# Worksheet 4.1 - Work

1. A 20.0 N pomegranate is lifted at a constant velocity from the floor to a height of 1.50 m. How much work is done on the object?

2. A 15.0 N potato is moved horizontally 3.00 m across a level floor using a horizontal force of 6.00 N. How much work is done on the potato?

3. A 2.20 N pear is held 2.20 m above the floor for 10.0 s. How much work is done on the pear?

4. A 10.0 kg pink grapefruit is accelerated horizontally from rest to a velocity of 11.0 m/s in 5.00 s by a horizontal force. How much work is done on the pink grapefruit assuming no friction?

5. A 90.0 N box of papayas is pulled 10.0 m along a level surface by a rope. If the rope makes an angle of 20° with the surface, and the force in the rope is 75.0 N, how much work is done on the box?
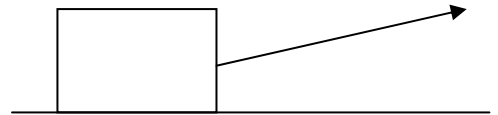
6. A 60.0 kg student runs at a constant velocity up a flight of stairs. If the height of the stairs is 3.2 m, what is the work done against gravity?

7. A 20.0 kg passionfruit is pulled horizontally 9.0 m along a level frictionless surface at a constant velocity. How much work is done on the passionfruit?

8. An 80.0 kg pumpkin is pushed up at a constant velocity along a frictionless incline as shown in the diagram. How much work is done on the pumpkin in moving it up the incline?

10.0 m   7.0 m
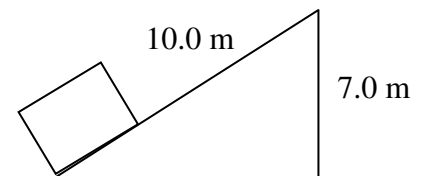
9. A 25.0 kg pickle is accelerated from rest through a distance of 6.0 m in 4.0 s across a level floor. If the friction force between the pickle and the floor is 3.8 N, what is the work done to move the object?

10. A 1165 kg car traveling at 55 km/h is brought to a stop while skidding 38 m. Calculate the work done on the car by the friction forces.

1) 30.0 J 2) 18.0 J 3) 0J 4) 605 J 5) 705 J 6) 1900 J 7) 0 J 8) 5500 J 9) 140 J 10) -1.4x10^5 J

# Worksheet 4.1 – Ep and Ek

1. A 25.0 N object is held 2.10 m above the ground. What is the potential energy with respect to the ground?

2. An uncopressed spring is 20.0 cm in length. What is the potential energy of the spring when an average force of 65.0 N compresses it to a length of 13.5 cm?

3. A 2.75 kg box is at the top of a frictionless incline as shown in the diagram. What is the potential energy with respect to the bottom of the incline?

7.00 m   10.0 m
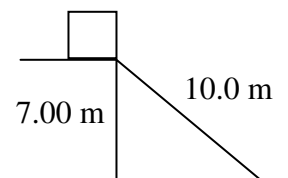
4. The bob of a pendulum has a mass of 2.0 kg and hangs 0.50 m above the floor. The bob is pulled sideways so that it is 0.75 m above the floor. What is its potential energy with respect to its equilibrium position?
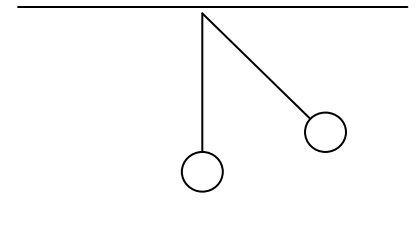
5. A 2.00×10^3 kg object is pushed to the top of an incline as shown. If the force applied along the incline is 6.00×10^2 N, what is the potential energy of the object when it is at the top of the incline with respect to the bottom?

6.0 m 12.0 m
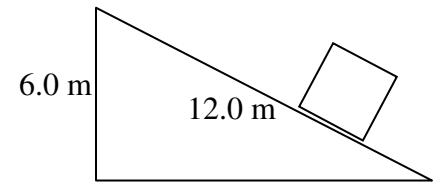
6. A 3.0 kg ewok is traveling at a constant speed of 7.5 m/s. What is its kinetic energy?

7. The kinetic energy of a 20.0 N droid is 5.00×10^2 J. What is the speed of the droid?

8. A 10.0 N lightsaber is accelerated from rest at a rate of 2.5 m/s². What is the kinetic energy of the lightsaber after it has accelerated over a distance of 15.0 m.

