PHYSICS 534

ANSWERS

EXERCISE-37 **Kinetic Energy Part-2 /3**

Erwin Schrodinger was awarded the Nobel prize for physics in 1933 for his work in atomic theory.

SCHRODINGER

Energy is the ability to do work. There are three types of work that can be done:

① Accelerating an object — The work done goes to the object in the form of E_K (kinetic energy) thereby increasing the velocity of the object.

② Raising an object — The work done goes to the object in the form of E_P (potential energy) thereby increasing the height of the object (from a reference line).

③ To overcome friction — The work done to overcome friction is “lost” as heat and sound energy.

An ideal system is one which has no friction. Frictionless systems do not exist in nature. However, since they simplify the solving of physics problems, it is often convenient to assume a system is frictionless. Once the problem is solved without friction, the effects caused by friction are added to the system. Remember that in an ideal system, there is no loss of energy due to friction.

A real system is one that has friction. All systems in nature are real systems. That is, all systems in nature lose some energy due to friction (usually in the form of heat and sound).

The Law of Conservation of Energy tells us that energy cannot be created nor destroyed. This means that when work is done, all of the energy must be accounted for. If the system is ideal, none of the work done is wasted as heat and sound. However, if the system is real, some of the work done is “lost” (as heat and sound energy).

---

1. Explain the difference between an ***ideal*** system and a ***real*** system:

a) Ideal system **A system that has no friction and therefore no loss of energy in the form of heat and sound.**

b) Real system **A system that has friction and therefore some loss of energy in the form of heat and sound.**

2. List the three types of work that can be done and tell what becomes of this work:

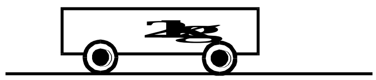
① **Accelerating** — **Energy goes to the object in the form of E_K.**

② **Raising** — **Energy goes to the object in the form of E_P.**

③ **Friction** — **Lost in the form of heat and sound.**

➢ **NOTE**: ***The lower case letter "f" is used to represent the force of friction. The diagrams are not drawn to scale.***

3. A 2 kg cart rests motionless on a horizontal plane.



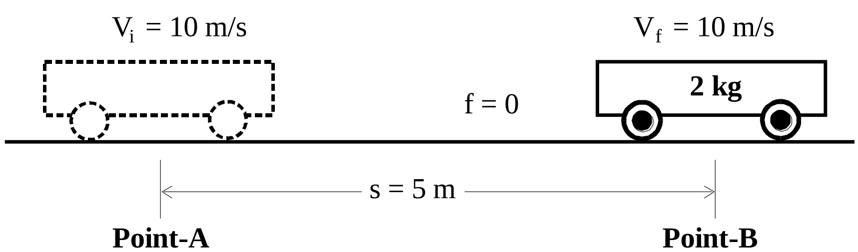
a) Is the cart at rest? ____Yes____

b) What is the resultant force? ____0____

c) What is the acceleration? ____0____

d) What is the kinetic energy (E_K) of the cart? ____0____

4. A 2 kg cart travels at a ***constant velocity*** of 10 m/s from Point-A to Point-B, a distance of 5 m. Assuming the system is <u>frictionless</u>, answer the following questions.



a) Was the cart at rest? (while going from A to B) ____**Yes**____

b) What was the applied force? ____**0**____

c) What was the frictional force? ____**0**____

d) What was the resultant force? ____**0**____

e) What was the acceleration? ____**0**____

f) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) ____**100 J**____

g) What was the final E_K of the cart? (Use $E_K = ½mv^2$) ____**100 J**____

h) How much energy did the cart gain? (ΔE_K) ____**0**____

i) How much work was done on the cart? ____**0**____

j) Fill in the amounts of work done:

