WTS TUTORING

WTS

WORK,ENERGY & POWER

GRADE : 12

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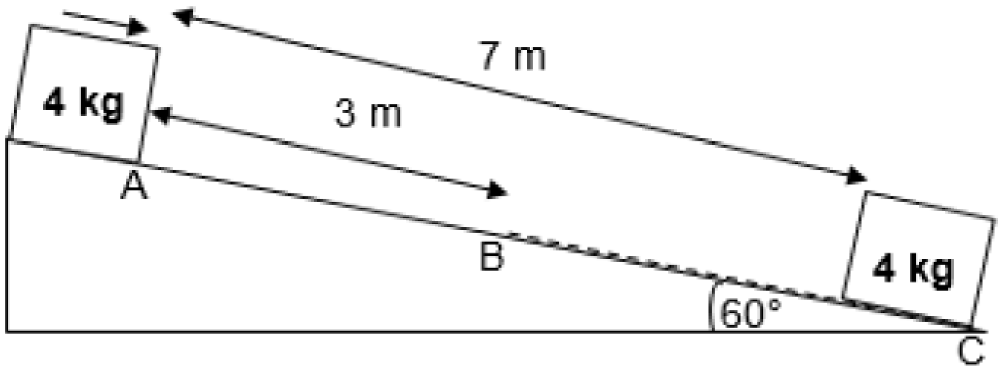
QUESTION 4 **(Start on a NEW page.)**

A 4 kg box at point **A** above the horizontal is released and slides down 7 m from **A** to **C** on an incline plane. The inclined plane from point **A** to **B** which is 3 m is frictionless whilst the plane from **B** to **C** is rough as shown in the diagram. The diagram is not drawn to scale.



4.1 State the principle of Conservation of Mechanical energy in words. (2)

4.2 Calculate the speed of the box at position **B**. (4)

4.3 The box experiences a constant kinetic frictional force of 13,6 N as it moves down from **B** to **C**.

4.3.1 State the Work-Energy Theorem in words. (2)

4.3.2 Draw a free-body diagram showing ALL forces acting on the box while moving from **B** to **C**. (3)

4.3.3 Use the energy principles to calculate the kinetic frictional force between **B** and **C** if the speed of the box at position **C**, the bottom of the plane is 3 $m \cdot s^{-1}$. (5)

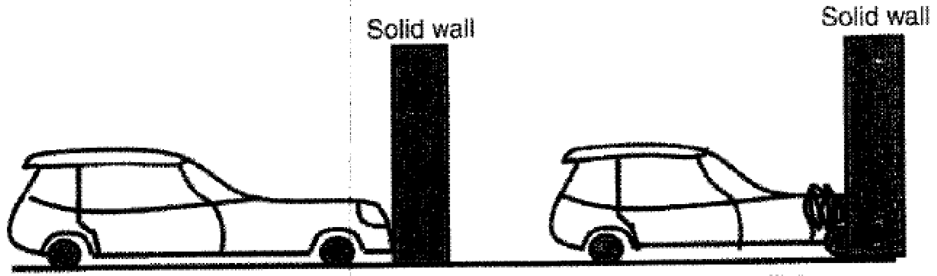
4.4 The angle between the incline and the horizontal is decreased. How will this affect the coefficient of kinetic friction acting on the box?

Write only INCREASE; DECREASE or REMAIN THE SAME. (1)

[17]

QUESTION 3 (Start on a new page.)

Most modern cars incorporate safety features that are designed to protect the driver and passengers in the event of a head-on collision. In testing one of such safety features, a car is crashed into a rigid concrete wall and its front crumples as shown in the diagram below.



The results of one such test are shown below.

Data: Car mass = 1000 kg	Speed of car at impact = 120 $km \cdot h^{-1}$
Original length of car = d_1 = 2,8 m	Crushed length of car = d_2 = 2,0 m

Ignore the effects of friction. Assume that there is no loss in mass as a result of the collision.