9. A 1200.0 N Wookie falls off a cliff on Earth. What is its kinetic energy after it falls for 4.50 s?

10. An 8.0 kg bantha poodoo is dropped from a height of 7.0 m. What is the kinetic energy of the poodoo just before it hits the ground?

11. A 9.00 kg object falls off of a 1.2 m high table. If all of the objects potential energy is converted into kinetic energy just before it hits the floor, how fast is it moving?

12. Solve #11 using kinematics this time. Is there any difference?

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1) 52.5 J 2) 4.2 J 3) 189 J 4) 4.9 J 5) 120000 J 6) 84 J 7) 22.1 m/s 8) 38 J 9) 1.2×10^5 J 10) 550 J 11) 4.85 m/s 12) 4.85 m/s

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Worksheet 4.1 – Law of Conservation of Energy
Use the Law of Conservation of Energy to solve the following problems.

1. Physics student is dropped (don't ask why or you're next). If they reach the floor at a speed of 3.2 m/s, from what height did they fall?

2. A heavy object is dropped from a vertical height of 8.0 m. What is its speed when it hits the ground?

3. A bowling ball is dropped from the top of a building. If it hits the ground with a speed of 37.0 m/s, how tall was the building?

4. A safe is hurled down from the top of a 1.3×10^2 m building at a speed of 11.0 m/s. What is its velocity as it hits the ground?

5. A box slides down a frictionless ramp. If it starts at rest, what is its speed at the bottom?
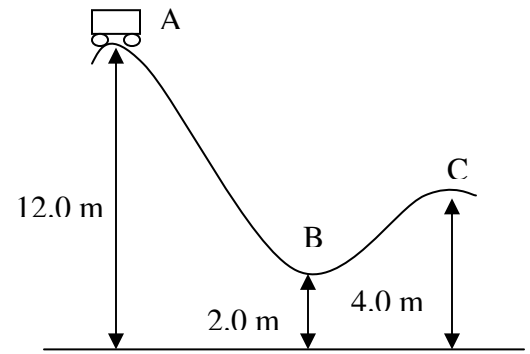
4.0 m 9.0 m
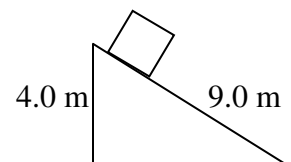
6. A pendulum is dropped from the position shown, 0.25 m above its equilibrium position. What is the speed of the pendulum bob as it passes through its equilibrium position?

1.00 m

0.25 m

12.0 m

30°
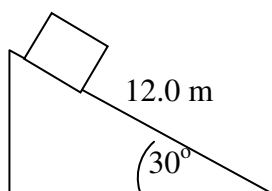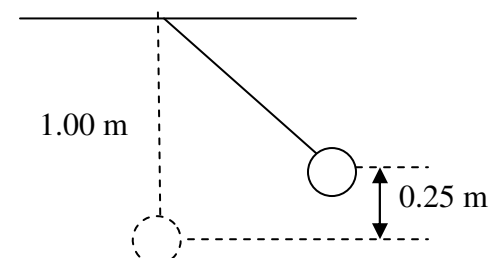
7. A box slides down a frictionless incline as shown. If the box starts from rest, what is its speed at the bottom?

8. A roller coaster car starts from rest at point A. What is its speed at point C if the track is frictionless?

A

12.0 m

C

B

4.0 m

2.0 m

9. A 2.5 kg object is dropped from a height of 10.0 m above the ground. Calculate the speed of the object as it hits the ground.

10. An 80.0 kg student running at 3.5 m/s grabs a rope that is hanging vertically. How high will the student swing?
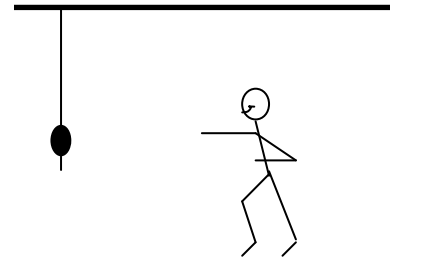
11. A pendulum is 1.20 m long. If the pendulum is pulled until it makes a 25.0° angle to the vertical, what is the speed of the pendulum bob when it passes through its equilibrium position? HINT: Determine the vertical drop of the pendulum bob first.