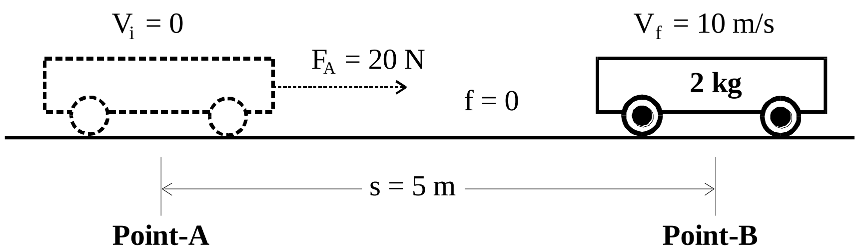
① To accelerate the cart ____**0**____

② To raise the cart ____**0**____

③ To overcome friction ____**0**____

④ Total work done ____**0**____

5. Starting from rest, a horizontal force of 20 N is applied to a 2 kg cart resulting in a final velocity of 10 m/s. Assuming the system is ideal (frictionless), answer the following questions concerning the cart while going from Point-A to Point-B (a distance of 5 m).



a) Was the cart at rest? (while going from A to B) **No**

b) What was the applied force? **20 N right**

c) What was the horizontal component of the applied force (F_H)? **20 N right**

d) What was the frictional force? **0**

e) What was the resultant force? (Use $F_R = F_H - f$) **20 N right**

f) What was the acceleration? (Use $a = F_R / m$) **10 m/s²**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **0**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **100 J**

i) How much work was done on the cart? (ΔE_K) **100 J**

j) What becomes of the work done on the cart?

Is transferred to the cart in the form of kinetic energy (faster speed).

k) How much work was done to overcome friction? (Use W = f s) **0**

l) What was the total work done? (Use $W = F_H s$) **100 J**

m) Where did the work that was done come from?

The applied force.

n) Fill in the amounts of work done:

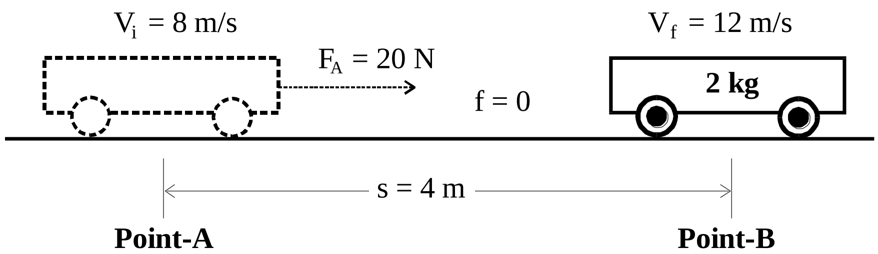
① To accelerate the cart **100 J**

② To raise the cart **0**

③ To overcome friction **0**

④ Total work done **100 J**

6. A horizontal force of 20 N is applied to a 2 kg cart whose initial velocity is 8 m/s resulting in a final velocity of 12 m/s. Assuming there is no friction (f = 0), answer the following questions concerning the cart in going from Point-A to Point-B (a distance of 4 m).



a) Was the cart at rest? (while going from A to B) **No**

b) What was the applied force? **20 N right**

c) What was the horizontal component of the applied force (F_H)? **20 N right**

d) What was the frictional force? **0**

e) What was the resultant force? (Use $F_R = F_H - f$) **20 N right**

f) What was the acceleration? (Use $a = F_R /m$) **10 m/s²**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **64 J**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **144 J**

i) How much work was done on the cart? (ΔE_K) **80 J**

j) What becomes of the work done on the cart?

Is transferred to the cart in the form of kinetic energy (faster speed).

k) How much work was done to overcome friction? (Use W = f s) **0**

l) What was the total work done? (Use $W = F_H s$) **80 J**

m) Where did the work that was done come from?