3.1 Draw a labelled, free-body diagram of all the forces acting on the car during impact. (3)

3.2 Convert 120 $km \cdot h^{-1}$ to SI units. (1)

3.3 State the WORK-ENERGY theorem. (2)

3.4 Assume that the force acting on the car is constant throughout the collision.

3.4.1 Use the WORK-ENERGY theorem to calculate the nett force acting on the car during the collision. (5)

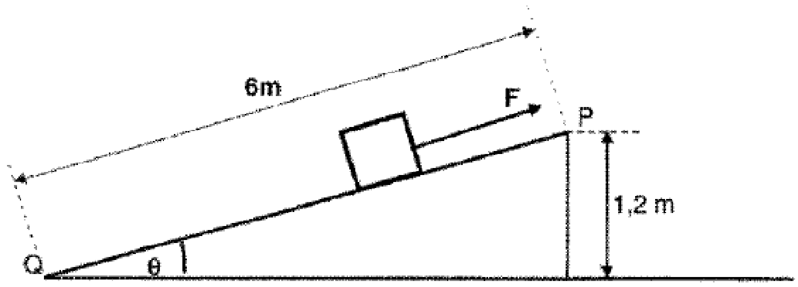
3.4.2 Calculate the time taken for the car to come to rest. (4)

3.4.3 Explain the purpose of a crumple zone in modern cars (3)

[18]

QUESTION 4 (Start on a new page.)

A 100 kg box slides down a rough inclined plane. A man applies a constant force **F** on the box such that it slides down the inclined plane at constant velocity.



4.1 Draw a labelled, free-body diagram showing all the forces acting on the box as it slides down the inclined plane. (4)

4.2 Write down the magnitude of the nett force acting on the box as it slides down the inclined plane. Give a reason for the answer. (2)

The frictional force between the box and the inclined plane is 60 N. The vertical height is 1,2 m.

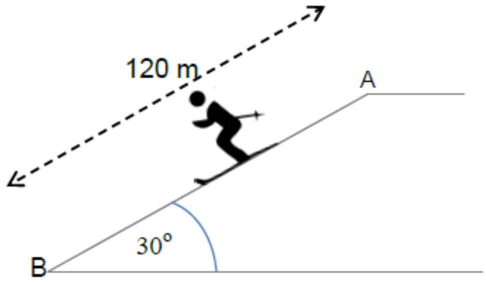
4.3 What is a *non-conservative force*? (2)

4.4 Calculate the work done by the man on the box. (6)

4.5 Calculate the magnitude of force **F** exerted by the man on the box. (4)
[18]

QUESTION 5 (Start on a new page)

A skier, mass 70 kg, is ready to ski. He started from rest at point **A** (top of slope) and skied down a slope inclined at 30° to the horizontal. He skied straight from point **A** to point **B** over a distance of 120 m without his ski poles touching the snow as shown in the diagram below, which is not drawn to scale.



The total kinetic friction between the skis and the slope was 150 N between points **A** and **B**.

5.1 Draw a free-body diagram showing all the forces acting on the skier while he was moving down the slope. (3)

5.2 Calculate the net work done on the skier as he moved from point **A** to point **B**. (5)

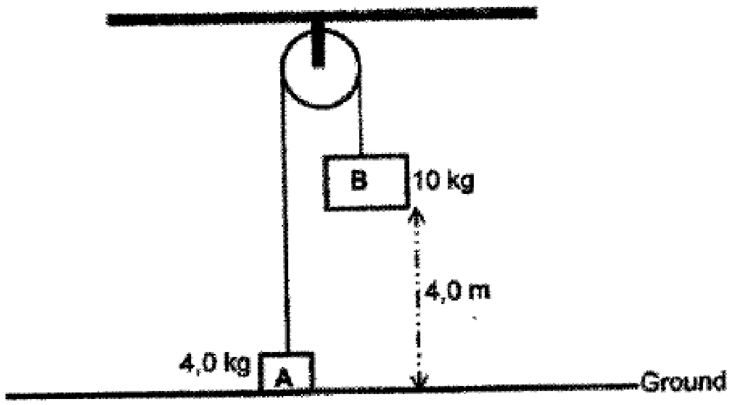
5.3 State the WORK-ENERGY THEOREM in words. (2)

