8th Grade: MAKING WORK EASIER

(Work Using Inclines and Fixed Pulleys)

Rational of this unit

We use inclines and pulleys to carry heavy items in our daily lives. Also, in these days of advancing industrialization one cannot overlook the roles of machinery such as cranes and diggers that put out great amounts of power. These machines can move large items with little effort, and have succeeded the use of simple tools such as inclines through experience over the years. Can we really say that our ***work*** benefits from us using tools?

By using tools, one can do ***work*** with very little effort. However, making the applied force small by itself does not mean ***work*** has benefited. In this case, the former ***work*** refers to work as used in daily life, and the latter is ***work*** as used in science. In this unit we will first clarify the concept of ***work*** as used in science, then help pupils develop the ability to observe daily life scientifically by showing workloads numerically.

Objectives: what pupils are expected to achieve in this unit

- Ability to use an incline when lifting an object and, by altering the angle of the incline, alter the size of the force applied. Understanding the connection between angle of inclination and force through experiences such as using an incline to move a drum barrel to a higher location, and substantiating this connection by numerical conversion of the results.
- With pulleys there are fixed pulleys, movable pulleys and wheel and axle arrangements. Understanding the characteristics of these pulleys through drawing water from wells and lifting heavy objects.
- Understanding the mechanics of work machinery such as cranes and diggers by properly fitting movable and fixed pulleys together.
- Arrive at the **principles of work** by comparing work done using tools and work done by hand.
- Ability to discuss the efficiency of work and explain giving examples.

Interrelation of contents of each grade

** The order below is as shown in the syllabus.*

Grade	What to teach (Making Work Easier)
1st Grade	• Making wheels • Using wheels
2nd Grade	• Making differently shaped wheels • The best shape for wheels • Rollers (pencils, corn stalks, corncobs, round sticks)
3rd Grade	–
4th Grade	• Safe use of simple tools (hammers, saws, jembes, pangas, knives, bottle openers) • Maintenance of simple tools (cleaning after use, sharpening of cutting tools, oiling, proper use, and proper storage methods)
5th Grade	• How to balance on a see-saw • Making a simple beam balance and balancing different materials on it to compare their masses.
6th Grade	• Motion (Moving objects, stopping moving objects) • Force (meaning of force, units of force (N))
7th Grade	• Meaning of friction • Advantages and disadvantages of the work of friction • Ways to increase and decrease friction • Positioning of a lever's fulcrum, load and effort (claw hammers, crowbars, hand-pushed wheelbarrows and plows)
8th Grade (This unit)	• Inclined slopes (ladders, stair case landings, spiralling roads climbing hills) • One fixed pulley (Items using one pulley, such as on a flagpole)

Before starting this unit

Current learning status of the pupils

Children see cranes and diggers carrying and lifting heavy objects, and have actually carried objects themselves using inclines. They are unknowingly experiencing a method of doing work more easily and smoothly, but do not understand how the magnitude of the applied force changes numerically through experiment, or that even if the force applied lowers that the distance travelling must become proportionately longer.

Preparatory Notes

- When pulling objects up an incline, you can get good data with little friction from the incline if you use an experimental-use dynamic cart. If applying a force diagonally without using an incline, you must first conduct an experiment and confirm that you will be able to get good results.

Objectives to be achieved by competency

Interest, motivation, and attitude

1. Taking an interest in things and phenomena of work, enthusiastically observing and conducting experiments, and trying to consider these observed matters and relate them to daily life.
2. Taking an interest in instances using pulleys, inclines, stairs, and ladders, and actively seeking cases making practical use of these tools.

Scientific thinking and communication activities

1. Ability to discover that you can pull an object with a smaller force when using an incline or pulley than you would not using any tools.
2. Ability to infer from experiments and experience that the workload is related not only to the magnitude of force but also the distance moved.

Knowledge, understanding, and skills in observation and experimentation

1. Ability to understand the basic concept, principles and rules regarding work and explain them.
2. Ability to explain that if you use tools such as inclines and stairs, you can do work easily without a large force.
3. Ability to explain that workload is related to magnitude of force and distance travelled, and the principle of work that no matter what method you use the amount of work done is the same, such that even with a small force you can increase the distance travelled proportionally.

Ideas behind the structuring the unit

First, ***work*** as used in daily life and that used in science is different. Make this difference clear and show the pupils how to show amount of work using numbers.

Next, let them observe that the reason we use tools in daily life is because the amount of work done is different when using tools and when using bare hands and understand the **principles of work** by seeking them through calculation.

Compare the same work being done by different people and machines, and discuss in terms of efficiency.

Unit teaching plan

(5 periods + 1 period for Final Unit Evaluation Test)

* The numeric value in parentheses represents the corresponding period (e.g. 1) means the first period).

* *(Evaluation: Knowledge and Skills 1), (Evaluation: Interest 1)*, etc. indicate the points at which teachers can check whether the pupils have attained the goals specified in the section *Objectives based on the viewpoint.*

Sub-Unit	Description
1. Work and Workloads (1 period)	1) Ability to distinguish between **work** as used in daily life and in science and clarify the definition of work. Also, understand formulas showing workload and become more proficient in utilizing them through application exercises. (This is learned in the 8th grade *Energy* unit, but review it again and try to further establish it) *(Evaluation: Interest 1, Knowledge and Skills 1)*
Intermediate Review (No time allotted)	Give the "1st **Sub-Unit Review Test**." (Homework can be given depending on the progress of the class.)
2. Work Using Tools (Using Inclines) (1 period)	2) Slopes are used to load and unload heavy loads. Examine through experimentation how this differs from lifting the load by hand. *(Evaluation: Interest 2, Thinking and Representation 1, Knowledge and Skills 2)*
3. Work Using Tools (Using Stairs) (1 period)	3) Examine through experimentation how using a ladder and stairs to reach a high place differ. *(Evaluation: Interest 2, Knowledge and Skills 3)*
4. Work Using Tools (Using Fixed Pulleys) (1 period)	4) Fixed pulleys are used to draw water from a well. Examine through experiencing how this differs from lifting the load by hand. *(Evaluation: Interest 2, Thinking and Representation 2, Knowledge and Skills 3)* • **Expansion:** Also try to examine movable pulleys in 4).

5. Work Efficiency (1 period)	5) Think about how efficiency of work can differ for the same job depending on how long it takes using everyday examples. *(Evaluation: Knowledge and Skills 3)*
Intermediate Review (No time allotted)	Give the "2nd to 5th **Sub-Unit Review Test**." (Homework can be given depending on the progress of the class.)
Unit End Review (1 period)	6) Give the "**Final Unit Evaluation Test**."

Lesson Plan

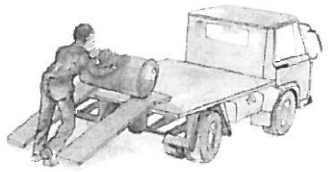
1. Work and Workloads (1 period: 1st period)

Goals of this sub-unit

- Ability to distinguish between **work** as used in daily life and in science and clarify the definition of work.

