to carry out the work of student teaching under the direction of a mentor.

1.7. Assumptions

1. Participants' answers and responses to the items in the questionnaire of the initial survey used in this research were sincerely truthful.
2. There was no interaction between students who are taught by physics without formula learning model and those are taught by traditional learning model.
3. The tests were administered under standard conditions.

2. LITERATURE REVIEW

2.1. İndonesia Demographics

The Republic of Indonesia is an archipelago country with 5 big islands and more than 17000 small islands, about 85% of them are inhabited. It is a very potential position because Indonesia is located between Asian and Australia continent, and also between Indian and Pacific oceans. So the traffic of trading and economic activity is so high. With approximately 1,919,440 square kilometers total area, Indonesia is located in Southeast Asia. They are scattered across both sides of equator. Lying along the equator line, Indonesia has a tropical climate.

Figure 2.1. Map of Indonesia

Indonesia has five big islands: in the west part is Sumatera; in the middle bottom is Java; Kalimantan straddling the equator; Sulawesi and in the east part is Papua. The most crowded island is Java with population more than 160 million. This takes 66% of total population in Indonesia. The most sparsely populated island is Papua. Other islands are small and approximately 85% of them are inhabited.

Indonesia is the world's fourth most populated country after China, India and United State. Indonesia has total population more than 240 million. Indonesia is known as the largest Moslem population in the World. More than 85% of total population in Indonesia is being Moslem. With approximately average population density 134 people per square kilometer (Henyana, Supriatna and İmansyah, 2011).

2.2. The Education System in İndonesia

Immense and diverse is the fundamental principle of education system in Indonesia. According to Asian Development Bank (2015), Indonesia is the fourth largest education system in the world, after China, India and United State. By the number, Indonesia has more than 340000 educational institutions with 60 million students and almost 4 million teachers.

Education is one of the most important and also easiest way to determinants the personal's attitudes, behaviors and knowledge. Education takes part an important view of how human's life and also how they solve their problem. This important indicator is educational attainment. Education level can describe the social level of a person in the society.

The most important indicator of individual status and quality of live in a social community is their education. The Indonesian government has special program for better educational services. Education had been designed under the Indonesian Ministry of Education and Culture from the lowest level to the highest level of education; start from elementary school, junior high school, senior high school to university. It operates at various levels area: at district level, regional, provincial and central. The Islamic education service is being under control of the Ministry of Religious Affairs.

Formal education is divided into public schools and private schools. The public schools are directly controlled by the government. All the facilities and budget are managed by the government. For the private schools, there are two types of private school: first is faith-based school and the second is private schools for profit. Faith-based Islamic school is the majority of private school in Indonesia

In 1994, the Indonesian Ministry of Education decided to extend the compulsory education become 9 years. For the first 6 years they are studying in primary school than 3 years for junior high school. It is not compulsory to follow the pre-school education. Bahasa Indonesia is the only official language in Indonesia and it is decided as a medium instruction in the school.

2.3. Educational Problem in Papua

Papua and Papua Barat are ranked last and third-last respectively in the Indonesia Human Development Index; more than 30% of the population in each province lives in poverty, and many children – seven times the national average in Papua – are not attending school (Fargher & Cislowski, 2012).

According to the statistical collected data from *Badan Pusat Statistik* (BPS), Jakarta 2014, in the year of 2011 Papua and West Papua Province has 2414 elementary schools or about 3.53% of the total elementary school in Indonesia, 588 junior high schools or about 1.85% of total junior high school in Indonesia, 388 senior high schools or 1.69% of the total senior high school in Indonesia and 65 universities or about 2.3% of total university in Indonesia.

In 2013 the number of illiteracy in Papua was 37.22% of total population in that province (BPS, 2012). It means that almost 1.05 million of people in Papua aren't being able to read and write in their daily activities.

Table 2.1. Total School in Papua and West Papua

Schools in Papua & West Papua		
	Total	As percentage of total school in the same level in Indonesia
Elementary School	2414	3.53 %
Junior High School	588	1.85 %
Senior High School	388	1.69 %
University	65	2.3 %

Source: computed data collected from Statistics of Education Facilities by province in Indonesia (Badan Pusat Statistik, 2014).

Picture 2.2. The Indigenous Papuan

The most important issue about the educational problem in Papua is related to the communication and transportation among geographical reasons. It was difficult to reach most of isolated area in Papua. The only way to go there is just by small plane. The plane operation is depends on the climate condition. People in isolated area cannot be easily equipped with proportional textbook, appropriate curriculum and experimental facilities. Some schools in isolated area are lack of professional teacher. The lack of professional teachers was coming from many reasons, such as rarely have the experiences to improve their knowledge, not having enough education, never upgrade the most update information and also there is no reliable transportation to reach the isolated area.

Picture 2.3. The School in Papua

There is no enough teaching materials in many school in remote area specially in Papua. School buildings are neglected and being never repaired by local government. It easy to find school that lack teaching facilities, poor furniture and minimum educational support. The teachers in remote area is lack of discipline, they just come and go without any clear schedule. Pay is so low. No one wants to be a professional teacher. Material books are not properly distributed to remote or rural areas. The educational system doesn't work so many Papuan pupils are still illiterate even they graduated elementary school (Tebay, 2005).

Papuan pupils need to have a special curriculum guideline because they are raised in different cultural background compared to those of others Indonesian or Western Countries. Culture, gender, lifestyle and life history build the perceptions and values. These perceptions and values bring them to different skills and knowledge development (Kelegai & Middleton, 2002).

2.4. Special Education Program for Indigenous Papua

In order to enhance the special program of better education, good health service, efficient public services, productive local economy empowerment and robust infrastructure in Papua, the Indonesian government decided to give Special Autonomy Law (SAL) for Papua. This SAL allows the Papua region to be decentralized or separately managed by local government in 2001. This agreement gave special opportunity to the local government to be able to have special authority to spend and manage their own budget and resources. Increasing budget allocation for local government is the most significant feature in Special Autonomy Lay (Salossa, 2006).

Almost 30 percent of budgets are being allocated for educational program (MgGibbon, 2005). Education is fundamental tool in order to support the country's economy. By the time, the implementation of the SAL in Papua was having some problems. It was difficult to set and spend the money for proper educational program. The number of corruption and collusion was still bein exist not only in the highest level but also in the lowest level, not only the public sector but also private sector. The key of better future for Papua under Special Autonomy Law is their human resources (Mollet, 2007).

2.5. Education for rural and remote area

The education change model needs to be radically changed for rural and remote areas. Although model schools are a government strategy based on government regulation with government establishing model schools in every non-target district across Papua province, there are significant problems with the current model for delivering change in rural and remote areas, which amount for 60-70% of children in Papua: (1) the cluster group model is inappropriate for rural and remote areas because of access and transport issues, as evidenced by the current level of dysfunction of the teacher and principal network; (2) the concept of model school is misleading, being based primarily on geographical factors, not on capacity to lead in education reform; some of the model schools visited appeared to lack both the facilities and leadership to host teacher development meetings; (3) selection of Master Trainers from teachers, principals, supervisors, education offices, university and LPMP (*Lembaga Penjaga Mutu Pendidikan*) has advantages for sustainability but is problematic if trainers do not have adequate experience in schools and sufficient understanding of pedagogy to provide mentoring support to untrained, low capacity teachers, or if trainers are unable to full fill the training or mentoring role. Model schools are a government strategy based on government regulations with government establishing model schools in every non-target district across Papua province (Fargher & Cislowski, 2012).

2.6. Meaningful Learning as the basic concept of *Gasing* Method

What the learner already knows is one of the most substantial factor that influencing learning activity. This inspires Ausubel to develop an interesting theory in order to make connection between what the learner already knows and learning a new knowledge. Ausubel (1963) attributed it into the Meaningful Learning Theory (MLT).

David Ausubel says that learners learn the new subject that never been learned before related to the already existing concepts. Meaningful learning is a crucial type of learning not only for classroom instruction but also all human activities. So, meaningful learning involves new knowledge that is related to what the learner already knows, and it can be easily retained and applied. Ausubel's theory emphasizes the need of a prior knowledge of the students in order to have good meaningful learning. Also, teachers should be aware of the students' prior knowledge in order to do the best meaning of it in their learning practices.

Ausubel develops an advanced tool as a way to help pupils make connections between the new ideas to what already known. This advanced tool is just a device or a mental learning aid that can help students get a personal experience on the new knowledge. The advance tool can be verbal phrases or graphs. Ausubel tries to help students assimilate and accommodate the new information through the learning process; this process has to be developed by the teacher to introduce new information.

According to David Ausubel (1963), the students have to be active, and teachers have to reinforce new knowledge by underlining important information, completing missing words, restructuring sentences, or by giving additional examples.

So, Ausubel´s Theory has three requirements:

- Relevant prior knowledge: Students build the mental pictures of the knowledge that can help them to connect to new information.
- Meaningful material: That is, students construct significant concepts and propositions, which must be relevant to the knowledge to be obtained.
- The learner have to choose to learn meaningfully: That is, students have to build their own learning construction in order to make a connection between new knowledge to the information that already known in some different ways.

Rote memory is important part of meaningful learning. Rote memory is used to recall all the information already known, such as subjects, events or graphs. Integration is the most important part in meaningful learning. Integration explains how the new knowledge is connected to the information already known.

Retention and transfer both is two important key of educational process. Retention is the ability to remember all the information already known. Transfer is the ability to use what already known in order to construct among new information, answer new questions or solve new problems (Mayer & Wittrock, 1996; Mayer, 2012).

2.7. *Gasing* Learning Model

The first step before learning physics *gasing* is being able to understand the basic mathematics. The students should take basic mathematics before they learn physics *gasing*. The Surya Collage of Education developed a *Gasing* Integrated Learning

System (GILS) to everyone who want to learn a special education of learning science. So what math *gasing* and physics *gasing* is? It will be describe in the paragraph bellow.