5.4 Hence, determine the magnitude of the velocity of the skier at the bottom of the slope. (4)

[14]

QUESTION 5 (Start on a new page)

Blocks **A** and **B** in the diagram below are connected by a light (massless), inextensible string passing over a light, frictionless pulley.



Block **B** is released from rest at a height of 4,0 m above the ground.
Ignore the effects of air resistance.

5.1 Draw a labeled free-body diagram for block **B** indicating ALL the forces acting on it as it moves downwards. (2)

5.2 State the NAME of the *conservative force* acting on block **A** while moving upwards. (1)

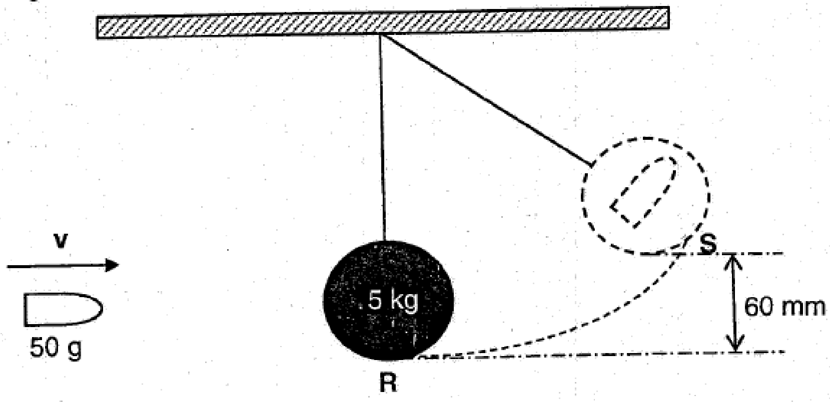
5.3 State, in words, the *work- energy theorem*. (2)

5.4 Using the **work-energy theorem**, show that block **B** hits the ground at a speed of 5, 797 $m \cdot s^{-1}$. (7)

5.5 Calculate the time it takes block **A** to travel 4,0 m upwards. (3)
[15]

QUESTION 4 (Start on a new page)

A wooden sphere of mass 5 kg hangs stationary from a light string. A bullet of mass 50 g moves horizontally with a constant speed **v** and hits the wooden sphere. The bullet enters the wooden sphere and the sphere-bullet system swings further to a maximum height at point **S** as shown in the diagram below.



4.1 Define the term *gravitational potential energy*. (2)

4.2 Calculate the:

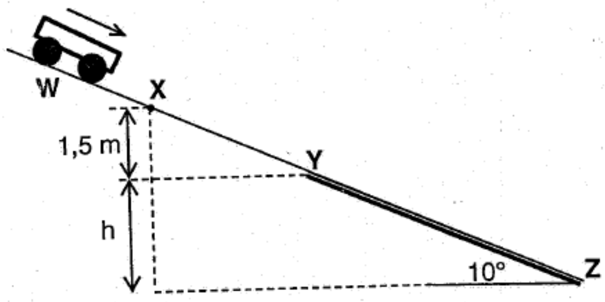
4.2.1 Gravitational potential energy of the sphere-bullet system at point **S** (3)

4.2.2 Speed of the sphere-bullet system at point **R** (4)

4.2.3 Speed **v** of the bullet before it hits the sphere (4)
[13]

QUESTION 5 (Start on a new page)

A trolley of mass 76 kg moves from rest from point **W** on a straight slope **WXYZ**. The trolley reaches point **X** with a speed of 3 $m \cdot s^{-1}$. The part **WXY** of the slope is frictionless and **YZ** is a rough surface.