Period 1: Definition of Work

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 minutes	• What did the word work mean? →What is work as used in daily life? →What is work as used in science?	• Have the pupils review what they learned in Unit 8, *Energy*. *(Evaluation: Interest 1)* Taking an interest in things and phenomena of work, enthusiastically observing and conducting experiments, and trying to consider these observed matters and relate them to daily life.
Questions	What is **work** as used in science? Be able to remember what was learned in the unit on energy and explain.	
Presentation 20 minutes	• Definition of work →When a force is applied to an object and makes it move, the force is said to have done work on the object. **Question:** John is pushing a drum can up an incline into a lorry bed in the given figure. Compared to him lifting it by hand, which would get the job done using a smaller force?	** Reference* • Workload = Force x Distance Moved W = FS →Units of distance : metres (m) →Units of force : newtons (N) →Units of work : joules (J)

	force?  **Question:** In which case could you do the job moving it a shorter distance? **Question:** He applied force, but the drum was heavy and didn't move at all. Was any work done? • Think of other examples.	• Have groups make their own questions and try to get other groups to answer them.
Summary 5 minutes	• Know that work is related to force and distance.	*(Evaluation: Knowledge and Skills 1)* Ability to understand the basic concept, principles and rules regarding work and explain them.

2. Work Using Tools (Using Inclines) (1 period: 2nd period)

Goals of this sub-unit

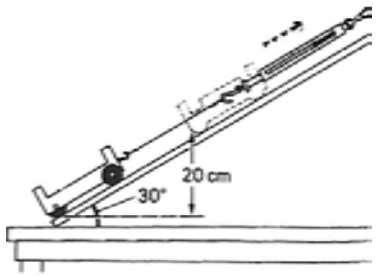
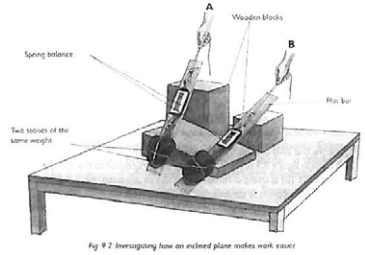
- Slopes are used to load and unload heavy loads. Examine through experimentation how this differs from lifting the load by hand.

Material Preparations

- Inclining board (alternatively a block to make an incline), dynamic cart (alternatively a wooden block or stone), spring balance, string (to connect the dynamic cart and spring balance)
- Worksheet

Period 2: Work Using Inclines

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Does using an incline offer a work benefit?	• Let the different groups give predictions. *(Evaluation: Interest 2)* Taking an interest in instances using pulleys, inclines, stairs, and ladders, and actively seeking cases making practical use of these tools.
Questions	Examine work using an incline.	
Presentation 20 minutes	• Conduct an experiment pulling an object up an incline.	• Have pupils record the results in their worksheet. *(Refer to pg. 220 regarding worksheet)*

	→Examine whether the workload will differ or not between pulling the cart (block or stone) up using an incline and pulling it up straight by hand.  • Experiment results →Things that changed – force, distance • Compare to predictions before the experiment.	• If you do not have a dynamic cart, using a wooden block or stone is also acceptable. • Any angle is fine for the inclination. • If you have extra time, let pupils conduct the experiment altering the angle of the incline, and have them investigate how the magnitude of the lifting force depends upon the angle of inclination.  Fig. 9.2 Investigating how an inclined plane makes work easier *(Evaluation: Thinking and Representation 1)* Ability to discover that you can pull an object with a smaller force when using an incline or pulley than you would not using any tools.
Summary 5 minutes	• Record results in the worksheet. • If using an incline the force applied becomes smaller, but the distance the object is moved becomes longer.	• Let the pupils summarize the results of the experiment. • The workload does not change compared to pulling the object up by hand. → This is called the **principle of work**. *(Evaluation: Knowledge and Skills 2)* Ability to explain that if you use tools such as inclines and stairs, you can do work easily without a large force.

3. Work Using Tools (Using Stairs) (1 period: 3rd period)

Goals of this sub-unit

- There are several types of stairs, and depending on the type the distance, time and effort required to reach the same height will change. Pupils will investigate the differences between stairs through experiment.

Material Preparations

- Stairs (letting them try out various kinds, like straight and spiral, is best), a ladder

Period 3: Work Using Stairs

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Does motion differ in using straight stairs and spiralling stairs? What about with a ladder?	• Let the different groups give predictions. *(Evaluation: Interest 2)* Taking an interest in instances using pulleys, inclines, stairs, and ladders, and actively seeking cases making practical use of these tools.
Questions	Think about what kind of stairs it is easier to go up.	
Presentation 20 minutes	• Try out the ladder and stairs. →Go up to the 2nd floor on the straight staircase. →Go up to the 2nd floor on the spiral staircase. →Go up to the 2nd floor on the ladder.  • Experiment results →Things that changed – force, distance climbed →The stairs were easier to climb, the ladder was harder • Compare to predictions before the experiment.	* If you do not have both a straight and spiralling staircase on campus, compare to a ladder. You may not have a ladder that can climb a full storey, but just let pupils go as high as you can. * Take sufficient care when on the ladder.  • Let pupils compare to predictions before the experiment.
Summary 5 minutes	• You can climb more easily using the stairs than the ladder, but must take more steps over a proportionately longer distance.	• The workload does not change compared to pulling the object up by hand. →**Principle of work** *(Evaluation: Knowledge and Skills 3)* Ability to explain that workload is related to magnitude of force and distance travelled, and the principle of work that no matter what method you use the amount of work done is the same, such that even with a small force you can increase the distance travelled proportionally.

4. Work Using Tools (Using Fixed Pulleys) (1 period: 4th period)

Goals of this sub-unit

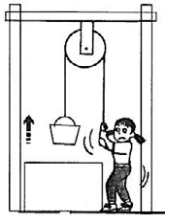
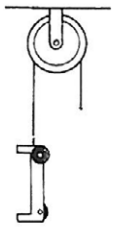
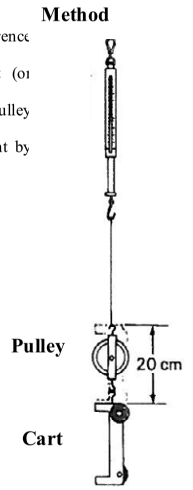
- Fixed pulleys are used to draw water up from a well. How much force would need to be applied lifting the bucket up by hand compared to that applied using a pulley? Consider the difference between the two through experimentation to understand the **principles of work**.

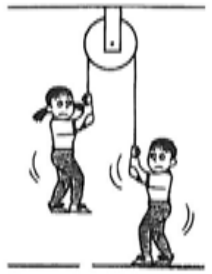
Expansion: Also try to examine movable pulleys.