Surya (2012) described *Gasing* into three components; GAmpang (easy), aSyIk (fun) and menyenaNGkan (enjoyable). *Gasing* is a physics learning method that constructs the children on how to learn science easily and it also can be fun and enjoyable. It is called easy because the methods are easily understood by students, not only for the smart students but also for the students who has lack of mathematical background. The method was developed specially by combining the basic math knowledge and what already students known into physics concept. This method made students have no problems in working out mathematics or physics problems. When students know how to solve the problems and use it into other problems, they will enjoy the learning and training process. They will feel that learning science is fun and enjoyable.

Gasing has a special crucial rule. This crucial rule is the teacher must believe that there is no stupid student. The students just need to have an appropriate method and best teacher (Surya, 2012).

One of the most important parts of learning science is how to make learning cycle become easy, fun and enjoyable (Shanty and Wijaya, 2012). The mathematical logic must be introduced in order to make sure that learning environment become easy. Enjoyable means the students must have their own high motivation which comes from inside (intrinsic factor). Fun is talking more about the outside the factor, it takes part in the direction of outside influences such as visual aids and games (extrinsic factor).

3. METHOD

In this chapter, there will be presented more detail information about design of the study, sample and population, variables, instruments and validity.

3.1. Design of the Study

According to Johnson and Turner (2003) in order to reflect complementary strengths and non-overlapping, the mixed research method can be used for providing multiple types of data that are collected with different methods research. Mixed research method is actually combining between qualitative and quantitative research techniques (Johnson and Onwuegbuzie, 2004).

Creswell (2003) described the construction of specific features of a mixed research methods.

- Sequential explanatory design, in which qualitative data are used to enhance, complement, and in some cases follow up on unexpected quantitative findings.
- Sequential exploratory design, in which quantitative data used to enhance and complement qualitative results.
- Sequential transformative design, in order to ensure that the views of a diverse range of participants are represented either qualitative or quantitative data may be collected first together in the same time.
- Concurrent triangulation design, which is qualitative and quantitative data are collected concurrently.in order to explore more on confirming, cross-validating, or corroborating findings from a single study.
- Concurrent nested design, in which qualitative and quantitative data are collected concurrently and analyzed together during the analysis phase.

3.1.1. Qualitative Research

Qualitative research explores more on meaning, purpose, or reality. Discovering the experiences, perspectives view, and thoughts of participants are vital goals of qualitative research (Hiatt, 1986). Qualitative research is used for exploring more detailed information of a topic. In Qualitative research, case studies, ethnographic studies, interviews can be used to collect the data (Lincoln & Guba, 1985).

We collected a yes-no answer questionnaire to approximately 115 students in the middle of the semester to the university students who are studying in Surya Collage of Education. The students were asked to full fill a questionnaire through what makes physics difficult? The content of the questionnaire was separated into three categories;

1. Factors that students could control
2. Factors that were course-related
3. Factors inherent to the nature of physics.

In this study, the sample consists of 115 physics students. The students were coming from different part of Indonesia. They are living in the different islands, such as: Sumatra, Kalimantan, Papua and West Papua. This research conducted 37 Sumatran students, 10 Kalimantan students, 36 Papuan students and 32 West Papuan students. All the students are studying in Surya School of Education. The accessible population consists of 482 physics teacher who are coming from 4 different islands in Indonesia and they are having their special preparation class for the first year of university. In these islands, students were sampled in class unit. A total number of 115 students in 5 classes rated their perception toward physics learning by filling the questionnaire on what makes physics difficult?

3.1.2. Quantitative Research

The key features of quantitative research method are consists of one more instrument, such as the use of questionnaire, test or survey (Harwell, 2011). It can be used to collect the required data and conduct probability to the statistical hypotheses. Quantitative methods are frequently used to examine the hypotheses by doing statistical calculation from the sample to be generalized about characteristics of a population (Lincoln & Guba, 1985).

In order to explore the effect of *gasing* learning model based on meaningful learning, an experimental design was conducted into two groups. These two groups are treated separately with different learning model.

Table 3.1. Experimental and Control Group

	Experimental Group *Deney Grubu*	Control Grup *Control Groubu*
Method *Yöntem*	Physics-Gasing learning method	Traditional learning method
Number of students *Öğrenci sayısı*	26	26
Number of male students *Erkek öğrenci sayısı*	9	16
Number of female students *Kız öğrenci sayısı*	17	10

3.2. Population and Sample

The target population of the initial survey on exploring the students' perception of what makes physics difficult is all the urban physics students who are taking a preparation class in Jakarta. Besides that, the accessible population of this research is defined as all rural physics students in Surya Collage of Education, Tangerang, Indonesia.

The sample was drawn from 115 of approximately 480 physics students who are studying in Surya Collage of Education that comprise the accessible population. The treatments were randomly assigned. The sample was consisted of 115 students who are coming from different islands in Indonesia (37 Sumatran students, 10 Kalimantan students, 36 Papuan students and 32 West Papua students). Sumatran students, Papuan students and West Papuan students are almost equal in participants number, but in other hand, the participants number of Kalimantan students was the most least than others.

Table 3.2. Distributions of participants toward their origin

Origin	Number of participant
Sumatra	37
Kalimantan	10
Papua	36
West Papua	32

For exploring the effectiveness of physics *gasing* learning method, the target population of this part is all physics students who are taking a preparation class for the first one year in Surya Collage of Education, Tangerang, Indonesia. They have to take a mathematics matriculation and introductory physics class before they start they study in university. The developed treatment in this study involved using physics-*gasing* learning model.

The number of all physics students in Surya Collage of Education accessible population was approximately 480. Only four classes had the matriculation class before they start their study in the university. Two of these four matriculation classes were selected fairly by considering the number of physics preparation classes. The students including in this study already had been trained the basic mathematics-*gasing* preparation in order to be able to attend the physics learning.

3.3. Variables

There are two dependent variables and also two independent variables in this study.

3.2.1. Independent Variables

Learning model and the pretest achievement scores on kinematics both are the independent variables in this conducted study.

3.2.2. Dependent Variables

The dependent variables were consisted of the posttest scores on the kinematics achievement test for the control group and experimental group.

3.4. Instruments

Two instruments: kinematics achievement test and the questionnaire on what makes physics difficult were explored in this study.

3.4.1. Questionnaire on what makes physics difficult

The questionnaire on what make physics difficult had been developed by Ornek, Haugan and Robinson (2008). The questionnaire is shown in the appendix 1. This questionnaire basically has three factors. There are factor related to the students, course related factor and factor related to the natural physics.

3.4.2. Kinematics Achievement Test

In order to investigate whether the different teaching methods used in the study have significantly different impacts on students' understanding of scientific concepts towards learning motion and force, research instruments were developed and applied to the students before and after the study. For this study the following two instruments were developed and used. Kinematics Achievement Test (KAT) which evaluates students' prior knowledge of the subject matter and the gain in academic achievements due to the instructional methods used. KAT is an instrument that can be used to measure the students' understanding toward kinematics. It consists of 30 questions including 15 multiple-choice related to the motion and 15 multiple-choice related to the force. The KAT instrument can be found at appendix 2.

3.5. Validity and Reliability of the Measuring Tools

In order to test or examine the quality of an instrument of social science research, it is important to do validity and reliability test first (Lameck, 2013). Reliability can be called as refers to consistent of research instrument (Handwerker, 2005). This means that, the research instrument should produce the same score over repeated measures.

3.5.1. The Validity and Reliability of the Questionnaire on What Makes Physics Difficult

Data's gathered with quantitative method was analyzed for this study. Ornek, Robinson and Haugan (2008) had developed and used it to test students' perception on what makes physics difficult with alpa cronbach 0,85.

The developed questionnaire consists of 3 major factors with 30 questions. Twenty nine questions were completed and returned by participants. The questionnaire that evaluates physics learning problem was used to collect the students' perception on what makes physics difficult. The questionnaire which was made up of three factors, such as: student related factor, course related factor & natural physics related factor. The first factor consists of 10 questions, the second factor 9 items of question and the third factor consists of 10 items.

3.5.2. The Validity and Reliability of the KAT

3.5.2.1. Validity test

We used the formula of Pearson product moment correlation coefficient to calculate the validity of each item on the physics achievement test toward force in this research.

$$r_{xy} = \frac{N\sum xy - \sum x \sum y}{\sqrt{(N\sum x^2 - (\sum x)^2)(N\sum y^2 - (\sum y)^2)}}$$

Where r_{xy} = the Pearson product moment correlation coefficient

x = the total score in every question

y = the total score of true answer in every sample

N = total samples

3.5.2.2. Reliability test

The KR20 formula was used in this research to calculate the reliability number of the instrument of research.

$$r_{ii} = \frac{k}{k-1}\left[\frac{V_t - \sum pq}{V_t}\right]$$

Where k = the number of items

Vt = the total test variance

p = the proportion of subject who gave true answer

q = the proportion of subject who gave wrong answer

r_{ii} = the reliability number by using KR20

3.5.2.3. Level of Difficulty

$$p = \frac{B}{Js}$$

Where p = the index of difficulty

B = the total of sample who gives true answer in every question

Js = the total of sample

3.5.2.4. Power of Differences

$$D = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

Where

D = the power of differences

B_A = the total of sample who gives true answer in the first part

B_B = the total of sample who gives true answer in the second part

J_A = the total of sample in the first part

J_B = the total of sample in the second part

3.6. Material Development

The research problems discussed in chapter one, addressed students' lack of engagements due to traditional teaching approach, where students are not active participants in teaching-learning environment. According to the literatures reviewed in chapter 2 traditional ways of teaching encourage students to become more passive and are not beneficial for ensuring permanent learning. Most of the studies discussed in the review also revealed that traditional instructions failed to motivate students in learning science in general and physics in particular and that there is more widespread agreement on the ineffectiveness of traditional instruction.

To overcome these problems, improve the quality of physics education and to reach the educational objectives prescribed in science curricula, students must be intellectually engaged and actively involved in their learning environment. As the most of studies reviewed in chapter 2 agreed, students' active participation can be promoted by using instructional methods based on meaningful learning.

In order to convert the plan of the study into action in which an integration of physics *gasing* learning model based on meaningful learning is used to enhance students' understanding of motion and force concepts, teaching materials were developed and applied. The materials developed in this stage were based on Surya Collage of Education (see Appendix 5) prepared from that program.