5.1 Define the term *normal force*. (2)

5.2 Draw a labelled free-body diagram to show ALL the forces acting on the trolley while it is moving from point **X** to point **Y**. (2)

5.3 Calculate the speed of the trolley at point **Y**. (4)

The coefficient of kinetic friction (μ_k) between the trolley and the surface of the slope **YZ** is 0,21. The trolley comes to rest at point **Z**.

5.4 Calculate the magnitude of the kinetic frictional force on the trolley while it moves from point **Y** to point **Z**. (3)

5.5 Explain why NO work is done by the normal force on the trolley. (1)

5.6 Use ENERGY PRINCIPLES only to calculate the height h. (6)

A block of 5 kg is added onto the trolley and the trolley-block system moves again from rest from point **W**.

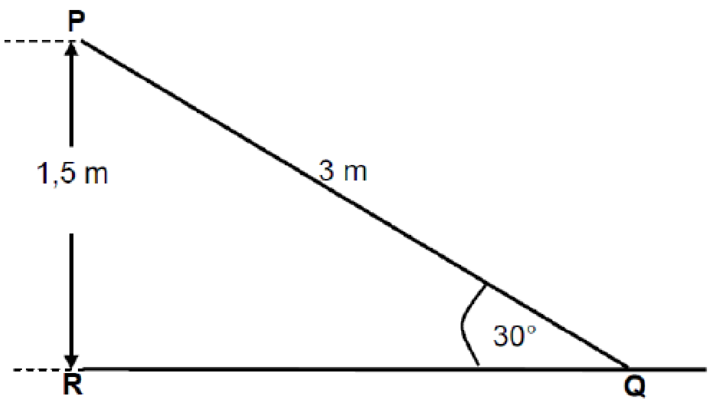
5.7 How will the speed of the trolley-block system at point **Y** compare to the speed of the TROLLEY ONLY, as calculated in QUESTION 5.3? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[19]

QUESTION 5

The simplified diagram below shows a slide **PQ** at a playground. The slide is 3 m long and 1,5 m high. A boy of mass 40 kg and a girl of mass 22 kg stand at the top of the slide at **P**.

The girl accelerates uniformly from rest down the slide. She experiences a constant frictional force of 1,9 N.

The boy falls vertically down from the top of the slide through the height **PR** of 1,5 m. Ignore the effects of air friction.



5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 Use the principle of CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the boy when he reaches the ground at **R.** (4)

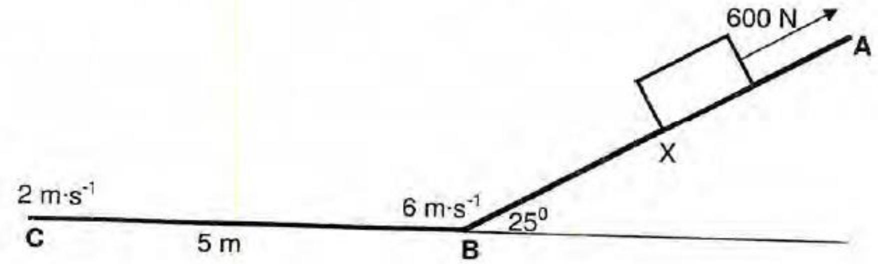
5.3 Use the WORK-ENERGY THEOREM to calculate the speed of the girl when she reaches the end of the slide at **Q.** (5)

5.4 How would the velocity of the girl at **Q** compare to that of the boy at **R** if the slide exerts no frictional force on the girl? Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)

[12]

QUESTION 5 (Begin on a new page.)

A crate is allowed to move down a frictionless slope **AB** at constant velocity by applying a force of 600 N as shown in the diagram below.