25.0
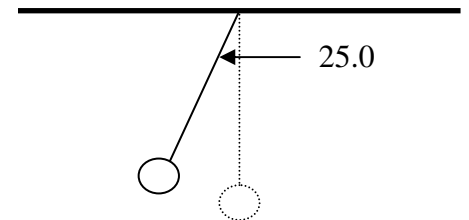
1) 0.52 m 2) 13 m/s 3) 69.8 m 4) 52 m/s 5) 8.9 m/s 6) 2.2 m/s 7) 10.8 m/s 8) 13 m/s 9) 14 m/s 10) 0.63 m 11) 1.5 m/s

Worksheet 4.2

9.0 m

6.0 m

1) A 45.0 kg student runs at a constant velocity up the incline shown. If the power output of the student is 1.50×10^3 W, how long does it take the student to run the 9.0 m along the incline?   (1.8 s)
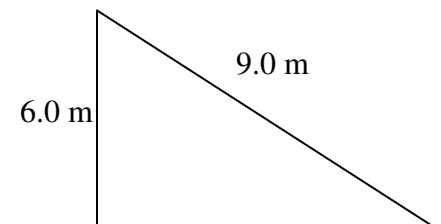
2) A 20.0 kg object is lifted vertically at a constant velocity 2.50 m in 2.00 s. Calculate the power output of the student.   (245 W)

3) A 2.00 kg object is accelerated uniformly from rest to 3.00 m/s while moving 1.5 m across a level frictionless surface. Calculate the power output.   (9.0 W)

4) An 8.5 x 102 kg elevator is pulled up at a constant velocity of 1.00 m/s by a 10.0 kW motor. Calculate the efficiency of the motor.   (83%)

5) A 5.0 kg object is accelerated uniformly from rest to 6.0 m/s while moving 2.0 m across a level surface. If the force of friction is 4.0 N, calculate the power output.   (1.5×10^2 W)

6) A 5.00×10^2 W electric motor lifts a 20.0 kg object 5.00 m in 3.50 s. What is the efficiency of the motor?   (56%)

7) If a 1.00×10^2 kW motor has an efficiency of 82%, how long will it take to lift a 50.0 kg object to a height of 8.00 m?   (0.048 s)

Worksheet 4.3 – Law of Conservation of Momentum

1. A 1.0 kg ball hits the floor with a velocity of 2.0 m/s. If the ball bounces up with a velocity of 1.6 m/s, what is the ball's change in momentum? (3.6 kgm/s)

2. A 0.144 kg baseball is pitched horizontally at + 38 m/s. The batter hits a horizontal line drive at – 38 m/s (the opposite direction!). What is the ball's change in momentum? (- 10.9 kgm/s)

3. The 800 kg physics dragster is traveling at 35 km/h east when it hits the gas and accelerates at 12.5 m/s^2 for 3.25 s. What is its change in momentum during this time? (32500 kgm/s)

4. A 30.0 kg object moving to the right at a velocity of 1.00 m/s collides with a 20.0 kg object moving to the left with a velocity of 5.00 m/s. If the 20.0 kg object continues to move to the left at a velocity of 1.25 m/s, what is the velocity of the 30.0 kg object? (1.50 m/s left)

5. A 4.50 x 10^3 kg railway car is moving east at a velocity of 5.0 m/s on a level frictionless track when it collides with a stationary 6.50 x 10^3 kg caboose. If the two cars lock together upon impact, how fast are they moving after collision? (2.0 m/s east)

6. A 925 kg car moving at a velocity of 18.0 m/s right collides with a stationary truck of unknown mass. The two vehicles lock together and move off at a velocity of 6.50 m/s. What is the mass of the truck? (1640 kg)

7. A 50.0 g bullet strikes a 7.00 kg wooden block. If the bullet becomes imbedded in the block and they both move off at a velocity of 5.00 m/s, what was the initial velocity of the bullet? (705 m/s)

8. A 40.0 g hot dog moving with a velocity of 9.00 m/s to the right collides with a 55.0 g hot dog bun with a velocity of 6.00 m/s to the left. If the two objects stick together upon collision, what is the velocity of the combined masses? (0.316 m/s right)

9. A 76 kg student, standing at rest on a frictionless surface throws a 0.20 kg cream pie horizontally at 22 m/s at Mr. Trask who is standing to the student's left. What was the velocity of the student after they throw the pie? (0.058 m/s right)

10. A 25 kg turkey is fired from a 1.1 x 10^3 kg turkey launcher. If the horizontal velocity of the turkey is 325 m/s east, what is the recoil velocity of the launcher? (7.4 m/s west)

11. A vehicle with a rocket engine is being tested on a smooth track. Starting from rest the engine is fired for a short period of time, releasing 4.5 x 10^2 kg of gases. It is estimated that the average velocity of the gases is 1.4 x 10^3 m/s to the right, and that the maximum velocity of the vehicle is 45 m/s left. What is the mass of the vehicle? (1.4x10^4 kg)

Worksheet 4.3 - Impulse

1. A rocket at rest with a mass of 9.5 x 10^3 kg is acted on by an average net force of 1.5 x 10^5 N upwards for 15 s. What is the final velocity of the rocket?