4. RESULTS

This chapter is divided into two parts. The first part deals with the information obtained from the survey with the rural students concerning the reasons of “what makes physics difficult”. From the survey, we try to develop a new method of learning physics to give an alternative ways of learning physics. Than an experimental research was conducted into this research in order to explore the effect of physics-*gasing* learning model on the students’ understanding toward kinematics and force. So the second part presents the results of the effect of physics without formula learning model on the students’ achievement test.

4.1. The result of the initial survey

In order to see how the students’ view on what makes physics difficult were explored from a form questionnaire (appendix 1). In other words, the first research question on what makes physics difficult was assessed through this instrument. The checklist was modified from the questionnaire that had been developed by the Ornek, Robinson and Haugan, (2008). There were three factors in the questionnaire. Each factor consists of 10 item questions. Each alternative in the checklist anwer was divided into agree and disagree. The number of items in each factor, and students’ averages on each factor is given in Table 4.1.

Table 4.1. The Average Score of Each Factor.

Factor	Average scores (%) who agree
Factor related to the students	68,71
Factor related to the courses	48,92
Factor related to the nature of physics	73,89

Table 4.1 indicates that factor related to the nature of physics is taking part as the maximum percentage on the reason why physics considered as a difficult subject. The factor related to the courses is taking part as the minimum percentage on the reason why physics considered as a difficult subject. It means that students have no problem with the course activity but it will be problem when they faced with physics subject. What is remarkable is that students think much problem when they hear or listen about physics word.

The average of each origin and gender on the questionnaire of what makes physics difficult and their average score on each factor are given in Table 4.2 and Table 4.3.

Table 4.2. The Average Score of Each Factor Toward the Students' Origin

Factors	Origin			
	Sumatra (%)	Kalimantan (%)	Papua (%)	WestPapua (%)
Factor related to the students	55,3	57,0	49,3	46,7
Factor related to the courses	39,2	36,6	36,7	31,9
Factor related to the nature of physics	51,8	60,0	54,9	56,2

According to the table 4.2 above, it showed that all Sumatran, Kalimantan, Papua and West Papua students have less than 40% said that physics was difficult because of the factor related to the course. More than fifty percent of the Sumatran and Kalimantan students agreed that the students controlled factor have an important impact on makes physics become difficult. But it just takes under fifty percent for the Papuan and West Papua students agreed. From the factor related to the nature of physics, all the origins have number more than fifty percent. So we can conclude that all the Sumatran, Kalimantan, Papua and West Papua all agree that the factor related to the nature of physics have a dominant impact on making physics become difficult.

Table 4.3. The average score of each factor of the questionnaire what makes physics difficult toward the students' gender

Factors	Gender	
	Male (%)	Female (%)
Factor related to the students	56,0	48,2
Factor related to the courses	38,0	38,1
Factor related to the nature of physics	59,4	52,0

From the table 4.3 above, the students' gender view on what makes physics difficult can be explored more detail. The female and male students mostly agreed that the factor related to the nature of physics and it took more than fifty percent. But they mostly didn't agree that the course controlled factor make physics difficult because it just takes not more than forty percent. It was interesting when how the factor related to the students regarding to the gender. It was different between male and female students. More than fifty percent of the male students agree that students-related factor makes physics difficult but not more than fifty percent of female students agree.

It was a same view on male and female students on the three factors of the reason on why physics difficult. The female and male students viewed that the factor related to the nature of physics is the most influenced factor among the three factors on why physics difficult. And the factor related to the course took the least reason on why physics difficult.

We can separate the items in Table 4.4 extremely into two groups. The first group is the item that has a high percentage of the students who mostly agree and the second group is the item that has a low percentage of the students who agree.

Table 4.4. The Percentage of Each Item Through Students Controlled Factor

	Percentage of students
Lack of motivation and interest	57
Not studying more	49
Not reading the textbook	46
Not completing CHIP assignment	21
Not doing practice many problems	70
Working only assigned problems	81
Not doing homework	21
Lack of previous experience	81
Lack of physics background	89
Lack of higher level mathematics	38

Lack of physics background, lack of previous experience and working only assigned problem are collected as the first group who has high percentage. From the table 4.4 showed that each part of the first group took more than 80%. The student agreed that lack of physics background (89%), lack of previous experience (81%) and working only assigned problem (81%) are important issues of making physics difficult when viewed from the students. The students must be able to work more than just solve the assigned problems, do one more experience in order to have better experience and read detaily the physical concept to enhance their physics background.

The second group consists of not completing CHIP (Computational Homework in Physics) assignment and not doing homework. This group took not more than 25%. So the students agreed that not doing homework and not completing CHIP assignment both are not have a big influence on making physics difficult.

Table 4.5. The Percentage of Each Item Through Course Controlled Factor

	Percent of students
Too much work	56
Hard CHIP homework	39
Lack of consistency between the lab/tutorial/lecture and homework	23
Textbooks, lectures, CHIP homework questions are too complicated	31
Tutorial sections are not useful	16
Being picky on grading	40
Not enough examples, real life applications, and problem solving especially conceptual questions in class	54
Hard questions on the exams and were not related to what solved in the class	19
Poor professors	41
Poor TAs	43

From table 4.5 there is no high percentage related to the course controlled factor. Each item in the course controlled factor takes part not more than 56%. Only two items have more than fifty percent, such as too much work (56%) and not enough examples, real life application and problem solving especially conceptual question in class (54%). Students think that physics is a subject who pushes them to do much work. They need to get more information on relationship between conceptual theory in the class and real life also they have to work hardly in the course to be successful in physics. Some items, such as tutorial sections are not useful and hard questions on the exam and were not related to what solved in the class both are have not more than twenty percent.

Table 4.6. The Percentage of Each Item Through Factor Related to the Nature of Physics.

	Percent of students
Physics is cumulative. If you miss one concept, it is hard to grasp the next one	97
Physics is very difficult subject	29
There is too much material to learn	59
Physics is very abstract	42
Physics requires good mathematics	95
Physics has too much theory	39
Physics has too many formulas to be learned	48
Physics has too many laws and rules	52
Physics is not interesting enough	7
Physics cannot be learned without mathematics background	79

We can devide the items in table 4.6 into two separately groups. The first group is being extremely high percentage and the second one is being extremely low percentage. The first group consists of physics is cumulative (97%) and physics required good mathematics (95%). Each item in the first group takes more than ninety percent of the students who agree that it becomes problem on making physics difficult. The students agree that physics is an accumulative subject and it requires good mathematics. The students must be able to work continously in order to get easy to grasp the next concept and also they have to be able to work better in mathematics subject in order to get better physical calculation. If they have no enough mathematics background, it will be problem in learning more on physics subject. And also if they miss one concept, it is difficult to follow and understand the next one.

Physics is not interesting enough is the only one of the second group who has extremely low percentage. It means students didn't think that physics is not interesting enough. Physics is interesting enough but they didn't know how to work better with physics.

4.2. Multiple Choice Achievement Test Result

The effectiveness of the physics-*gasing* learning model was analyzed through students' achievement toward kinematics and force. Two groups had been divided into experimental group and control group. The experimental group and control group each consist of 26 students. The control group was taught by conventional physics learning model. And the experimental group was taught by physics-*gasing* learning model.

4.2.1. Students' Pretest Score on Kinematics

The independent samples test was explored in order to test whether there is significant different between pre-test score in control group and experimental group. The data obtained are as provided in the table 4.7.

Table 4.7. Comparison of Multiple Choice Pretest Scores

	N	Mean	SD	df	T	p
Experimental group	26	5.08	1.13	50	2.398	.020
Control group	26	4.35	1.06			

According to the table 4.7 the pretest kinematics achievement grade average of the experiment group students is 5.08. And the pre-test kinematics achievement grade average of the control group is 4.35. And the result shown that $t(50)=2.398$, $p>0.01$. It means that there is no significant difference on pretest score between control group and experimental group.

4.2.2. The control group's comparasion on pretest and post-test toward kinematics

Table 4.8. The Comparasion of Pretest and Posttest Scores of Kinematics Achievement Test in Control Group

	N	mean	SD	df	t	p
Pretest of Kinematics	26	4.35	1.06	25	-4.917	.000
Posttest of Kinematics	26	5.61	1.06			

Table 4.8 shows that there is a significant difference between pretest (mean = 4.35, SD = 1.06) and posttest (mean = 5.61, SD = 1.06) marks, t (25) = -4.917, $p < .01$). The mean scores indicate that the control group posttest have significant higher achievement than pretest on kinematics chapter. The p value indicates that there is a significant difference between protest and pretest score.

4.2.3. The experimental group's comparison on pretest and post-test toward kinematics.

The pre-test and post-test had had been conducted to the experimental group. The table 4.9 provides data that can be examined to find out is there any significant difference between the pretest score and posttest score of the experimental group.

Table 4.9. The comparison of pretest and posttest scores in experimental group.

	N	mean	SD	df	t	p
Pretest of Kinematics	26	5.08	1.13	25	-8.713	.000
Posttest of Kinematics	26	7.60	1.13			

From the table 4.9 we found that the pretest score of the experimental group is 5.08 and the posttest score is 7.60. It seems to be higher. By the statistical calculation, the result of the paired t-test is ($t(25)=-8.713$, $p<0.01$). The p value <0.01, so it means that there is a significant difference between posttest and pretest grade on experimental group.

4.2.4. Students' Posttest Score on Kinematics

At the end of the study, independent samples t-test were also explored to investigate whether is there a significant mean difference among the groups with respect to students' posttest grade on KAT due to the different instructional methods used.

Table 4.10. The results of independent samples t-test analysis for group comparison with respect to posttest scores on achievement test toward kinematics.

	N	Mean	SD	df	t	p
Experimental group	26	7.60	1.13	50	6.515	.000
Control group	26	5.61	1.06			

In table 4.10, t-test results revealed that there is significant mean difference between posttest scores of the students in two groups with respect to KAT after the implementation of the study ($t = 6.515$ & $p = 0.000 < 0.01$). This observable difference in achievement between students in experimental and control groups is thought to be: experimental students' greater engagement in the lessons as compared with the traditional classes; learning by doing through meaningful learning increased students understanding and the more students understand the topic the more they develop better achievement. Furthermore, the significantly higher academic achievements of the experimental group with respect KAT is thought to be the consequence of motivational increase due to the introductory physics based on meaningful learning supported by physics gasing model used.