5.1 Define the term *normal force*. (2)

5.2 Calculate the mass of the crate. (5)

The crate is then brought to rest at point **X** (by applying a larger force) when the cable suddenly snaps causing the crate to accelerate down the slope reaching point **B** with a speed of 6 $m \cdot s^{-1}$. It then moves along a rough horizontal portion **BC** and reaches a speed of 2 $m \cdot s^{-1}$ at point **C**.

5.3 State in words the principle of conservation of mechanical energy. (2)

5.4 Calculate the:

5.4.1 Height at point **X** (4)

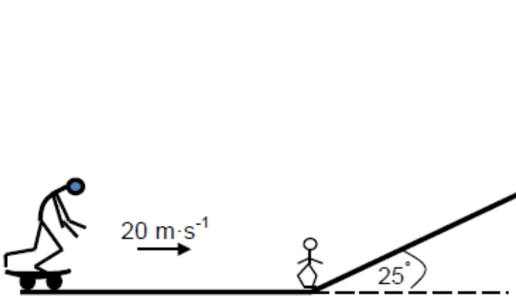
5.4.2 Coefficient of kinetic friction from **B** to **C** (5)

[18]

QUESTION 4 (Start on a new page.)

A roller-skater approaches an inclined plane at a constant velocity of 20 m·s^{-1} as shown below. Just before reaching the incline, he picks up a boy standing in his way and then continues up the incline and reaches point **B**.

The total mass of the roller skater is 68 kg and that of the boy is 12 kg.



4.1 State the principle of conservation of linear momentum. (2)

4.2 Calculate the magnitude of the combined velocity of the roller-skater and the boy just after the boy is picked up. (4)

4.3 Use energy principles to calculate the distance that they will move up the incline before coming to a stop at point **B**. Ignore the effects of friction. (5)

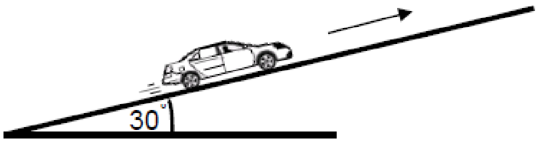
4.4 How will the answer to QUESTION 4.3 be affected if friction between the wheels of the roller-skate and the surface is NOT ignored?

Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

[13]

QUESTION 5 **(Start on a new page.)**

A car of mass 700 kg moves up a rough inclined plane as shown in the diagram below.



5.1 What is the net work done on the car if the car moves up the inclined plane at CONSTANT velocity? (1)

5.2 Draw a labelled free body diagram showing all the forces acting on the car as it moves up the inclined plane. (4)

5.3 The car now starts from rest at the base of the slope and accelerates up the inclined plane. The car's engine exerts a force of 6 000 N and the coefficient of kinetic friction between the wheels of the car and surface is 0,32.

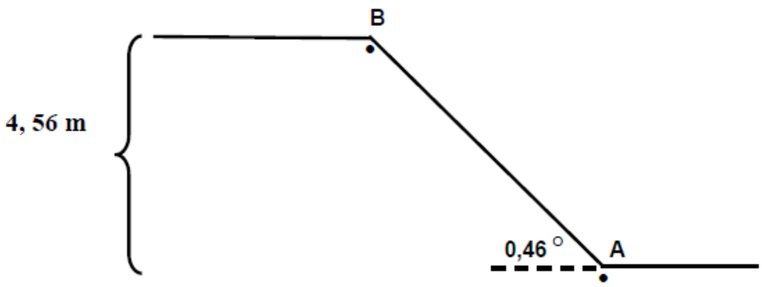
5.3.1 State the work-energy theorem in words. (2)

5.3.2 Use energy principles to calculate the magnitude of the velocity of the car after moving a distance of 70 m up the incline. (8)

[15]

QUESTION 5

A car of mass 1500 kg needs to maintain a constant speed of 10 $m.s^{-1}$ up a constant hill of height 4,56 m inclined at 0,46 ° to the horizontal.



The co-efficient of kinetic friction(μ_k), between the surface of the hill and the tyres of the car is 0,017.