Material Preparations

- Fixed pulley, dynamic cart (alternatively a wooden block or stone), spring balance, string (to connect the dynamic cart and spring balance)

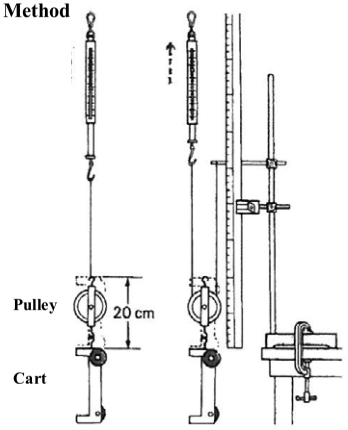
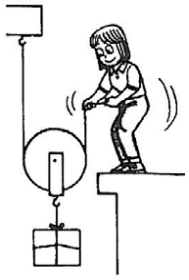
Period 4: Work Using Fixed Pulleys

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Does using a pulley to draw water from a well make the work easier? 	• Let the different groups give predictions. *(Evaluation: Interest 2)* Taking an interest in instances using pulleys, inclines, stairs, and ladders, and actively seeking cases making practical use of these tools.
Questions	Examine whether using a fixed pulley makes work easier.	
Presentation 20 minutes	• Experiment →Examine the difference between pulling a cart (or block) up using a fixed pulley and pulling it up straight by hand.  	• Have pupils predict the results when conducting the experiment. • Have pupils record the results in their worksheet. *(Refer to pg. 221 regarding worksheet)* * If you do not have a cart, using a wooden block or stone is also acceptable. * Pull the string straight down when using the fixed pulley. * If you have extra time, let pupils pull the string at an angle and to the side to examine how the force applied changes. * Fixing the pulley to a tree in the school yard for the experiment will raise pupils' interest.

	* Pull the string straight down when using the fixed pulley. • What changed → Direction of force applied • What did not change → Force magnitude, distance pulled	 *(Evaluation: Thinking and Representation 2)* Ability to infer from experiments and experience that the workload is related not only to the magnitude of force but also the distance moved.
Summary 5 minutes	• People often think that using tools makes work easier, but in the case of the fixed pulley only the direction of the force applied changes without any other particular changes.	• Let the pupils summarize the discussion from the experiment results. • The workload does not change compared to pulling the object up by hand. →Principle of work *(Evaluation: Knowledge and Skills 3)* Ability to explain that workload is related to magnitude of force and distance travelled, and the principle of work that no matter what method you use the amount of work done is the same, such that even with a small force you can increase the distance travelled proportionally.

Period 5: Work Using Movable Pulleys (Held after Period 4: extension)

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Using a fixed pulley did not provide a work benefit. • Does using a movable pulley offer a benefit in terms of work?	• Let the different groups give predictions.
Questions	Examine whether using a movable pulley makes work easier.	
Presentation 20 minutes	• Experiment →Examine whether workload will differ between pulling the cart (block or stone) up using a movable pulley and pulling it up straight by hand.	• Have the pupils record the results in their worksheet. *(Refer to pg. 221 regarding worksheet)* • Let pupils predict how the fixed pulley and movable

	Method  • Discuss the workload from the experiment results. • What changed in the experiment results → Force magnitude, distance pulled • What did not change →Workload	pulley systems will differ, even though they are the same pulleys. * Pull the string straight up when using the movable pulley. * If you have extra time, let pupils pull the string at an angle and to the side to examine how the force applied changes. * If there is a well at the school, let them try out the difference for themselves.  • Let pupils compare to predictions before the experiment.
Summary 5 minutes	• If using a movable pulley the force applied becomes smaller, but the distance the object is moved becomes longer.	• Let the pupils summarize the discussion from the experiment results. • The workload does not change compared to pulling the object up by hand. →Principle of work

[Worksheet] ---------- * To be used in 2nd Period

Does Using an Incline Give a Work Advantage?

Date: **Class:** **Name:**

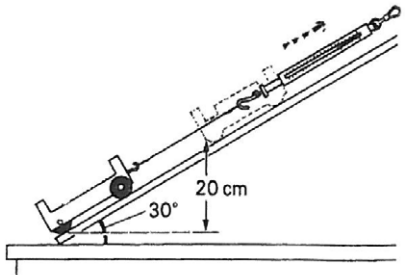
1. Material Preparations

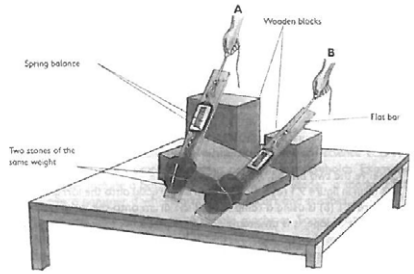
Inclining board (alternatively a block to make an incline), dynamic cart (alternatively a wooden block or stone), spring balance, string (to connect the dynamic cart and spring balance)

2. Procedure

1) Pull the cart (stone or wooden block) slowly up to a height of 20cm. Measure the magnitude of the force (spring balance reading) when pulling up.

2) Pull the cart (stone or wooden block) up to a height of 20cm using an incline as shown in the figure. Measure the magnitude of the force (spring balance reading) and distance the cart was pulled when pulling up.





3. Results

	Distance to pull up 20cm	Force (N)
Pulling straight up	20	
Using an incline		
Changing angle of incline		

4. Discussion

Between pulling straight up and using the incline, which allowed you to raise the cart to the required height with less force? Which moved a farther distance? Does using an incline give a work benefit?

* *Keep this worksheet for the next class.*

[Worksheet] ---------- * To be used in 4th Period

Does Using a Fixed Pulley Give a Work Advantage?

Date: **Class:** **Name:**

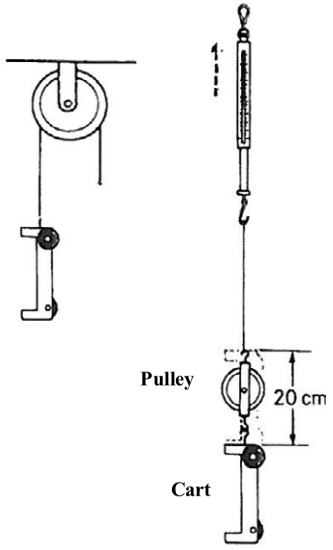
1. Material Preparations

Pulley, dynamic cart (alternatively a wooden block or stone), spring balance, string (to connect the dynamic cart and spring balance)

2. Procedure

1) Pull the cart (stone or wooden block) slowly up to a height of 20cm. Measure the magnitude of the force (spring balance reading) when pulling up.

2) Pull the cart (stone or wooden block) up to a height of 20cm using a fixed pulley as shown in the figure. Measure the magnitude of the force (spring balance reading) and distance the cart was pulled when pulling up.