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter is divided into three subsections. Conclusions are given in the first subsection. The second subsection presents the discussion of the results. Finally, the last section presents recommendations for further research studies.

The purpose of this study was to make an investigation in order to find out what students believe makes physics and to compare the effects of physics without formula based on meaningful learning and traditional teaching methods on students' academic achievement in force and motion. Students from different island in Indonesia who are taking a preparation course in Surya Collage of education was taken into account of survey. The effects of the physics without formula based meaningful learning among the physics students were investigated.

In this study the effects of physics without formula based on meaningful learning on students' academic achievements and their perception towards what makes physics difficult were investigated. Academic achievement test towards physics in pretest-posttest experimental design were used. Besides these, students' opinions towards what makes physics difficult, in initial questionnaire, were also determined and interpreted. According to the results of independent samples t-test in pretest scores with respect to achievement test, there was no significant mean score difference between the groups. After the implementation of the study, the results of t-test revealed that there is significant mean difference between the groups and that the experimental group who were exposed to the instruction based on meaningful learning with physics without formula were more successful than the control group who were exposed to traditional physics instruction.

A related survey had been developed before in order to find out what students believe makes physics and what can be done to overcome these difficulties. Ornek, Robinson and Haugan (2008) developed an initial free-response survey given to approximately

1400 students in an introductory physics course and a second survey, which was given to approximately 400 students in another semester, distilled from the responses to the first survey. Faculty members and teaching assistants for physics courses was also asked to complete the second survey. They found that the perceptions of the students and faculty members are different in terms of difficulties which students have in a physics course. The perceptions of students and TAs are mostly the same. Both students and faculty members agree that student-related factors, such as not studying more have the most influence on students' success in physics.

From the initial survey results, we can conclude that students from different part of Indonesia have no much different perceptions about what make physics difficult. Students think closely in terms of their problem toward physics learning. This study has shown that basically the lack of mathematics background becomes the most important reason on physics difficult. We need to provide our students with a scenario in which one model is supported by simple mathematics so that the students can be easier to understand the introductory physics. Consequently, although introductory physics is difficult, we can convince our students with arguments that are closely linked to mathematical evidence.

Even though we cannot generalize our findings to all physics courses because every physics course might be different, we believe the findings about how the students think about physics and difficulties in physics can be useful to faculty of physics courses in other universities. We recommend that faculty members try a similar survey for their classes because it would give them an opportunity to see that course in the way their students perceive it.

According to many students, introductory physics is difficult (Ornek, Robinson and Haugan, 2008). This study shows that learning physics is difficult for many reasons. Students' views about a course influence their understanding and learning of that course. Many students think and say, "Physics is difficult". According to Angell, Guttersrud, Henriksen and Isnes (2004) on the research of the views of high school students and physics teachers about physics. They found that students find physics difficult because they have to contend with different representations such as experiments, formulas and calculations, graphs, and conceptual explanations at the same time. Physics requires the ability to use algebra and geometry and to go from the specific to the general and back Redish (1994). According to Carter and Brickhouse (1989) students, faculty and teaching assistants will live in different World and it will be difficult to communicate because they speak different languages.

This study has shown that basically the the lack of mathematics background become the most important reason on physics difficult. We need to provide our students with a scenario in which one model is supported by simple mathematics so that the students can be easier to understand the introductory physics. Consequently, although introductory physics is difficult, we can convince our students with arguments that are closely linked to mathematical evidence.

Related to the second study conducted, instructions based on meaningful learning through physics without formula seem to be more effective in enhancing students' achievement in mechanics than instructions based on traditional lecturing.

RECOMMENDATION

The research of what makes physics difficult provides one more valuables information that can be used by educational policy makers or teachers on designing an appropriate curriculum, preparing course materials and choosing the learning method.

On the basis of the findings from this study and the literatures reviewed, it is recommended that:

- Every physics course is never be same and always controlled by different condition and culture so it is mostly impossible to generalize our research findings to all physics courses. But the findings about difficulties in physics course can be useful to educational policy makes to decide an alternative solution on giving better teaching model especially in physics learning. We recommend to all educational policy makers, teachers or faculty members to make a similar research in order to give them an opportunity to understand better the students' problem on physics learning.

- We recommend that it should be an alternative physics teaching book that provides simpler and easier mathematics on the physics learning.
- Similar studies should be carried out for different grade levels and for different topics with large samples so that the results of this study about the effects of learning physics based on meaningful learning through physics without formula on students' academic achievements can be generalized.

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APPENDICES

Appendix 1

Questionnaire on "What makes physics difficult?"

Student-Controlled Factors		Yes	No
1.	Lack of motivation and interest		
2.	Not studying more		
3.	Not reading the textbook		
4.	Not completing CHIP assignment		
5.	Not doing practice many problems		
6.	Working only assigned problems		
7.	Not doing homework		
8.	Lack of previous experience		
9.	Lack of physics background		
10.	Lack of higher level mathematics		
Course-Controlled Factors			
11.	Too much work		
12.	Hard CHIP homework		
13.	Lack of consistency between the lab/tutorial/lecture and homework		
14.	Textbooks, lectures, CHIP homework questions are too complicated		
15.	Tutorial sections are not useful		
16.	Being picky on grading		
17.	Not enough examples, real life applications, and problem solving especially conceptual questions in class		
18.	Hard questions on the exams and were not related to what solved in the class		
19.	Poor professors		
20.	Poor TAs		
Factors Related to the Nature of Physics			
21.	Physics is cumulative. If you miss one concept, it is hard to grasp the next one		
22.	Physics is very difficult subject		
23.	There is too much material to learn		
24.	Physics is very abstract		
25.	Physics requires good mathematics		
26.	Physics has too much theory		
27.	Physics has too many formulas to be learned		
28.	Physics has too many laws and rules		
29.	Physics is not interesting enough		
30.	Physics cannot be learned without mathematics background		

Appendix 2
Physics Achievement Test toward Kinematics

1. A bicyclist moves at a constant speed of 4 m/s. How long it will take for the bicyclist to move 36 m?
   A. 3 s B. 6 s C. 12 s D. 9 s E. 144 s

2. A train moves at a constant velocity of 50 km/h. How far will it move in 0.5 h?
   A. 10 km B. 20 km C. 25 km D. 45 km E. 50 km

3. A toy car moves 8 m in 4 s at the constant velocity. What is the car's velocity?
   A. 1 m/s B. 2 m/s C. 3 m/s D. 4 m/s E. 5 m/s

4. Starting from the origin, a car travels 4 km east and then 7 km west. What is the traveled distance of the car from the initial point?
   A. 3 km B. 3 km C. 4 km D. 7 km E. 11 km

5. An object moves with a constant acceleration of 5 m/s2. Which of the following statements is true?
   A. The object's velocity stays the same
   B. The object moves 5 m each second
   C. The object's acceleration increases by 5 m/s2 each second
   D. The object's acceleration decreases by 5 m/s2 each second
   E. the object's velocity increases by 5 m/s each second

6. Two automobiles are 150 kilometers apart and traveling toward each other. One automobile is moving at 60 km/h and the other is moving at 40 km/h. In how many hours will they meet?
   (A) 1.5 (B) 1.75 (C) 2.0 (D) 2.5 (E) 1

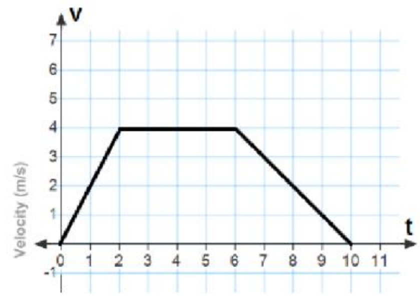
7. A toy car moves 3.0 m to the North in one second. The car then moves at 9.0 m/s due South for two seconds. What is the average speed of the car for this three second trip?
   (A) 4.0 m/s (B) 5.0 m/s (C) 6.0 m/s (D) 2 m/s (3) 7 m/s

8. An object moves at a constant speed of 6 m/s. This means that the object:
   a. Increases its speed by 6 m/s every second
   b. Decreases its speed by 6 m/s every second
   c. Doesn't move
   d. Has a positive acceleration
   e. Moves 6 meters every second

9. A boot initially travelling at 10 m/s accelerates uniformly at the rate of 5 m/s^2 for 10 seconds. How far does the boat travel during this time?
   A. 250 m
   B. 500 m
   C. 350 m
   D. 50 m
   E. 100 m

10. An object start from rest and falls freely. What is the velocity of the object at the end of 3 second? ($g = 10\ m/s^2$)
A. 30 m/s B. 10 m/s C. 20 m/s D. 25 m/s E. 15 m/s

11. What is the magnitude of acceleration of the object between 6 s and 10 s?



A. $0\ m/s^2$
B. $1\ m/s^2$
C. $2\ m/s^2$
D. $3\ m/s^2$
E. $4\ m/s^2$

12. A rock is dropped from a window 5 m above the ground. The rock hits the ground 1 second later with a speed of 10 m/s. What is the average speed of the rock during this time?

a. 5 m/s
b. 8 m/s
c. 15 m/s
d. 50 m/s
e. 25 m/s

13. Starting from rest, object 1 falls freely for 4.0 seconds, and object 2 falls freely for 8.0 seconds. Compared to object 1, object 2 falls:
a. half as far
b. twice as far
c. three times as far
d. four times as far
e. same as far

14. A ball which is dropped from the top of a building strikes the ground with a speed of 30 m/s. Assume air resistance can be ignored. The height of the building is approximately:
a. 15 m
b. 30 m
c. 45 m
d. 75 m
e. 90 m

15. A car starts from rest and uniformly accelerates to a final speed of 20.0 m/s in a time of 15.0 s. How far does the car travel during this time?
a. 100 m
b. 300 m
c. 450 m
d. 600 m
e. 150 m

16. A person pushes a heavy cabinet across a level wooden floor. Force X is the force required to start the cabinet moving. Force Y is the force required to maintain a slow, steady forward motion. Which of the following statements describes the two forces, X and Y?

a. Force X is added to force Y.