5.1 State the WORK-ENERGY theorem. (2)

5.2 Draw a labelled free body diagram to show all the forces acting on the car whilst it is moving up the incline with a constant speed of 10 $m.s^{-1}$. (4)

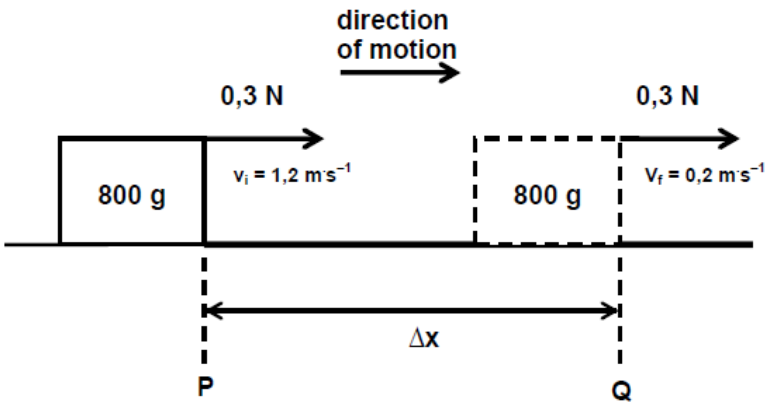
5.3 Show that the magnitude of the kinetic frictional force that acts on the car is 249,98 N while it moves up the hill. (3)

5.4 Use the WORK-ENERGY theorem to calculate the average power the engine of the car must provide to ensure that the car is able to get up the hill from A to B whilst maintaining a constant speed of 10 $m.s^{-1}$. (7)

[16]

QUESTION 4 (Start on a new page)

A block of mass 800 g moves under the influence of a force of 0,30 N. When the block reaches a velocity of 1,2 $m \cdot s^{-1}$, it enters a rough surface. The block experiences a constant frictional force of 0,86 N as it moves from point P to point Q as shown below causing its speed to decrease to 0,2 $m \cdot s^{-1}$ after a displacement, Δ**x** .



4.1 Draw a labelled free body diagram showing all the forces acting on the block as it moves across the rough surface. (4)

4.2 Determine the net force acting on the block as it moves across the surface. (3)

4.3 State the Work Energy Theorem in words. (2)

4.4 Use **Energy Principles** to calculate the displacement, Δ**x**, of the block. (4)

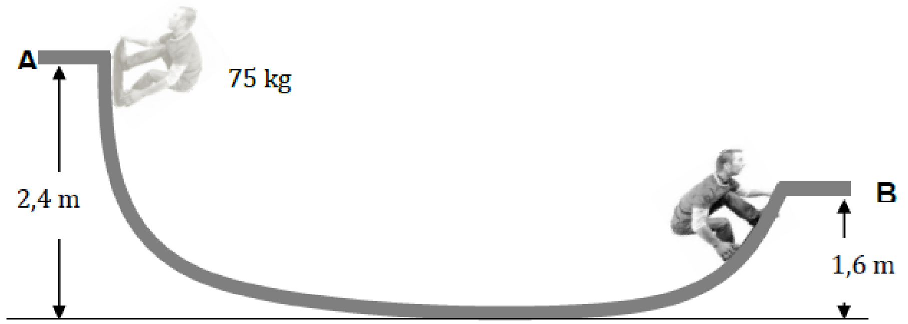
4.5 NAME **ONE** non – conservative force acting on the block as it moves across the surface. (1)

[14]

QUESTION 5

A skateboarder is practising a sequence of tricks at the local skate park on a half-pipe. The total mass of the skateboarder and skateboard is 75 kg. The skater leaves point A, 2,4 m above the ground. He skates down the ramp towards point B. He reaches Point B, 1,6 m above the ground, with a speed of 3,75 $m \cdot s^{-1}$ just by rolling along and without using his feet to push himself along the half-pipe.