3. Results

	Distance to pull up 20cm	Force (N)	Direction of Force
Pulling straight up	20		up
Using a fixed pulley			

4. Discussion

Between pulling straight up and using the fixed pulley, which allowed you to raise the cart to the required height with less force? Which moved a farther distance? Does using a fixed pulley give a work benefit?

** Keep this worksheet for the next class.*

[Worksheet] ---------- * To be used after 4th period in extension

Does Using a Movable Pulley Give a Work Advantage?

Date: **Class:** **Name:**

1. Objective

Even though they use the same pulley, changing the method of use allows a small force to do work. Examine the difference in workload comparing pulling the cart (block or stone) up using a movable pulley and pulling it up straight by hand or using a fixed pulley.

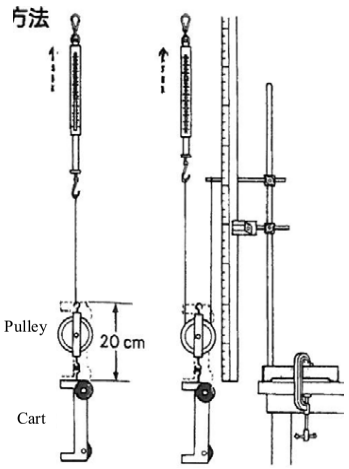
2. Material Preparations

Pulley, dynamic cart (alternatively a wooden block or stone), spring balance, string (to connect the dynamic cart and spring balance)

3. Procedure

1) Pull the cart (stone or wooden block) attached to a pulley slowly up to a height of 20cm. Measure the magnitude of the force (spring balance reading) when pulling up.

2) Pull the cart (stone or wooden block) up to a height of 20cm using a movable pulley as shown in the figure. Measure the magnitude of the force (spring balance reading) and distance the cart was pulled when pulling up.



4. Results

	Distance to pull up 20cm	Force (N)	Direction
Pulling straight up	20		up
Using a movable pulley			

5. Discussion

Between pulling straight up and using the movable pulley, which allowed you to raise the cart to the required height with less force? Which moved a farther distance? Does using a fixed pulley give a work benefit?

** Keep this worksheet for the next class.*

1st Sub-Unit Review Test

* given after end of 1st period

Class: Name:

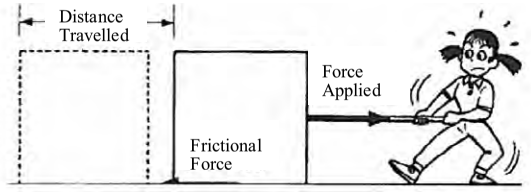
1. Answer these questions about work as used in science.

1) What is work? Explain.

(**Applying a force to an object and moving it in the direction of that force**)

2) **Mary** applied a force to the right on a box as shown in the figure below. Which direction did the box move?

(**to the right**)



3) When pulling the box to the right, which direction does the frictional force acting upon it act?

(**to the left (the opposite direction of the moving object)**)

4) Enter the correct words in the blanks below.

Between the floor and the object, there is an interfering force acting in the (**opposite**) direction of that in which the object is trying to move. This interfering force is called (**frictional force**). Without applying a force (**larger**) than the interfering force, the object will not move.

2. For the following items **a) to d)**, write ***yes*** in the blank if scientific work has been done and ***no*** if it has not.

a) After dinner, I solved the computational problems with mental arithmetic. (**no**)

b) I lifted a book on the ground with a mass of 500g up onto a shelf 50cm high. (**yes**)

c) I pushed an object in the school yard with a mass of 50kg, but it did not move. (**no**)

d) I moved a 10kg load from the right shelf to the left shelf. (**yes**)

2nd to 5th Sub-Unit Review Test

* given after end of 5th period

Class: Name:

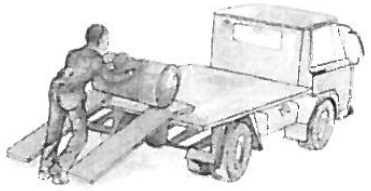
1. Put a **=, <, or >** in the following blanks related to lifting a drum can to the height of a lorry bed straight up by hand and using an incline.

1) Distance moved in lifting the drum can

Distance lifting directly by hand (<) distance lifting using an incline

2) Magnitude of force in lifting the drum can

Magnitude of force lifting directly by hand (>) magnitude of force lifting using an incline



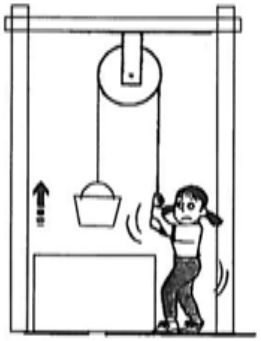
2. Put a **=, <, or >** in the following blanks related to drawing water with a bucket directly and using a fixed pulley.

1) Distance moved in drawing up the bucket of water

Distance drawing up directly (=) distance drawing up using a fixed pulley

2) Magnitude of force in drawing the bucket of water

Magnitude of force drawing up directly (=) magnitude of force drawing up using a fixed pulley

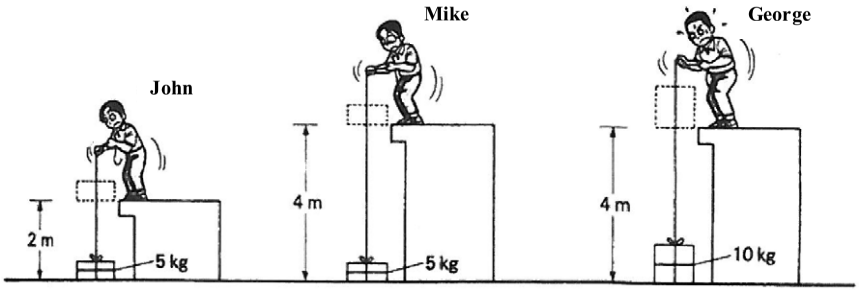


Final Unit Evaluation Test

* Given at end of unit

Class: Name:

1. **John, Mike** and **George** lifted the 5kg and 10kg boxes to a height of 2m or 4m as shown in the figure below.

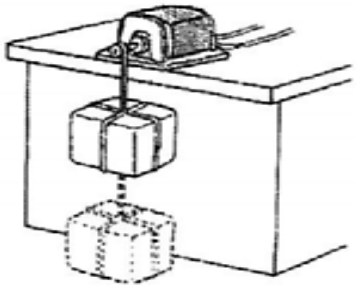


(1) Which of the following relation equations **a – d** below show the size of the workload done by **A(John), B(Mike) and C(George)** above? (**b**)

a) A > B = C **b)** A < B < C **c)** A > B > C **d)** A = B = C

(2) When a motor was used to do the same work pulling up as done by **George** above, it took 20 seconds. Which workload was greater, that done by **George** or that done by the motor?