2. A 26.3 kg object is traveling at 21.0 m/s north. What average net force is required to bring this object to a stop in 2.60 s?

3. An average force of 31.6 N south is used to accelerate a 15.0 kg object uniformly from rest to 10.0 m/s. What is the change in momentum?

4. An average net force of 25.0 N acts north on an object for 7.20 x 10^{-1} s. What is the change in momentum of the object?

5. A 5.00 kg object accelerates uniformly from rest to a velocity of 15.0 m/s east. What is the change in momentum on the object?

6. An average net force caused an 11.0 kg object to accelerate uniformly from rest. If this object travels 26.3 m west in 3.20 s, what is the change in momentum of the object?

7. A 1.30 kg object is dropped from a height of 6.5 m. How far did the object fall when its momentum is 6.0 kgm/s?

8. An average net force of 16.0 N acts on an object for 2.00×10^{-1} s causing it to accelerate from rest to 3.50 m/s. What is the mass of the object?

9. A 0.500 kg object is thrown vertically upward with an average applied force of 8.20 N by a student. The force is applied through a displacement of 1.50 m.
a. What is the average net force acting on the object?
b. What is the velocity of the object when it leaves the student's hand? (Assume initial velocity is zero)

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1) 237 m/s 2) 212 N south 3) 150 Ns south 4) 18 Ns north 5) 75 Ns 6) 181 Ns west 7) 1.1 m 8) 0.91 kg 9)a. 3.30 N b. 4.4 m/s

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Worksheet 4.4

1. A 1.4×10^3 kg car is westbound at a velocity of 37.0 km/h when it collides with a 2.0×10^3 kg truck northbound at a velocity of 35 km/h. If these two vehicles lock together upon collision, what is the initial velocity of the vehicles after collision?   (7.2 m/s 37° W of N)

2. A 6.2 kg object heading north at 3.0 m/s collides with an 8.0 kg object heading west at 3.5 m/s. If these two masses stick together upon collision, what is their velocity after collision?   (2.4 m/s 56° W of N)

3. A 4.0×10^4 N Truck moving west at a velocity of 8.0 m/s collides with a 3.0×10^4 N truck heading south at a velocity of 5.0 m/s. If these two vehicles lock together upon impact, what is their velocity?(5.0 m/s 25° S of W)

4. A 50.0 kg object is moving east at an unknown velocity when it collides with a 60.0 kg stationary object. After collision, the 50.0 kg object is traveling at a velocity of 6.0 m/s 50.0^o N of E and the 60.0 kg object is traveling at a velocity of 6.3 m/s 38° S of E.
a. What was the velocity of the 50.0 kg object before collision?   (9.86 m/s due east)
b. Determine whether this collision was elastic or inelastic.   (Ek loss of 340 J, so inelastic)

5. A 15.0 kg penguin waddling east at a velocity of 7.0 m/s collides with a stationary 10.0 kg penguin. After the collision the 15.0 kg penguin is traveling at a velocity of 4.2 m/s 20.0^o S of E.
a. What is the velocity of the 10.0 kg penguin after collision?   (5.1 m/s 25° N of E)
b. is this collision elastic or inelastic?   (Inelastic, E_k loss of 110J)

6. A watermelon explodes into three equal masses. One mass moves east at 15.0 m/s. If a second mass moves at a velocity of 10.0 m/s 45.0^o S of E, what is the velocity of the third mass? (Hint: the total momentum is zero, so how will your vector arrows add up?)

BRAIN-MELTER SPECIAL
Mr. Trask's head explodes into three pieces after thinking too hard about this very problem (but HOW!?). As we all know, Mr. Trask's head has a mass of 15kg (that's a lot of physics up there). A 6.0 kg chunk flies off at 12.0 m/s 15° N of W and a 5.0 kg chunk sails at 8.0 m/s 35° E of S. What is the velocity of the final piece?