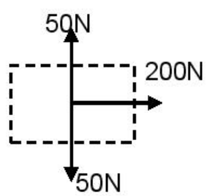
b. Force X is less than force Y.

c. Force X is unrelated to force Y.

d. Force X is greater than force Y.

e. Force X is equal with force Y

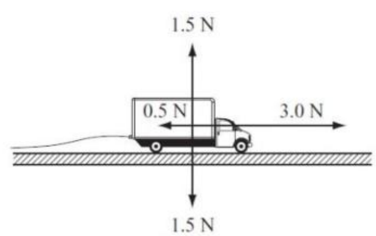
17. The free-body diagram below represents all the forces acting on an object.



What is the net force acting on this object?

a. 0 N up
b. 100 N down
c. 200 N right
d. 200 N left
e. 300 N right

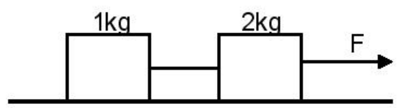
18. A toy truck powered by a battery is accelerating to the right. A string with negligible mass is attached to the truck. The diagram below shows the forces acting on the truck.



If a child pulls the string to the left, what force must the child exert to make the toy truck move to the right at a constant velocity?

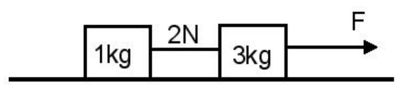
a. 1.0 N
b. 1.5 N
c. 2.5 N
d. 6.0 N
e. 2 N

19. When the frictionless system shown above is accelerated by an applied force of magnitude the tension in the string between the blocks is



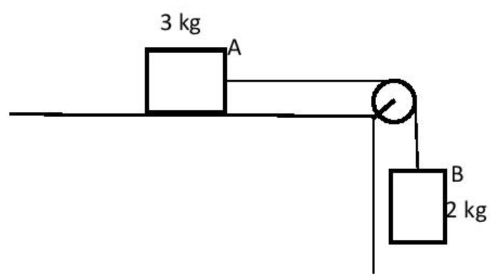
a. F
b. 2/3 F
c. ½ F
d. 1/3 F
e. 2F

20. Two blocks of mass 1.0 kg and 3.0 kg are connected by a string which has a tension of 2.0 N. A force F acts in the direction shown to the right. Assuming friction is negligible, what is the value of F?



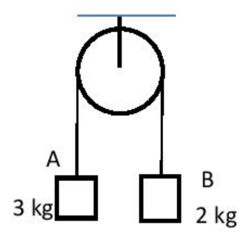
a. 2.0 N
b. 4.0 N
c. 6.0 N
d. 8.0 N

21. What is the value of acceleration of this system? The floor is frictionless



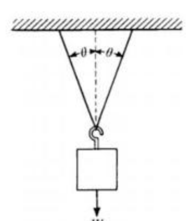
a. 1 m/s^2
b. 2 m/s^2
c. 3 m/s^2
d. 4 m/s^2
e. 5 m/s^2

22. Calculate the acceleration of these system!



a. 1 m/s^2
b. 2 m/s^2
c. 3 m/s^2
d. 4 m/s^2
e. 5 m/s^2

23. When an object of weight W is suspended from the center of a massless string as shown above, the tension at any point in the string is



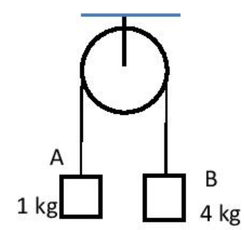
a. 2W cosθ
b. ½W cosθ
c. W/(2cosθ)
d. W/(cosθ)
e. ½W sinθ

24. A 4.0 kg mass is attached to one end of a rope 2 m long. If the mass is swung in a vertical circle from the free end of the rope, what is the tension in the rope when the mass is at its highest point if it is moving with a speed of 5 m/s?

(A) 5.4 N (B) 10.8 N (C) 50 N (D) 65.4 N (E) 100 N

25. A person pushes a couch across a wooden floor. What force changes when the couch first begins to move?
a. frictional force
b. gravitational force
c. normal force
d. tension force
e. Magnetic force

26. The magnitude of the tension of the string between these two blocks is



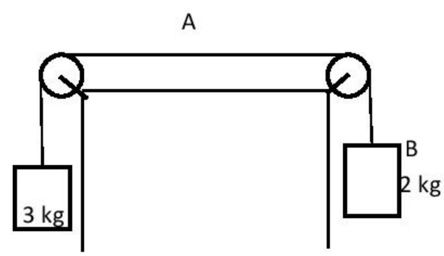
a. 10 N
b. 12 N
c. 14 N
d. 16 N
e. 18 N

27. A ball of mass m is fastened to a string. The ball swings at constant speed in a vertical circle of radius R with the other end of the string held fixed. Neglecting air resistance, what is the difference between the string's tension at the bottom of the circle and at the top of the circle?
(A) mg (B) 2mg (C) 4mg (D) 8mg (E) 10 mg

.

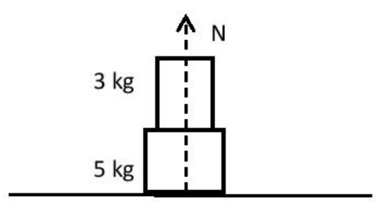
28. A ball falls straight down through the air under the influence of gravity. There is a retarding force F on the ball with magnitude given by F = bv, where v is the speed of the ball and b is a positive constant. The ball reaches a terminal velocity after a time t. The magnitude of the acceleration at time t/2 is
a. Increasing
b. Decreasing
c. 10 m/s/s
d. Zero
e. Same/No different

29. The magnetude of the tension of the string is



a. 20 N
b. 22 N
c. 24 N
d. 26 N
e. 28 N

30. The magnitude of N is ....



a. 8N
b. 2 N
c. 15 N
d. 30 N
e. 80 N

Apendix 3 : Validity and Reliability

No	Veri	soru 1	soru 2	soru 3	soru 4	soru 5	soru 6	soru 7	soru 8	soru 9	soru 10
1	veri 1	1	1	1	1	0	1	1	1	1	1
2	veri 2	0	1	1	1	1	1	1	1	1	1
3	veri 3	0	1	1	1	1	1	1	1	1	1
4	veri 4	1	1	0	1	1	1	1	1	1	1
5	veri 5	0	1	1	1	1	1	0	1	1	1
6	veri 6	1	1	0	1	1	1	1	1	1	1
7	veri 7	1	1	1	1	1	1	1	1	1	0
8	veri 8	1	1	1	1	0	1	1	1	1	1
9	veri 9	0	1	0	1	1	0	1	1	1	1
10	veri 10	1	1	1	0	1	1	1	1	1	1
11	veri 11	1	1	1	1	1	1	1	1	1	1
12	veri 12	1	1	1	1	0	1	1	1	1	0
13	veri 13	0	1	1	1	1	1	1	1	1	0
14	veri 14	1	1	1	1	1	1	1	1	1	0
15	veri 15	0	1	0	1	0	1	1	1	1	1
16	veri 16	1	1	1	1	1	1	1	1	1	0
17	veri 17	0	1	0	1	0	1	0	1	1	0
18	veri 18	1	1	0	1	0	0	1	1	1	1
19	veri 19	0	1	0	1	1	1	1	0	1	0
20	veri 20	1	1	0	1	1	1	1	1	1	1
21	veri 21	0	1	0	1	0	1	1	1	1	1
22	veri 22	1	0	0	1	1	0	1	1	1	0
23	veri 23	0	0	1	0	1	0	0	1	0	1
24	veri 24	1	1	1	1	0	1	1	1	0	1
25	veri 25	0	0	0	0	1	1	0	0	0	0
26	veri 26	0	0	1	0	0	0	1	1	0	1
27	veri 27	0	0	1	0	0	0	0	1	1	1
28	veri 28	0	0	0	0	1	0	1	0	0	1
29	veri 29	0	1	1	0	1	1	0	1	0	0
30	veri 30	1	0	0	0	0	0	1	1	1	0
31	veri 31	0	1	0	1	1	1	1	0	1	0
32	veri 32	1	0	0	1	1	1	0	0	1	1
33	veri 33	0	1	1	1	1	1	1	1	1	0
34	veri 34	1	0	1	1	0	1	1	1	1	0
35	veri 35	0	1	0	0	1	1	0	1	1	0
36	veri 36	0	1	1	0	1	1	0	1	0	0
37	veri 37	0	0	1	1	0	1	1	1	1	1
38	veri 38	1	0	1	1	0	1	0	1	1	0
39	veri 39	0	1	0	1	1	1	1	1	1	0
40	veri 40	0	0	1	0	0	1	0	1	1	0
	X	18	28	23	29	25	32	29	35	33	21
	rxy	0.416	0.441	0.252	0.619	0.083	0.397	0.443	0.316	0.613	0.299
	rtabel	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312
	Valid status	valid	valid	invalid	valid	invalid	valid	valid	valid	valid	invalid
	Ba	12	20	12	19	14	18	18	19	20	13
	Bb	6	8	11	10	11	14	11	16	13	8
	D	0.3	0.6	0.05	0.45	0.15	0.2	0.35	0.15	0.35	0.25
	Different	enough	good	bad	good	bad	bad	enough	bad	enough	enough
	P	0.45	0.7	0.575	0.725	0.625	0.8	0.725	0.875	0.825	0.525
	Difficulty	normal	normal	normal	easy	normal	easy	easy	easy	easy	normal
	p	0.45	0.7	0.575	0.725	0.625	0.8	0.725	0.875	0.825	0.525
	q	0.55	0.3	0.425	0.275	0.375	0.2	0.275	0.125	0.175	0.475
	pq	0.248	0.210	0.244	0.199	0.234	0.160	0.199	0.109	0.144	0.249
	Result	used	used	reject	used	reject	used	used	used	used	reject