The skateboarder has not oiled the wheels of his skateboard for some time, so there is significant friction between the axles and the wheels of the skateboard.

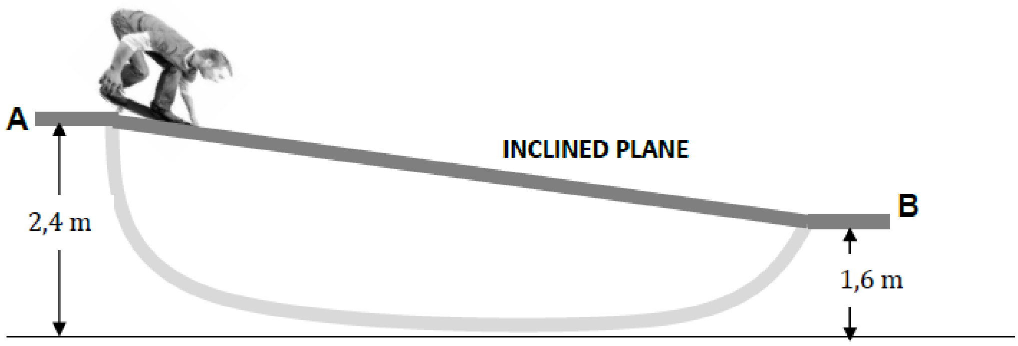


5.1 State in words, the *work-energy theorem*. (2)

5.2 Calculate the work done by the gravitational force on the skateboarder as he moves from Point A to Point B. (4)

5.3 Using the work energy theorem, determine the work done by the frictional force exerted on the skateboard. (6)

5.4 The skateboarder thinks about constructing an inclined plane to join Points A and B to provide an alternative route between these two points.



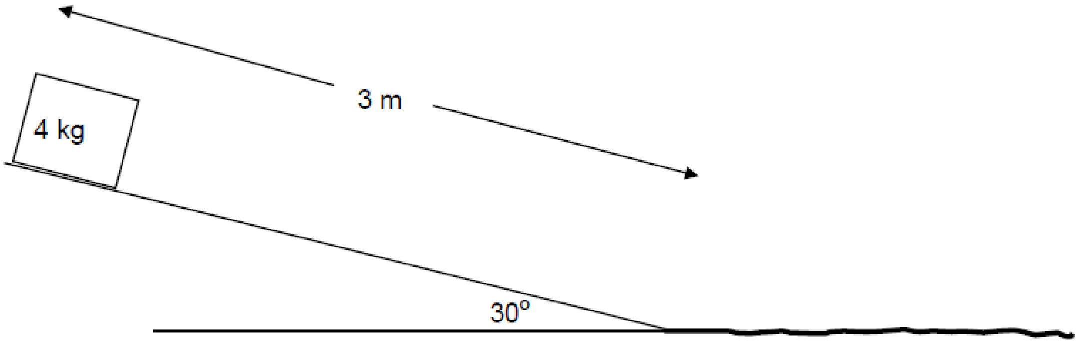
5.4.1 How would the work done by the gravitational force change if he were to roll from Point A to Point B along the inclined plane instead of following the curved track? Answer only INCREASES, DECREASES or REMAINS THE SAME. (1)

5.4.2 Explain your answer to QUESTION 5.4.1. (2)

[15]

QUESTION 5 (Start on a new page.)

An object of mass 4 kg starting from rest slides down an inclined plane of length 3 m as shown in the diagram below. The plane is inclined by an angle of 30° to the ground. The coefficient of kinetic friction μ_k is 0,2..



At the bottom of the plane, the mass slides along a rough horizontal surface with a coefficient of kinetic friction 0,5 until it comes to rest.

5.1 Draw a labelled free body diagram indicating ALL the forces acting on the object as it slides down the incline (3)

5.2 Write down the work-energy theorem in words (2)

Calculate the:

5.3 Distance the object slides along the rough horizontal surface. (8)
[13]

MERCY!!!!!

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