ANSWERS

Work, Energy and Power: Problem Set

Problem 1

Renatta Gass is out with her friends. Misfortune occurs and Renatta and her friends find themselves getting a *work*out. They apply a cumulative force of 1080 N to push the car 218 m to the nearest fuel station. Determine the work done on the car.

2.35×10^5 J

Problem 2

Hans Full is pulling on a rope to drag his backpack to school across the ice. He pulls upwards and rightwards with a force of 22.9 Newtons at an angle of 35 degrees above the horizontal to drag his backpack a horizontal distance of 129 meters to the right. Determine the work (in Joules) done upon the backpack.

2.42×10^3 J

Problem 3

Lamar Gant, U.S. powerlifting star, became the first man to deadlift five times his own body weight in 1985. Deadlifting involves raising a loaded barbell from the floor to a position above the head with outstretched arms. Determine the work done by Lamar in deadlifting 300 kg to a height of 0.90 m above the ground.

2.6×10^3 J

Problem 4

Sheila has just arrived at the airport and is dragging her suitcase to the luggage check-in desk. She pulls on the strap with a force of 190 N at an angle of 35° to the horizontal to displace it 45 m to the desk. Determine the work done by Sheila on the suitcase.

7.0×10^3 J

Problem 5

While training for breeding season, a 380 gram male squirrel does 32 pushups in a minute, displacing its center of mass by a distance of 8.5 cm for each pushup. Determine the total work done on the squirrel while moving upward (32 times).

10 J

Problem 6

During the Powerhouse lab, Jerome runs up the stairs, elevating his 102 kg body a vertical distance of 2.29 meters in a time of 1.32 seconds at a constant speed.

a. Determine the work done by Jerome in climbing the stair case. 2.30×10^3 J
b. Determine the power generated by Jerome.

↳ 1.73×10^3 W

Problem 7

A new conveyor system at the local packaging plan will utilize a motor-powered mechanical arm to exert an average force of 890 N to push large crates a distance of 12 meters in 22 seconds. Determine the power output required of such a motor.

485 W

Problem 8

The Taipei 101 in Taiwan is a 1667-foot tall, 101-story skyscraper. The skyscraper is the home of the world's fastest elevator. The elevators transport visitors from the ground floor to the Observation Deck on the 89th floor at speeds up to 16.8 m/s. Determine the power delivered by the motor to lift the 10 passengers at this speed. The combined mass of the passengers and cabin is 1250 kg.

$P = \frac{W}{t} = \frac{Fd}{t} = F \cdot v$ 2.06×10^5 W

Problem 9

The ski slopes at Bluebird Mountain make use of tow ropes to transport snowboarders and skiers to the summit of the hill. One of the tow ropes is powered by a 22-kW motor which pulls skiers along an icy incline of 14° at a constant speed. Suppose that 18 skiers with an average mass of 48 kg hold onto the rope and suppose that the motor operates at full power.

a. Determine the cumulative weight of all these skiers. ↗ 8.5×10^3 N
b. Determine the force required to pull this amount of weight up a 14° incline at a constant speed. 2.0×10^3 N
c. Determine the speed at which the skiers will ascend the hill. 11 m/s

Problem 10

The first asteroid to be discovered is Ceres. It is the largest and most massive asteroid is our solar system's asteroid belt, having an estimated mass of 3.0×10^{21} kg and an orbital speed of 17900 m/s. Determine the amount of kinetic energy possessed by Ceres.

4.8×10^{29} J

Problem 11

A bicycle has a kinetic energy of 124 J. What kinetic energy would the bicycle have if it had ...

a.... twice the mass and was moving at the same speed? 248 J

b. ... the same mass and was moving with twice the speed? 496 J

c. ... one-half the mass and was moving with twice the speed? 248 J

d. ... the same mass and was moving with one-half the speed? 31 J

e. ... three times the mass and was moving with one-half the speed? 93 J

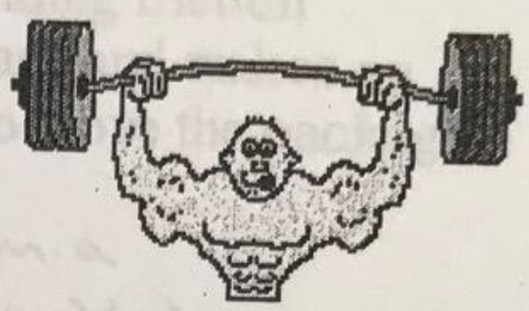
Problem 12

A 78-kg skydiver has a speed of 62 m/s at an altitude of 870 m above the ground.

a. Determine the kinetic energy possessed by the skydiver. 1.5×10^5 J
b. Determine the potential energy possessed by the skydiver. 6.7×10^5 J
c. Determine the total mechanical energy possessed by the skydiver 8.1×10^5 J

Use your understanding of work and power to answer the following questions. When finished, click the button to view the answers.

1. Two physics students, Will N. Andable and Ben Pumpiniron, are in the weightlifting room. Will lifts the 100-pound barbell over his head 10 times in one minute; Ben lifts the 100-pound barbell over his head 10 times in 10 seconds. Which student does the most work? _____ Which student delivers the most power? _____ Explain your answers.