The applied force.

n) Fill in the amounts of work done:

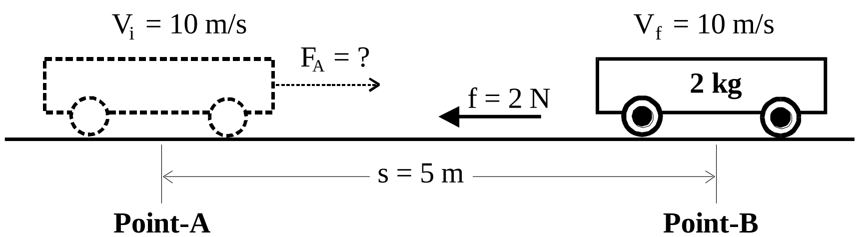
① To accelerate the cart **80 J**

② To raise the cart **0**

③ To overcome friction **0**

④ Total work done **80 J**

7. A 2 kg cart travels at a ***constant velocity*** of 10 m/s for a distance of 5 m. If the frictional force is 2 N, answer the following questions concerning the cart in going from Point-A to Point-B.



a) Was the cart at rest? (while going from A to B) **Yes**

b) What was the applied force? **2 N right**

c) What was the horizontal component of the applied force (F_H)? **2 N right**

d) What was the frictional force? **2 N left**

e) What was the resultant force? (Use $F_R = F_H - f$) **0**

f) What was the acceleration? (Use $a = F_R / m$) **0**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **100 J**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **100 J**

i) How much work was done on the cart? (ΔE_K) **0**

j) How much work was done to overcome friction? (Use W = f s) **10 J**

k) What becomes of the work done to overcome friction?
It is lost to friction (in the form of heat and sound energy).

l) What was the total work done? (Use $W = F_H s$) **10 J**

m) Where did the work that was done come from?
The applied force.

n) Fill in the amounts of work done:

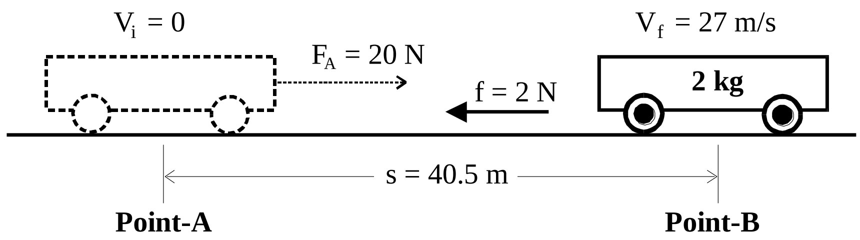
① To accelerate the cart **0**

② To raise the cart **0**

③ To overcome friction **10 J**

④ Total work done **10 J**

8. A horizontal force of 20 N is applied to a 2 kg cart, initially at rest, giving it a final velocity of 27 m/s. If the frictional force is 2 N, answer the following questions concerning the cart in going from Point-A to Point-B (a distance of 40.5 m).



a) Was the cart at rest? (while going from A to B) **No**

b) What was the applied force? **20 N right**

c) What was the horizontal component of the applied force (F_H)? **20 N right**

d) What was the frictional force? **2 N left**

e) What was the resultant force? (Use $F_R = F_H - f$) **18 N right**

f) What was the acceleration? (Use $a = F_R / m$) **9 m/s²**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **0**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **729 J**

i) How much work was done on the cart? (ΔE_K) **729 J**

j) What becomes of the work done on the cart?

It is transferred to the cart in the form of kinetic energy (faster speed).

k) How much work was done to overcome friction? (Use W = f s) **81 J**

l) What becomes of the work done to overcome friction?

Lost to friction (in the form of heat and sound energy).

m) What was the total work done? (Use $W = F_H s$) **810 J**

n) Where did the work that was done come from?