(**neither (they are the same)**)

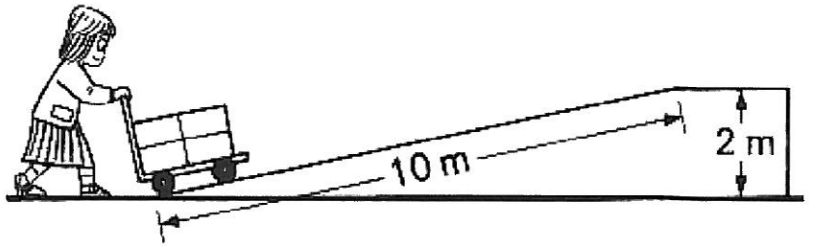


(3) The box that was lifted up to an elevated position has the ability to do work upon other objects by falling. What is this ability called?

(**Potential Energy**)

(MAKING WORK EASIER／8th grade)

2. A load of 50kg is placed upon a cart with a mass of 10kg as shown in the figure below. The cart was pushed up an incline to a height of 2m. Answer the following questions.



1) Which requires less force applied to do, lifting the load by hand to a height of 2 metres or pushing the load up an incline (10 metres long) to a height of 2 metres?

(**Using an incline**)

2) From the principle of work, what became proportionately bigger for the method in 1) above that did the work with less applied force compared to the other method?

(**The distance to move the load to a height of 2m**)

3) The magnitude of gravitational force put upon a weight with a mass of 1kg is about 10 newtons (N). What is the total magnitude of gravitational force put upon the 10kg cart carrying a load with a mass of 50kg?

(**600**) N

4) From the results of 3) above, how much total force would be needed to lift up the 10kg cart carrying a load with a mass of 50kg?

(**600**) N

5) The amount of work done when applying a force and moving an object is given in joules (J). The magnitude of force needed to move 1 newton a distance of 1 metre is 1 joule. How much total work is done when lifting the 10kg cart carrying a load with a mass of 50kg straight up to a height of 2 metres?

(**600**) N (**2**) m = (**1200**) J

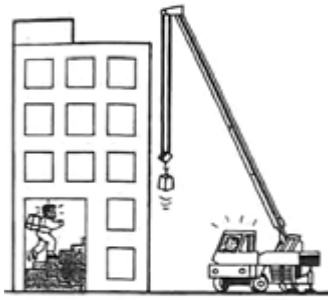
6) From the principle of work, what is the difference in the amount of work done when lifting the load straight up and when lifting using the incline?

(**nothing (they are the same)**)

7) From 5) and 6) above, how big is the force when lifting the load using an incline? Answer as if there were no frictional force.

(**120**) N

3. As shown in the figure, it took a person 10 minutes to lift an object with a mass of 30kg to the roof of a 20m-high building, and took a crane 30 seconds to do the same work. Answer the following questions.



1) Show the relationship between the workload done by the person and the workload done by the crane using symbols (=, <, >).

Workload done by the person (=) workload done by the crane

2) Which is more efficient, the person or the crane? Give your reason with the answer.

(the crane)

Reason: (Because they did the same amount of work, but the crane finished it faster)

Student Questionnaires

1. What kinds of studying have you done in the past for the above test problems?

0.	None at all	This was done 10% of the time for all problems.
1.	No	This was done 30% of the time for all problems.
2.	Average	This was done 50% of the time for all problems.
3.	Yes	This was done 70% of the time for all problems.
4.	Absolutely yes	This was done over 90% of the time for all problems.

Answering Questions using Pictures and Diagrams in the Textbook or Illustrations Drawn on the Blackboard

1. The Students answered the questions by walking up to the board and drawing diagrams or writing words.

0. 1. 2. 3. 4.

2. The teacher asked and answered the questions by drawing diagrams or writing words on the board.

0. 1. 2. 3. 4.

3. Questions were answered using pictures and diagrams in the textbook.

0. 1. 2. 3. 4.

Experiments

1. Did the students conduct any experiments or observations?

0. 1. 2. 3. 4.

2. The teacher conducted the experiments.

0. 1. 2. 3. 4.

3. The students conducted the experiments by following the teacher's instructions.

0. 1. 2. 3. 4.

Discussion and Thinking

4. We talked with friends in the class and thought about the problems.

0. 1. 2. 3. 4.

5. We thought about the problems carefully with friends and stated our ideas logically.

0. 1. 2. 3. 4.

6. We thought about the problems carefully when coming up with a hypothesis and after the experiment.

0. 1. 2. 3. 4.

Understanding Ideas

7. I was able to understand new ideas.

0. 1. 2. 3. 4.

8. I was able to see new viewpoint of looking at and thinking about science.

0. 1. 2. 3. 4.

9. I was able to grasp the principles hidden beneath the facts.

0. 1. 2. 3. 4.

Application of Knowledge

10. I was able to apply the new knowledge that I learned in school in my daily life.

0. 1. 2. 3. 4.

11. The teacher has explained that the new knowledge things the students are learning in school are connected with actual life.

0. 1. 2. 3. 4.

12. I was able to learn that the new principles and viewpoints toward science can be applied to a variety of different phenomena.

0. 1. 2. 3. 4.

Pursuing Knowledge through Problem Solving

13. We were first given a problem and then were to solve that problem.

0. 1. 2. 3. 4.

14. We made predictions, put then to the test, formulate scientific explanations, and put them to practical use.

0. 1. 2. 3. 4.

15. The students were asked to verify through the experiment that they had created a hypothesis as well as a plan for the observation.

0. 1. 2. 3. 4.

2. When you learned each unit for the above test problems, did you become interested in the material?

0.	None at all	This was true 10% of the time for all problems.
1.	No	This was true 30% of the time for all problems.
2.	Average	This was true 50% of the time for all problems.
3.	Yes	This was true 70% of the time for all problems.
4.	Absolutely yes	This was true over 90% of the time for all problems.

Interest and Motivation

1. I was very interested in science lessons.

0. 1. 2. 3. 4.

2. I became more motivated to learn.

0. 1. 2. 3. 4.

3. I was interested in what we were learning from start to finish.

0. 1. 2. 3. 4.

Concentration and Involvement

4. I was actively engaged in learning the topic.

0. 1. 2. 3. 4.

5. I enjoyed learning the topic so much I lost track of time.

0. 1. 2. 3. 4.

6. I was very focused on learning topic material but at the same time, I was also very excited and enjoyed myself.

0. 1. 2. 3. 4.

Cooperation and Collaboration

7. I enjoyed the learning process while collaborating with friends.

0. 1. 2. 3. 4.

8. I was able to learn through cooperation and mutual support with my friends.

0. 1. 2. 3. 4.

9. I shared my experiments and ideas with my friends and we all had a fun time learning together.

0. 1. 2. 3. 4.

Level of Earnestness and Enjoyment during Experiments

10. The experiments were very enjoyable.

0. 1. 2. 3. 4.

11. Since experiments need five senses, I carefully moved my hands and eyes when collecting the data.

0. 1. 2. 3. 4.

12. During the experiments, I recorded my observations accurately and carefully.

0. 1. 2. 3. 4.