Same work

Ben more "power"ful → less time

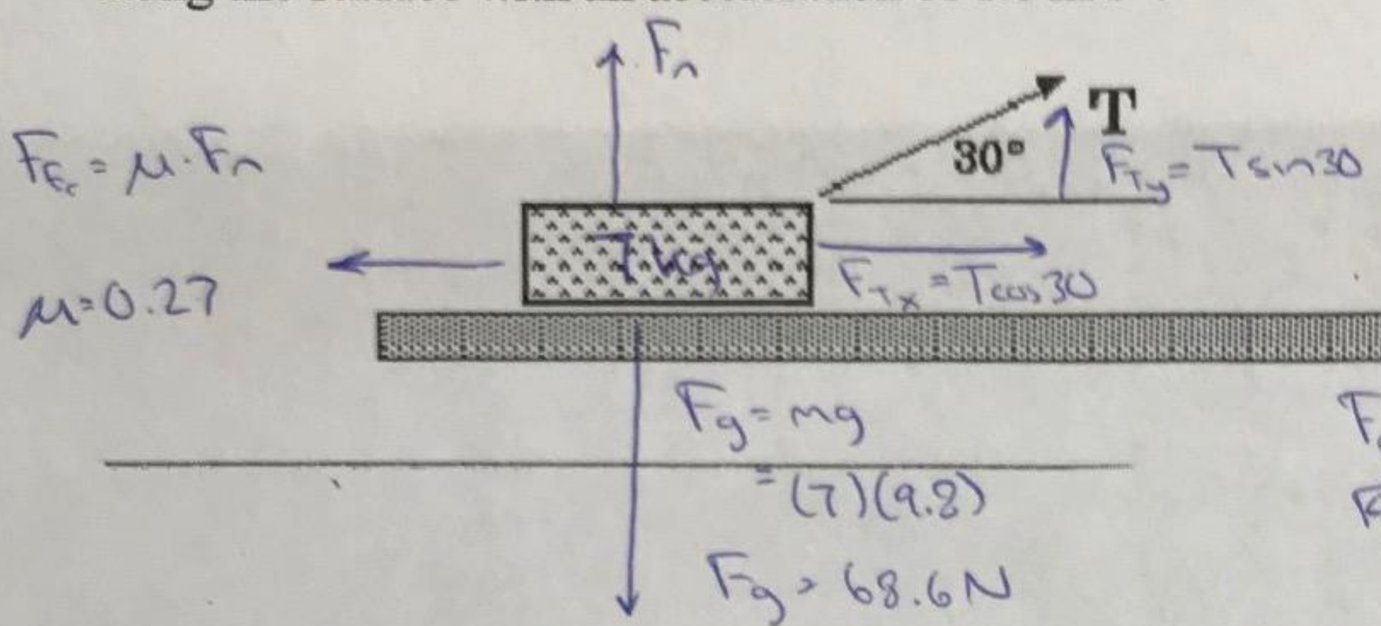
2. During a physics lab, Jack and Jill ran up a hill. Jack is twice as massive as Jill; yet Jill ascends the same distance in half the time. Who did the most work? _____ Who delivered the most power? _____ Explain your answers.

Jack more work.

Jill has same power. less work & less time

(Friction)

A 7-kg package sits on a rough but level floor. The coefficient of sliding friction between the package and the floor is 0.27. A cord is attached to the package and makes an angle of 30° above the horizontal. What must be the tension in the cord to move the package along the surface with an acceleration of 1.0 m/s^2?



$F_{net} = m \cdot a$
$= (7)(1)$
$F_{net} = 7N$

$F_{Fr} = \mu \cdot F_n$

$F_{net} = F_{Tx} - F_{Fr}$

$7 = T\cos 30 - f_{Fr}$

$7 = T\cos 30 - 0.27(F_n)$

$7 = T\cos 30 - 0.27(68.6 - T\sin 30)$

$7 = T\cos 30 - 18.522 + 0.135T$

$7 = 0.86T - 18.522 + 0.135T$

$7 + 18.522 = 1.001T$

$25.522 = 1.001T$

$T = 25.5N$

$F_n + F_{Ty} = F_g$

$F_n + T\sin 30 = 68.6N$

$F_n = 68.6 - T\sin 30$

A man pushes a 20-kg lawn mower at constant speed with a force of 80 N directed along the handle, which makes an angle of 37° with the horizontal. Calculate the following:

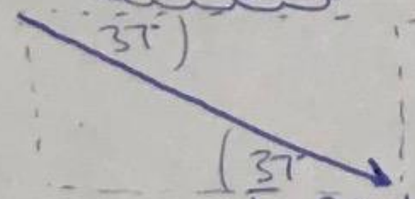
a) the horizontal and vertical components of the man's force.

b) the horizontal retarding force on the mower.

c) the normal force between the mower and the lawn (be sure to include the mower's weight).

d) the effective coefficient of friction in this case.

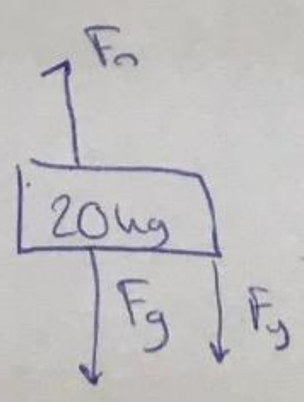
A.) $F_x = F\cos\theta$
$= 80\cos 37$
$F_x = 64N$



$F_y = F\sin\theta$
$= 80\sin 37$
$F_y = 48N$
Down

B.) Constant speed = no acceleration
= Net force = 0
$\therefore$ Retarding force = 64N

C.)



$F_n = F_g + F_y$
$= (20)(9.8) + 48$
$F_n = 244N$

D.) $F_{Fr} = F_n \cdot \mu$

$\mu = \frac{F_{Fr}}{F_n} = \frac{64}{244}$

$\mu = 0.262$