soru 11	soru 12	soru 13	soru 14	soru 15	soru 16	soru 17	soru 18	soru 19	soru 20
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23	31	25	25	20	28	18	12	23	23
0.582	0.504	0.414	0.582	0.031	0.599	0.574	0.374	0.595	0.239
0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312
valid	valid	valid	valid	invalid	valid	valid	valid	valid	invalid
14	18	15	15	11	18	12	8	14	14
9	13	10	10	9	10	6	4	9	9
0.25	0.25	0.25	0.25	0.1	0.4	0.3	0.2	0.25	0.25
enough	enough	enough	enough	bad	enough	enough	bad	enough	enough
0.575	0.775	0.625	0.625	0.5	0.7	0.45	0.3	0.575	0.575
nomal	easy	nomal	nomal	nomal	nomal	nomal	difficult	nomal	nomal
0.575	0.775	0.625	0.625	0.5	0.7	0.45	0.3	0.575	0.575
0.425	0.225	0.375	0.375	0.5	0.3	0.55	0.7	0.425	0.425
0.244	0.174	0.234	0.234	0.250	0.210	0.248	0.210	0.244	0.244
used	used	used	used	reject	used	used	reject	used	reject

soru 21	soru 22	soru 23	soru 24	soru 25	soru 26	soru 27	soru 28	soru 29	soru 30
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31	35	25	26	29	25	24	19	29	25
0.316	0.430	0.660	0.371	0.633	0.154	0.296	0.770	0.527	0.323
0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312
valid	valid	valid	valid	valid	invalid	invalid	valid	valid	valid
18	20	15	12	17	13	13	12	17	15
13	15	10	14	12	12	11	7	12	10
0.25	0.25	0.25	-0.1	0.25	0.05	0.1	0.25	0.25	0.25
enough	enough	enough	bad	enough	bad	bad	enough	enough	enough
0.775	0.875	0.625	0.65	0.725	0.625	0.6	0.475	0.725	0.625
easy	easy	normal	normal	easy	normal	normal	normal	easy	normal
0.775	0.875	0.625	0.65	0.725	0.625	0.6	0.475	0.725	0.625
0.225	0.125	0.375	0.35	0.275	0.375	0.4	0.525	0.275	0.375
0.174	0.109	0.234	0.228	0.199	0.234	0.240	0.249	0.199	0.234
used	used	used	used	used	reject	reject	used	used	used

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0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	0	0	0	1	1
0	0	1	1	1	1	0	1	1	0
1	0	1	0	0	1	0	1	1	1
0	0	0	0	1	0	0	0	0	0
22	11	21	23	23	19	11	22	34	23
0.417	0.296	0.658	0.462	0.570	0.380	0.232	0.531	0.393	0.404
0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312
valid	invalid	valid	valid	valid	valid	invalid	valid	valid	valid
14	8	13	14	14	13	9	15	19	15
8	3	8	9	9	6	2	7	15	8
0.3	0.25	0.25	0.25	0.25	0.35	0.35	0.4	0.2	0.35
enough	enough	enough	enough	enough	enough	enough	enough	bad	enough
0.55	0.275	0.525	0.575	0.575	0.475	0.275	0.55	0.85	0.575
normal	difficult	normal	normal	normal	normal	difficult	normal	easy	normal
0.55	0.275	0.525	0.575	0.575	0.475	0.275	0.55	0.85	0.575
0.45	0.725	0.475	0.425	0.425	0.525	0.725	0.45	0.15	0.425
0.248	0.199	0.249	0.244	0.244	0.249	0.199	0.248	0.128	0.244
used	reject	used	used	used	used	reject	used	used	used

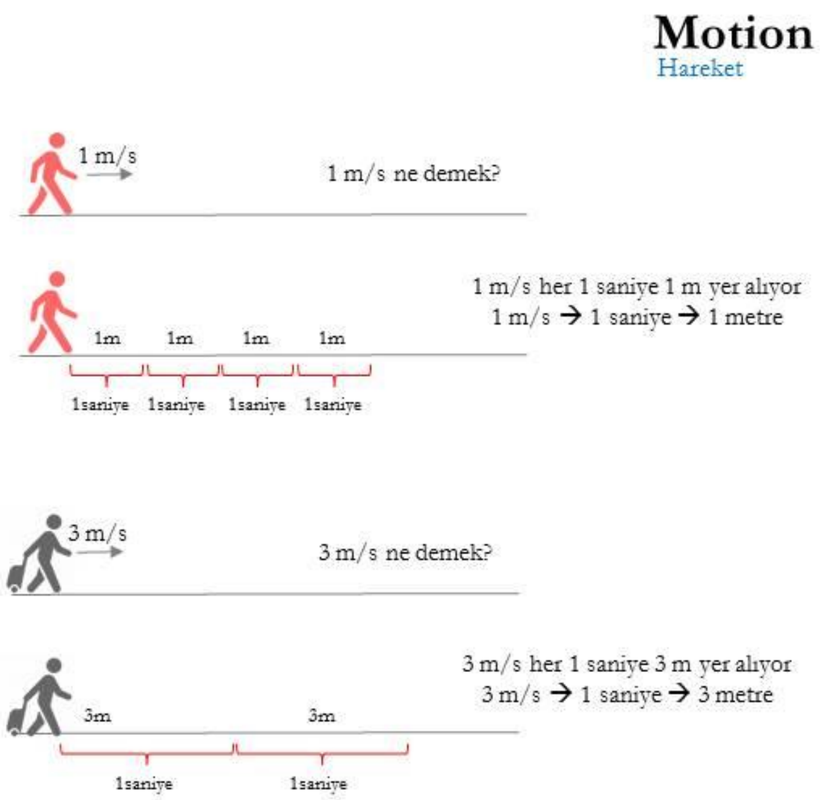
Appendix 4

Recapitulation of Validity and Reliability Test

No	Validity	Level of Difficulty	Power of Difference	Result
Soru1	0.416	0.3	0.450	Used
Soru2	0.441	0.6	0.700	Used
Soru3	0.252	0.05	0.575	Rejected
Soru4	0.619	0.45	0.725	Used
Soru5	0.083	0.15	0.625	Rejected
Soru6	0.397	0.2	0.800	Used
Soru7	0.443	0.35	0.725	Used
Soru8	0.316	0.15	0.875	Used
Soru9	0.613	0.35	0.825	Used
Soru10	0.299	0.25	0.525	Rejected
Soru11	0.582	0.25	0.575	Used
Soru12	0.504	0.25	0.775	Used
Soru13	0.414	0.25	0.625	Used
Soru14	0.582	0.25	0.625	Used
Soru15	0.031	0.1	0.500	Rejected
Soru16	0.599	0.4	0.700	Used
Soru17	0.574	0.3	0.450	Used
Soru18	0.374	0.2	0.300	Rejected
Soru19	0.595	0.25	0.575	Used
Soru20	0.239	0.25	0.575	Rejected
Soru21	0.316	0.25	0.775	Used
Soru22	0.430	0.25	0.875	Used
Soru23	0.660	0.25	0.625	Used
Soru24	0.371	-0.1	0.650	Used
Soru25	0.633	0.25	0.725	Used
Soru26	0.154	0.05	0.625	Rejected
Soru27	0.296	0.1	0.600	Rejected
Soru28	0.770	0.25	0.475	Used
Soru29	0.527	0.25	0.725	Used
Soru30	0.323	0.25	0.625	Used
Soru31	0.417	0.3	0.550	Used
Soru32	0.296	0.25	0.275	Rejected
Soru33	0.658	0.25	0.525	Used
Soru34	0.462	0.25	0.575	Used
Soru35	0.570	0.25	0.575	Used
Soru36	0.380	0.35	0.475	Used
Soru37	0.232	0.35	0.275	Rejected
Soru38	0.531	0.4	0.550	Used
Soru39	0.393	0.2	0.850	Used
Soru40	0.404	0.35	0.575	Used

Appendix 5

Teaching Materials



Motion

Hareket

How to solve this problem?

When they will meet?

There are two men, Mr. Red and Mr. Black. They are separated in distance 10 m. If Mr. Red walking with speed 3 m/s to the right side and Mr. Black waling 2 m/s to the left side. When they will meet each others?

All the students usually think like this ….

$S = S_1 + S_2$

$S = V_1\, t_1 + S_{o2} + V_2 t_2$

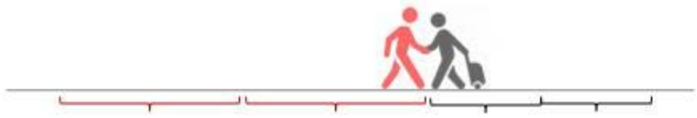
$0 = V_1\, t_1 + 10 + (-V_2)\, t_2$

Motion
Hareket

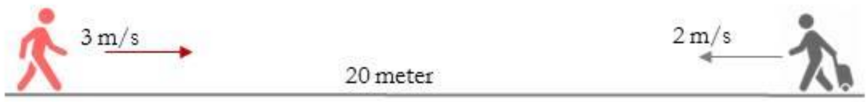
How to solve this problem?

1 saniyede

2 saniyede



Motion
Hareket



Let's start .....