Spirit of Inquiry

13. I began to have more an inquiring mind toward new discoveries.

0. 1. 2. 3. 4.

14. I became very excited and curious about challenging the unknown.

0. 1. 2. 3. 4.

15. I made a strong effort to learn what is known by trying to find examples, drawing illustrations, and through discussions and experiments.

0. 1. 2. 3. 4.

Logic and Objectivity

16. I attempted to find plenty of evidence and facts to check whether my hypothesis held true.

0. 1. 2. 3. 4.

17. I was able to confirm that the principles and concepts were true by applying them to actual life.

0. 1. 2. 3. 4.

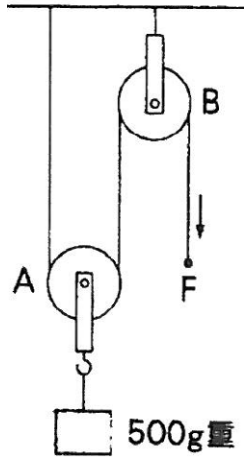
18. The explanations were very convincing and easy to understand for the entire class. I was very satisfied with the interpretations which were logical and accorded with the truth.

0. 1. 2. 3. 4.

Appendix

Teaching Notes for Movable Pulley Experiment (p.14)

- Work in groups of 4.
- Let the groups talk and clarify individual roles, then have them conduct the experiment.



* If you do not have a cart, using a wooden block or stone is also acceptable.

* Pull the string straight up when using the movable pulley.

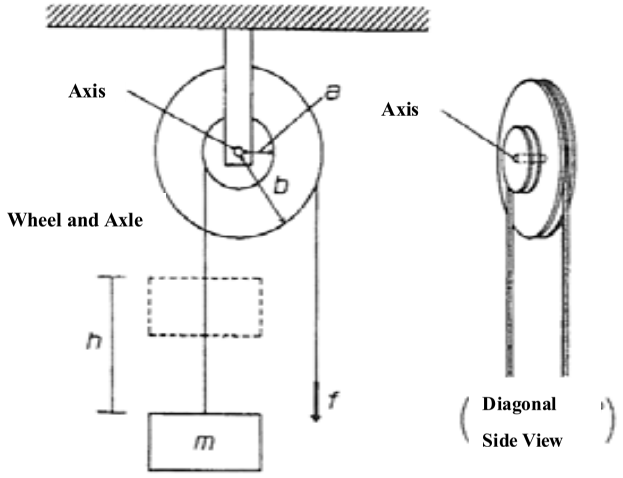
* If you have extra time, let pupils pull the string at an angle and to the side to examine whether the force applied changes or not.

* The goal is to have them realize that you can get differing results with the same pulley depending on how it is used.

* If you have extra time, you should conduct an experiment with a combination of movable and fixed pulleys and let the pupils discuss things.

* Also if you have extra time, you should demonstrate an experiment using a wheel and axle as shown in the figure to the right and have pupils think about things.

* You can try to tie things together with learning about levers through the wheel and axle.



Appendix

Examples of assessment questions which is used in Kenyan text books

In what ways does using a single fixed pulley help us when raising loads?

A. It reduces the effort required.
B. Enables us to do work conviniently.
C. Increases the effort needed.
D. Reduces the time required to raise the load.

(Longhorn; Understanding Science, Pupil's Book 8　P.71)

A man uses a ramp to move a barrel of oil from the ground into a lorry. Which of these statements is TRUE?
(A) the work he had to do using the ramp is less than if he had lifted it straight up
(B) the work he had to do using the ramp is more than if he had lifted it straight up
(C) the distance he had to move the barrel is more if he does not use the ramp
(D) the effort needed was less when using the ramp

A single fixed pulley system is used to lift water from a well. Which of these statements is TRUE?
(A) the effort is less than the load
(B) the distance moved by the effort is more than the distance moved by the load
(C) the distance moved by the effort is the same as the distance moved by the load
(D) the work done by the person lifting using a pulley is more than the work done without the pulley

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.107)

The illustration shown is that of a pulley.

It is not true to say that _____.
(A) the illustration is that of a single fixed pulley
(B) the effort used to raise the load is less than the load
(C) the pulley helps to change the direction of the force
(D) the effort moves the same distance as the load

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.131)

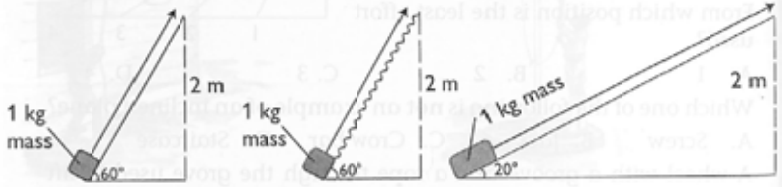
What type of machine is used to lift the flags?
A. Inclined plane　B. Lever　C. Single fixed pulley　D. Rope

The diagram below shows a pulley.

Mark the position of the load and effort.
Pupils in a Standard Eight class looked at a pulley like the one shown in question 3 and made the followng statements: The pulley:
(i) is not useful because the effort used has to come from somebody.
(ii) is useful because we can pull downwards.
(iii) is useful because it adds some effort to make work easier.
Which statement was correct?

(JKF; Primary Science Education Foundation Science 8　P.145)

8. Below are three inclined planes such that the height of each inclined plane is 2 m. A and C are smooth but B is rough. Both A and B have the same angle of inclination.



A B C

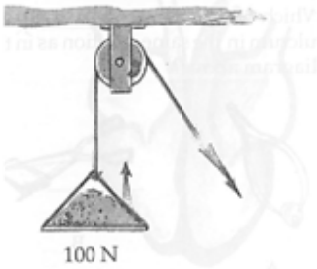
Which of the following statements are true?

(i) The work done to lift the 1 kg mass is the same in all.
(ii) The effort used in C is less than the effort used in A.
(iii) The effort used in A is less than the effort used in B.
(iv) The effort used in B is less than the effort used in C.

A. (iv) B. (iii) C. (ii) D. (i), (ii) and (iii)

(Oxford; Science in Action 8 P.86)

The diagram shows a load of 100N being lifted using a single fixed pulley.



100 N

The effort required to raise the load is

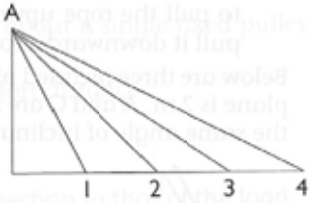
A. slightly more than the load.
B. exactly equal to the load.
C. slightly less than the load.
D. half the load.

(Longhorn; Understanding Science, Pupil's Book 8 P.71)

A road winding up a hill is an example of

A. a ladder. B. a staircase.
C. a wedge. D. an inclined plane.

The diagram below shows four slopes of a wooden plank for raising loads from positions 1, 2, 3 and 4 to point A.



From which position is the least effort used?