The applied force.

o) Fill in the amounts of work done:

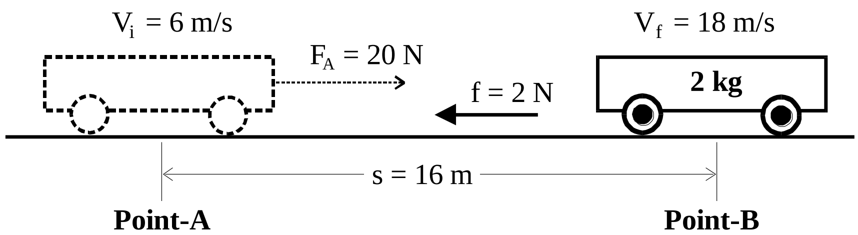
① To accelerate the cart **729 J**

② To raise the cart **0**

③ To overcome friction **81 J**

④ Total work done **810 J**

9. A horizontal force of 20 N is applied to a 2 kg cart, whose initial velocity is 6 m/s, resulting in a final velocity of 18 m/s. If the frictional force is 2 N, answer the following questions concerning the cart in going from Point-A to Point-B (a distance of 16 m).



a) Was the cart at rest? (while going from A to B) **No**

b) What was the applied force? **20 N right**

c) What was the horizontal component of the applied force (F_H)? **20 N right**

d) What was the frictional force? **2 N left**

e) What was the resultant force? (Use $F_R = F_H - f$) **18 N right**

f) What was the acceleration? (Use $a = F_R /m$) **9 m/s²**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **36 J**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **324 J**

i) How much work was done on the cart? (ΔE_K) **288 J**

j) What becomes of the work done on the cart?

It is transferred to the cart in the form of kinetic energy (faster speed).

k) How much work was done to overcome friction? (Use W = f s) **32 J**

l) What becomes of the work done to overcome friction?

Lost to friction (in the form of heat and sound energy).

m) What was the total work done? (Use $W = F_H s$) **320 J**

n) Where did the work that was done come from?

The applied force.

o) Fill in the amounts of work done:

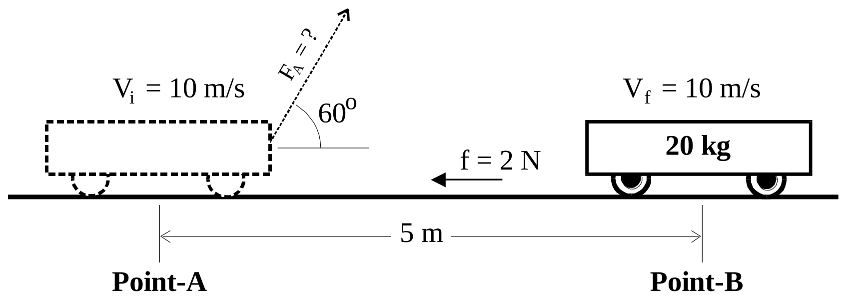
① To accelerate the cart **288 J**

② To raise the cart **0**

③ To overcome friction **32 J**

④ Total work done **320 J**

10. A force is applied, at 60^o from the horizontal, to a 20 kg cart causing it to travel at a ***constant velocity*** of 10 m/s. If the force of friction is 2 N, answer the following questions concerning the cart in going from Point-A to Point-B (a distance of 5 m).



a) Was the cart at rest? (while going from A to B) **Yes**

b) What was the applied force? **4 N at 60^o N of E**

c) What was the horizontal component of the applied force (F_H)? **2 N right**

d) What was the frictional force? **2 N left**

e) What was the resultant force? (Use $F_R = F_H - f$) **0**

f) What was the acceleration? (Use $a = F_R /m$) **0**

g) What was the initial E_K of the cart? (Use $E_K = ½mv^2$) **1000 J**

h) What was the final E_K of the cart? (Use $E_K = ½mv^2$) **1000 J**

i) How much work was done on the cart? (ΔE_K) **0**

j) How much work was done to overcome friction? (Use W = f s) **10 J**

k) What becomes of the work done to overcome friction?

Lost (in the form of heat and sound energy).

l) What was the total work done? (Use $W = F_H s$) **10 J**

m) Where did the work that was done come from?

The applied force.

n) Fill in the amounts of work done:

① To accelerate the cart **0**

② To raise the cart **0**

③ To overcome friction **10 J**

④ Total work done **10 J**

❖❖❖❖❖❖❖❖❖❖❖❖❖