Every 1 second can move 3 m

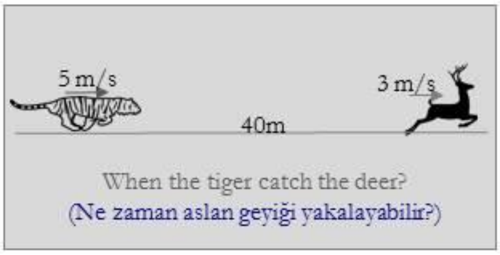
Every 1 second can move 2 m

Every 1 second, getting closer 5 m
(her 1 saniyede 5 metre yakınlaşiyor)

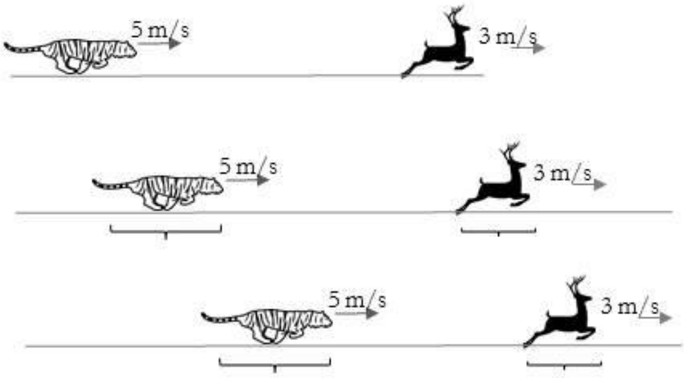
We can write (böyle yazabiliriz)

Her 1 saniyede ====> 5 metre

4 saniyede ====> 20 metre



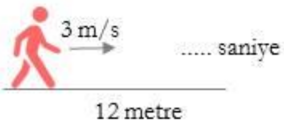
Motion
Hareket

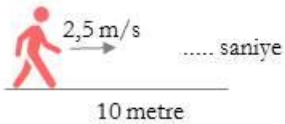


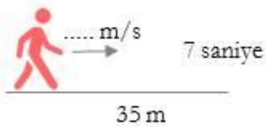
It easy because
In 1 second the tiger go to the right side 5 m
In 1 second the deer go to the right side 3 m

Every 1 second ==> 2 metre
2 second ==> 40 metre

Hareket
Problemleri



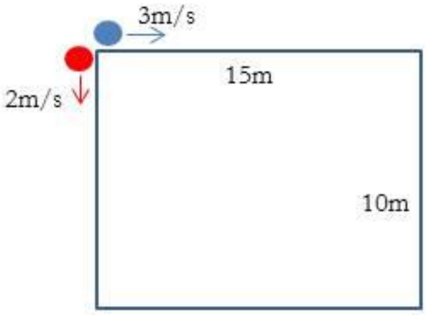


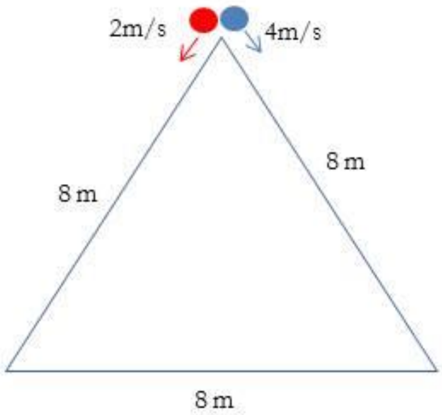


When & where they will meet?

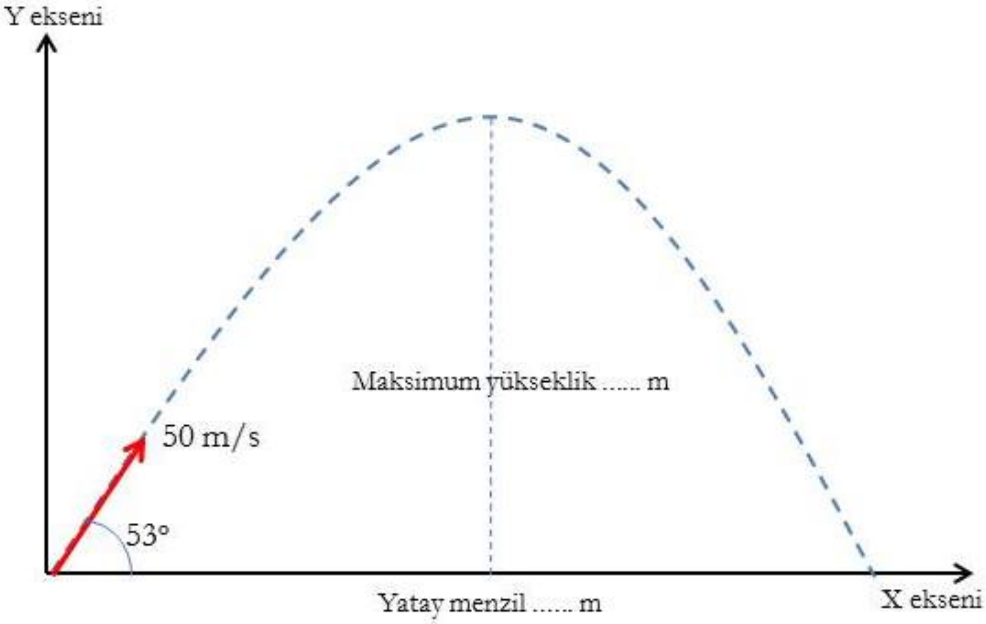
Hareket
Problemleri

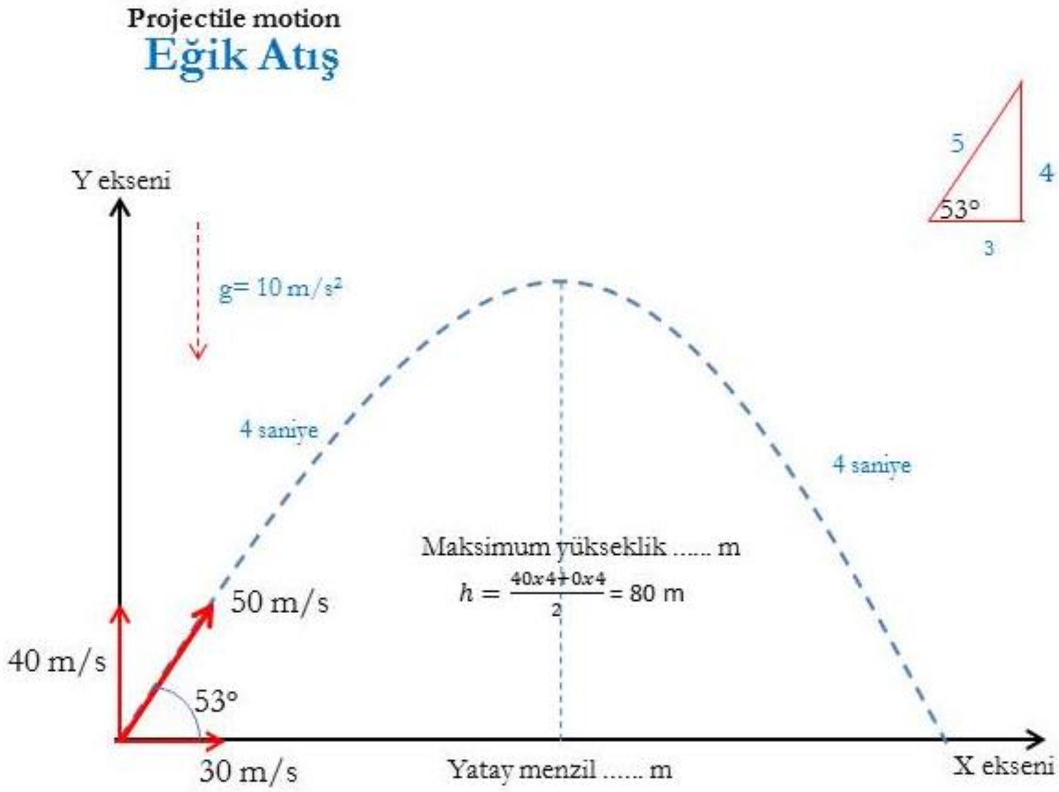
When the tiger catch the deer?

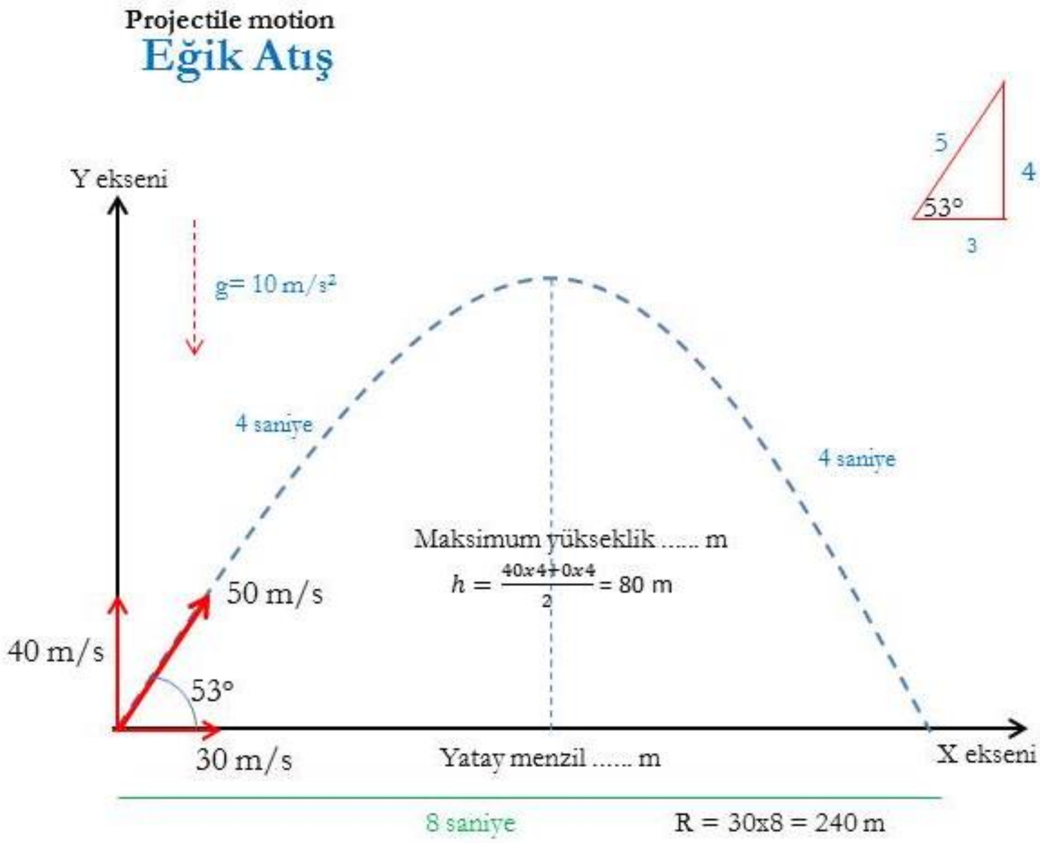




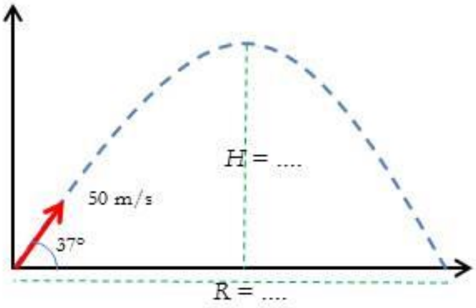
Projectile motion
Eğik Atış

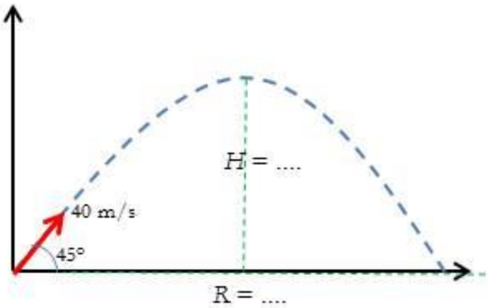


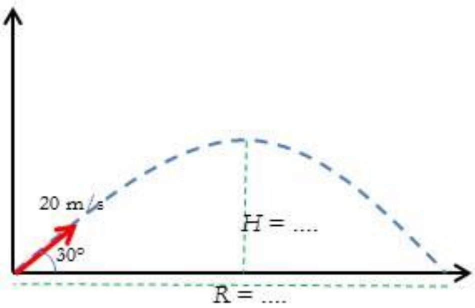

Projectile motion
Eğik Atış
5
4
53°
3
Y ekseni
g= 10 m/s²
4 saniye
4 saniye
Maksimum yükseklik ...... m
h = (40x4+0x4)/2 = 80 m
50 m/s
40 m/s
53°
30 m/s
Yatay menzil ...... m
X ekseni