A. 1 B. 2 C. 3 D. 4

Which one of the following is **not** an example of an inclined plane?

A. Screw B. Jack C. Crow bar D. Staircase

(Oxford; Science in Action 8 P.85)

Appendix

Examples of materials which is used in Kenyan text books

Inclined planes

1. Ladder

When climbing a higher level, you may need an inclined plane. This is a slope which makes it easier for you to climb. A ladder is an example of an inclined slope.

The object you are lifting is the load.

The length of the slope shows the distance effort has to move.

When the slope is long and less steep the effort required is low. This is why it was easier to climb the tree when the lower part of the ladder was far away from the tree.

When the slope is short and steep more effort is needed to move the load. This is why it was more difficult to climb the tree when the lower part of ladder was too close to the tree.

When using a ladder always make sure you have a long gentle slope so that you can use less effort and make your work very easy.

(JKF; Primary Science Education Foundation Science 8　P.138)

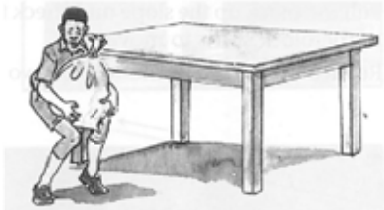


Figure 11.4: Lifting a bag onto a table

(Oxford; Science in Action 8　P.81)

(a) Loading a drum without a simple machine　(b) Loading a drum using a ramp

Fig. 9.1:A ramp is an inclined plane

(KLB; Primary Science Pupils' Book for Standard Eight　P.161)

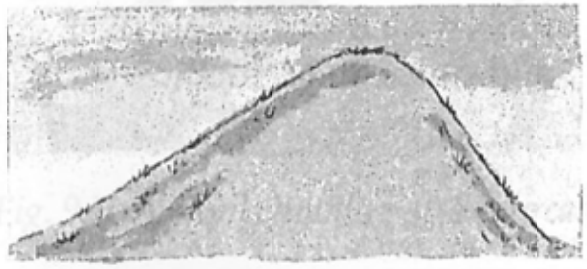


Fig. 9.1: Steep slope

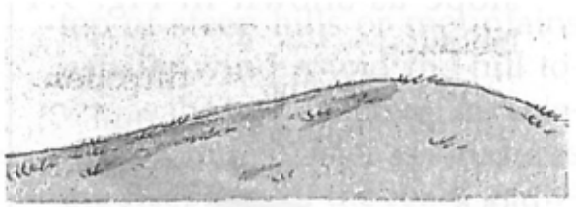


Fig. 9.2: Gentle slope

(Longhorn; Understanding Science, Pupil's Book 8　P.65)

Lifting materials for construction

(JKF; Primary Science Education Foundation Science 8　P.140)

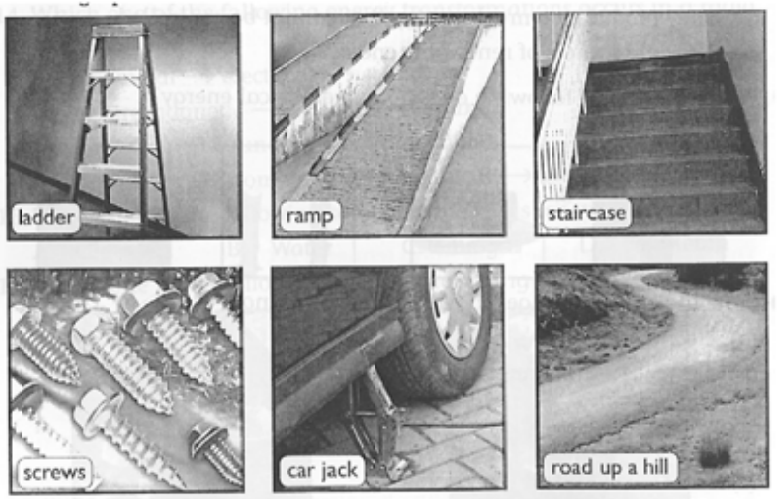
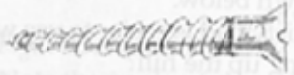


Figure 11.2: Inclined planes

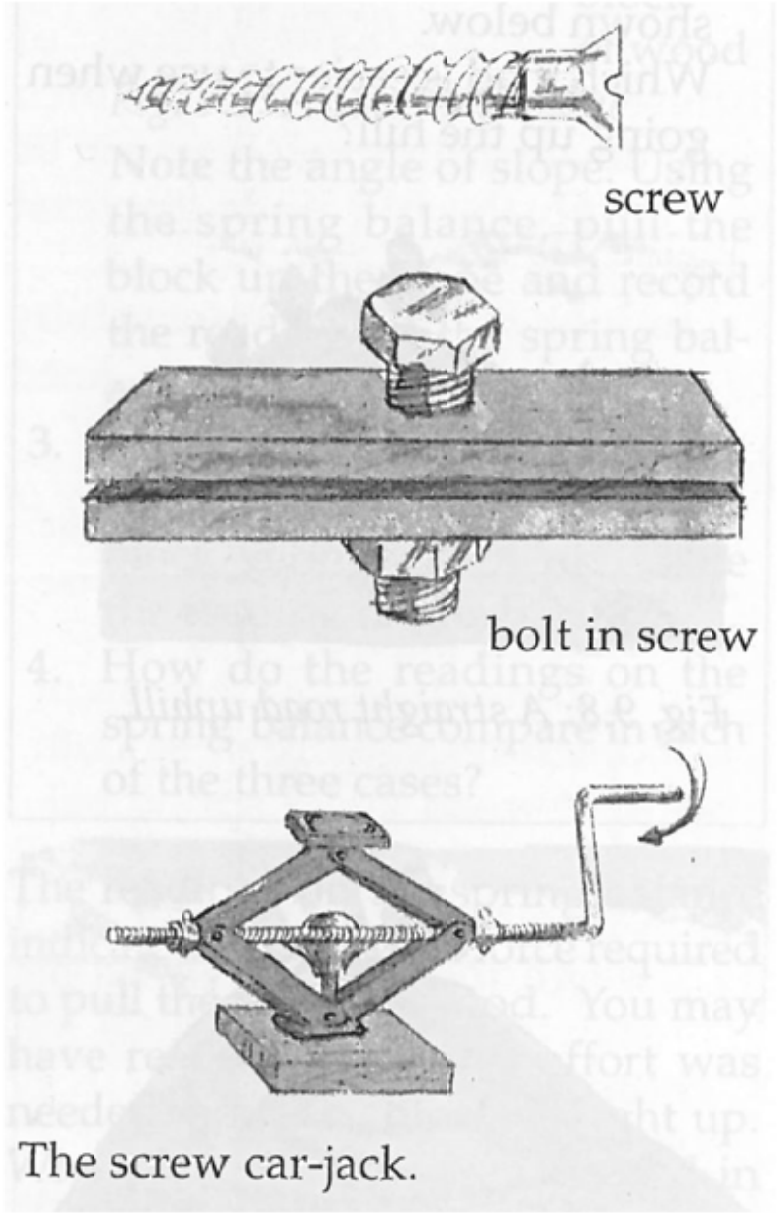
(Oxford; Science in Action 8　P.80)

Fig. 9.10: A spiral winding road uphill.

Other examples of inclined planes are as shown below:



(Longhorn; Understanding Science, Pupil's Book 8　P.68)



(Longhorn; Understanding Science, Pupil's Book 8　P.68)

(MAKING WORK EASIER／8th grade)

When splitting firewood or logs, we use an axe. An axe is wedge shaped to make work easier. We can make splitting of logs easier by driving a wedge at a point where we have made a crack.

The wedge is a double inclined plane. The wedge widens the crack and makes work easier.

Figure 11.12: A wedge

(Oxford; Science in Action 8　P.83)

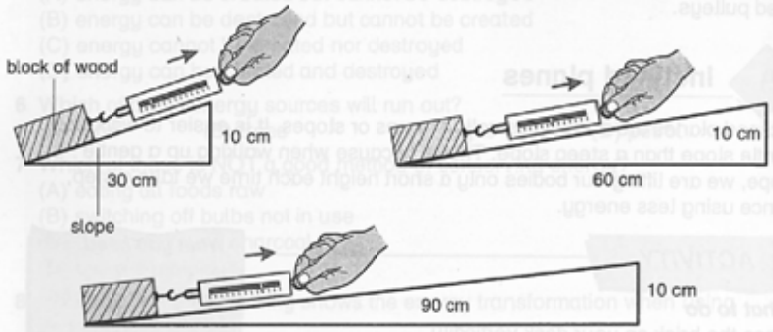


Figure 9.1 *Pulling a wooden block up different slopes*

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.100)

▶ ***The less steep the ramp, the smaller the force needed to pull something up it. The longer the ramp, the less steep it is. A heavy load may be raised more easily by pulling it up a sloping surface.***

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.100)

Single fixed pulleys

A pulley is a simple machine used for raising loads. It consists of a wheel with a grooved rim through which a rope, a chain or a belt is passed. When a pulley has only one wheel, it is called a **single pulley**.

Pulleys make work easier by changing the direction of the force. Instead of climbing to the top of the flagpole to raise the flag, a pulley is fixed at the top of the flag pole. A rope is passed through the pulley and can be pulled while standing on the ground, to raise a flag.

A pulley is therefore a machine which changes the direction of effort when lifting or lowering a load. This makes work convenient.

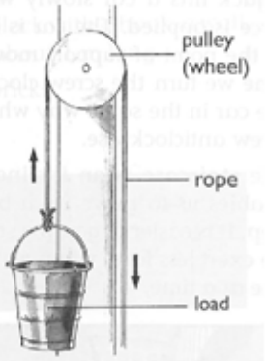
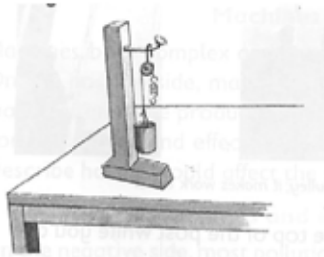
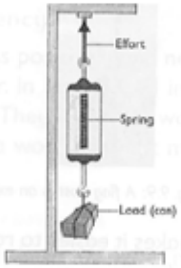


Figure 11.13: Parts of a single fixed pulley

(Oxford; Science in Action 8 P.84)



(a) Lifting a load using a pulley



(b) Lifting a load without a pulley

(KLB; Primary Science Pupils' Book for Standard Eight P.165)

You are going to make and use a single fixed pulley.
Connect the 1 kg load to a string. Try to lift the 1 kg load using a spring balance.
Write the reading on the spring balance in your exercise book.

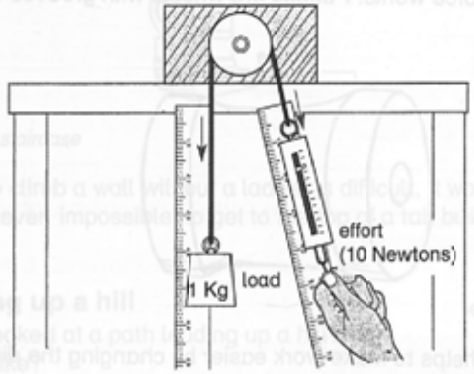


Figure 9.8 *Measuring the effort with a single pulley system*

(Macmillan; Macmillan Primary Science, Pupil's book 8 P.104)

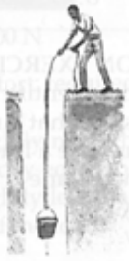


Fig. 9.12: Raising water without a pulley.

(Longhorn; Understanding Science, Pupil's Book 8 P.69)

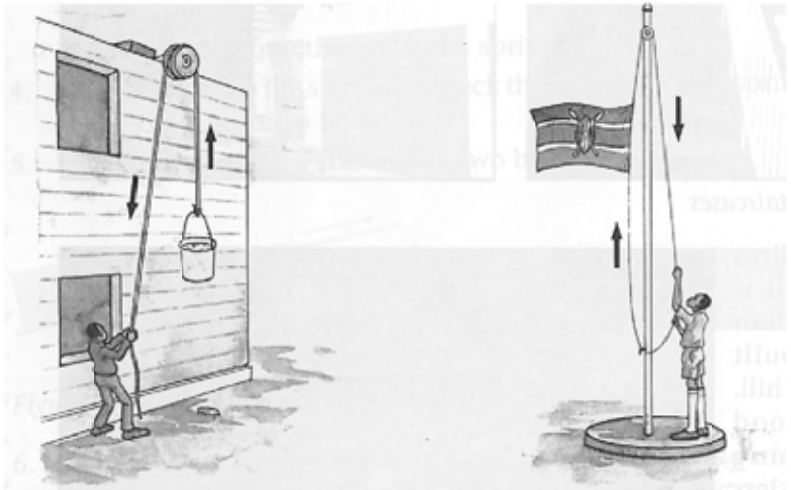


Figure 11.14: Examples of single fixed pulleys

(Oxford; Science in Action 8　P.84)

Unit Summary and Important Terms

- Simple machines are devices that simplify work.
- There are different classes of simple machines. Some examples include levers, inclined planes, wedges and pulleys.
- Inclined pulleys are slopes.
- Some examples of inclined planes are a ladder, a staircase and a road winding up a hill.
- It is easier to climb a gentle slope than a steep slope.
- A load is pulled a longer distance on a gentle slope than on a steep slope. More effort is, however, spent on the latter case.
- A pulley is a wheel over which a rope or a chain is stretched.
- An example of a single fixed pulley is a flag post.

(KLB; Primary Science Pupil's Book for Standard Eight　P.168)