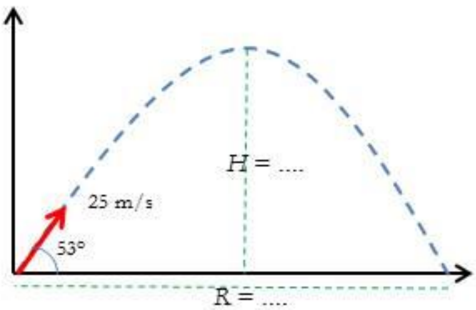

Projectile motion
Eğik Atış
5
4
53°
3
Y ekseni
g= 10 m/s²
4 saniye
4 saniye
Maksimum yükseklik ...... m
h = (40x4+0x4)/2 = 80 m
50 m/s
40 m/s
53°
30 m/s
Yatay menzil ...... m
X ekseni
8 saniye
R = 30x8 = 240 m

Eğik Atış
Problemleri

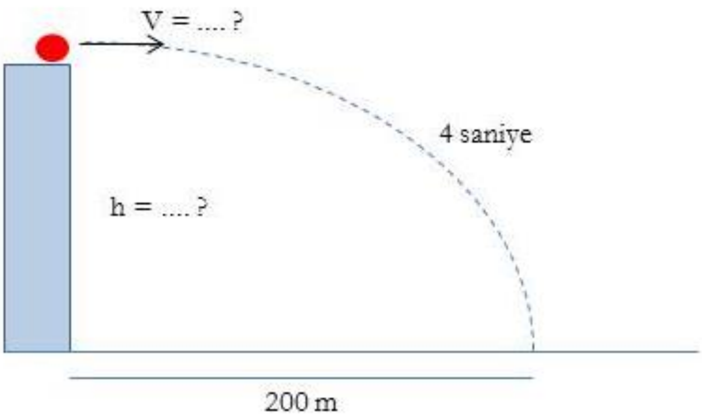






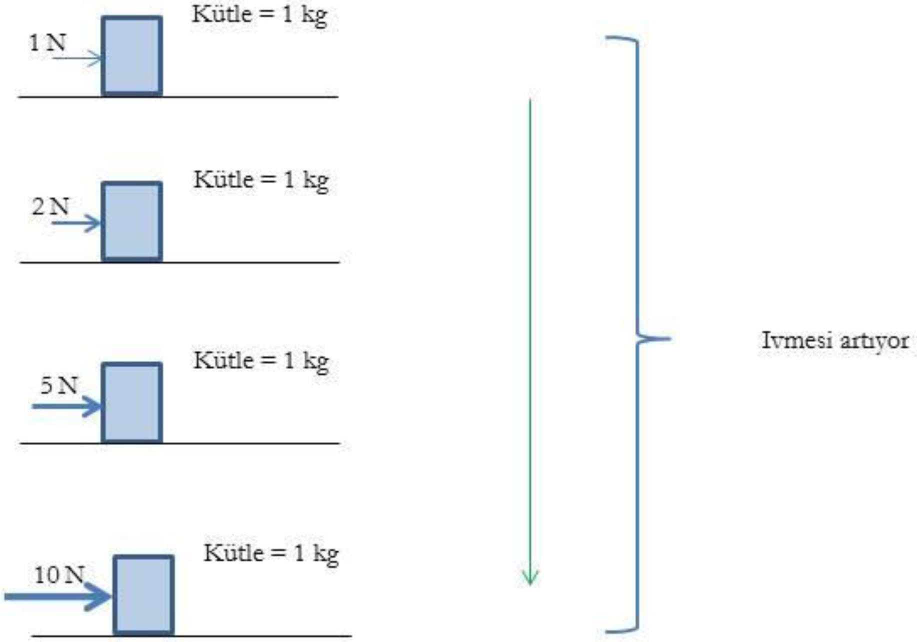


Eğik Atış
Problemleri



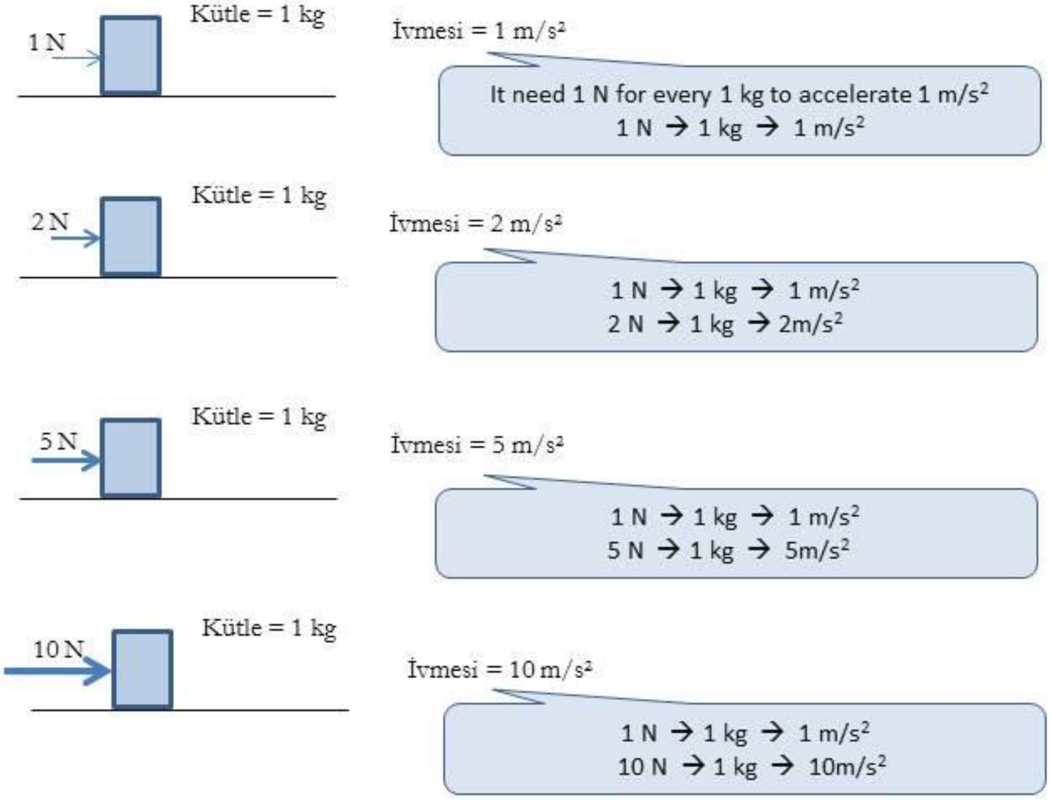
Force

Kuvvet



Force

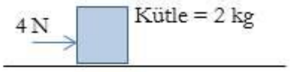
Kuvvet

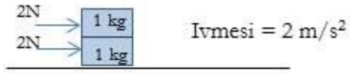


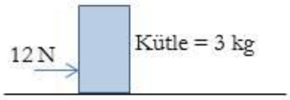
Force
Kuvvet

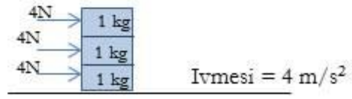
If the mass > 1 kg, how it was?

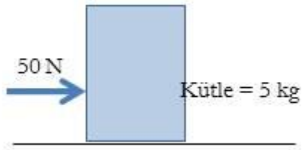
Kütlenin 1 den fazla olursa, nasıl oluyor?

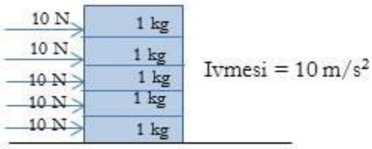




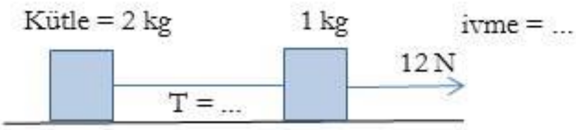




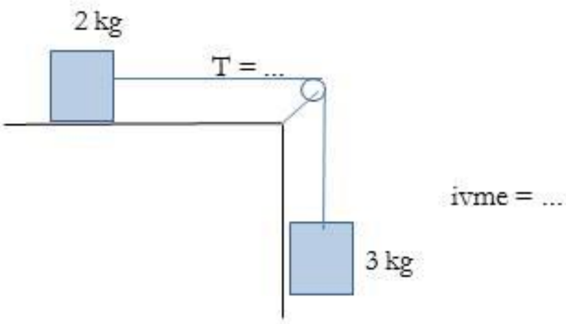


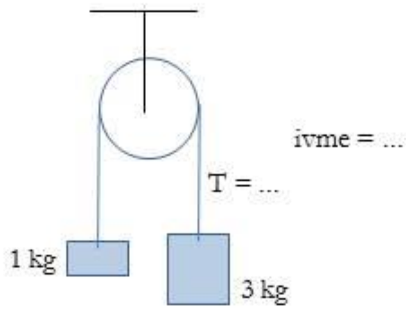


Kuvvet
Problemleri



$\mu = 0$





$\mu = 0$